



US009647218B2

(12) **United States Patent**  
**Kwong et al.**

(10) **Patent No.:** **US 9,647,218 B2**  
(45) **Date of Patent:** **May 9, 2017**

(54) **ORGANIC ELECTROLUMINESCENT MATERIALS AND DEVICES**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Universal Display Corporation**,  
Ewing, NJ (US)

4,769,292 A 9/1988 Tang et al.  
5,061,569 A 10/1991 VanSlyke et al.  
(Continued)

(72) Inventors: **Raymond Kwong**, Fo Tan (HK); **Siu Tung Lam**, Apleichau (HK); **Chi Hang Lee**, Chaiwan (HK)

FOREIGN PATENT DOCUMENTS

EP 0650955 5/1995  
EP 1725079 11/2006  
(Continued)

(73) Assignee: **UNIVERSAL DISPLAY CORPORATION**, Ewing, NJ (US)

OTHER PUBLICATIONS

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 231 days.

Adachi, Chihaya et al., "Organic Electroluminescent Device Having a Hole Conductor as an Emitting Layer," Appl. Phys. Lett., 55(15): 1489-1491 (1989).

(Continued)

(21) Appl. No.: **14/464,430**

(22) Filed: **Aug. 20, 2014**

*Primary Examiner* — Gregory Clark  
(74) *Attorney, Agent, or Firm* — Duane Morris LLP

(65) **Prior Publication Data**  
US 2015/0129849 A1 May 14, 2015

(57) **ABSTRACT**

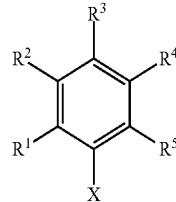
A compound having the structure of Formula 1,

**Related U.S. Application Data**

(60) Provisional application No. 61/904,098, filed on Nov. 14, 2013.

Formula 1

(51) **Int. Cl.**  
**H01L 51/50** (2006.01)  
**H01L 51/00** (2006.01)



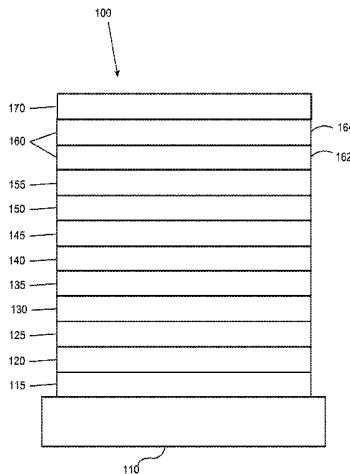
(52) **U.S. Cl.**  
CPC ..... **H01L 51/0072** (2013.01); **H01L 51/0059** (2013.01); **H01L 51/0074** (2013.01); **H01L 51/5016** (2013.01)

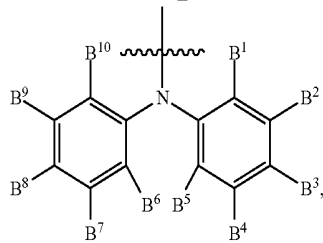
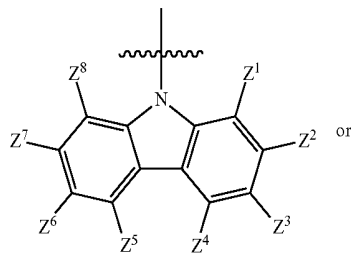
as well as, a first device and a formulation including the same are disclosed. In the structure of Formula 1:

R<sup>5</sup> is

(Continued)

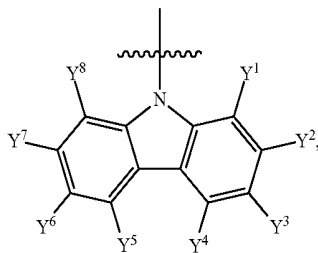
(58) **Field of Classification Search**  
None  
See application file for complete search history.



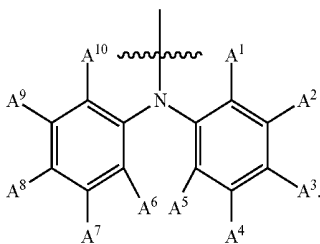


and

(a) at least one of R<sup>1</sup>-R<sup>4</sup> is



or (b) R<sup>1</sup> is



In addition, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, A<sup>1</sup>, A<sup>2</sup>, A<sup>3</sup>, A<sup>4</sup>, A<sup>5</sup>, A<sup>6</sup>, A<sup>7</sup>, A<sup>8</sup>, A<sup>9</sup>, A<sup>10</sup>, B<sup>1</sup>, B<sup>2</sup>, B<sup>3</sup>, B<sup>4</sup>, B<sup>5</sup>, B<sup>6</sup>, B<sup>7</sup>, B<sup>8</sup>, B<sup>9</sup>, B<sup>10</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup>, and Z<sup>8</sup>, are each independently selected from a variety of substituents, where adjacent A, B, Y, and Z groups are, optionally, joined to form a fused ring structure. Finally, X includes an acceptor group selected from -C<sub>m</sub>F<sub>2m+1</sub>, -Si<sub>m</sub>F<sub>2m+1</sub>, -NCO, -NCS, -OCN, -SCN, -OC<sub>m</sub>F<sub>2m+1</sub>, and -SC<sub>m</sub>F<sub>2m+1</sub>.

25 Claims, 3 Drawing Sheets

(56)

References Cited

U.S. PATENT DOCUMENTS

5,247,190 A 9/1993 Friend et al.  
5,703,436 A 12/1997 Forrest et al.

5,707,745 A	1/1998	Forrest et al.
5,834,893 A	11/1998	Bulovic et al.
5,844,363 A	12/1998	Gu et al.
6,013,982 A	1/2000	Thompson et al.
6,087,196 A	7/2000	Sturm et al.
6,091,195 A	7/2000	Forrest et al.
6,097,147 A	8/2000	Baldo et al.
6,294,398 B1	9/2001	Kim et al.
6,303,238 B1	10/2001	Thompson et al.
6,337,102 B1	1/2002	Forrest et al.
6,468,819 B1	10/2002	Kim et al.
6,528,187 B1	3/2003	Okada
6,602,618 B2*	8/2003	Watanabe ..... H01L 51/0081 313/504
6,687,266 B1	2/2004	Ma et al.
6,835,469 B2	12/2004	Kwong et al.
6,921,915 B2	7/2005	Takiguchi et al.
7,087,321 B2	8/2006	Kwong et al.
7,090,928 B2	8/2006	Thompson et al.
7,154,114 B2	12/2006	Brooks et al.
7,250,226 B2	7/2007	Tokito et al.
7,279,704 B2	10/2007	Walters et al.
7,332,232 B2	2/2008	Ma et al.
7,338,722 B2	3/2008	Thompson et al.
7,393,599 B2	7/2008	Thompson et al.
7,396,598 B2	7/2008	Takeuchi et al.
7,431,968 B1	10/2008	Shtein et al.
7,445,855 B2	11/2008	Mackenzie et al.
7,534,505 B2	5/2009	Lin et al.
2002/0034656 A1	3/2002	Thompson et al.
2002/0134984 A1	9/2002	Igarashi
2002/0158242 A1	10/2002	Son et al.
2003/0138657 A1	7/2003	Li et al.
2003/0152802 A1	8/2003	Tsuboyama et al.
2003/0162053 A1	8/2003	Marks et al.
2003/0175553 A1	9/2003	Thompson et al.
2003/0230980 A1	12/2003	Forrest et al.
2004/0036077 A1	2/2004	Ise
2004/0137267 A1	7/2004	Igarashi et al.
2004/0137268 A1	7/2004	Igarashi et al.
2004/0174116 A1	9/2004	Lu et al.
2005/0025993 A1	2/2005	Thompson et al.
2005/0112407 A1	5/2005	Ogasawara et al.
2005/0238919 A1	10/2005	Ogasawara
2005/0244673 A1	11/2005	Satoh et al.
2005/0260441 A1	11/2005	Thompson et al.
2005/0260449 A1	11/2005	Walters et al.
2006/0008670 A1	1/2006	Lin et al.
2006/0202194 A1	9/2006	Jeong et al.
2006/0240279 A1	10/2006	Adamovich et al.
2006/0251923 A1	11/2006	Lin et al.
2006/0263635 A1	11/2006	Ise
2006/0280965 A1	12/2006	Kwong et al.
2007/0190359 A1	8/2007	Knowles et al.
2007/0278938 A1	12/2007	Yabunouchi et al.
2008/0015355 A1	1/2008	Schafer et al.
2008/0018221 A1	1/2008	Egen et al.
2008/0106190 A1	5/2008	Yabunouchi et al.
2008/0124572 A1	5/2008	Mizuki et al.
2008/0220265 A1	9/2008	Xia et al.
2008/0297033 A1	12/2008	Knowles et al.
2009/0008605 A1	1/2009	Kawamura et al.
2009/0009065 A1	1/2009	Nishimura et al.
2009/0017330 A1	1/2009	Iwakuma et al.
2009/0030202 A1	1/2009	Iwakuma et al.
2009/0039776 A1	2/2009	Yamada et al.
2009/0045730 A1	2/2009	Nishimura et al.
2009/0045731 A1	2/2009	Nishimura et al.
2009/0101870 A1	4/2009	Pakash et al.
2009/0108737 A1	4/2009	Kwong et al.
2009/0115316 A1	5/2009	Zheng et al.
2009/0165846 A1	7/2009	Johannes et al.
2009/0167162 A1	7/2009	Lin et al.
2009/0179554 A1	7/2009	Kuma et al.

FOREIGN PATENT DOCUMENTS

EP 2034538 3/2009  
JP 2004-178896 \* 6/2004 ..... C09K 11/06

(56)

## References Cited

## FOREIGN PATENT DOCUMENTS

JP	200511610	1/2005
JP	2007123392	5/2007
JP	2007254297	10/2007
JP	2008074939	4/2008
WO	0139234	5/2001
WO	0202714	1/2002
WO	0215645	2/2002
WO	03040257	5/2003
WO	03060956	7/2003
WO	2004093207	10/2004
WO	2004107822	12/2004
WO	2005014551	2/2005
WO	2005019373	3/2005
WO	2005030900	4/2005
WO	2005089025	9/2005
WO	2005123873	12/2005
WO	200609024	1/2006
WO	2006056418	6/2006
WO	2006072002	7/2006
WO	2006082742	8/2006
WO	2006098120	9/2006
WO	2006100298	9/2006
WO	2006103874	10/2006
WO	2006114966	11/2006
WO	2006132173	12/2006
WO	2007002683	1/2007
WO	2007004380	1/2007
WO	2007063754	6/2007
WO	2007063796	6/2007
WO	2008056746	5/2008
WO	2008101842	8/2008
WO	2008132085	11/2008
WO	2009000673	12/2008
WO	2009003898	1/2009
WO	2009008311	1/2009
WO	2009018009	2/2009
WO	2009050290	4/2009
WO	2009021126	5/2009
WO	2009062578	5/2009
WO	2009063833	5/2009
WO	2009066778	5/2009
WO	2009066779	5/2009
WO	2009086028	7/2009
WO	2009100991	8/2009

## OTHER PUBLICATIONS

Adachi, Chihaya et al., "Nearly 100% Internal Phosphorescence Efficiency in an Organic Light Emitting Device," *J. Appl. Phys.*, 90(10): 5048-5051 (2001).

Adachi, Chihaya et al., "High-Efficiency Red Electrophosphorescence Devices," *Appl. Phys. Lett.*, 78(11):1622-1624 (2001).

Aonuma, Masaki et al., "Material Design of Hole Transport Materials Capable of Thick-Film Formation in Organic Light Emitting Diodes," *Appl. Phys. Lett.*, 90:183503-1-183503-3.

Baldo et al., "Highly Efficient Phosphorescent Emission from Organic Electroluminescent Devices," *Nature*, vol. 395, 151-154, (1998).

Baldo et al., "Very high-efficiency green organic light-emitting devices based on electrophosphorescence," *Appl. Phys. Lett.*, vol. 75, No. 3, 4-6 (1999).

Gao, Zhiqiang et al., "Bright-Blue Electroluminescence From a Silyl-Substituted ter-(phenylene-vinylene) derivative," *Appl. Phys. Lett.*, 74(6): 865-867 (1999).

Guo, Tzung-Fang et al., "Highly Efficient Electrophosphorescent Polymer Light-Emitting Devices," *Organic Electronics*, 115-20 (2000).

Hamada, Yuji et al., "High Luminance in Organic Electroluminescent Devices with Bis(10-hydroxybenzo[h]quinolinato) beryllium as an Emitter," *Chem. Lett.*, 905-906 (1993).

Holmes, R.J. et al., "Blue Organic Electrophosphorescence Using Exothermic Host-Guest Energy Transfer," *Appl. Phys. Lett.*, 82(15):2422-2424 (2003).

Hu, Nan-Xing et al., "Novel High Tg Hole-Transport Molecules Based on Indolo[3,2-b]carbazoles for Organic Light-Emitting Devices," *Synthetic Metals*, 111-112:421-424 (2000).

Huang, Jinsong et al., "Highly Efficient Red-Emission Polymer Phosphorescent Light-Emitting Diodes Based on Two Novel Tris(1-phenylisoquinolinato-C2,N)iridium(III) Derivates," *Adv. Mater.*, 19:739-743 (2007).

Huang, Wei-Sheng et al., "Highly Phosphorescent Bis-Cyclometalated Iridium Complexes Containing Benzoimidazole-Based Ligands," *Chem. Mater.*, 16(12):2480-2488 (2004).

Hung, L.S. et al., "Anode Modification in Organic Light-Emitting Diodes by Low-Frequency Plasma Polymerization of CHF<sub>3</sub>," *Appl. Phys. Lett.*, 78(5):673-675 (2001).

Ikai, Masamichi and Tokito, Shizuo, "Highly Efficient Phosphorescence From Organic Light-Emitting Devices with an Exciton-Block Layer," *Appl. Phys. Lett.*, 79(2):156-158 (2001).

Ikeda, Hisao et al., "P-185 Low-Drive-Voltage OLEDs with a Buffer Layer Having Molybdenum Oxide," *SID Symposium Digest*, 37:923-926 (2006).

Inada, Hiroshi and Shirota, Yasuhiko, "1,3,5-Tris[4-(diphenylamino)phenyl]benzene and its Methylsubstituted Derivatives as a Novel Class of Amorphous Molecular Materials," *J. Mater. Chem.*, 3(3):319-320 (1993).

Kanno, Hiroshi et al., "Highly Efficient and Stable Red Phosphorescent Organic Light-Emitting Device Using bis[2-(2-benzothiazoyl)phenolato]zinc(II) as host material," *Appl. Phys. Lett.*, 90:123509-1-123509-3 (2007).

Kido, Junji et al., "1,2,4-Triazole Derivative as an Electron Transport Layer in Organic Electroluminescent Devices," *Jpn. J. Appl. Phys.*, 32:L917-L920 (1993).

Kuwabara, Yoshiyuki et al., "Thermally Stable Multilayered Organic Electroluminescent Devices Using Novel Starburst Molecules, 4,4',4"-Tri(N-carbazolyl)triphenylamine (TCTA) and 4,4',4"-Tris(3-methylphenylphenyl-amino)triphenylamine (m-MTDATA), as Hole-Transport Materials," *Adv. Mater.*, 6(9):677-679 (1994).

Kwong, Raymond C. et al., "High Operational Stability of Electrophosphorescent Devices," *Appl. Phys. Lett.*, 81(1) 162-164 (2002).

Lamansky, Sergey et al., "Synthesis and Characterization of Phosphorescent Cyclometalated Iridium Complexes," *Inorg. Chem.*, 40(7):1704-1711 (2001).

Lee, Chang-Lyoul et al., "Polymer Phosphorescent Light-Emitting Devices Doped with Tris(2-phenylpyridine) Iridium as a Triplet Emitter," *Appl. Phys. Lett.*, 77(15):2280-2282 (2000).

Lo, Shih-Chun et al., "Blue Phosphorescence from Iridium(III) Complexes at Room Temperature," *Chem. Mater.*, 18 (21):5119-5129 (2006).

Ma, Yuguang et al., "Triplet Luminescent Dinuclear-Gold(I) Complex-Based Light-Emitting Diodes with Low Turn-On voltage," *Appl. Phys. Lett.*, 74(10):1361-1363 (1999).

Mi, Bao-Xiu et al., "Thermally Stable Hole-Transporting Material for Organic Light-Emitting Diode an Isoindole Derivative," *Chem. Mater.*, 15(16):3148-3151 (2003).

Nishida, Jun-ichi et al., "Preparation, Characterization, and Electroluminescence Characteristics of  $\alpha$ -Diimine-type Platinum(II) Complexes with Perfluorinated Phenyl Groups as Ligands," *Chem. Lett.*, 34(4): 592-593 (2005).

Niu, Yu-Hua et al., "Highly Efficient Electrophosphorescent Devices with Saturated Red Emission from a Neutral Osmium Complex," *Chem. Mater.*, 17(13):3532-3536 (2005).

Noda, Tetsuya and Shirota, Yasuhiko, "5,5'-Bis(dimesitylboryl)-2,2'-bithiophene and 5,5'-Bis(dimesitylboryl)-2,2',2"-terthiophene as a Novel Family of Electron-Transporting Amorphous Molecular Materials," *J. Am. Chem. Soc.*, 120 (37):9714-9715 (1998).

Okumoto, Kenji et al., "Green Fluorescent Organic Light-Emitting Device with External Quantum Efficiency of Nearly 10%," *Appl. Phys. Lett.*, 89:063504-1-063504-3 (2006).

(56)

## References Cited

## OTHER PUBLICATIONS

- Palilis, Leonidas C., "High Efficiency Molecular Organic Light-Emitting Diodes Based on Silole Derivatives and Their Exciplexes," *Organic Electronics*, 4:113-121 (2003).
- Paulose, Betty Marie Jennifer S. et al., "First Examples of Alkenyl Pyridines as Organic Ligands for Phosphorescent Iridium Complexes," *Adv. Mater.*, 16(22):2003-2007 (2004).
- Ranjan, Sudhir et al., "Realizing Green Phosphorescent Light-Emitting Materials from Rhenium(I) Pyrazolato Diimine Complexes," *Inorg. Chem.*, 42(4):1248-1255 (2003).
- Sakamoto, Youichi et al., "Synthesis, Characterization, and Electron-Transport Property of Perfluorinated Phenylene Dendrimers," *J. Am. Chem. Soc.*, 122(8):1832-1833 (2000).
- Salbeck, J. et al., "Low Molecular Organic Glasses for Blue Electroluminescence," *Synthetic Metals*, 91209-215 (1997).
- Shirota, Yasuhiko et al., "Starburst Molecules Based on p-Electron Systems as Materials for Organic Electroluminescent Devices," *Journal of Luminescence*, 72-74:985-991 (1997).
- Sotoyama, Wataru et al., "Efficient Organic Light-Emitting Diodes with Phosphorescent Platinum Complexes Containing N<sup>+</sup> C<sup>+</sup> N-Coordinating Tridentate Ligand," *Appl. Phys. Lett.*, 86:153505-1-153505-3 (2005).
- Sun, Yiru and Forrest, Stephen R., "High-Efficiency White Organic Light Emitting Devices with Three Separate Phosphorescent Emission Layers," *Appl. Phys. Lett.*, 91:263503-1-263503-3 (2007).
- T. Östergård et al., "Langmuir-Blodgett Light-Emitting Diodes of Poly(3-Hexylthiophene) Electro-Optical Characteristics Related to Structure," *Synthetic Metals*, 87:171-177 (1997).
- Takizawa, Shin-ya et al., "Phosphorescent Iridium Complexes Based on 2-Phenylimidazo[1,2- $\alpha$ ]pyridine Ligands Tuning of Emission Color toward the Blue Region and Application to Polymer Light-Emitting Devices," *Inorg. Chem.*, 46(10):4308-4319 (2007).
- Tang, C.W. and VanSlyke, S.A., "Organic Electroluminescent Diodes," *Appl. Phys. Lett.*, 51(12):913-915 (1987).
- Tung, Yung-Liang et al., "Organic Light-Emitting Diodes Based on Charge-Neutral Ru II Phosphorescent Emitters," *Adv. Mater.*, 17(8):1059-1064 (2005).
- Van Slyke, S. A. et al., "Organic Electroluminescent Devices with Improved Stability," *Appl. Phys. Lett.*, 69(15):2160-2162 (1996).
- Wang, Y. et al., "Highly Efficient Electroluminescent Materials Based on Fluorinated Organometallic Iridium Compounds," *Appl. Phys. Lett.*, 79(4):449-451 (2001).
- Wong, Keith Man-Chung et al., "A Novel Class of Phosphorescent Gold(III) Alkynyl-Based Organic Light-Emitting Devices with Tunable Colour," *Chem. Commun.*, 2906-2908 (2005).
- Wong, Wai-Yeung, "Multifunctional Iridium Complexes Based on Carbazole Modules as Highly Efficient Electrophosphors," *Angew. Chem. Int. Ed.*, 45:7800-7803 (2006).

\* cited by examiner

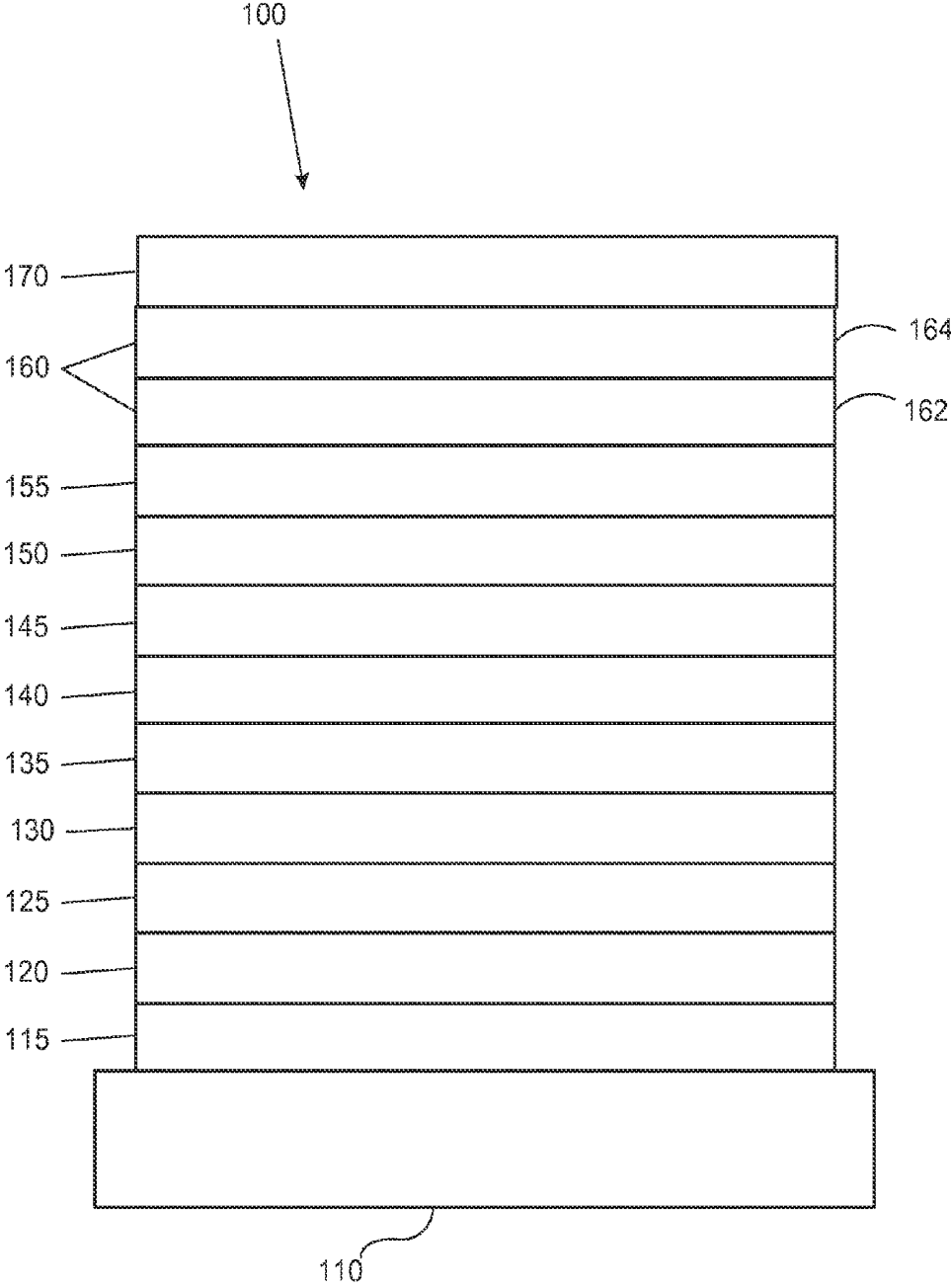


FIGURE 1

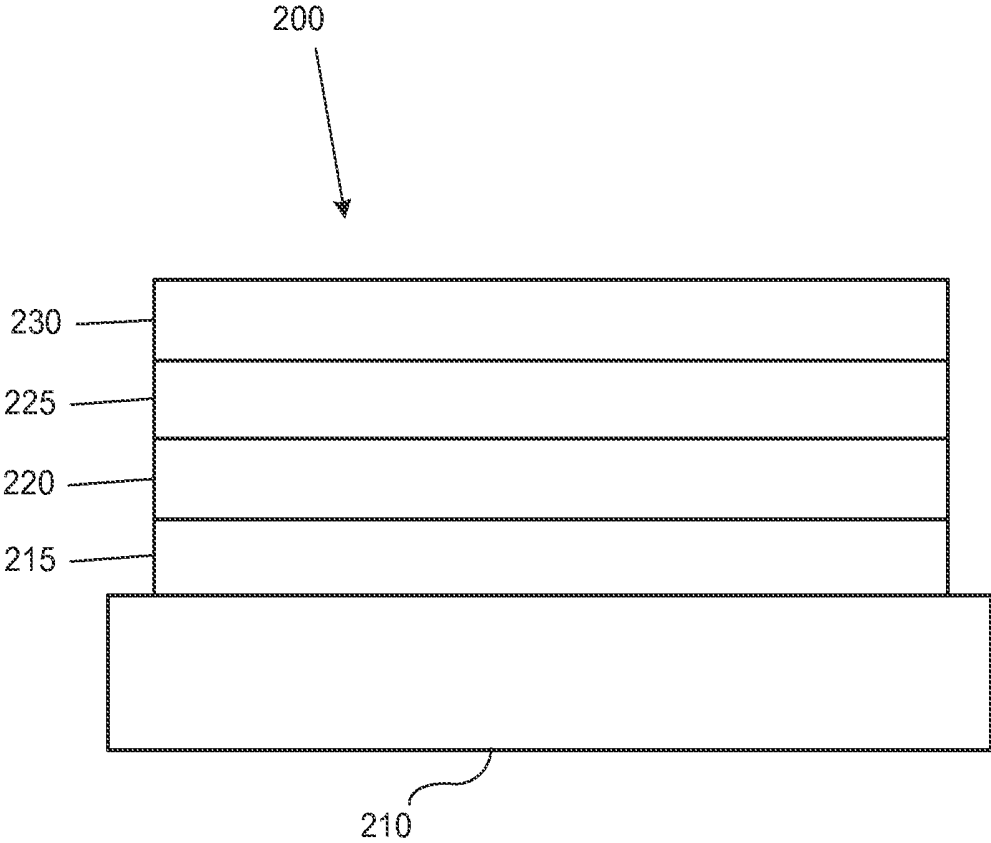
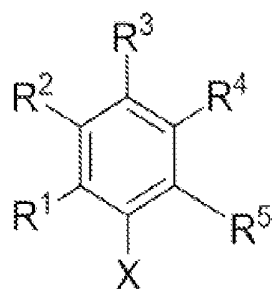
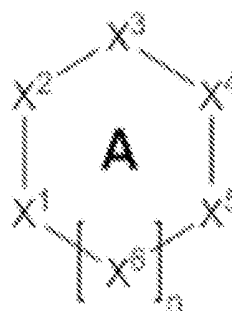


FIGURE 2



Formula 1



Formula 2

Figure 3

1

## ORGANIC ELECTROLUMINESCENT MATERIALS AND DEVICES

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application Ser. No. 61/904,098, filed Nov. 14, 2013, the entire content of which is incorporated herein by reference.

### PARTIES TO A JOINT RESEARCH AGREEMENT

The claimed invention was made by, on behalf of, and/or in connection with one or more of the following parties to a joint university corporation research agreement: Regents of the University of Michigan, Princeton University, University of Southern California, and the Universal Display Corporation. The agreement was in effect on and before the date the claimed invention was made, and the claimed invention was made as a result of activities undertaken within the scope of the agreement.

### FIELD OF THE INVENTION

The present invention relates to compounds for use as emitters and devices, such as organic light emitting diodes, including the same.

### BACKGROUND

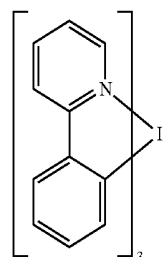
Opto-electronic devices that make use of organic materials are becoming increasingly desirable for a number of reasons. Many of the materials used to make such devices are relatively inexpensive, so organic opto-electronic devices have the potential for cost advantages over inorganic devices. In addition, the inherent properties of organic materials, such as their flexibility, may make them well suited for particular applications such as fabrication on a flexible substrate. Examples of organic opto-electronic devices include organic light emitting devices (OLEDs), organic phototransistors, organic photovoltaic cells, and organic photodetectors. For OLEDs, the organic materials may have performance advantages over conventional materials. For example, the wavelength at which an organic emissive layer emits light may generally be readily tuned with appropriate dopants.

OLEDs make use of thin organic films that emit light when voltage is applied across the device. OLEDs are becoming an increasingly interesting technology for use in applications such as flat panel displays, illumination, and backlighting. Several OLED materials and configurations are described in U.S. Pat. Nos. 5,844,363, 6,303,238, and 5,707,745, which are incorporated herein by reference in their entirety.

One application for phosphorescent emissive molecules is a full color display. Industry standards for such a display call for pixels adapted to emit particular colors, referred to as "saturated" colors. In particular, these standards call for saturated red, green, and blue pixels. Color may be measured using CIE coordinates, which are well known to the art.

One example of a green emissive molecule is tris(2-phenylpyridine) iridium, denoted Ir(ppy)<sub>3</sub>, which has the following structure:

2



In this, and later figures herein, we depict the dative bond from nitrogen to metal (here, Ir) as a straight line.

As used herein, the term "organic" includes polymeric materials as well as small molecule organic materials that may be used to fabricate organic opto-electronic devices. "Small molecule" refers to any organic material that is not a polymer, and "small molecules" may actually be quite large. Small molecules may include repeat units in some circumstances. For example, using a long chain alkyl group as a substituent does not remove a molecule from the "small molecule" class. Small molecules may also be incorporated into polymers, for example as a pendent group on a polymer backbone or as a part of the backbone. Small molecules may also serve as the core moiety of a dendrimer, which consists of a series of chemical shells built on the core moiety. The core moiety of a dendrimer may be a fluorescent or phosphorescent small molecule emitter. A dendrimer may be a "small molecule," and it is believed that all dendrimers currently used in the field of OLEDs are small molecules.

As used herein, "top" means furthest away from the substrate, while "bottom" means closest to the substrate. Where a first layer is described as "disposed over" a second layer, the first layer is disposed further away from substrate. There may be other layers between the first and second layer, unless it is specified that the first layer is "in contact with" the second layer. For example, a cathode may be described as "disposed over" an anode, even though there are various organic layers in between.

As used herein, "solution processible" means capable of being dissolved, dispersed, or transported in and/or deposited from a liquid medium, either in solution or suspension form.

A ligand may be referred to as "photoactive" when it is believed that the ligand directly contributes to the photoactive properties of an emissive material. A ligand may be referred to as "ancillary" when it is believed that the ligand does not contribute to the photoactive properties of an emissive material, although an ancillary ligand may alter the properties of a photoactive ligand.

As used herein, and as would be generally understood by one skilled in the art, a first "Highest Occupied Molecular Orbital" (HOMO) or "Lowest Unoccupied Molecular Orbital" (LUMO) energy level is "greater than" or "higher than" a second HOMO or LUMO energy level if the first energy level is closer to the vacuum energy level. Since ionization potentials (IP) are measured as a negative energy relative to a vacuum level, a higher HOMO energy level corresponds to an IP having a smaller absolute value (an IP that is less negative). Similarly, a higher LUMO energy level corresponds to an electron affinity (EA) having a smaller absolute value (an EA that is less negative). On a conventional energy level diagram, with the vacuum level at the top, the LUMO energy level of a material is higher than the HOMO energy level of the same material. A "higher"

3

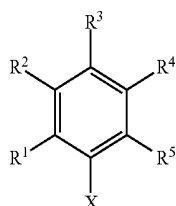
HOMO or LUMO energy level appears closer to the top of such a diagram than a “lower” HOMO or LUMO energy level.

As used herein, and as would be generally understood by one skilled in the art, a first work function is “greater than” or “higher than” a second work function if the first work function has a higher absolute value. Because work functions are generally measured as negative numbers relative to vacuum level, this means that a “higher” work function is more negative. On a conventional energy level diagram, with the vacuum level at the top, a “higher” work function is illustrated as further away from the vacuum level in the downward direction. Thus, the definitions of HOMO and LUMO energy levels follow a different convention than work functions.

More details on OLEDs, and the definitions described above, can be found in U.S. Pat. No. 7,279,704, which is incorporated herein by reference in its entirety.

## SUMMARY OF THE INVENTION

According to an embodiment, a compound comprising a structure according to Formula 1:

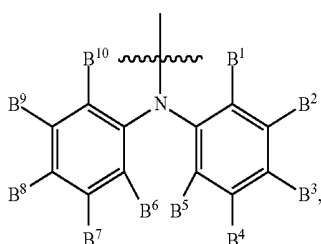
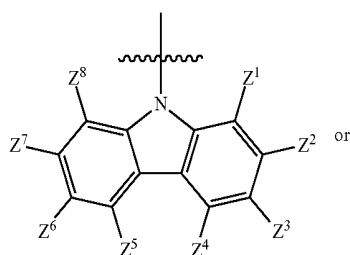


Formula 1

is described.

In the structure according to Formula 1:

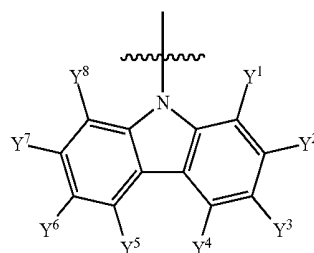
R<sup>5</sup> is



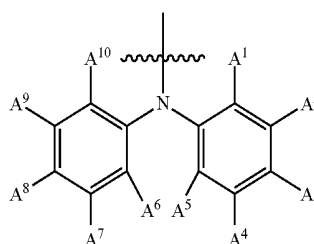
4

and

(a) at least one of R<sup>1</sup>-R<sup>4</sup> is



or (b) R<sup>1</sup> is



25

25

where R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, A<sup>1</sup>, A<sup>2</sup>, A<sup>3</sup>, A<sup>4</sup>, A<sup>5</sup>, A<sup>6</sup>, A<sup>7</sup>, A<sup>8</sup>, A<sup>9</sup>, A<sup>10</sup>, B<sup>1</sup>, B<sup>2</sup>, B<sup>3</sup>, B<sup>4</sup>, B<sup>5</sup>, B<sup>6</sup>, B<sup>7</sup>, B<sup>8</sup>, B<sup>9</sup>, B<sup>10</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup>, and Z<sup>8</sup>, are each independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, —SC<sub>m</sub>F<sub>2m+1</sub>, and combinations thereof;

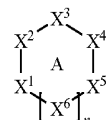
adjacent A, B, Y, and Z groups are, optionally, joined to form a fused ring structure; and

X comprises an acceptor group selected from the group consisting of —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

According to another embodiment, a first device is also provided. The first device can include a first organic light emitting device that includes an anode; a cathode; and an emissive layer disposed between the anode and the cathode. The emissive layer can include a first emitting compound comprising a structure according to Formula 2:

50

Formula 2



55

In the compound of Formula 2,

ring A is an aromatic or heteroaromatic ring;

n is 0 or 1;

when n is 0, X<sup>1</sup>, X<sup>2</sup>, X<sup>3</sup>, X<sup>4</sup>, and X<sup>5</sup> are independently selected from the group consisting of CR, N, NR, O, S, and Se, and at least one of X<sup>1</sup> to X<sup>5</sup> is CR; when n is 1, X<sup>1</sup>, X<sup>2</sup>, X<sup>3</sup>, X<sup>4</sup>, X<sup>5</sup>, and X<sup>6</sup> are independently selected from the group consisting of CR and N, and at least one of X<sup>1</sup> to X<sup>6</sup> is CR;

65

each R is independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazoyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ ,  $-SC_mF_{2m+1}$ , and combinations thereof;

adjacent R groups are, optionally, joined to form a fused ring structure;

$m \geq 1$ ;

at least one R group comprises a donor group with at least one electron-donating nitrogen; and

at least one R group comprises an acceptor group selected from the group consisting of  $-F$ ,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ .

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an organic light emitting device.

FIG. 2 shows an inverted organic light emitting device that does not have a separate electron transport layer.

FIG. 3 shows Formulas 1 and 2 as disclosed herein.

#### DETAILED DESCRIPTION

Generally, an OLED comprises at least one organic layer disposed between and electrically connected to an anode and a cathode. When a current is applied, the anode injects holes and the cathode injects electrons into the organic layer(s). The injected holes and electrons each migrate toward the oppositely charged electrode. When an electron and hole localize on the same molecule, an "exciton," which is a localized electron-hole pair having an excited energy state, is formed. Light is emitted when the exciton relaxes via a photoemissive mechanism. In some cases, the exciton may be localized on an excimer or an exciplex. Non-radiative mechanisms, such as thermal relaxation, may also occur, but are generally considered undesirable.

The initial OLEDs used emissive molecules that emitted light from their singlet states ("fluorescence") as disclosed, for example, in U.S. Pat. No. 4,769,292, which is incorporated by reference in its entirety. Fluorescent emission generally occurs in a time frame of less than 10 nanoseconds.

More recently, OLEDs having emissive materials that emit light from triplet states ("phosphorescence") have been demonstrated. Baldo et al., "Highly Efficient Phosphorescent Emission from Organic Electroluminescent Devices," *Nature*, vol. 395, 151-154, 1998; ("Baldo-I") and Baldo et al., "Very high-efficiency green organic light-emitting devices based on electrophosphorescence," *Appl. Phys. Lett.*, vol. 75, No. 3, 4-6 (1999) ("Baldo-II"), which are incorporated by reference in their entireties. Phosphorescence is described in more detail in U.S. Pat. No. 7,279,704 at cols. 5-6, which are incorporated by reference.

FIG. 1 shows an organic light emitting device **100**. The figures are not necessarily drawn to scale. Device **100** may include a substrate **110**, an anode **115**, a hole injection layer **120**, a hole transport layer **125**, an electron blocking layer **130**, an emissive layer **135**, a hole blocking layer **140**, an electron transport layer **145**, an electron injection layer **150**, a protective layer **155**, a cathode **160**, and a barrier layer **170**. Cathode **160** is a compound cathode having a first conduc-

tive layer **162** and a second conductive layer **164**. Device **100** may be fabricated by depositing the layers described, in order. The properties and functions of these various layers, as well as example materials, are described in more detail in U.S. Pat. No. 7,279,704 at cols. 6-10, which are incorporated by reference.

More examples for each of these layers are available. For example, a flexible and transparent substrate-anode combination is disclosed in U.S. Pat. No. 5,844,363, which is incorporated by reference in its entirety. An example of a p-doped hole transport layer is m-MTDATA doped with  $F_4$ -TCNQ at a molar ratio of 50:1, as disclosed in U.S. Patent Application Publication No. 2003/0230980, which is incorporated by reference in its entirety. Examples of emissive and host materials are disclosed in U.S. Pat. No. 6,303,238 to Thompson et al., which is incorporated by reference in its entirety. An example of an n-doped electron transport layer is BPhen doped with Li at a molar ratio of 1:1, as disclosed in U.S. Patent Application Publication No. 2003/0230980, which is incorporated by reference in its entirety. U.S. Pat. Nos. 5,703,436 and 5,707,745, which are incorporated by reference in their entireties, disclose examples of cathodes including compound cathodes having a thin layer of metal such as Mg:Ag with an overlying transparent, electrically-conductive, sputter-deposited ITO layer. The theory and use of blocking layers is described in more detail in U.S. Pat. No. 6,097,147 and U.S. Patent Application Publication No. 2003/0230980, which are incorporated by reference in their entireties. Examples of injection layers are provided in U.S. Patent Application Publication No. 2004/0174116, which is incorporated by reference in its entirety. A description of protective layers may be found in U.S. Patent Application Publication No. 2004/0174116, which is incorporated by reference in its entirety.

FIG. 2 shows an inverted OLED **200**. The device includes a substrate **210**, a cathode **215**, an emissive layer **220**, a hole transport layer **225**, and an anode **230**. Device **200** may be fabricated by depositing the layers described, in order. Because the most common OLED configuration has a cathode disposed over the anode, and device **200** has cathode **215** disposed under anode **230**, device **200** may be referred to as an "inverted" OLED. Materials similar to those described with respect to device **100** may be used in the corresponding layers of device **200**. FIG. 2 provides one example of how some layers may be omitted from the structure of device **100**.

The simple layered structure illustrated in FIGS. 1 and 2 is provided by way of non-limiting example, and it is understood that embodiments of the invention may be used in connection with a wide variety of other structures. The specific materials and structures described are exemplary in nature, and other materials and structures may be used. Functional OLEDs may be achieved by combining the various layers described in different ways, or layers may be omitted entirely, based on design, performance, and cost factors. Other layers not specifically described may also be included. Materials other than those specifically described may be used. Although many of the examples provided herein describe various layers as comprising a single material, it is understood that combinations of materials, such as a mixture of host and dopant, or more generally a mixture, may be used. Also, the layers may have various sublayers. The names given to the various layers herein are not intended to be strictly limiting. For example, in device **200**, hole transport layer **225** transports holes and injects holes into emissive layer **220**, and may be described as a hole transport layer or a hole injection layer. In one embodiment,

an OLED may be described as having an “organic layer” disposed between a cathode and an anode. This organic layer may comprise a single layer, or may further comprise multiple layers of different organic materials as described, for example, with respect to FIGS. 1 and 2.

Structures and materials not specifically described may also be used, such as OLEDs comprised of polymeric materials (PLEDs) such as disclosed in U.S. Pat. No. 5,247,190 to Friend et al., which is incorporated by reference in its entirety. By way of further example, OLEDs having a single organic layer may be used. OLEDs may be stacked, for example as described in U.S. Pat. No. 5,707,745 to Forrest et al, which is incorporated by reference in its entirety. The OLED structure may deviate from the simple layered structure illustrated in FIGS. 1 and 2. For example, the substrate may include an angled reflective surface to improve out-coupling, such as a mesa structure as described in U.S. Pat. No. 6,091,195 to Forrest et al., and/or a pit structure as described in U.S. Pat. No. 5,834,893 to Bulovic et al., which are incorporated by reference in their entireties.

Unless otherwise specified, any of the layers of the various embodiments may be deposited by any suitable method. For the organic layers, preferred methods include thermal evaporation, ink-jet, such as described in U.S. Pat. Nos. 6,013,982 and 6,087,196, which are incorporated by reference in their entireties, organic vapor phase deposition (OVPD), such as described in U.S. Pat. No. 6,337,102 to Forrest et al., which is incorporated by reference in its entirety, and deposition by organic vapor jet printing (OVJP), such as described in U.S. Pat. No. 7,431,968, which is incorporated by reference in its entirety. Other suitable deposition methods include spin coating and other solution based processes. Solution based processes are preferably carried out in nitrogen or an inert atmosphere. For the other layers, preferred methods include thermal evaporation. Preferred patterning methods include deposition through a mask, cold welding such as described in U.S. Pat. Nos. 6,294,398 and 6,468,819, which are incorporated by reference in their entireties, and patterning associated with some of the deposition methods such as ink-jet and OVJD. Other methods may also be used. The materials to be deposited may be modified to make them compatible with a particular deposition method. For example, substituents such as alkyl and aryl groups, branched or unbranched, and preferably containing at least 3 carbons, may be used in small molecules to enhance their ability to undergo solution processing. Substituents having 20 carbons or more may be used, and 3-20 carbons is a preferred range. Materials with asymmetric structures may have better solution processability than those having symmetric structures, because asymmetric materials may have a lower tendency to recrystallize. Dendrimer substituents may be used to enhance the ability of small molecules to undergo solution processing.

Devices fabricated in accordance with embodiments of the present invention may further optionally comprise a barrier layer. One purpose of the barrier layer is to protect the electrodes and organic layers from damaging exposure to harmful species in the environment including moisture, vapor and/or gases, etc. The barrier layer may be deposited over, under or next to a substrate, an electrode, or over any other parts of a device including an edge. The barrier layer may comprise a single layer, or multiple layers. The barrier layer may be formed by various known chemical vapor deposition techniques and may include compositions having a single phase as well as compositions having multiple phases. Any suitable material or combination of materials may be used for the barrier layer. The barrier layer may

incorporate an inorganic or an organic compound or both. The preferred barrier layer comprises a mixture of a polymeric material and a non-polymeric material as described in U.S. Pat. No. 7,968,146, PCT Pat. Application Nos. PCT/US2007/023098 and PCT/US2009/042829, which are herein incorporated by reference in their entireties. To be considered a “mixture”, the aforesaid polymeric and non-polymeric materials comprising the barrier layer should be deposited under the same reaction conditions and/or at the same time. The weight ratio of polymeric to non-polymeric material may be in the range of 95:5 to 5:95. The polymeric material and the non-polymeric material may be created from the same precursor material. In one example, the mixture of a polymeric material and a non-polymeric material consists essentially of polymeric silicon and inorganic silicon.

Devices fabricated in accordance with embodiments of the invention may be incorporated into a wide variety of consumer products, including flat panel displays, computer monitors, medical monitors, televisions, billboards, lights for interior or exterior illumination and/or signaling, heads up displays, fully transparent displays, flexible displays, laser printers, telephones, cell phones, personal digital assistants (PDAs), laptop computers, digital cameras, camcorders, viewfinders, micro-displays, 3-D displays, vehicles, a large area wall, theater or stadium screen, or a sign. Various control mechanisms may be used to control devices fabricated in accordance with the present invention, including passive matrix and active matrix. Many of the devices are intended for use in a temperature range comfortable to humans, such as 18 degrees C. to 30 degrees C., and more preferably at room temperature (20-25 degrees C.), but could be used outside this temperature range, for example, from -40 degree C. to +80 degree C.

The materials and structures described herein may have applications in devices other than OLEDs. For example, other optoelectronic devices such as organic solar cells and organic photodetectors may employ the materials and structures. More generally, organic devices, such as organic transistors, may employ the materials and structures.

The term “halo” or “halogen” as used herein includes fluorine, chlorine, bromine, and iodine.

The term “alkyl” as used herein contemplates both straight and branched chain alkyl radicals. Preferred alkyl groups are those containing from one to fifteen carbon atoms and includes methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, and the like. Additionally, the alkyl group may be optionally substituted.

The term “cycloalkyl” as used herein contemplates cyclic alkyl radicals. Preferred cycloalkyl groups are those containing 3 to 7 carbon atoms and includes cyclopropyl, cyclopentyl, cyclohexyl, and the like. Additionally, the cycloalkyl group may be optionally substituted.

The term “alkenyl” as used herein contemplates both straight and branched chain alkene radicals. Preferred alkenyl groups are those containing two to fifteen carbon atoms. Additionally, the alkenyl group may be optionally substituted.

The term “alkynyl” as used herein contemplates both straight and branched chain alkyne radicals. Preferred alkynyl groups are those containing two to fifteen carbon atoms. Additionally, the alkynyl group may be optionally substituted.

The terms “aralkyl” or “arylalkyl” as used herein are used interchangeably and contemplate an alkyl group that has as a substituent an aromatic group. Additionally, the aralkyl group may be optionally substituted.

9

The term “heterocyclic group” as used herein contemplates aromatic and non-aromatic cyclic radicals. Hetero-aromatic cyclic radicals also means heteroaryl. Preferred hetero-non-aromatic cyclic groups are those containing 3 or 7 ring atoms which includes at least one hetero atom, and includes cyclic amines such as morpholino, piperdino, pyrrolidino, and the like, and cyclic ethers, such as tetrahydrofuran, tetrahydropyran, and the like. Additionally, the heterocyclic group may be optionally substituted.

The term “aryl” or “aromatic group” as used herein contemplates single-ring groups and polycyclic ring systems. The polycyclic rings may have two or more rings in which two carbons are common to two adjoining rings (the rings are “fused”) wherein at least one of the rings is aromatic, e.g., the other rings can be cycloalkyls, cycloalkenyls, aryl, heterocycles, and/or heteroaryls. Additionally, the aryl group may be optionally substituted.

The term “heteroaryl” as used herein contemplates single-ring hetero-aromatic groups that may include from one to three heteroatoms, for example, pyrrole, furan, thiophene, imidazole, oxazole, thiazole, triazole, pyrazole, pyridine, pyrazine and pyrimidine, and the like. The term heteroaryl also includes polycyclic hetero-aromatic systems having two or more rings in which two atoms are common to two adjoining rings (the rings are “fused”) wherein at least one of the rings is a heteroaryl, e.g., the other rings can be cycloalkyls, cycloalkenyls, aryl, heterocycles, and/or heteroaryls. Additionally, the heteroaryl group may be optionally substituted.

The alkyl, cycloalkyl, alkenyl, alkynyl, aralkyl, heterocyclic group, aryl, and heteroaryl may be optionally substituted with one or more substituents selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, cyclic amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ether, ester, nitrile, isonitrile, sulfonyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

As used herein, “substituted” indicates that a substituent other than H is bonded to the relevant position, such as carbon. Thus, for example, where  $R^1$  is mono-substituted, then one  $R^1$  must be other than H. Similarly, where  $R^1$  is di-substituted, then two of  $R^1$  must be other than H. Similarly, where  $R^1$  is unsubstituted,  $R^1$  is hydrogen for all available positions.

The “aza” designation in the fragments described herein, i.e. aza-dibenzofuran, aza-dibenzothiophene, etc. means that one or more of the C—H groups in the respective fragment can be replaced by a nitrogen atom, for example, and without any limitation, azatriphenylene encompasses both dibenzo[f,h]quinoxaline and dibenzo[f,h]quinoline. One of ordinary skill in the art can readily envision other nitrogen analogs of the aza-derivatives described above, and all such analogs are intended to be encompassed by the terms as set forth herein.

It is to be understood that when a molecular fragment is described as being a substituent or otherwise attached to another moiety, its name may be written as if it were a fragment (e.g. phenyl, phenylene, naphthyl, dibenzofuryl) or as if it were the whole molecule (e.g. benzene, naphthalene, dibenzofuran). As used herein, these different ways of designating a substituent or attached fragment are considered to be equivalent.

10

A compound comprising a structure according to Formula 1

1

5

10

15

20

25

30

35

40

45

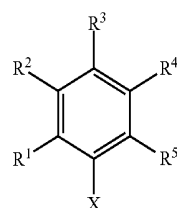
50

55

60

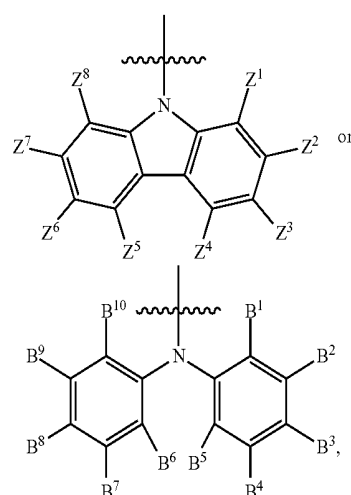
65

Formula 1



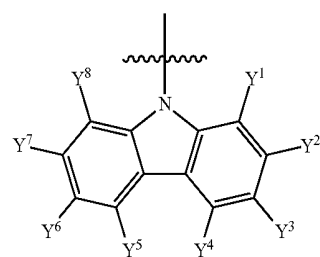
is described. In the structure according to Formula 1:

$R^5$  is

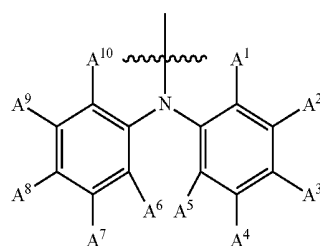


and

(a) at least one of  $R^1$ - $R^4$  is



or (b) is



$R^1, R^2, R^3, R^4, A^1, A^2, A^3, A^4, A^5, A^6, A^7, A^8, A^9, A^{10}, B^1, B^2, B^3, B^4, B^5, B^6, B^7, B^8, B^9, B^{10}, Y^1, Y^2, Y^3, Y^4, Y^5, Y^6, Y^7, Y^8, Z^1, Z^2, Z^3, Z^4, Z^5, Z^6, Z^7,$  and  $Z^8,$  are each

## 11

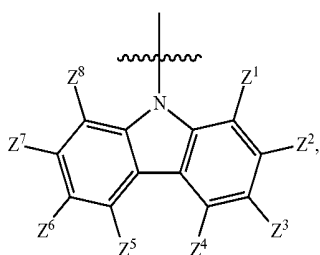
independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ ,  $-SC_mF_{2m+1}$ , and combinations thereof;

adjacent A, B, Y, and Z groups are, optionally, joined to form a fused ring structure; and

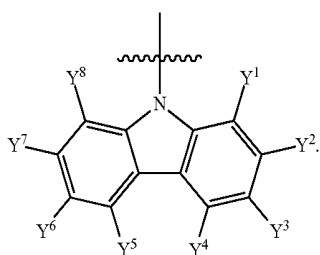
X comprises an acceptor group selected from the group consisting of  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ .

In some embodiments, A<sup>5</sup> & A<sup>6</sup> are not joined to form a fused ring, while A<sup>5</sup> & A<sup>6</sup> are joined to form a fused ring in other embodiments. In some embodiments, B<sup>5</sup> & B<sup>6</sup> are not joined to form a fused ring, while B<sup>5</sup> & B<sup>6</sup> are joined to form a fused ring in other embodiments.

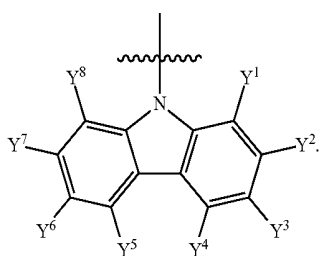
In some embodiments, R<sup>5</sup> is



and at least one of R<sup>1</sup>-R<sup>4</sup> is

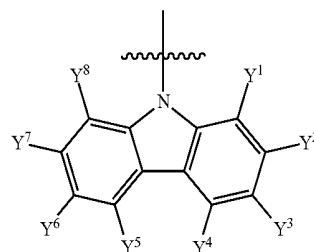


In some embodiments, at least two of R<sup>1</sup>-R<sup>4</sup> are

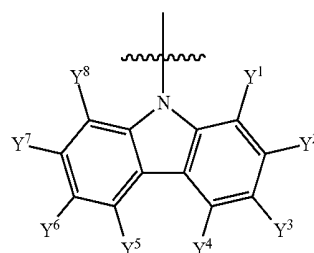


## 12

In some embodiments, at least three of R<sup>1</sup>-R<sup>4</sup> are



while all four of R<sup>1</sup>-R<sup>4</sup> are

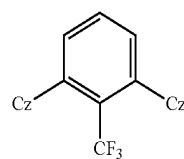


in other embodiments.

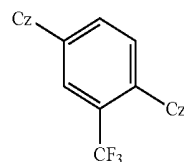
In some embodiments, at least one of R<sup>1</sup>-R<sup>4</sup> comprises an acceptor group selected from the group consisting of  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ . In some embodiments, at least two of R<sup>1</sup>-R<sup>4</sup> comprise an acceptor group selected from the group consisting of  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ . In some embodiments, at least three of R<sup>1</sup>-R<sup>4</sup> comprise an acceptor group selected from the group consisting of  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ .

In some embodiments, at least one of R<sup>1</sup>-R<sup>4</sup> is an electron withdrawing group with a Hammett value ( $\sigma_{para}$ ) of at least 0.05. In some embodiments, at least two of R<sup>1</sup>-R<sup>4</sup> are electron withdrawing groups with a Hammett value ( $\sigma_{para}$ ) of at least 0.05. In some embodiments, at least three of R<sup>1</sup>-R<sup>4</sup> are electron withdrawing groups with a Hammett value ( $\sigma_{para}$ ) of at least 0.05.

In some embodiments, the compound is selected from the group consisting of:



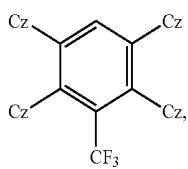
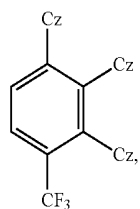
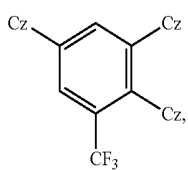
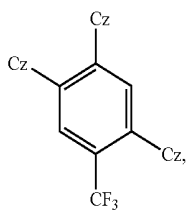
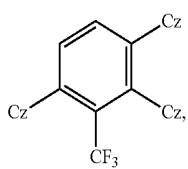
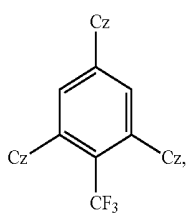
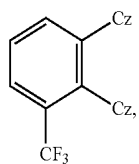
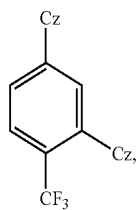
Compound 1



Compound 2

13

-continued

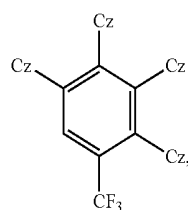


14

-continued

Compound 3

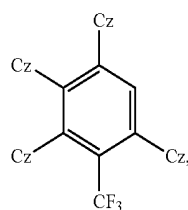
5



Compound 12

Compound 4

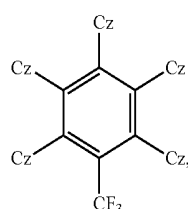
10



Compound 13

Compound 6

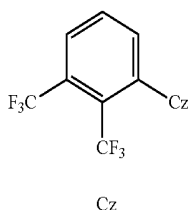
15



Compound 14

Compound 7

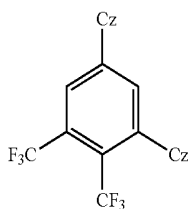
20



Compound 15

Compound 8

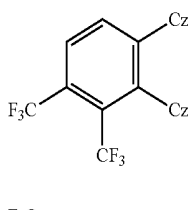
30



Compound 29

Compound 9

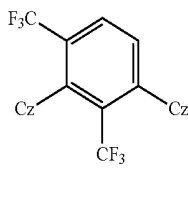
35



Compound 30

Compound 10

50

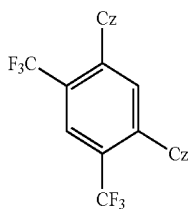


Compound 31

55

Compound 11

60

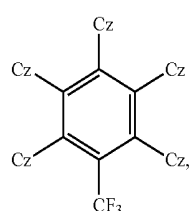
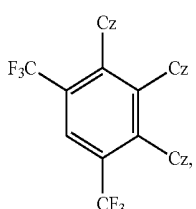
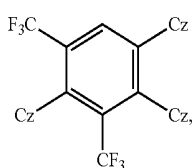
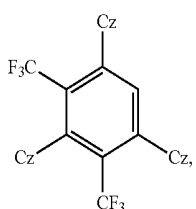
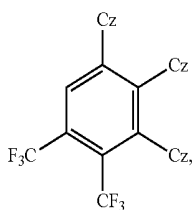
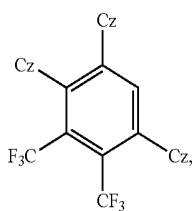
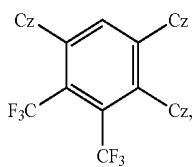
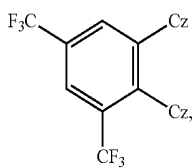


Compound 32

65

15

-continued

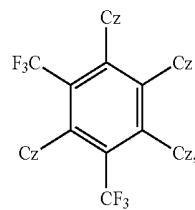


16

-continued

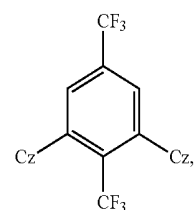
Compound 33

5



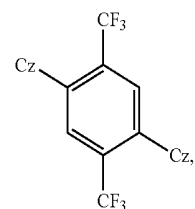
Compound 34

10



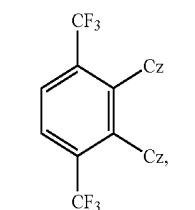
Compound 35

15



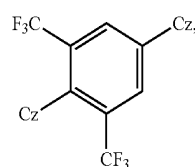
Compound 36

25



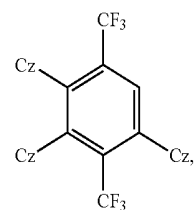
Compound 37

35



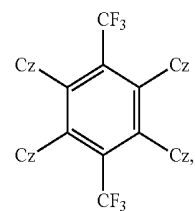
Compound 38

45



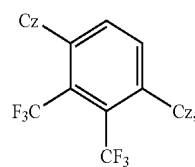
Compound 39

50



Compound 40

60



65

Compound 41

Compound 42

Compound 43

Compound 44

Compound 45

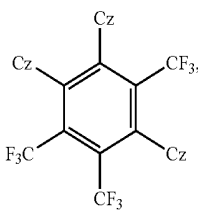
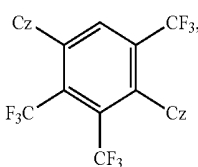
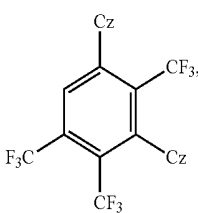
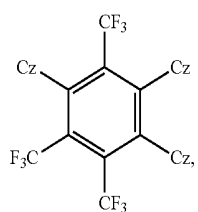
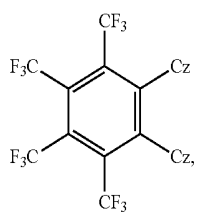
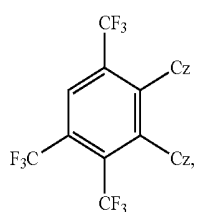
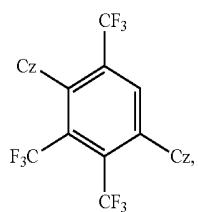
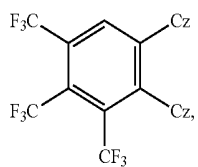
Compound 46

Compound 47

Compound 48

17

-continued



18

-continued

Compound 49

5

Compound 50

10

15

Compound 51

20

25

Compound 52

30

Compound 53

35

40

Compound 54

45

50

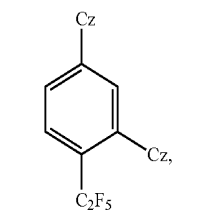
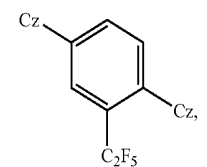
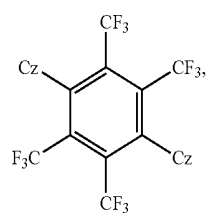
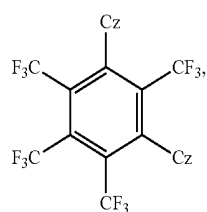
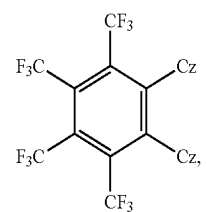
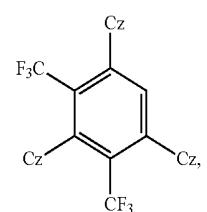
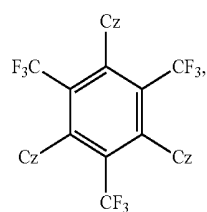
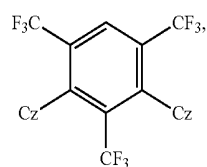
Compound 55

55

Compound 56

60

65



Compound 57

Compound 58

Compound 59

Compound 60

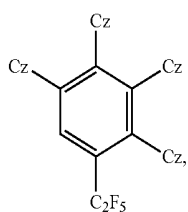
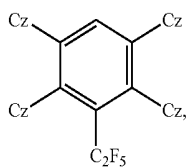
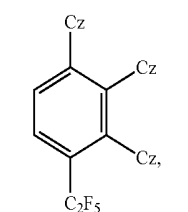
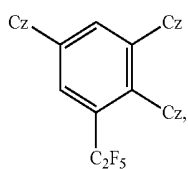
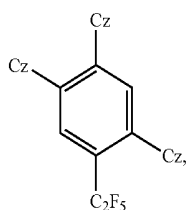
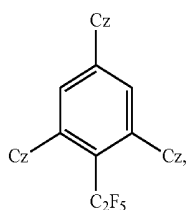
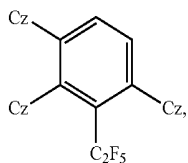
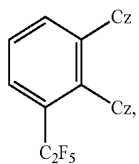
Compound 61

Compound 62

Compound 63

Compound 64

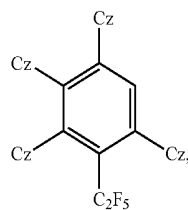
**19**  
-continued



**20**  
-continued

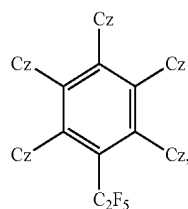
Compound 65

5



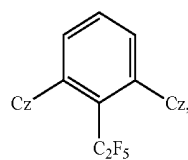
Compound 66

10



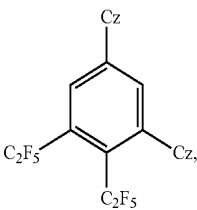
Compound 67

15



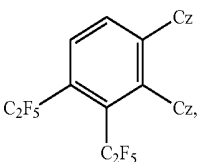
Compound 69

25



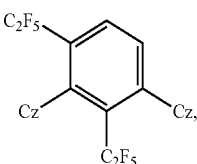
Compound 70

35



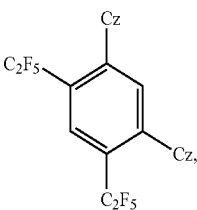
Compound 71

40



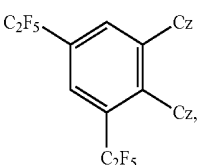
Compound 72

50



Compound 73

60



65

Compound 74

Compound 75

Compound 76

Compound 91

Compound 92

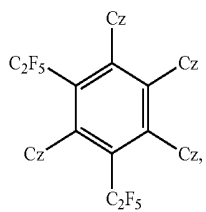
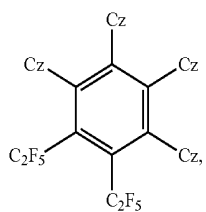
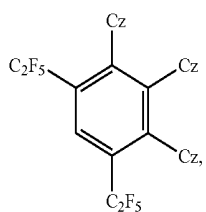
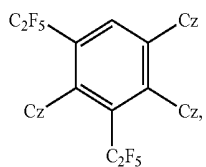
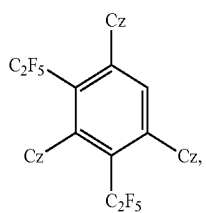
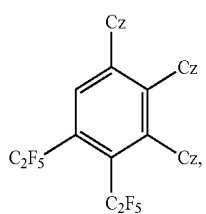
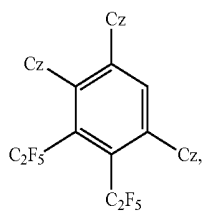
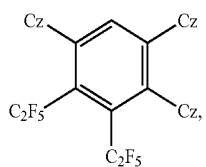
Compound 93

Compound 94

Compound 95

21

-continued

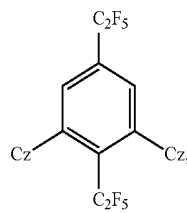


22

-continued

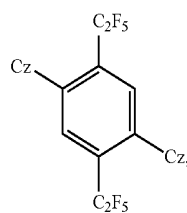
Compound 96

5



Compound 97

10

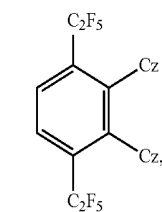


Compound 98

15

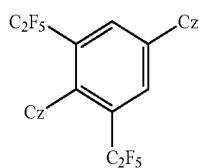
Compound 99

25



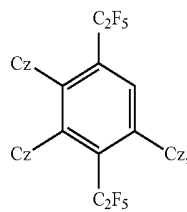
Compound 100

35



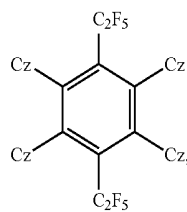
Compound 101

40

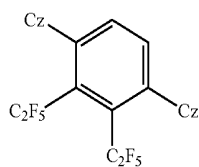


Compound 102

50

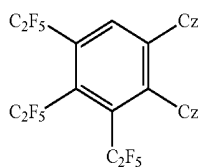


55



Compound 103

60



65

Compound 104

Compound 105

Compound 106

Compound 107

Compound 108

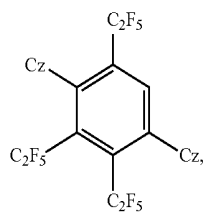
Compound 109

Compound 110

Compound 111

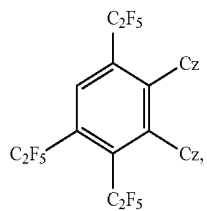
23

-continued



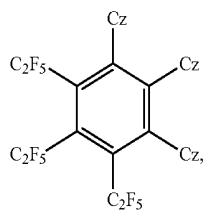
Compound 112

5



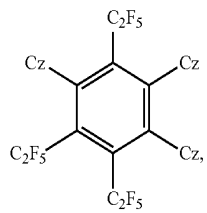
Compound 113

10



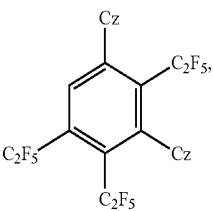
Compound 114

15



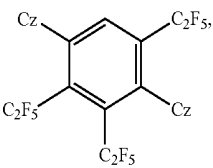
Compound 115

20



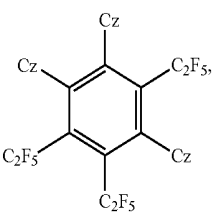
Compound 116

25



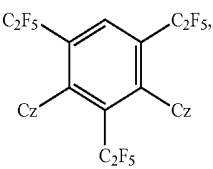
Compound 117

30



Compound 118

35

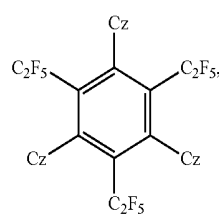


Compound 119

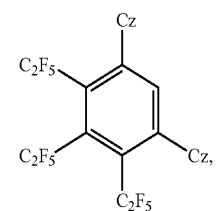
40

24

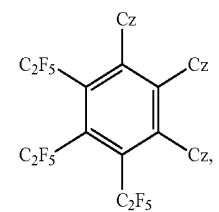
-continued



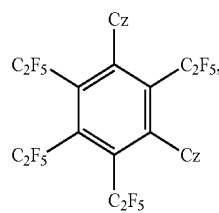
Compound 120



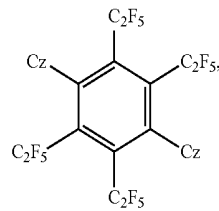
Compound 121



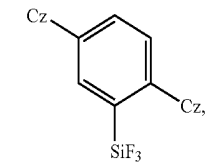
Compound 122



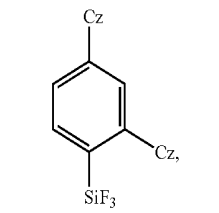
Compound 123



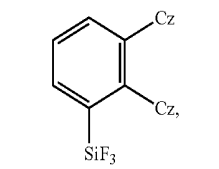
Compound 124



Compound 125



Compound 126



Compound 127

45

50

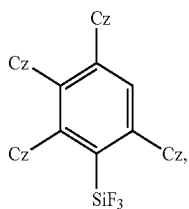
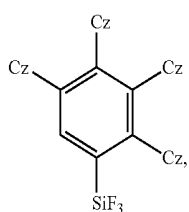
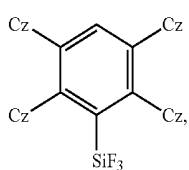
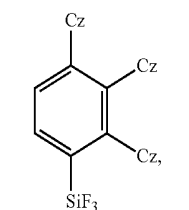
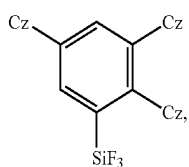
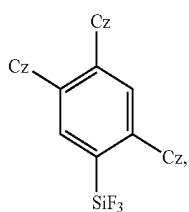
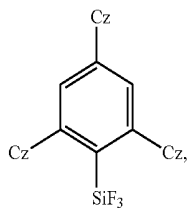
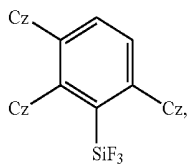
55

60

65

25

-continued



26

-continued

Compound 128

5

Compound 129

10

15

Compound 131

20

25

Compound 132

30

Compound 133

35

40

Compound 134

45

Compound 135

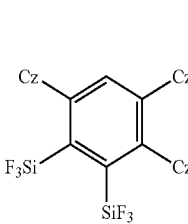
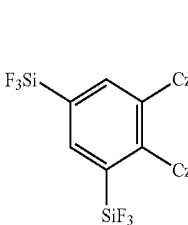
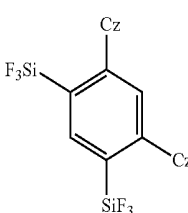
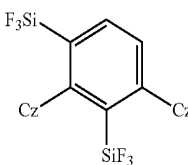
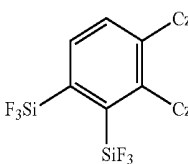
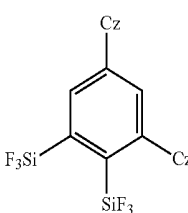
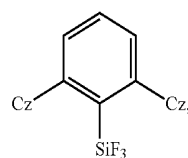
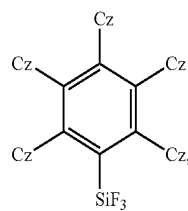
50

55

Compound 136

60

65



Compound 137

Compound 138

Compound 153

Compound 154

Compound 155

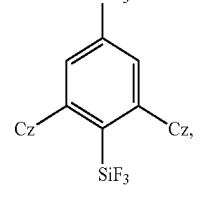
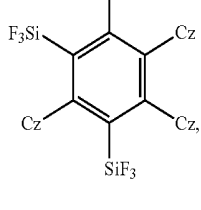
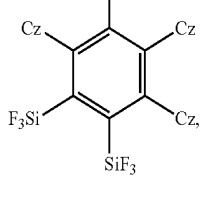
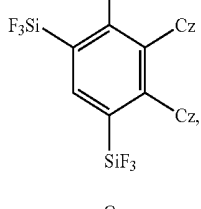
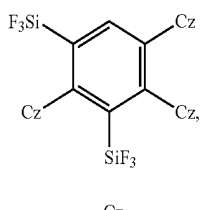
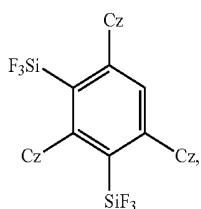
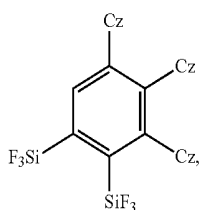
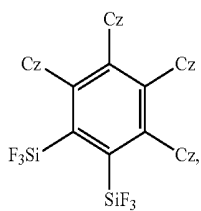
Compound 156

Compound 157

Compound 158

27

-continued



28

-continued

Compound 159

5

Compound 160

10

15

Compound 161

20

25

Compound 162

30

Compound 163

35

40

Compound 164

45

Compound 165

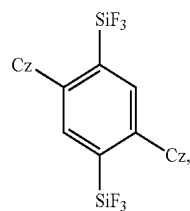
50

55

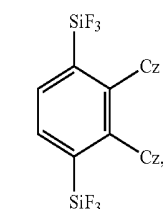
Compound 166

60

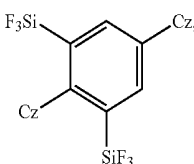
65



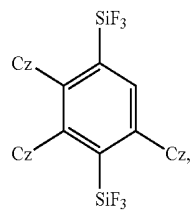
Compound 167



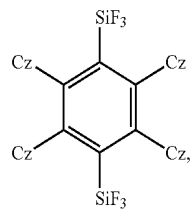
Compound 168



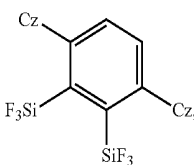
Compound 169



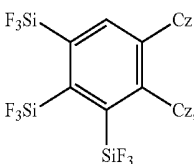
Compound 170



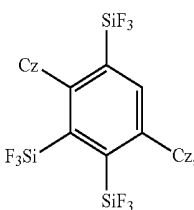
Compound 171



Compound 172



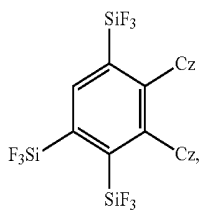
Compound 173



Compound 174

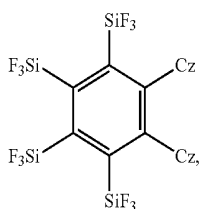
29

-continued



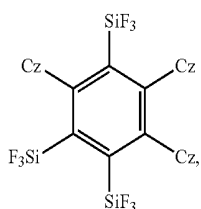
Compound 175

5



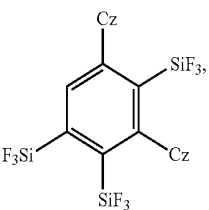
Compound 176

10



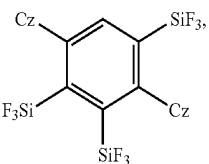
Compound 177

15



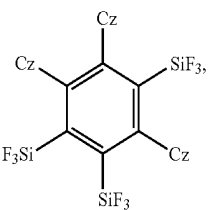
Compound 178

20



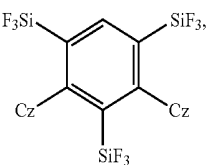
Compound 179

25



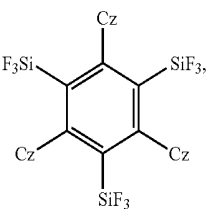
Compound 180

30



Compound 181

35

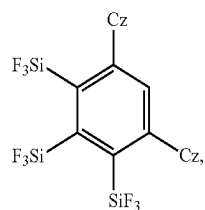


Compound 182

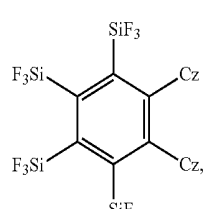
40

30

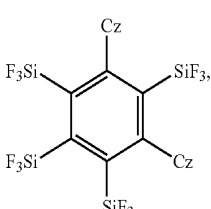
-continued



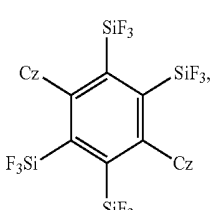
Compound 183



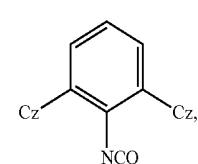
Compound 184



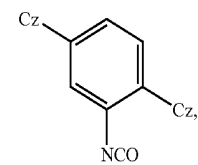
Compound 185



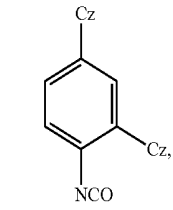
Compound 186



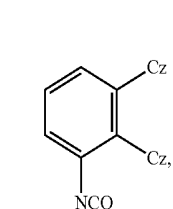
Compound 187



Compound 188



Compound 189



Compound 190

45

50

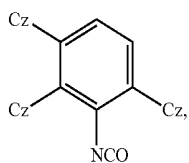
55

60

65

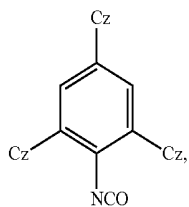
31

-continued



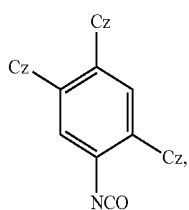
Compound 191

5



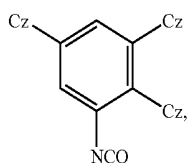
Compound 192

10



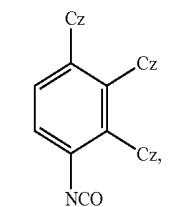
Compound 194

20



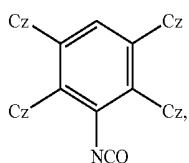
Compound 195

30



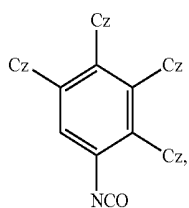
Compound 196

35



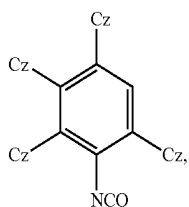
Compound 197

45



Compound 198

50



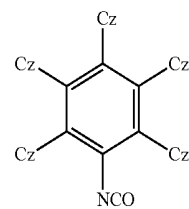
Compound 199

60

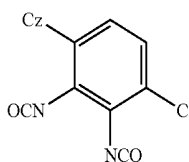
65

32

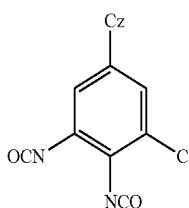
-continued



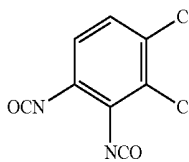
Compound 200



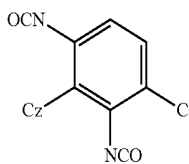
Compound 215



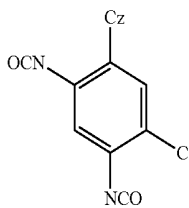
Compound 216



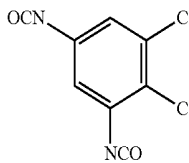
Compound 217



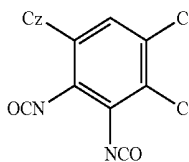
Compound 218



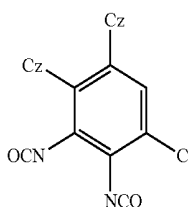
Compound 219



Compound 220



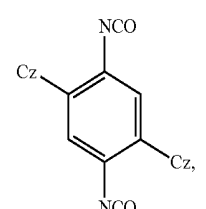
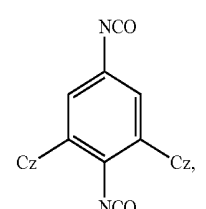
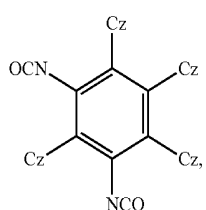
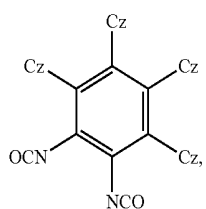
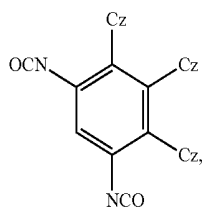
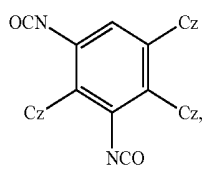
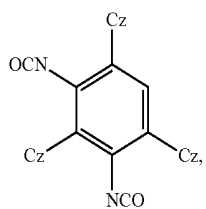
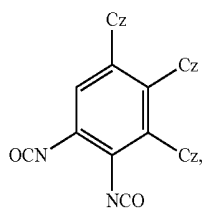
Compound 221



Compound 222

33

-continued

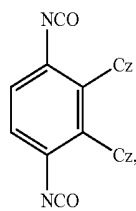


34

-continued

Compound 223

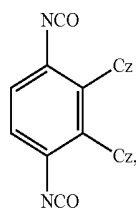
5



Compound 231

Compound 224

10

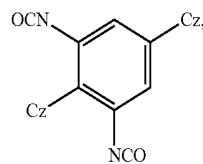


Compound 231

15

Compound 225

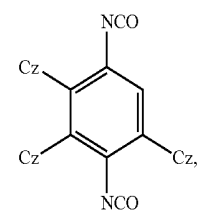
20



Compound 232

Compound 226

25

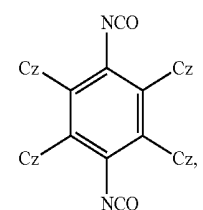


Compound 233

30

Compound 227

35

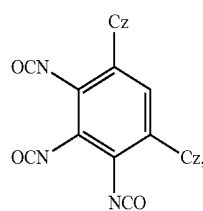


Compound 234

40

Compound 228

45

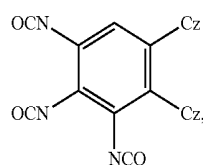


Compound 235

50

Compound 229

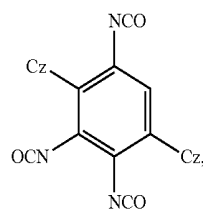
55



Compound 236

Compound 230

60

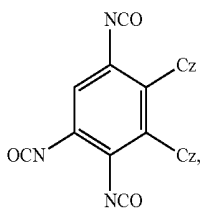


Compound 237

65

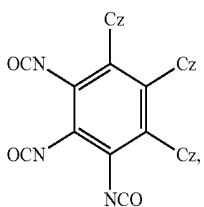
35

-continued



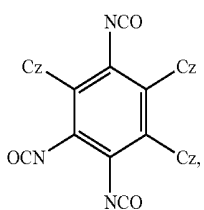
Compound 238

5



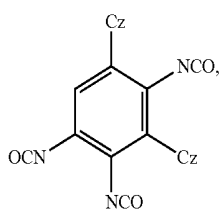
Compound 239

10



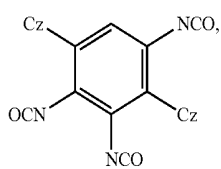
Compound 240

20



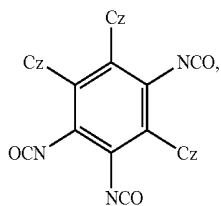
Compound 241

30



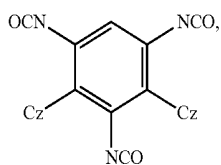
Compound 242

40



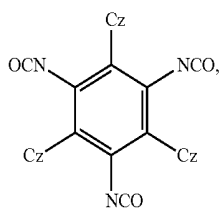
Compound 243

45



Compound 244

50

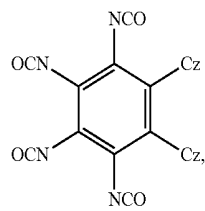


Compound 245

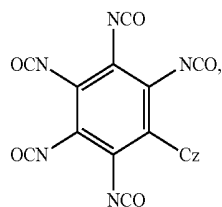
65

36

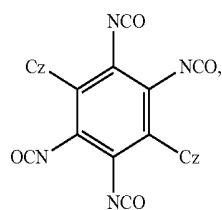
-continued



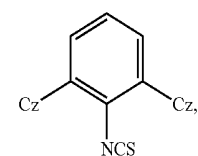
Compound 246



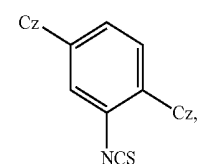
Compound 247



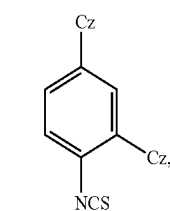
Compound 248



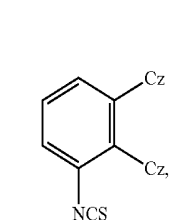
Compound 249



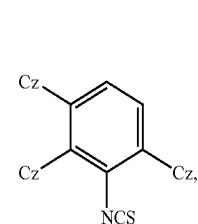
Compound 250



Compound 251



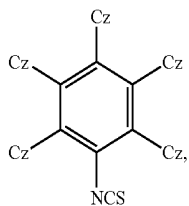
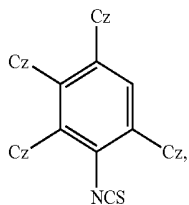
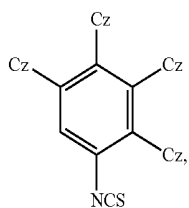
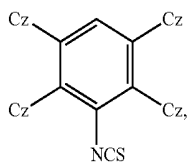
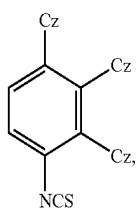
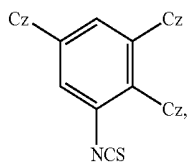
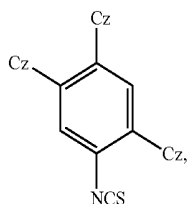
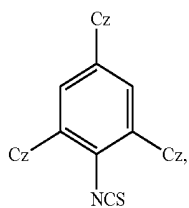
Compound 252



Compound 253

37

-continued

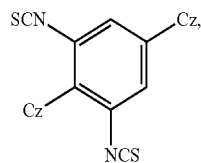


38

-continued

Compound 254

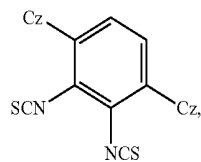
5



Compound 277

Compound 256

10

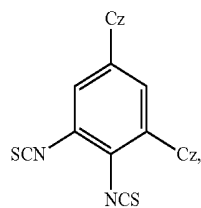


Compound 278

15

Compound 257

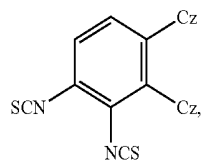
20



Compound 279

Compound 258

25

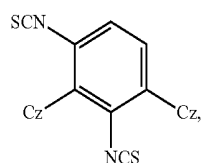


Compound 280

30

Compound 259

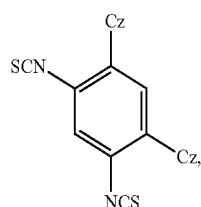
35



Compound 281

Compound 260

40

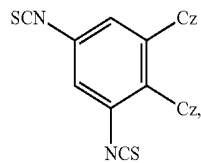


Compound 282

45

Compound 261

50

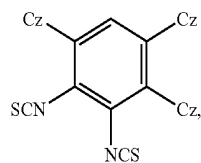


Compound 283

55

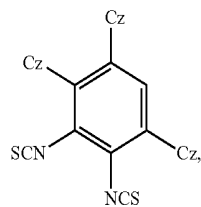
Compound 262

60



Compound 284

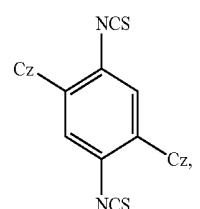
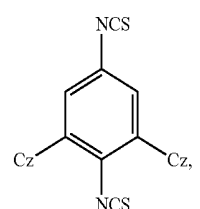
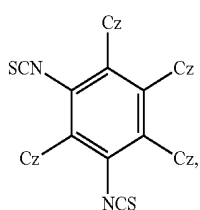
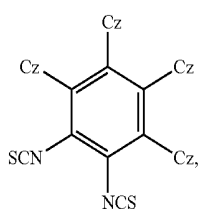
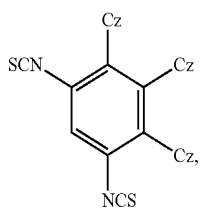
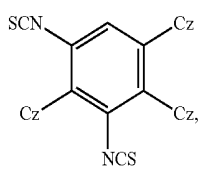
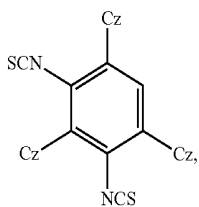
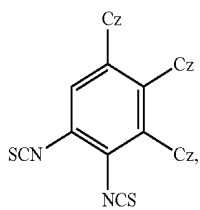
65



Compound 285

39

-continued

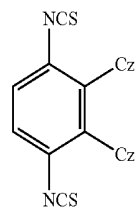


40

-continued

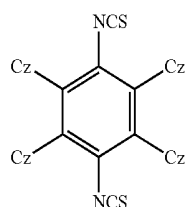
Compound 286

5



Compound 287

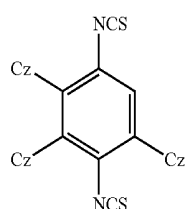
10



15

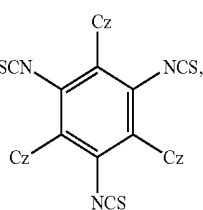
Compound 288

20



Compound 289

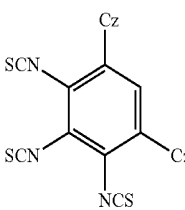
25



30

Compound 290

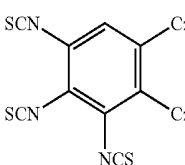
35



40

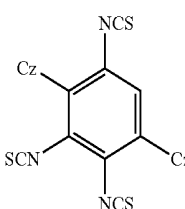
Compound 291

45



Compound 292

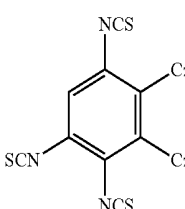
50



55

Compound 293

60



65

Compound 294

Compound 295

Compound 296

Compound 297

Compound 298

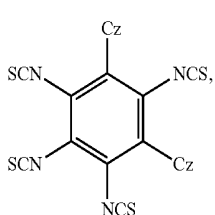
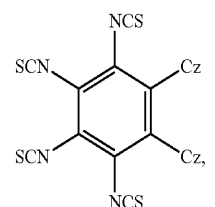
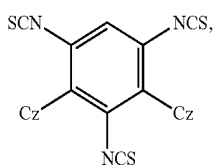
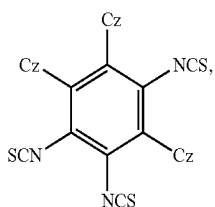
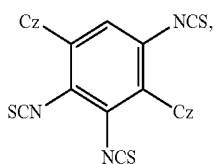
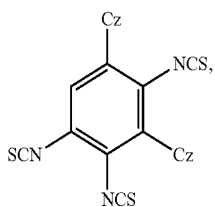
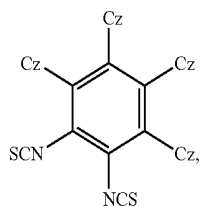
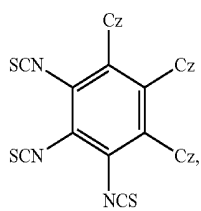
Compound 299

Compound 300

Compound 301

41

-continued



42

-continued

Compound 302

5

Compound 303

15

Compound 304

20

25

Compound 305

30

Compound 306

35

40

Compound 307

45

Compound 308

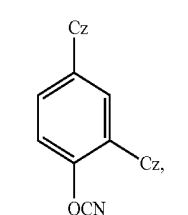
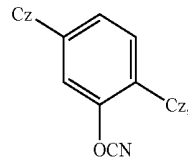
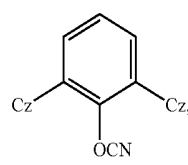
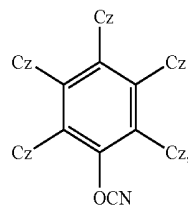
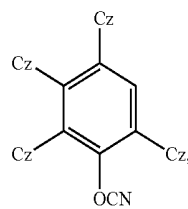
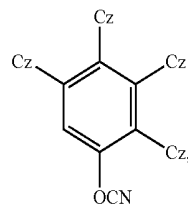
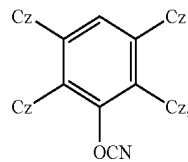
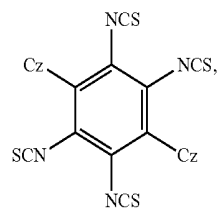
50

55

Compound 309

60

65



Compound 310

Compound 311

Compound 312

Compound 313

Compound 314

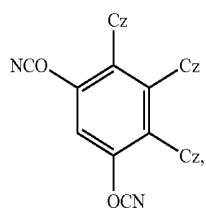
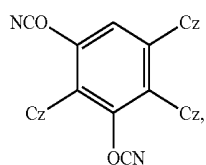
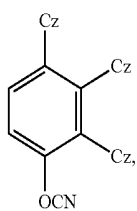
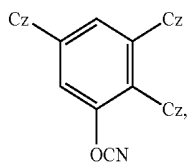
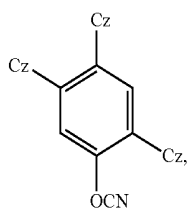
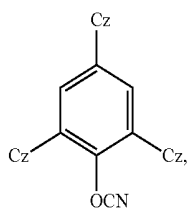
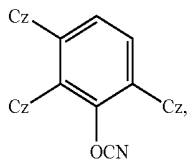
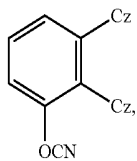
Compound 329

Compound 330

Compound 331

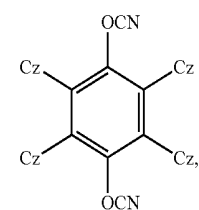
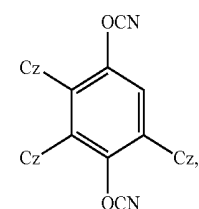
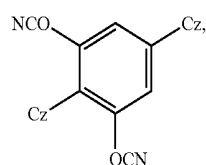
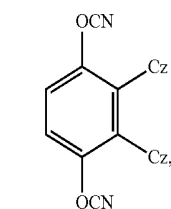
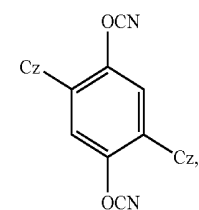
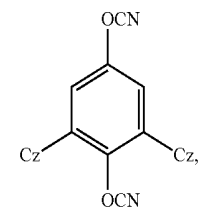
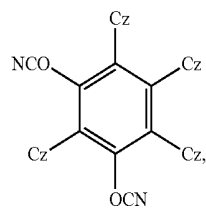
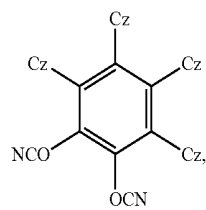
**43**

-continued



**44**

-continued



Compound 332

5

Compound 333

10

Compound 334

15

Compound 336

25

Compound 337

35

Compound 338

40

Compound 339

50

Compound 340

60

65

Compound 341

Compound 342

Compound 343

Compound 344

Compound 345

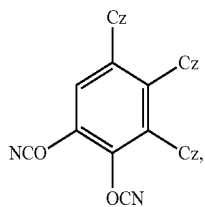
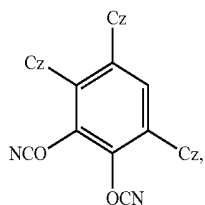
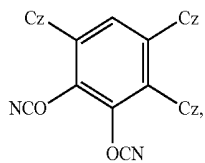
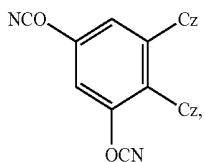
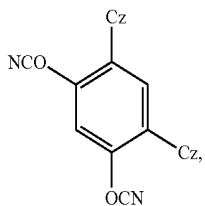
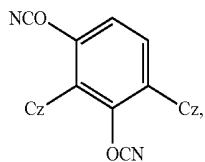
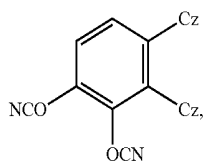
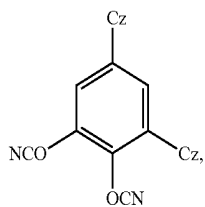
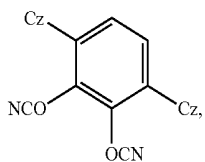
Compound 346

Compound 347

Compound 348

45

-continued

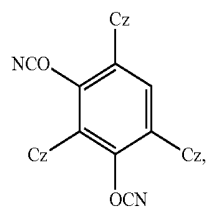


46

-continued

Compound 349

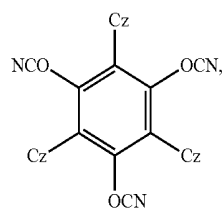
5



Compound 358

Compound 350

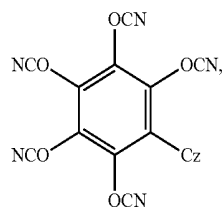
10



Compound 359

Compound 351

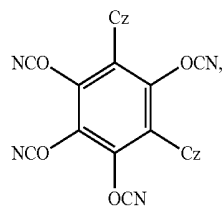
20



Compound 360

Compound 352

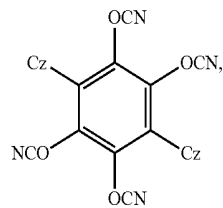
25



Compound 361

Compound 353

30



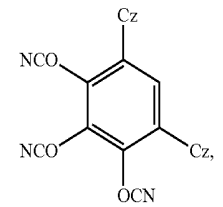
Compound 362

Compound 354

40

Compound 355

45



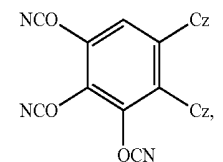
Compound 363

Compound 356

55

Compound 357

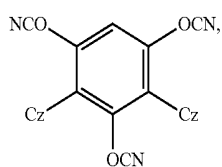
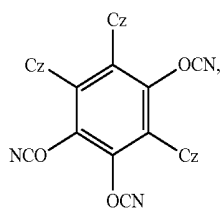
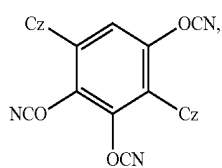
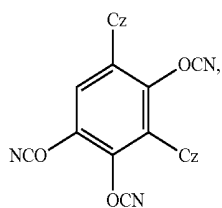
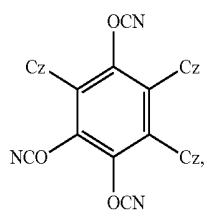
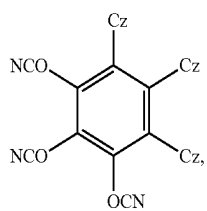
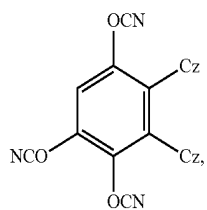
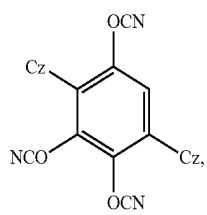
60



Compound 364

65

47

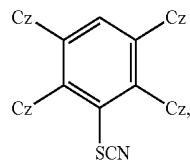


48

-continued

Compound 365

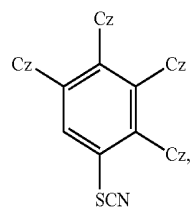
5



Compound 373

Compound 366

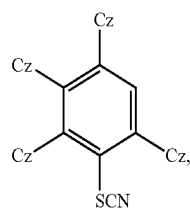
15



Compound 374

Compound 367

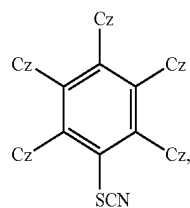
25



Compound 375

Compound 368

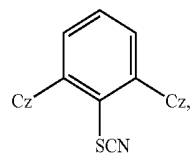
35



Compound 376

Compound 369

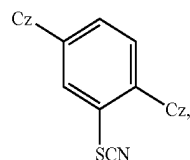
45



Compound 391

Compound 370

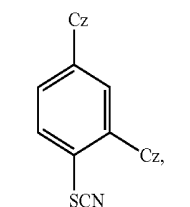
55



Compound 392

Compound 371

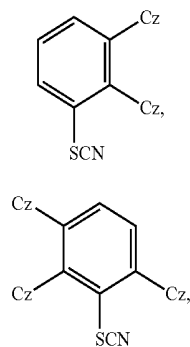
65



Compound 393

Compound 372

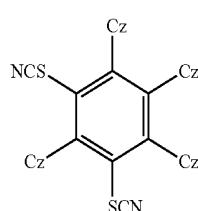
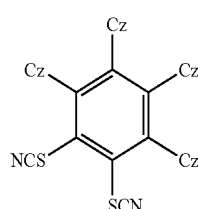
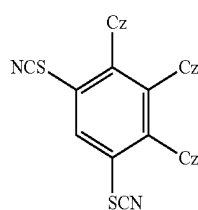
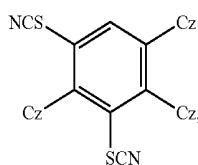
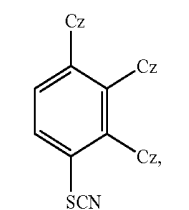
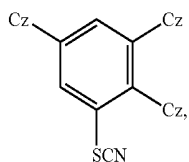
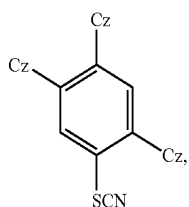
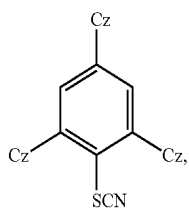
75



Compound 395

**49**

-continued

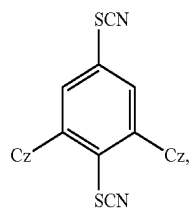


**50**

-continued

Compound 396

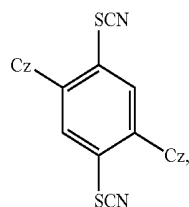
5



Compound 405

Compound 398

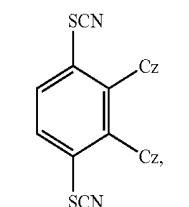
10



Compound 406

Compound 399

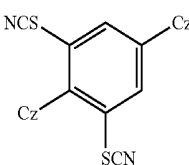
15



Compound 407

Compound 400

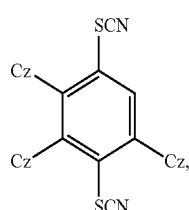
25



Compound 408

Compound 401

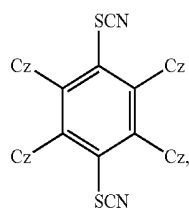
30



Compound 409

Compound 402

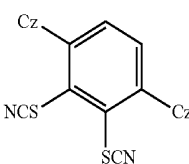
40



Compound 410

Compound 403

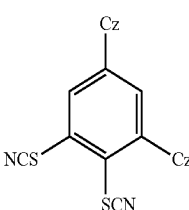
50



Compound 411

Compound 404

55

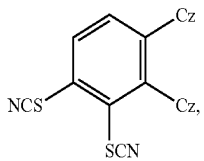


Compound 412

65

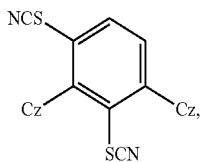
**51**

-continued



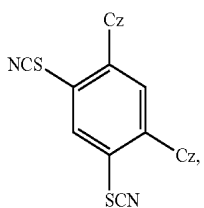
Compound 413

5



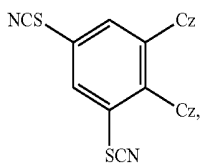
Compound 414

10



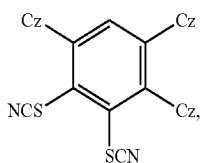
Compound 415

15



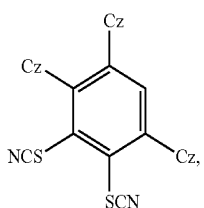
Compound 416

20



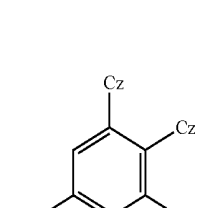
Compound 417

30



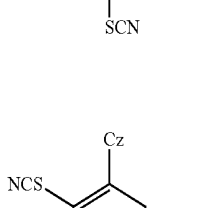
Compound 418

35



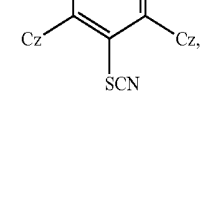
Compound 419

40



Compound 420

45

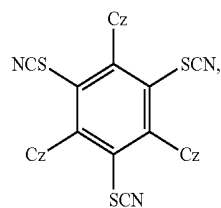


Compound 421

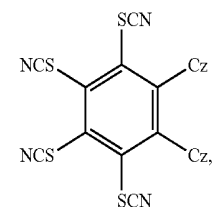
50

**52**

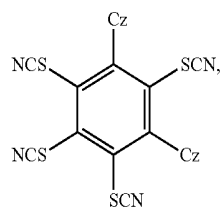
-continued



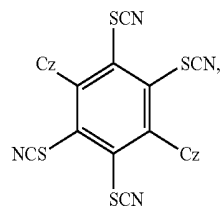
Compound 421



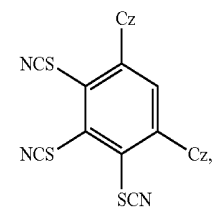
Compound 422



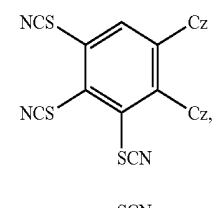
Compound 423



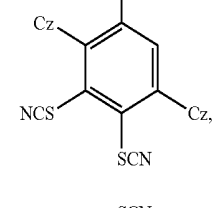
Compound 424



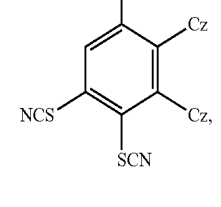
Compound 425



Compound 426



Compound 427



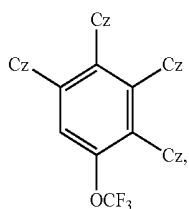
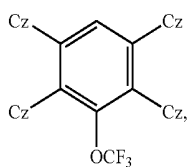
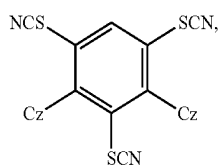
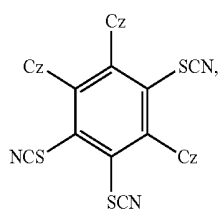
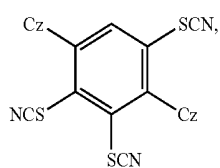
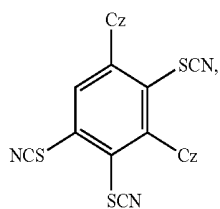
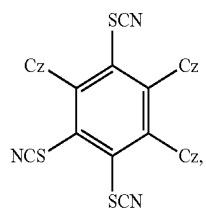
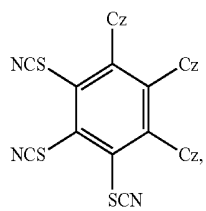
Compound 428

60

65

53

-continued



54

-continued

Compound 429

5

Compound 430

15

Compound 431

20

Compound 432

30

Compound 433

35

Compound 434

45

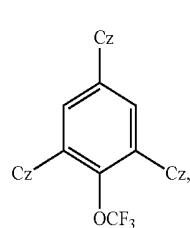
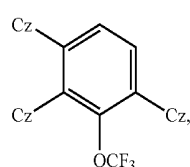
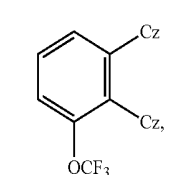
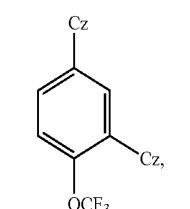
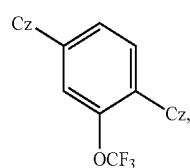
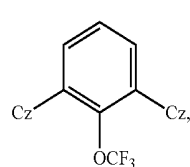
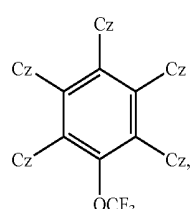
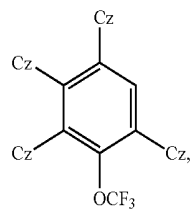
Compound 435

55

Compound 436

60

65



Compound 437

Compound 438

Compound 453

Compound 454

Compound 455

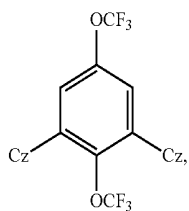
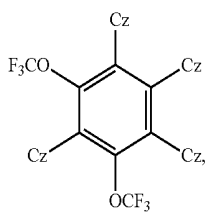
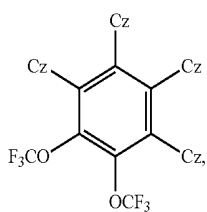
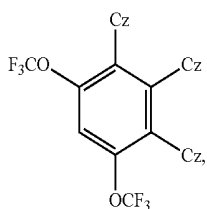
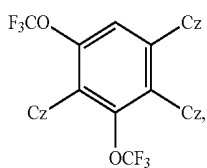
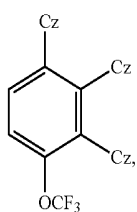
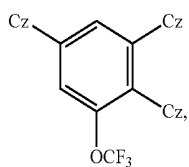
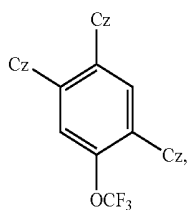
Compound 456

Compound 457

Compound 458

55

-continued

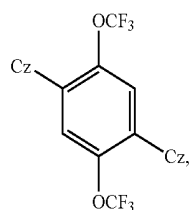


56

-continued

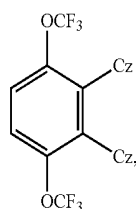
Compound 460

5



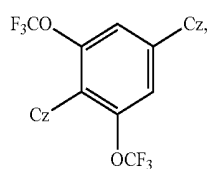
Compound 461

10



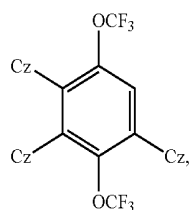
Compound 462

15



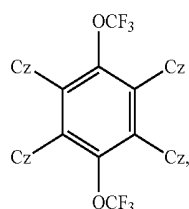
Compound 463

20



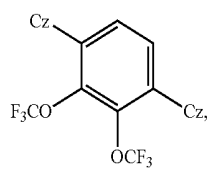
Compound 464

25



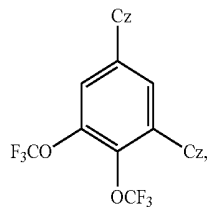
Compound 465

30



Compound 466

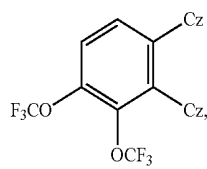
35



40

Compound 467

45



50

55

60

65

Compound 468

Compound 469

Compound 470

Compound 471

Compound 472

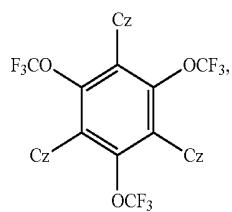
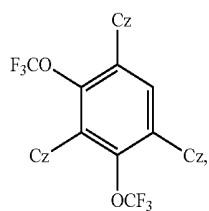
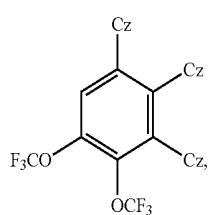
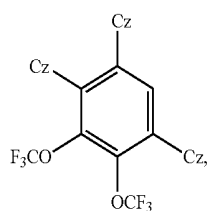
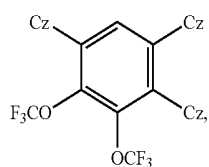
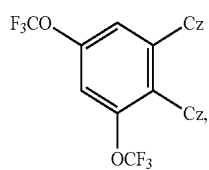
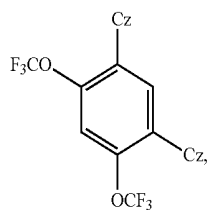
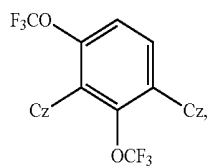
Compound 473

Compound 474

Compound 475

57

-continued

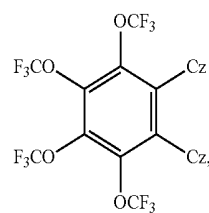


58

-continued

Compound 476

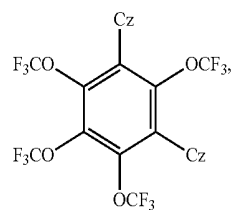
5



Compound 484

Compound 477

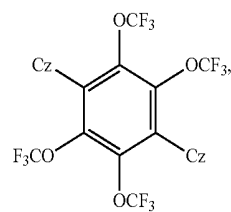
10



Compound 485

Compound 478

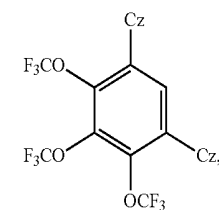
20



Compound 486

Compound 479

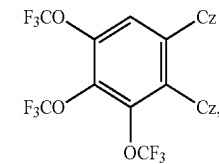
25



Compound 487

Compound 480

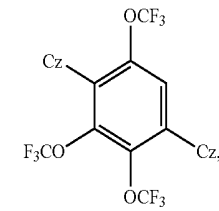
30



Compound 488

Compound 481

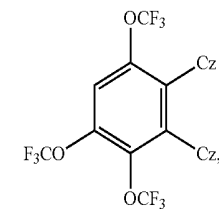
35



Compound 489

Compound 482

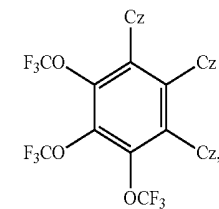
40



Compound 490

Compound 483

45



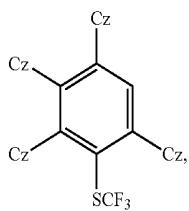
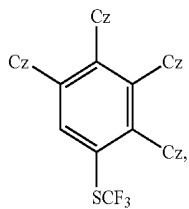
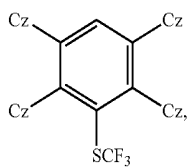
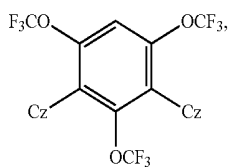
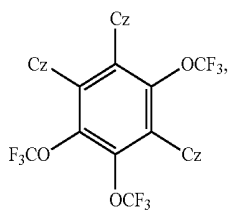
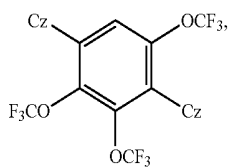
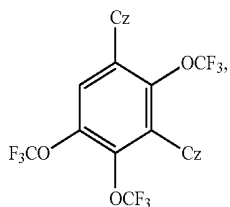
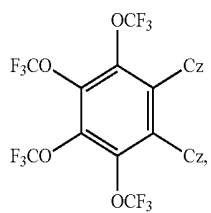
Compound 491

60

65

59

-continued



60

-continued

Compound 492

5

Compound 493

15

Compound 494

20

Compound 495

25

30

Compound 496

35

40

Compound 497

45

Compound 498

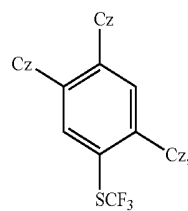
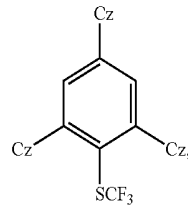
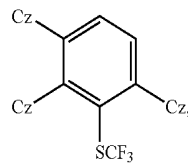
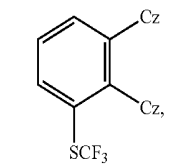
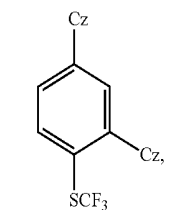
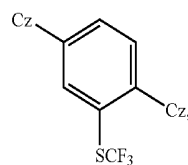
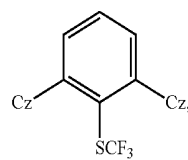
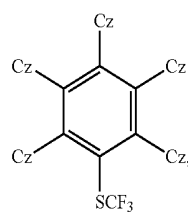
50

55

Compound 499

60

65



Compound 500

Compound 515

Compound 516

Compound 517

Compound 518

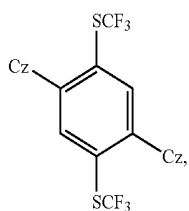
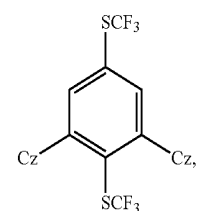
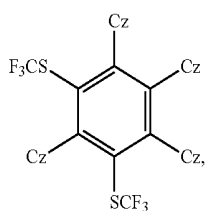
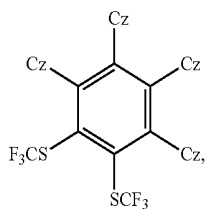
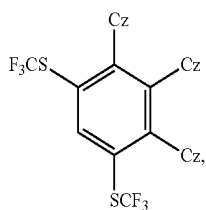
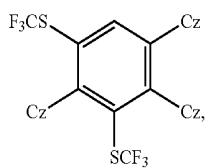
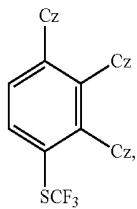
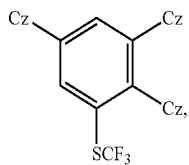
Compound 519

Compound 520

Compound 522

**61**

-continued

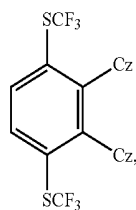


**62**

-continued

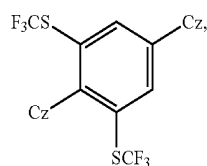
Compound 523

5



Compound 524

10

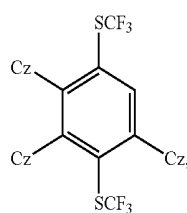


Compound 525

15

Compound 525

20

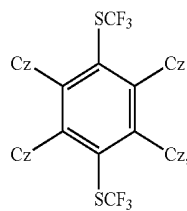


Compound 526

25

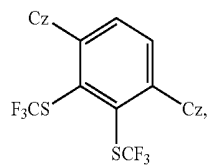
Compound 527

35



Compound 528

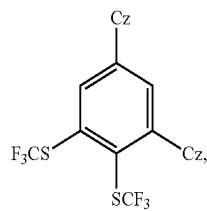
40



Compound 529

50

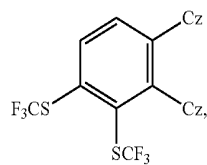
45



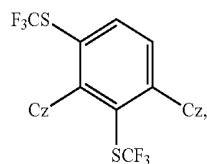
55

Compound 530

60



65



Compound 531

Compound 532

Compound 533

Compound 534

Compound 535

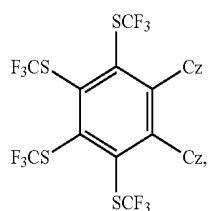
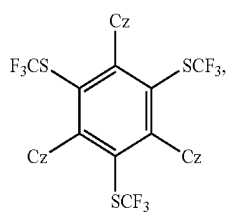
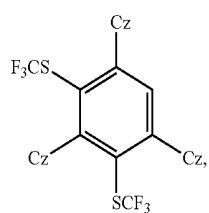
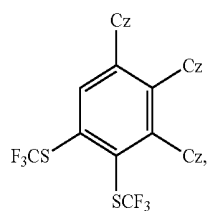
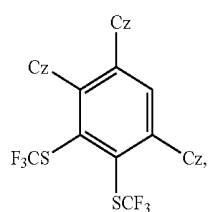
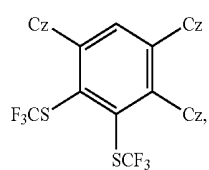
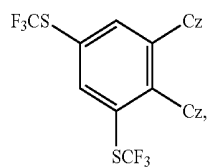
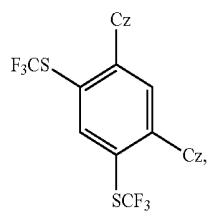
Compound 536

Compound 537

Compound 538

63

-continued

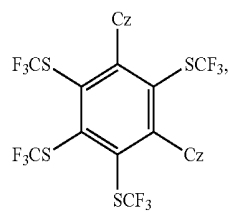


64

-continued

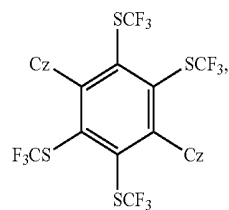
Compound 539

5



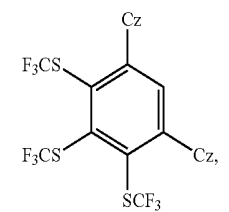
Compound 540

10



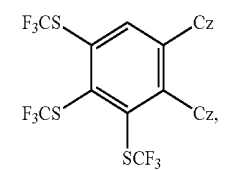
Compound 541

15



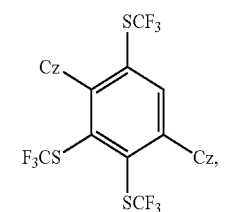
Compound 542

25



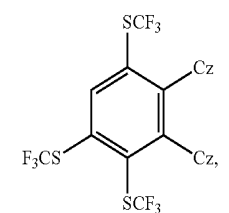
Compound 543

35



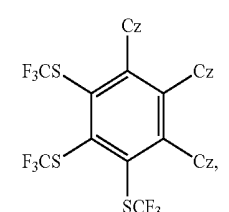
Compound 544

40



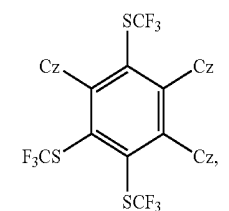
Compound 545

45



Compound 546

55



65

Compound 547

Compound 548

Compound 549

Compound 550

Compound 551

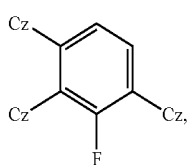
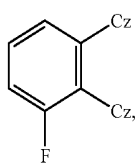
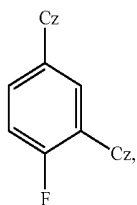
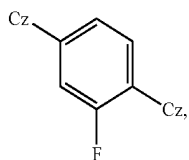
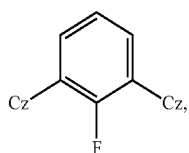
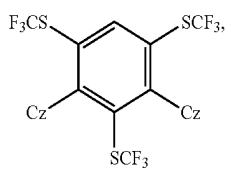
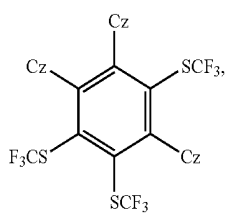
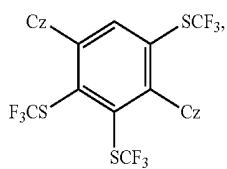
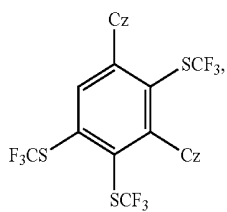
Compound 552

Compound 553

Compound 554

65

-continued

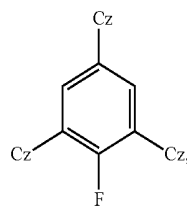


66

-continued

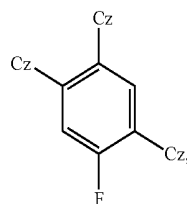
Compound 555

5



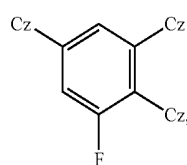
Compound 556

10



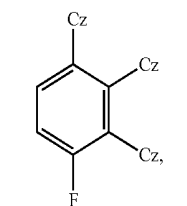
Compound 557

15



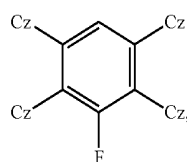
Compound 558

25



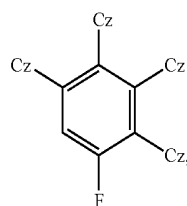
Compound 559

30



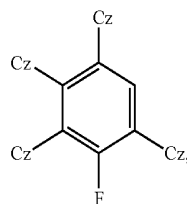
Compound 560

40



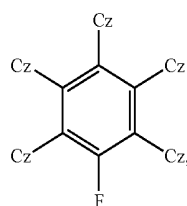
Compound 561

45



Compound 562

55



Compound 563

60

65

Compound 564

Compound 566

Compound 567

Compound 568

Compound 569

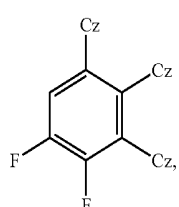
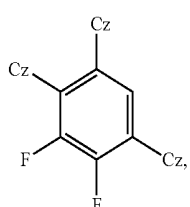
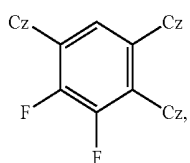
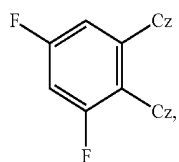
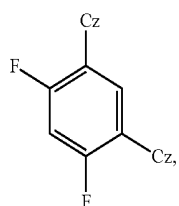
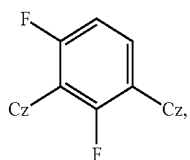
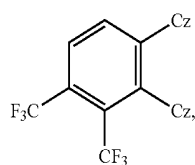
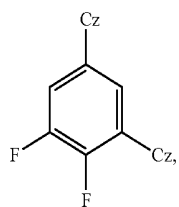
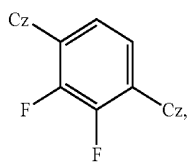
Compound 570

Compound 571

Compound 572

67

-continued



68

-continued

Compound 587

5

Compound 588

10

Compound 589

15

Compound 590

20

Compound 591

25

Compound 592

30

Compound 593

35

Compound 594

40

Compound 595

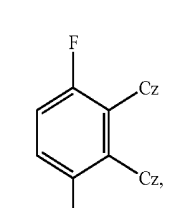
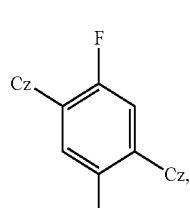
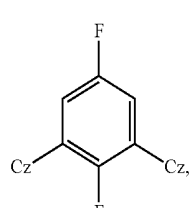
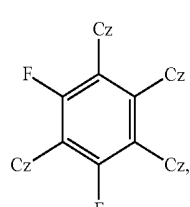
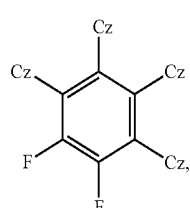
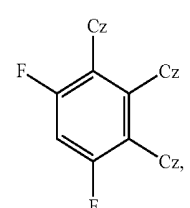
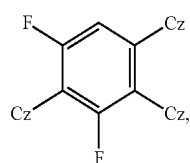
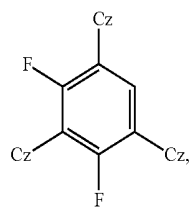
45

50

55

60

65



Compound 596

Compound 597

Compound 598

Compound 599

Compound 600

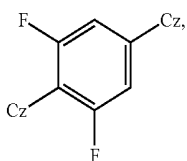
Compound 601

Compound 602

Compound 603

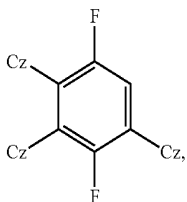
69

-continued



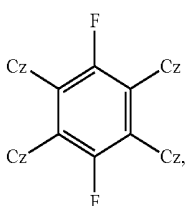
Compound 604

5



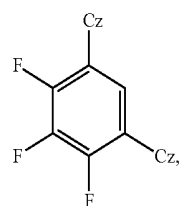
Compound 605

10



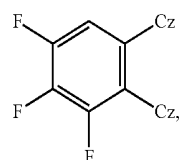
Compound 606

15



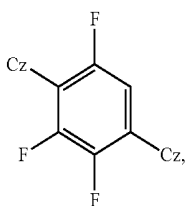
Compound 607

20



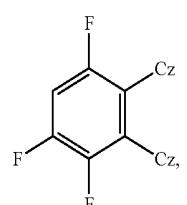
Compound 608

25



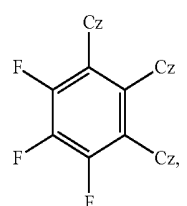
Compound 609

30



Compound 610

35

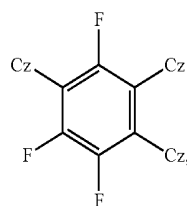


Compound 611

40

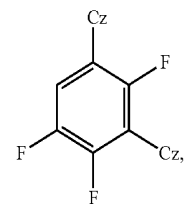
70

-continued

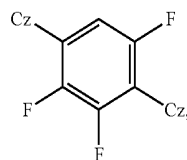


Compound 612

45

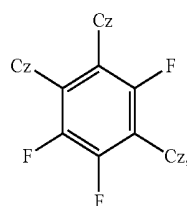


Compound 613



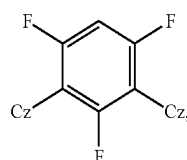
Compound 614

50



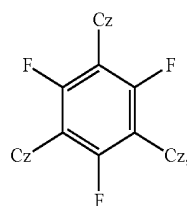
Compound 615

55



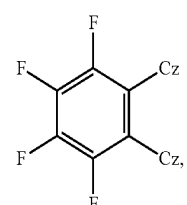
Compound 616

60



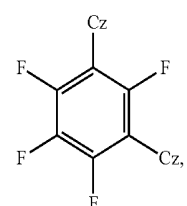
Compound 617

65



Compound 618

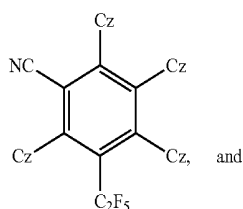
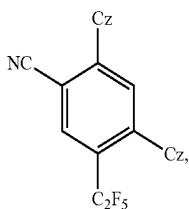
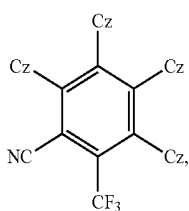
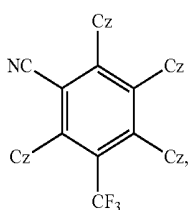
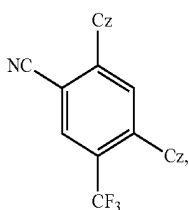
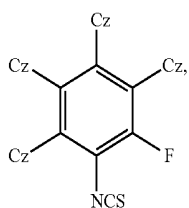
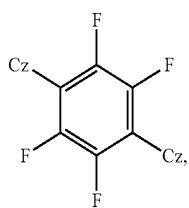
70



Compound 619

71

-continued

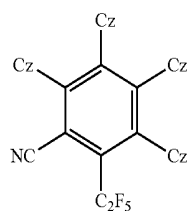


72

-continued

Compound 620

5



Compound 742

Compound 736

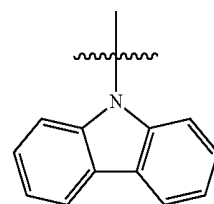
10

As used herein, Cz is

15

Compound 737

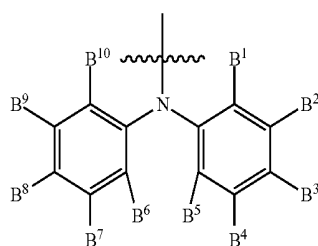
20



In some embodiments, R<sup>5</sup> is

Compound 738

30

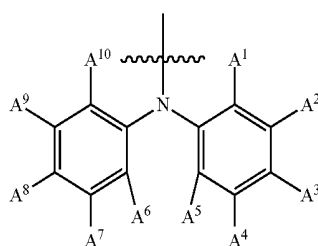


35

Compound 739

and R<sup>1</sup> is

40



45

Compound 740

50

In some embodiments, A<sup>5</sup> and A<sup>6</sup> are joined by a single bond. In some embodiments, B<sup>5</sup> and B<sup>6</sup> are joined by a single bond.

55

Compound 741

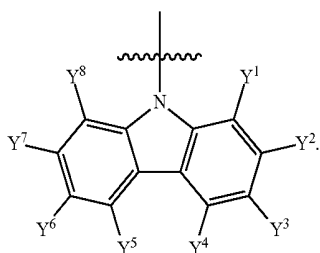
60

In some such embodiments, at least one of R<sup>2</sup>-R<sup>4</sup> comprises an acceptor group selected from the group consisting of -C<sub>m</sub>F<sub>2m+1</sub>, -Si<sub>m</sub>F<sub>2m+1</sub>, -NCO, -NCS, -OCN, -SCN, -OC<sub>m</sub>F<sub>2m+1</sub>, and -SC<sub>m</sub>F<sub>2m+1</sub>. In some embodiments, at least two of R<sup>2</sup>-R<sup>4</sup> comprise an acceptor group selected from the group consisting of -C<sub>m</sub>F<sub>2m+1</sub>, -Si<sub>m</sub>F<sub>2m+1</sub>, -NCO, -NCS, -OCN, -SCN, -OC<sub>m</sub>F<sub>2m+1</sub>, and -SC<sub>m</sub>F<sub>2m+1</sub>. In some embodiments, at least three of R<sup>2</sup>-R<sup>4</sup> comprise an acceptor group selected from the group consisting of -C<sub>m</sub>F<sub>2m+1</sub>, -Si<sub>m</sub>F<sub>2m+1</sub>, -NCO, -NCS, -OCN, -SCN, -OC<sub>m</sub>F<sub>2m+1</sub>, and -SC<sub>m</sub>F<sub>2m+1</sub>.

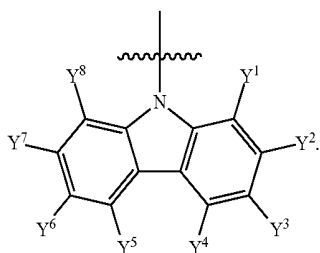
65

73

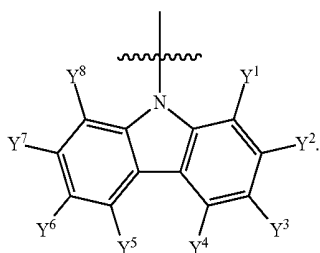
In some embodiments, at least one of R<sup>2</sup>-R<sup>4</sup> is



In some embodiments, at least two of R<sup>2</sup>-R<sup>4</sup> are

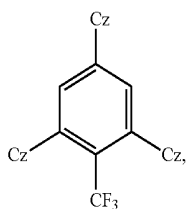
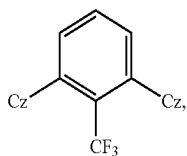


In some embodiments, all three of R<sup>2</sup>-R<sup>4</sup> are



In some embodiments, at least one of R<sup>2</sup>-R<sup>4</sup> is an electron withdrawing group with a Hammett value ( $\sigma_{para}$ ) of at least 0.05. In some embodiments, at least two of R<sup>2</sup>-R<sup>4</sup> are electron withdrawing groups with a Hammett value ( $\sigma_{para}$ ) of at least 0.05. In some embodiments, at least three of R<sup>2</sup>-R<sup>4</sup> are electron withdrawing groups with a Hammett value ( $\sigma_{para}$ ) of at least 0.05.

In some more specific embodiments, the compound is selected from the group consisting of:



Compound 1

Compound 6

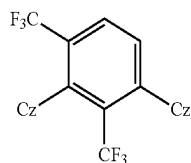
74

-continued

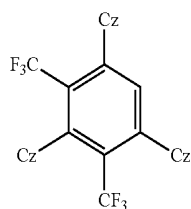
Compound 7



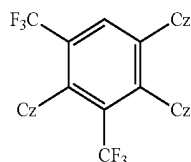
Compound 31



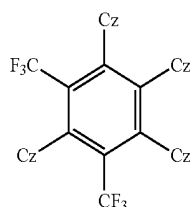
Compound 37



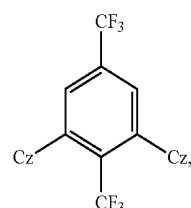
Compound 38



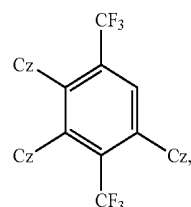
Compound 41



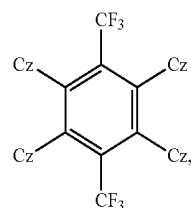
Compound 42



Compound 46



Compound 47



5

10

15

20

25

30

35

40

45

50

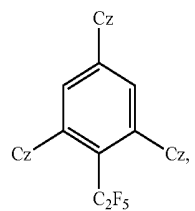
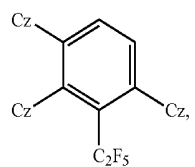
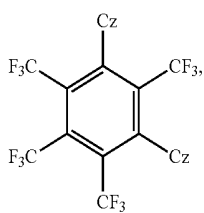
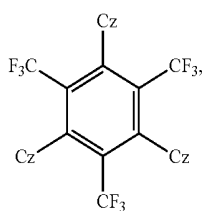
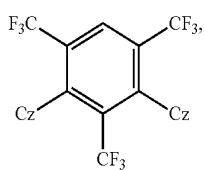
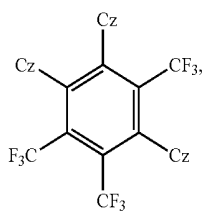
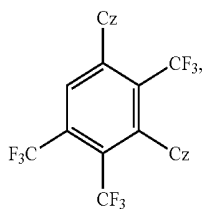
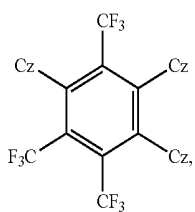
55

60

65

75

-continued

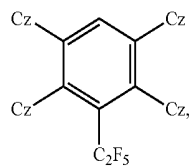


76

-continued

Compound 53

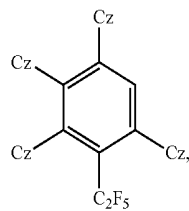
5



Compound 72

Compound 54

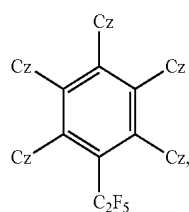
10



Compound 74

Compound 56

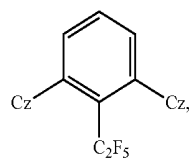
20



Compound 75

Compound 57

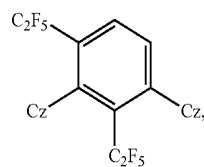
30



Compound 76

Compound 58

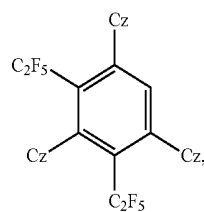
35



Compound 93

Compound 61

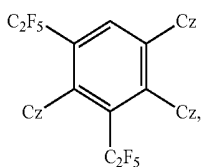
40



Compound 99

Compound 66

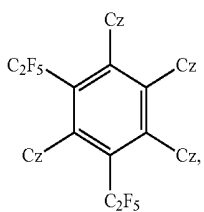
50



Compound 100

Compound 67

60

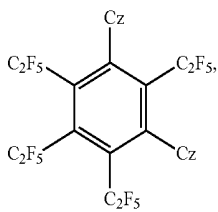
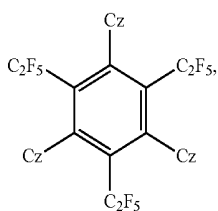
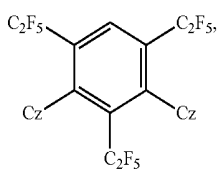
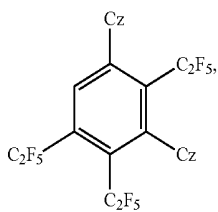
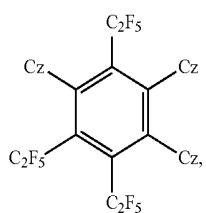
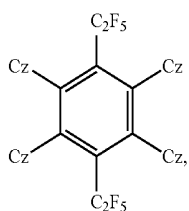
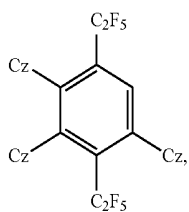
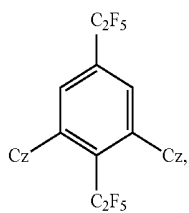


Compound 103

65

77

-continued

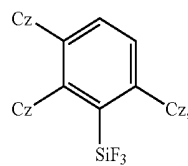


78

-continued

Compound 104

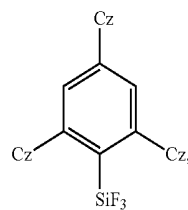
5



Compound 128

Compound 108

10

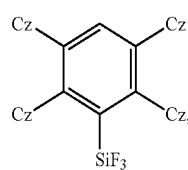


Compound 129

15

Compound 109

20

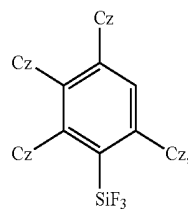


Compound 134

25

Compound 115

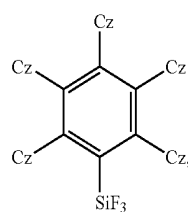
30



Compound 136

Compound 116

35

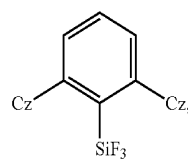


Compound 137

40

Compound 119

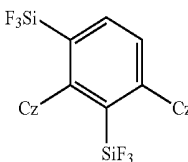
45



Compound 138

Compound 120

50

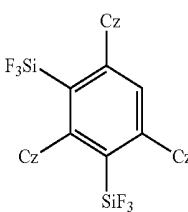


Compound 155

55

Compound 123

60

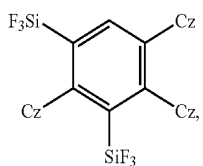


Compound 161

65

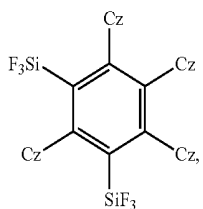
79

-continued



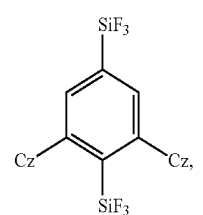
Compound 162

5



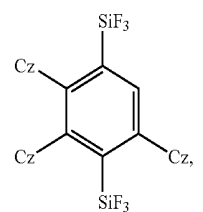
Compound 165

10



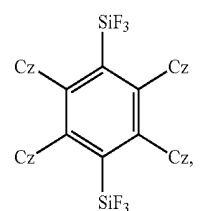
Compound 166

20



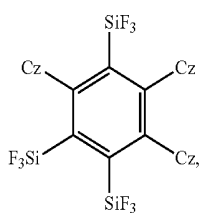
Compound 170

30



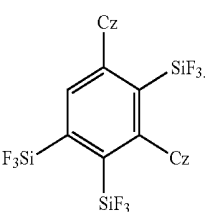
Compound 171

40



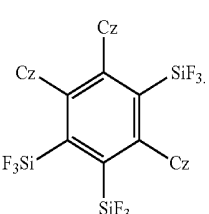
Compound 177

45



Compound 178

55

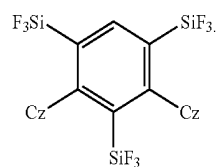


Compound 180

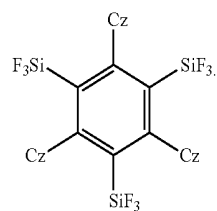
65

80

-continued

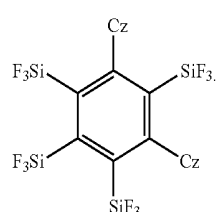


Compound 181



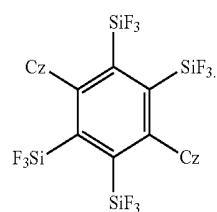
Compound 182

15



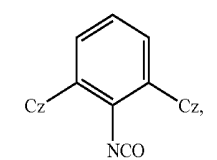
Compound 185

25



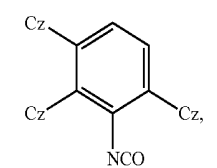
Compound 186

35



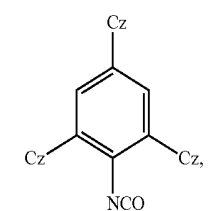
Compound 187

40



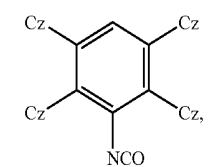
Compound 191

45



Compound 192

55

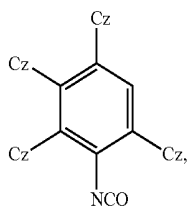


Compound 197

65

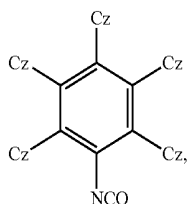
81

-continued



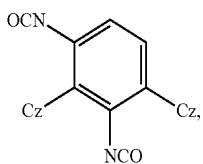
Compound 199

5



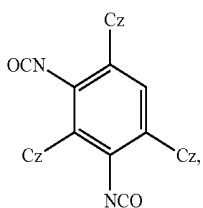
Compound 200

10



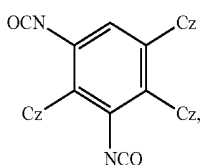
Compound 218

15



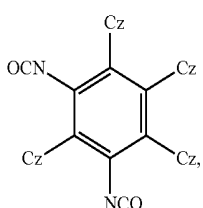
Compound 224

20



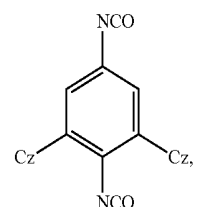
Compound 225

25



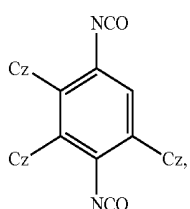
Compound 228

30



Compound 229

35



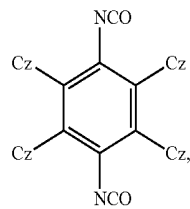
Compound 233

40

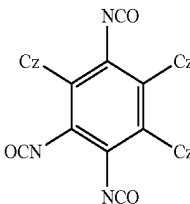
45

82

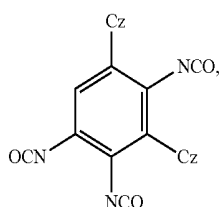
-continued



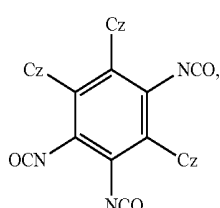
Compound 234



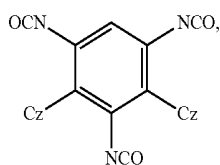
Compound 240



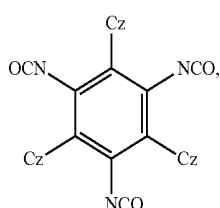
Compound 241



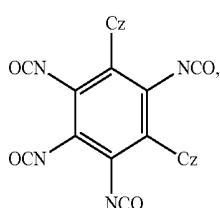
Compound 243



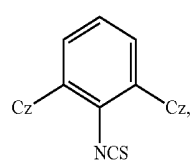
Compound 244



Compound 245



Compound 247



Compound 249

50

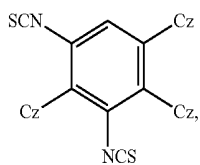
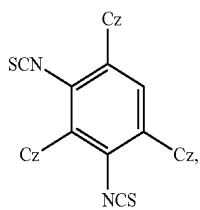
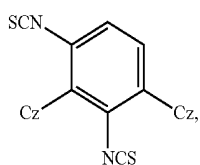
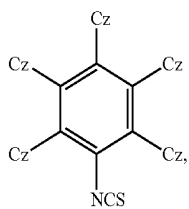
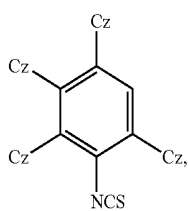
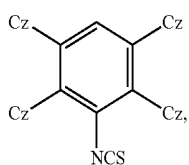
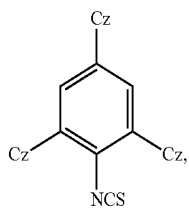
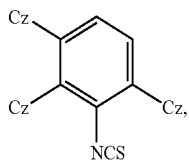
55

60

65

83

-continued

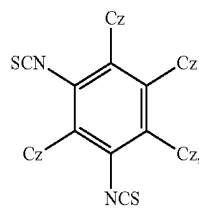


84

-continued

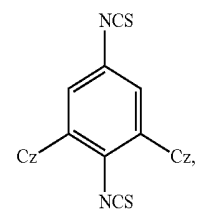
Compound 253

5



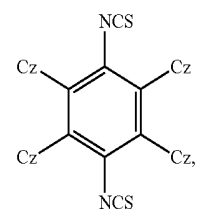
Compound 254

10



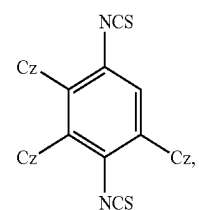
Compound 259

20



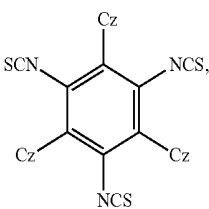
Compound 261

25



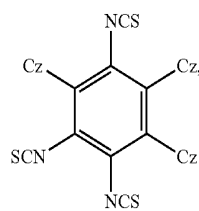
Compound 262

35



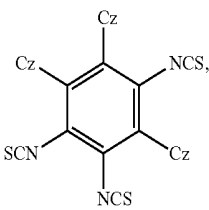
Compound 281

45



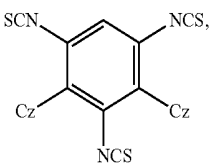
Compound 287

55



Compound 288

65



Compound 291

Compound 292

Compound 295

Compound 296

Compound 297

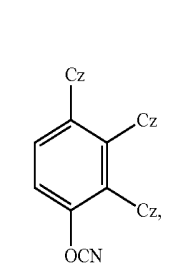
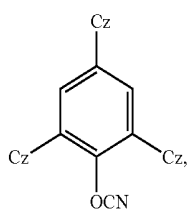
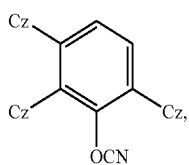
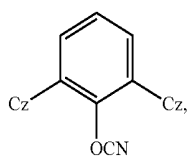
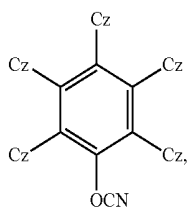
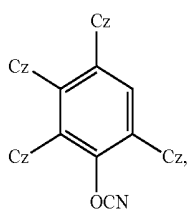
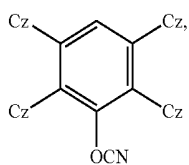
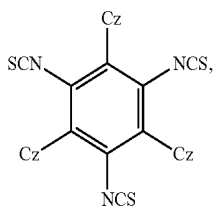
Compound 303

Compound 306

Compound 307

85

-continued

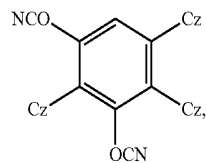


86

-continued

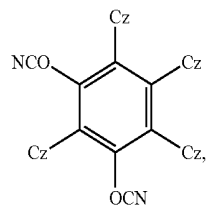
Compound 309

5



Compound 311

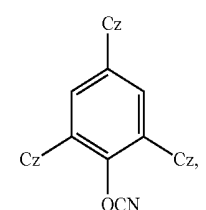
10



15

Compound 313

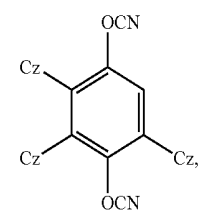
20



25

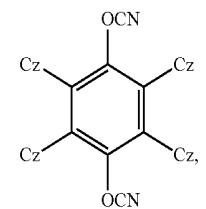
Compound 314

30



Compound 329

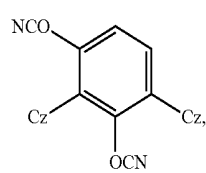
35



40

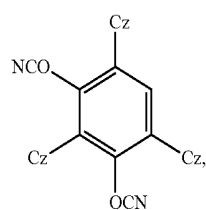
Compound 333

45



Compound 334

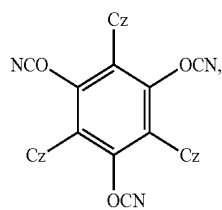
50



55

Compound 338

60



65

Compound 339

Compound 342

Compound 343

Compound 347

Compound 348

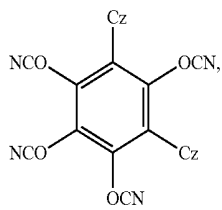
Compound 352

Compound 358

Compound 359

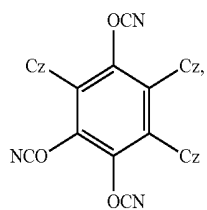
87

-continued



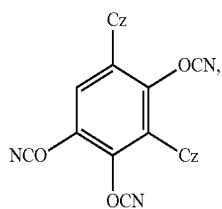
Compound 361

5



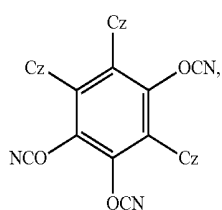
Compound 368

10



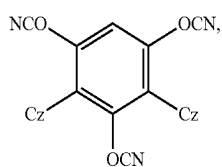
Compound 369

20



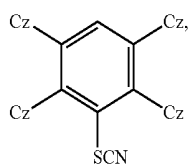
Compound 371

30



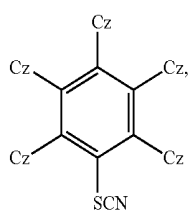
Compound 372

40



Compound 373

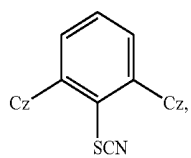
45



Compound 376

50

55

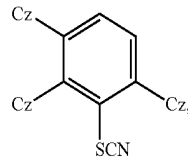


Compound 391

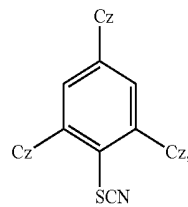
65

88

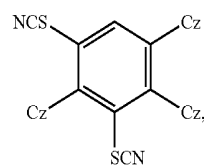
-continued



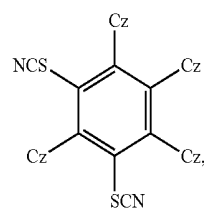
Compound 395



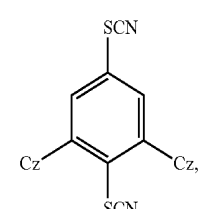
Compound 396



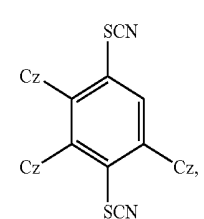
Compound 401



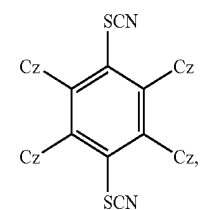
Compound 404



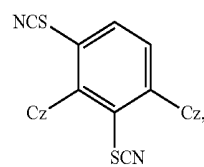
Compound 405



Compound 409



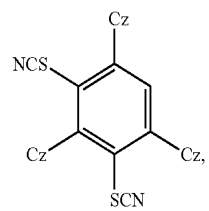
Compound 410



Compound 414

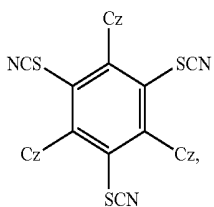
89

-continued



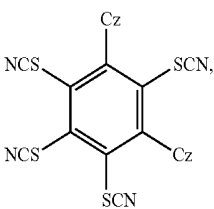
Compound 420

5



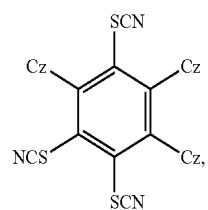
Compound 421

10



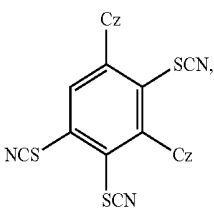
Compound 423

20



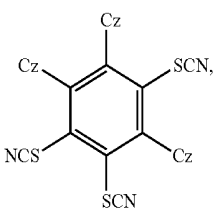
Compound 430

30



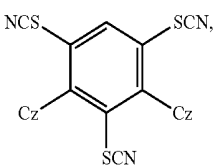
Compound 431

40



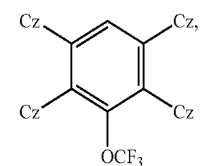
Compound 433

45



Compound 434

55



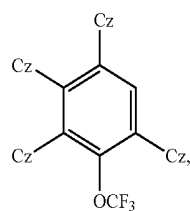
Compound 435

60

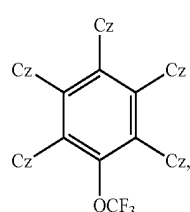
65

90

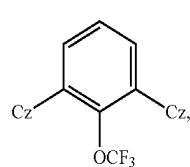
-continued



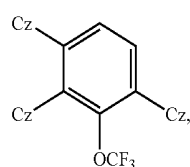
Compound 437



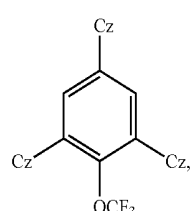
Compound 438



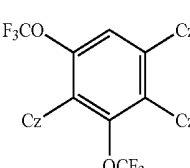
Compound 453



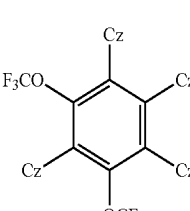
Compound 457



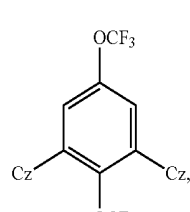
Compound 458



Compound 463



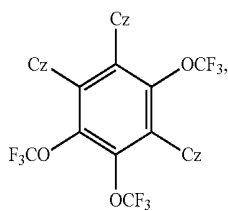
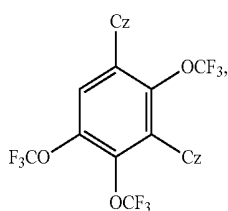
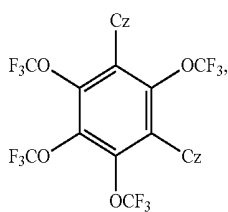
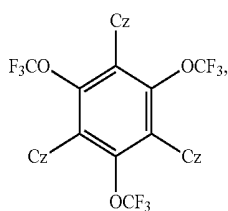
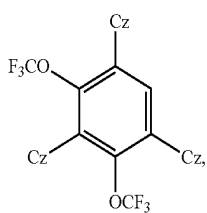
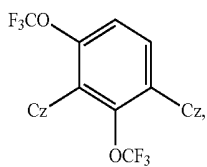
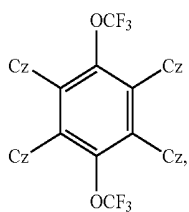
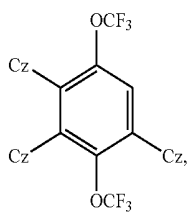
Compound 466



Compound 467

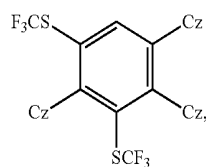
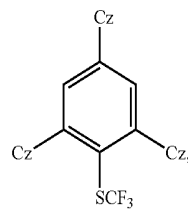
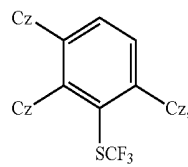
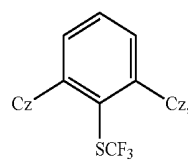
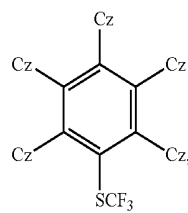
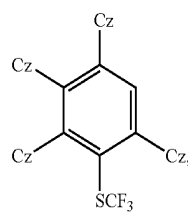
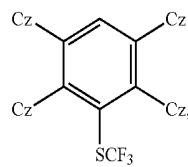
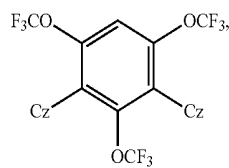
91

-continued



92

-continued



Compound 471

5

Compound 472

10

15

Compound 476

20

Compound 482

25

30

Compound 483

35

40

Compound 485

45

Compound 493

50

55

Compound 495

60

65

Compound 496

Compound 497

Compound 499

Compound 500

Compound 515

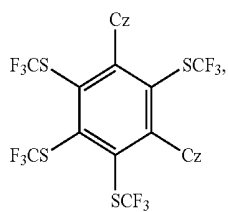
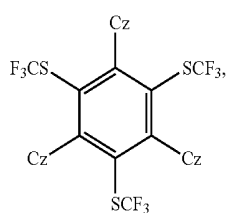
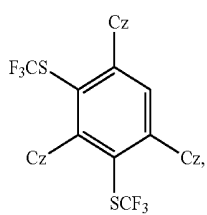
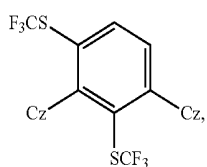
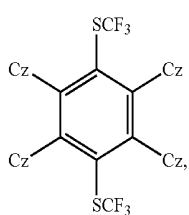
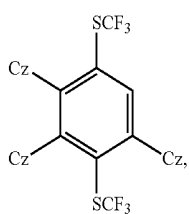
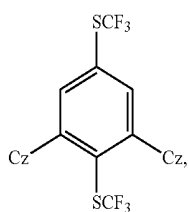
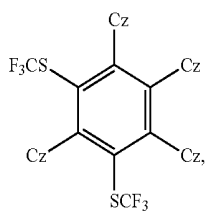
Compound 519

Compound 520

Compound 525

93

-continued

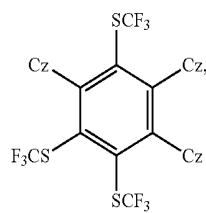


94

-continued

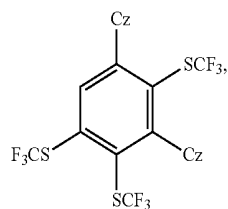
Compound 528

5



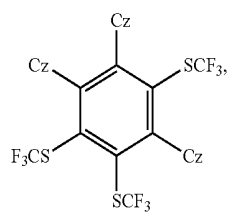
Compound 529

10



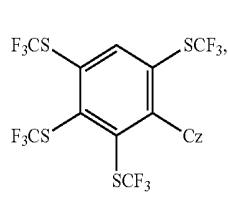
Compound 533

15



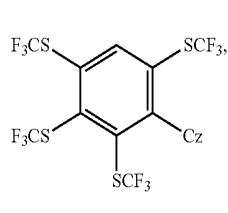
Compound 534

20



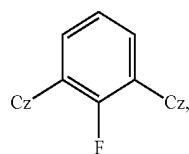
Compound 534

25



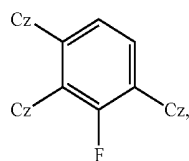
Compound 538

35



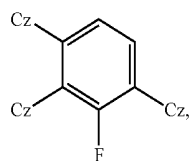
Compound 544

40



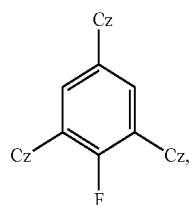
Compound 544

45



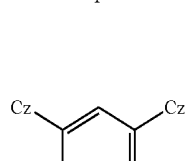
Compound 545

50



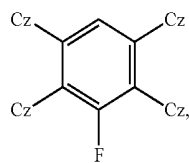
Compound 547

55



Compound 547

60



Compound 554

Compound 555

Compound 557

Compound 558

Compound 559

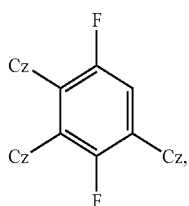
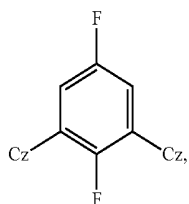
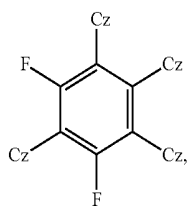
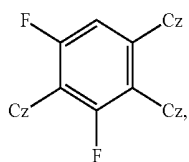
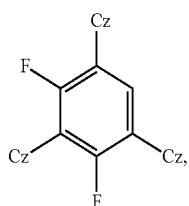
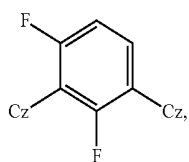
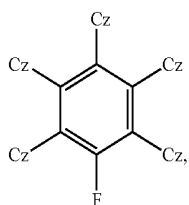
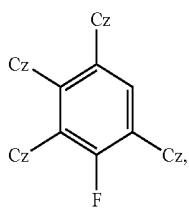
Compound 563

Compound 564

Compound 569

95

-continued

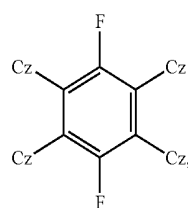


96

-continued

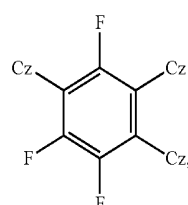
Compound 571

5



Compound 572

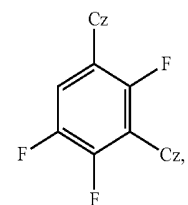
10



15

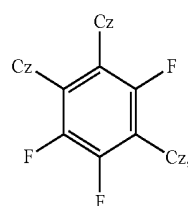
Compound 590

20



Compound 596

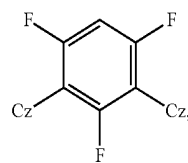
25



30

Compound 597

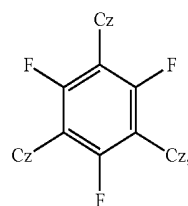
35



40

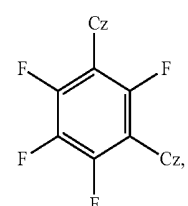
Compound 600

45



Compound 601

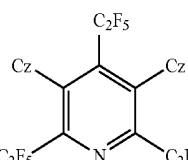
50



55

Compound 605

60



65

Compound 606

Compound 612

Compound 613

Compound 615

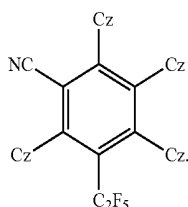
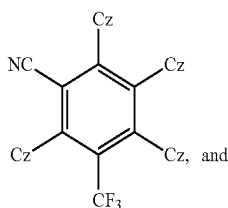
Compound 616

Compound 617

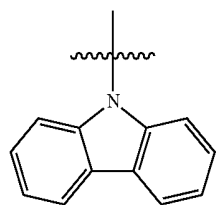
Compound 619

Compound 731

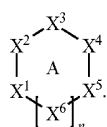
-continued



As used herein, Cz is



According to another aspect of the present disclosure, a first device is also provided. The first device can include a first organic light emitting device that includes an anode; a cathode; and an emissive layer disposed between the anode and the cathode. The emissive layer can include a first emitting compound comprising a structure according to Formula 2:



In the compound of Formula 2,

ring A is an aromatic or heteroaromatic ring;

n is 0 or 1;

when n is 0, X<sup>1</sup>, X<sup>2</sup>, X<sup>3</sup>, X<sup>4</sup>, and X<sup>5</sup> are independently selected from the group consisting of CR, N, NR, O, S, and Se, and at least one of X<sup>1</sup> to X<sup>5</sup> is CR;

when n is 1, X<sup>1</sup>, X<sup>2</sup>, X<sup>3</sup>, X<sup>4</sup>, X<sup>5</sup>, and X<sup>6</sup> are independently selected from the group consisting of CR and N, and at least one of X<sup>1</sup> to X<sup>6</sup> is CR;

each R is independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazoyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, —SC<sub>m</sub>F<sub>2m+1</sub>, and combinations thereof;

adjacent R groups are, optionally, joined to form a fused ring structure;

m ≥ 1;

Compound 738 at least one R group comprises a donor group with at least one electron-donating nitrogen; and

at least one R group comprises an acceptor group selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

Compound 741 In some embodiments, at least two R groups comprise a donor group with at least one electron-donating nitrogen. In some embodiments, at least three R groups comprise a donor group with at least one electron-donating nitrogen, or at least four R groups comprise a donor group with at least one electron-donating nitrogen, or at least five R groups comprise a donor group with at least one electron-donating nitrogen. In some embodiments the donor group comprising at least one electron-donating nitrogen is a carbazole.

In some embodiments, at least two R groups comprise an acceptor group selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>. In some embodiment, at least three R groups, at least four R groups, or at least five R groups comprise an acceptor group selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

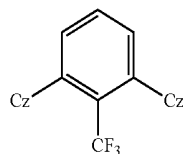
In some embodiments, n=1, at least two of X<sup>1</sup> to X<sup>6</sup> are CR, and at least two R groups are independently selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>. In some embodiments, n=1, wherein at least two of X<sup>1</sup> to X<sup>6</sup> are CR, at least one R group is selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>, and at least one R is an electron withdrawing group with a Hammett value (σ<sub>para</sub>) of at least 0.05.

In some embodiments, the compound in the emissive layer is a compound according to the structure of Formula 1, and all its variants, as described herein, with the provision that in addition to any other substituents listed for R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup>, and Z<sup>8</sup> each of R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup>, and Z<sup>8</sup> can independently also be —F.

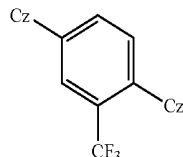
In some embodiments, the compound of formula 2 can be selected from the group consisting of:

45

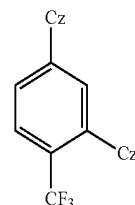
Compound 1



Compound 2



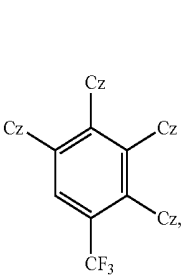
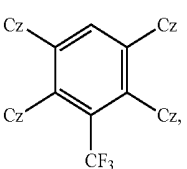
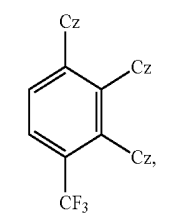
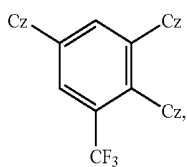
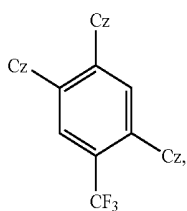
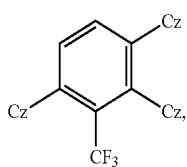
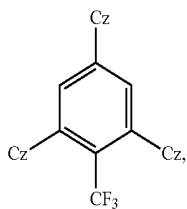
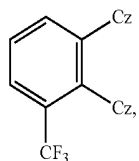
Compound 3



65

99

-continued



100

-continued

Compound 4

5

Compound 6

10

Compound 7

20

Compound 8

25

Compound 9

35

Compound 10

40

Compound 11

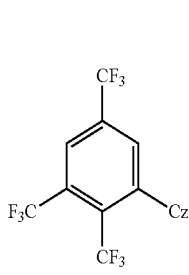
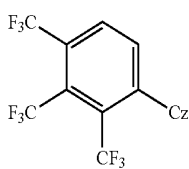
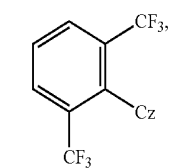
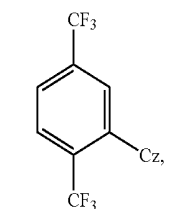
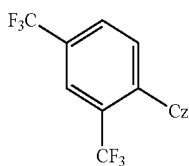
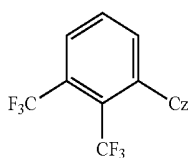
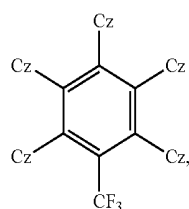
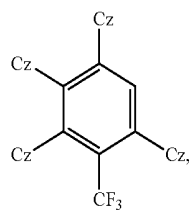
50

55

Compound 12

60

65



Compound 13

Compound 14

Compound 15

Compound 16

Compound 17

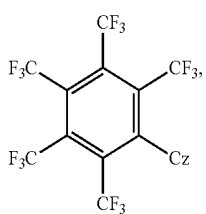
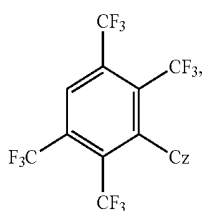
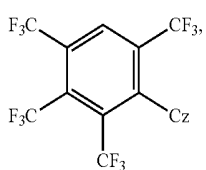
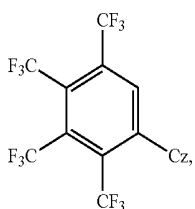
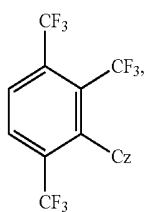
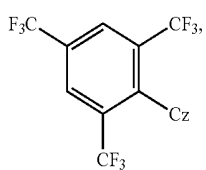
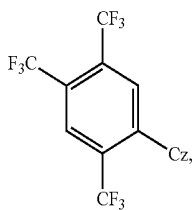
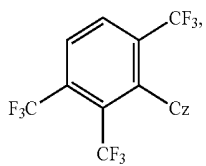
Compound 18

Compound 19

Compound 20

101

-continued

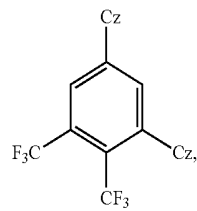


102

-continued

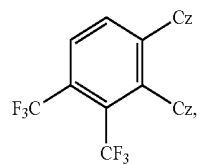
Compound 21

5



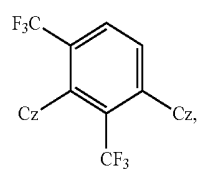
Compound 22

10



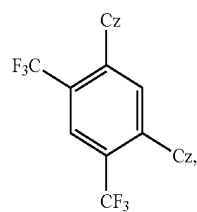
Compound 23

20



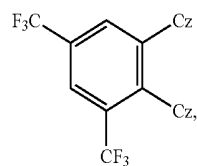
Compound 24

25



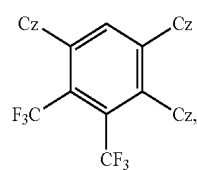
Compound 25

35



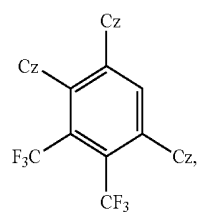
Compound 26

45



Compound 27

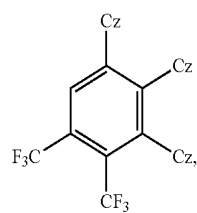
50



55

Compound 28

60



65

Compound 29

Compound 30

Compound 31

Compound 32

Compound 33

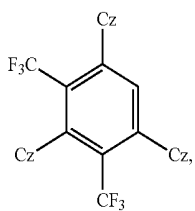
Compound 34

Compound 35

Compound 36

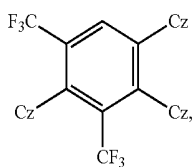
103

-continued



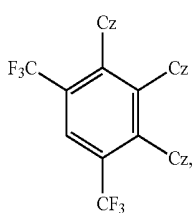
Compound 37

5



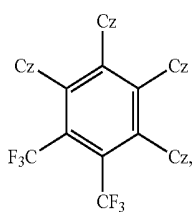
Compound 38

10



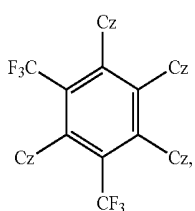
Compound 39

15



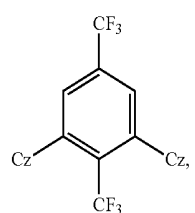
Compound 40

25



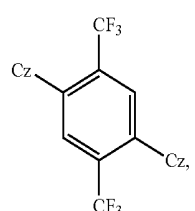
Compound 41

35



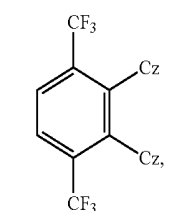
Compound 42

45



Compound 43

55

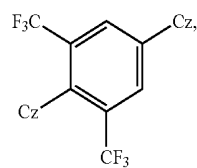


Compound 44

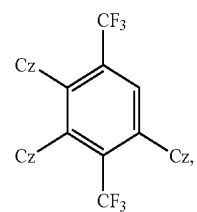
65

104

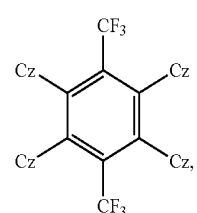
-continued



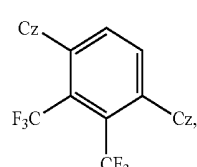
Compound 45



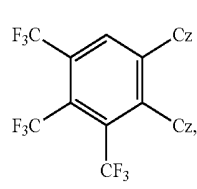
Compound 46



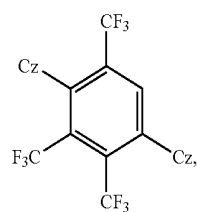
Compound 47



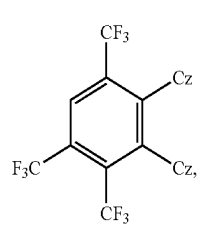
Compound 48



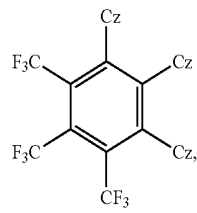
Compound 49



Compound 50



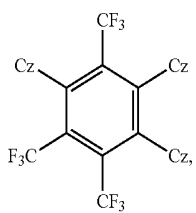
Compound 51



Compound 52

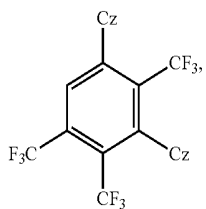
105

-continued



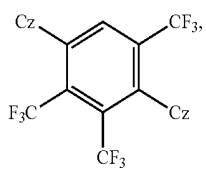
Compound 53

5



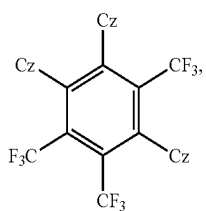
Compound 54

10



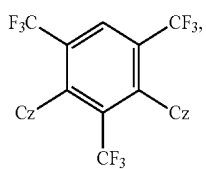
Compound 55

15



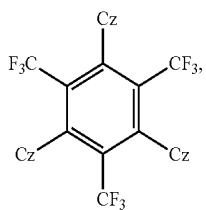
Compound 56

20



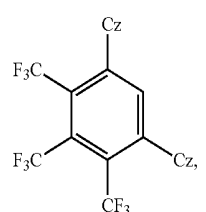
Compound 57

25



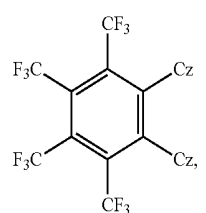
Compound 58

30



Compound 59

35



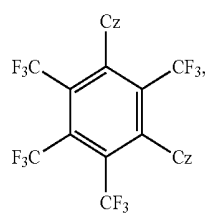
Compound 60

40

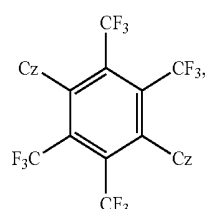
45

106

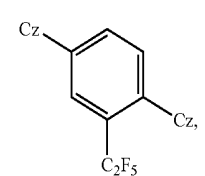
-continued



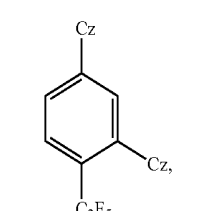
Compound 61



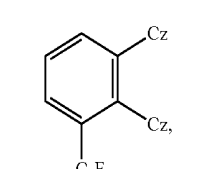
Compound 62



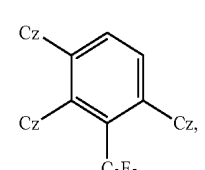
Compound 63



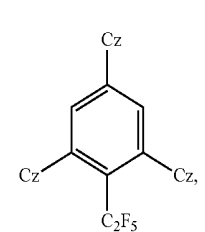
Compound 64



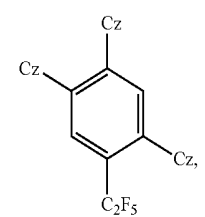
Compound 65



Compound 66



Compound 67



Compound 69

50

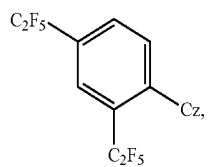
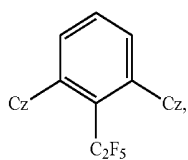
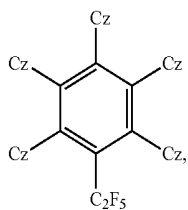
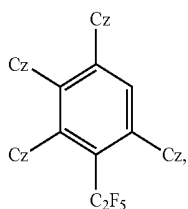
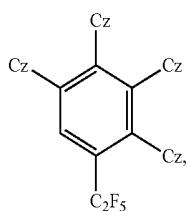
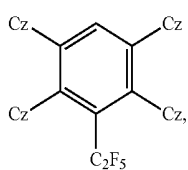
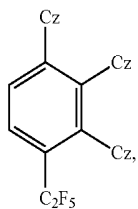
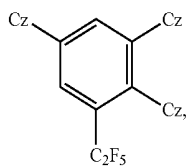
55

60

65

107

-continued

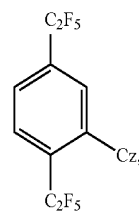


108

-continued

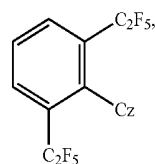
Compound 70

5



Compound 71

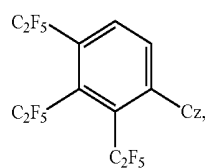
10



15

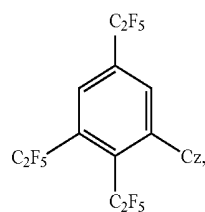
Compound 72

20



Compound 73

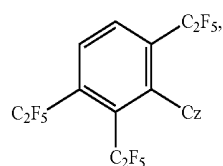
25



30

Compound 74

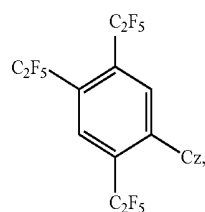
35



40

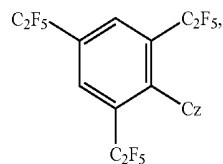
Compound 75

45



Compound 76

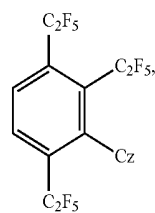
50



55

Compound 77

60



65

Compound 78

Compound 79

Compound 80

Compound 81

Compound 82

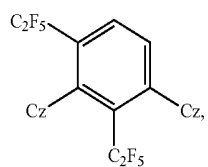
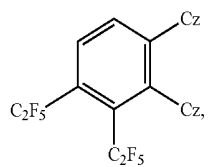
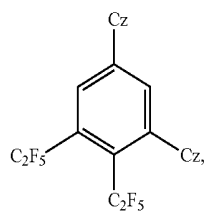
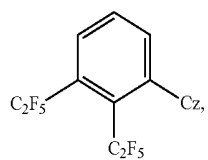
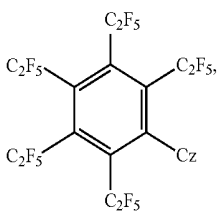
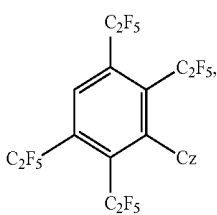
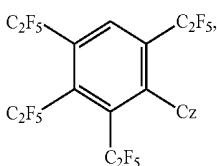
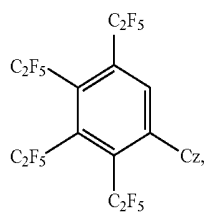
Compound 83

Compound 84

Compound 85

109

-continued

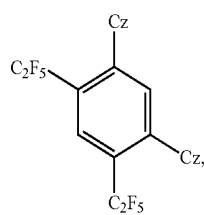


110

-continued

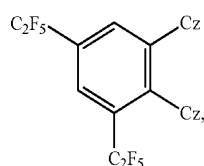
Compound 86

5



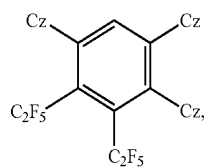
Compound 87

10



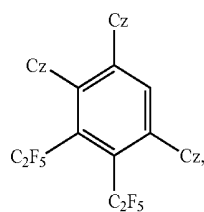
Compound 88

15



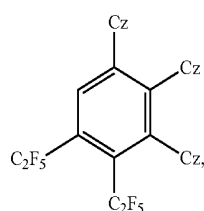
Compound 89

20



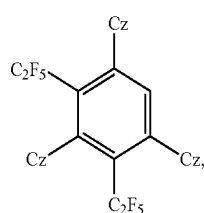
Compound 90

25



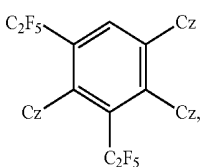
Compound 91

30



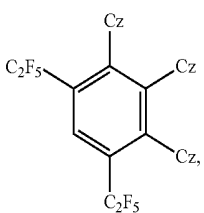
Compound 92

35



Compound 93

40



Compound 94

Compound 95

Compound 96

Compound 97

Compound 98

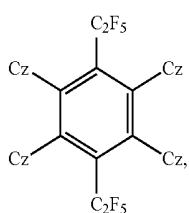
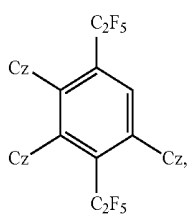
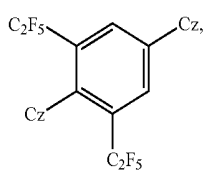
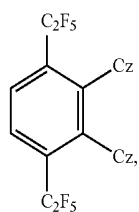
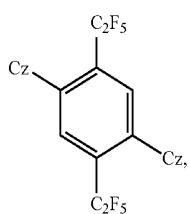
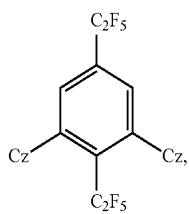
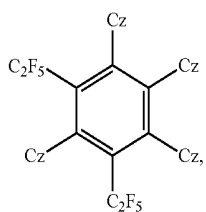
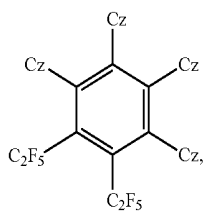
Compound 99

Compound 100

Compound 101

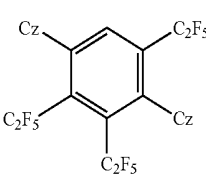
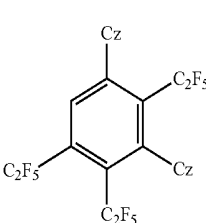
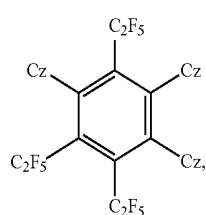
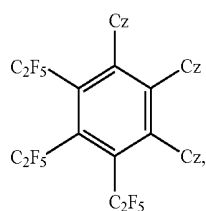
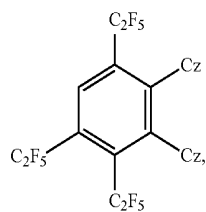
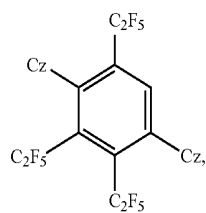
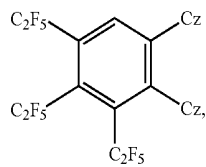
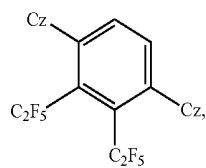
111

-continued



112

-continued



Compound 102

5

Compound 103

10

15

Compound 104

20

25

Compound 105

30

Compound 106

35

40

Compound 107

45

Compound 108

50

55

Compound 109

60

65

Compound 110

Compound 111

Compound 112

Compound 113

Compound 114

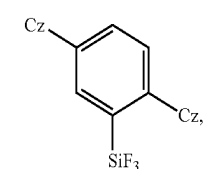
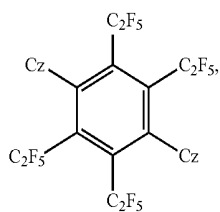
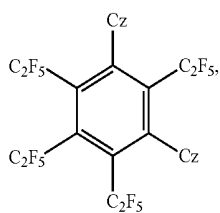
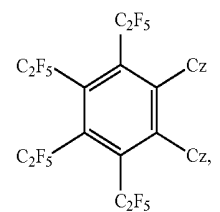
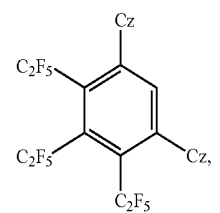
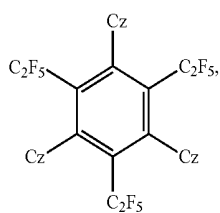
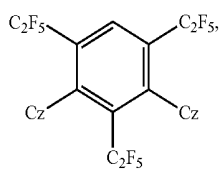
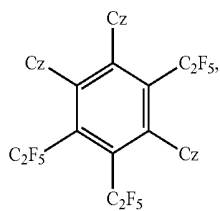
Compound 115

Compound 116

Compound 117

113

-continued

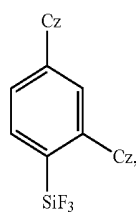


114

-continued

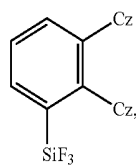
Compound 118

5



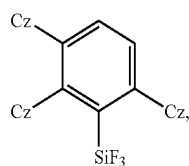
Compound 119

10



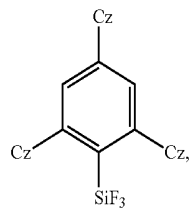
Compound 120

15



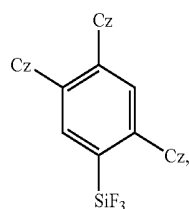
Compound 121

20



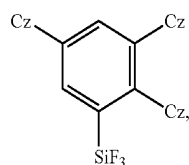
Compound 122

25



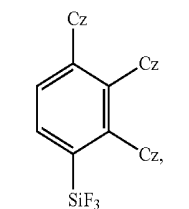
Compound 123

30



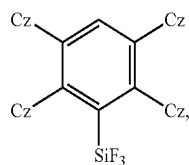
Compound 124

35



Compound 125

40



Compound 126

45

Compound 126

Compound 127

Compound 128

Compound 129

Compound 131

Compound 132

Compound 133

Compound 134

Compound 125

50

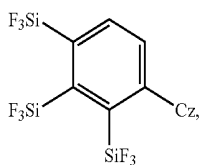
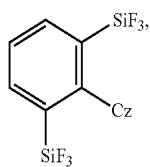
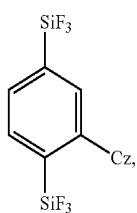
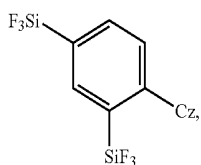
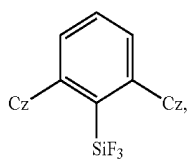
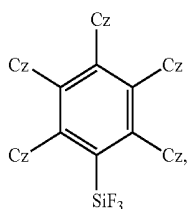
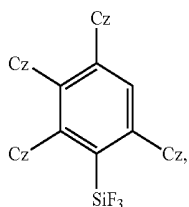
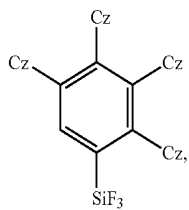
55

60

65

115

-continued

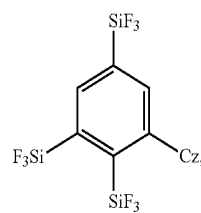


116

-continued

Compound 135

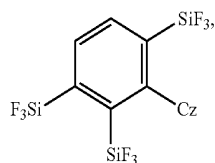
5



Compound 143

Compound 136

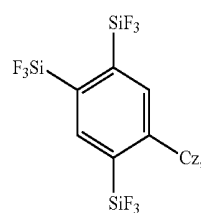
10



Compound 144

Compound 137

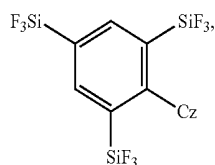
15



Compound 145

Compound 138

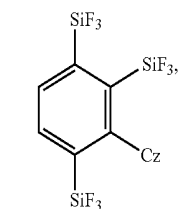
20



Compound 146

Compound 139

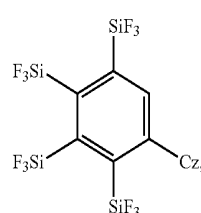
25



Compound 147

Compound 140

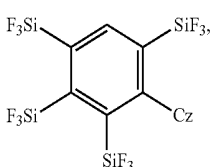
30



Compound 148

Compound 141

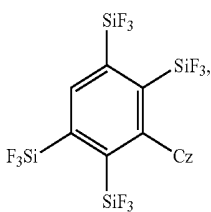
35



Compound 149

Compound 142

40



Compound 150

45

50

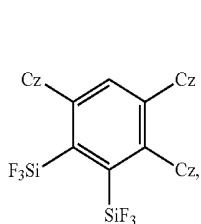
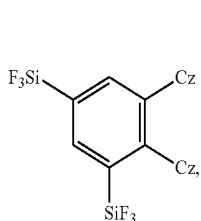
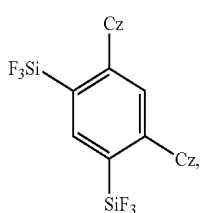
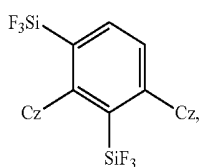
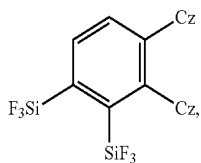
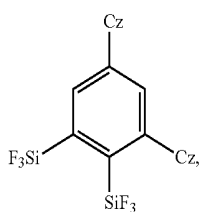
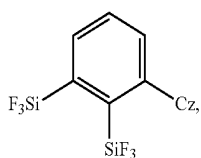
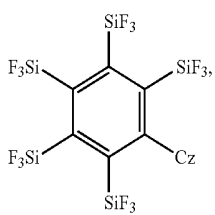
55

60

65

117

-continued

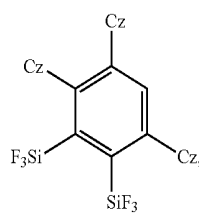


118

-continued

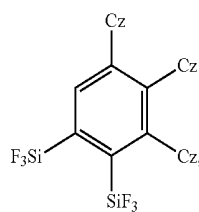
Compound 151

5



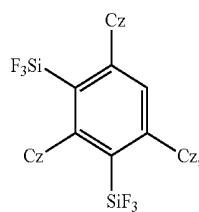
Compound 152

10



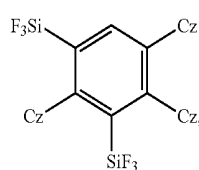
Compound 153

20



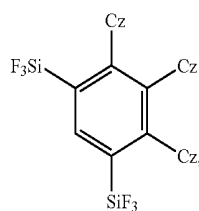
Compound 154

25



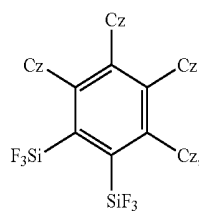
Compound 155

35



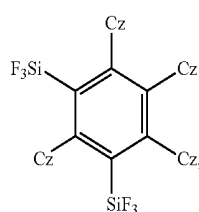
Compound 156

40



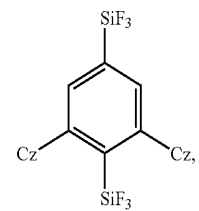
Compound 157

50



Compound 158

60



65

Compound 159

Compound 160

Compound 161

Compound 162

Compound 163

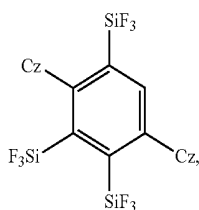
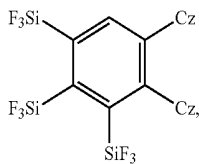
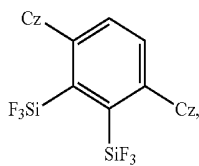
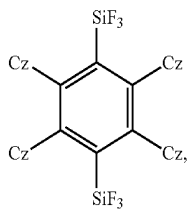
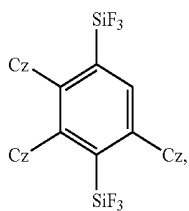
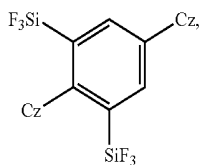
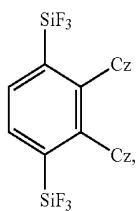
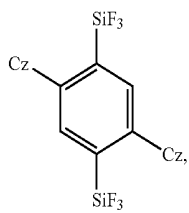
Compound 164

Compound 165

Compound 166

119

-continued

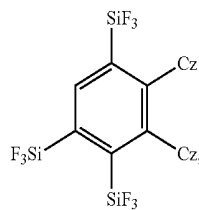


120

-continued

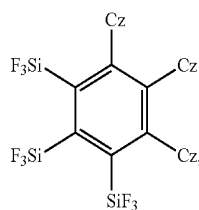
Compound 167

5



Compound 168

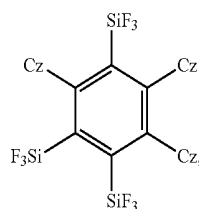
10



15

Compound 169

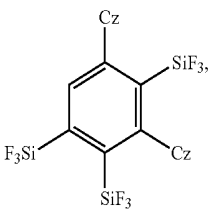
20



25

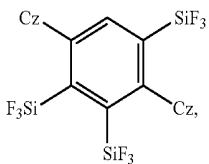
Compound 170

30



Compound 171

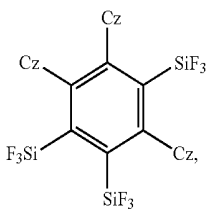
35



40

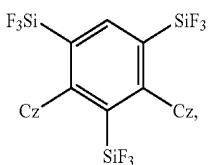
Compound 172

45



Compound 173

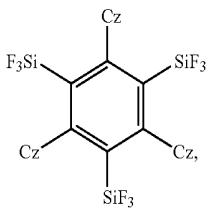
50



55

Compound 174

60



65

Compound 175

Compound 176

Compound 177

Compound 178

Compound 179

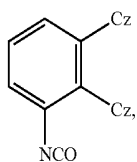
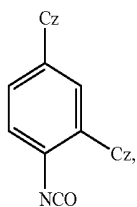
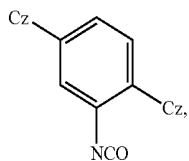
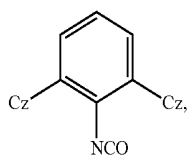
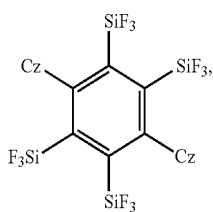
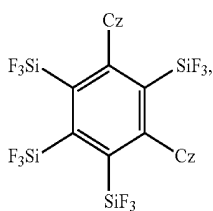
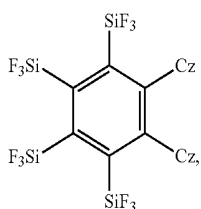
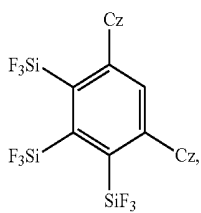
Compound 180

Compound 181

Compound 182

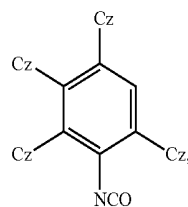
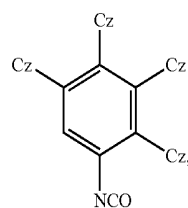
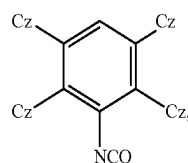
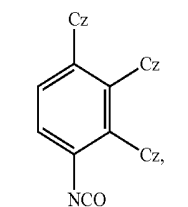
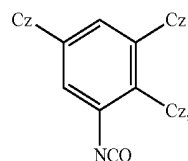
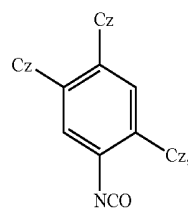
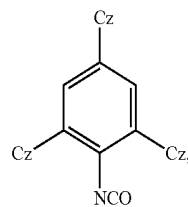
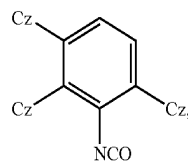
121

-continued



122

-continued



Compound 183

5

Compound 184

10

Compound 184

15

Compound 185

20

25

Compound 186

30

Compound 187

40

Compound 188

45

Compound 189

50

55

Compound 190

60

65

Compound 191

Compound 192

Compound 194

Compound 195

Compound 196

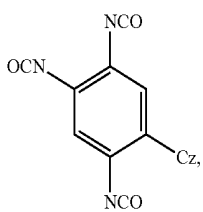
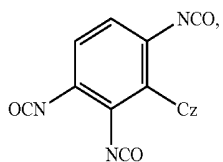
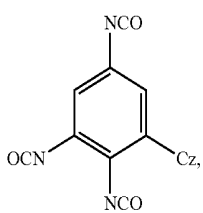
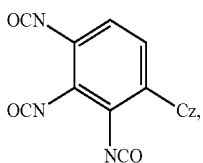
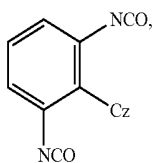
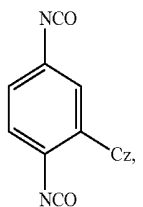
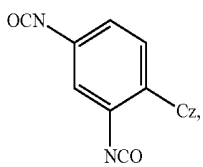
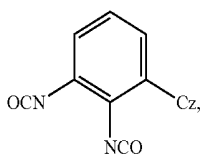
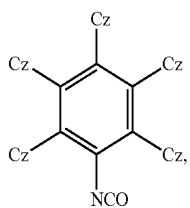
Compound 197

Compound 198

Compound 199

123

-continued

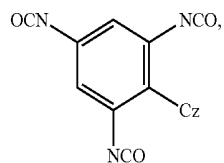


124

-continued

Compound 200

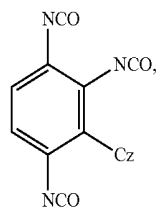
5



Compound 209

Compound 201 10

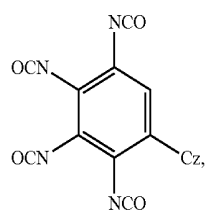
15



Compound 210

Compound 202

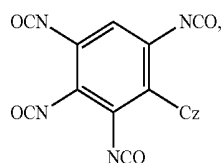
20



Compound 211

Compound 203

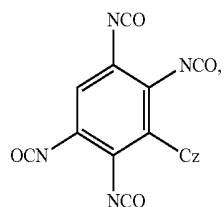
25



Compound 212

Compound 204

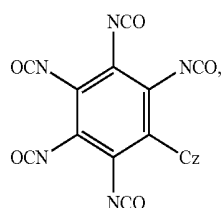
35



Compound 213

Compound 205

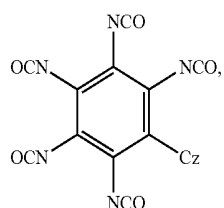
40



Compound 214

Compound 206

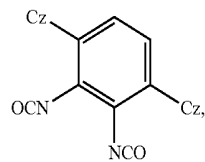
45



Compound 215

Compound 207

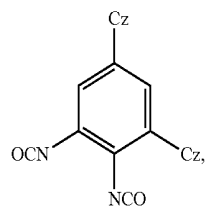
55



Compound 216

Compound 208

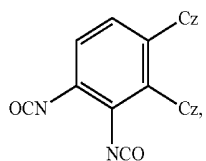
60



65

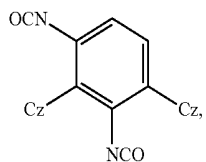
**125**

-continued



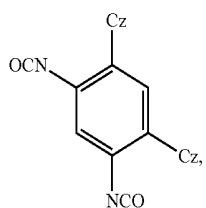
Compound 217

5



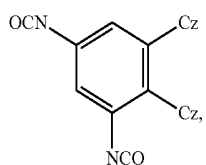
Compound 218

10



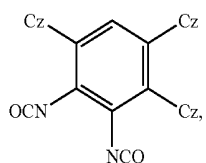
Compound 219

15



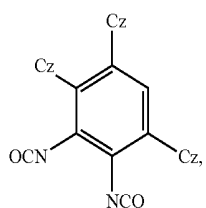
Compound 220

25



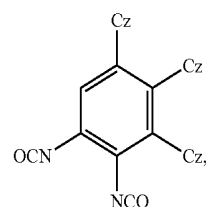
Compound 221

30



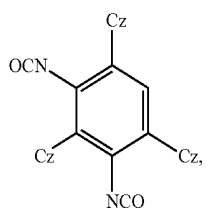
Compound 222

40



Compound 223

50



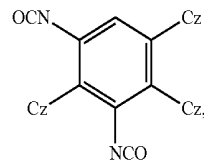
Compound 224

60

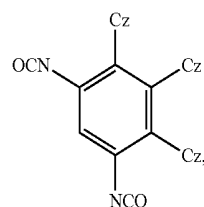
65

**126**

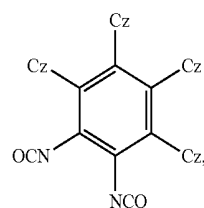
-continued



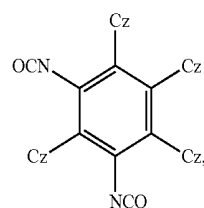
Compound 225



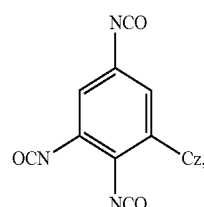
Compound 226



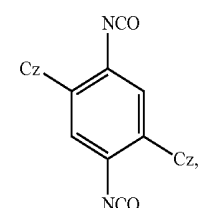
Compound 227



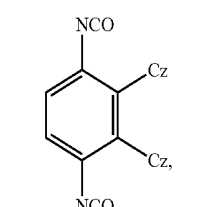
Compound 228



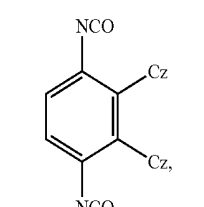
Compound 229



Compound 230



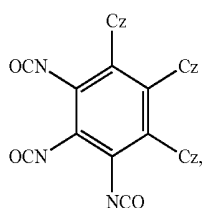
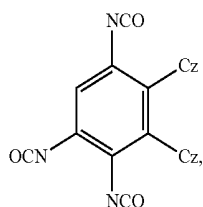
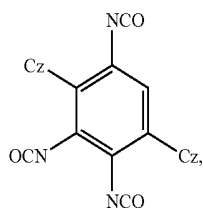
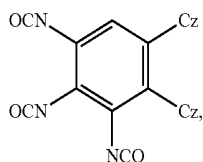
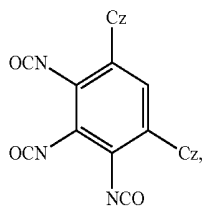
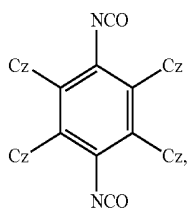
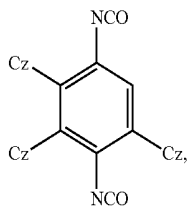
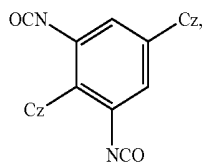
Compound 231



Compound 231

127

-continued

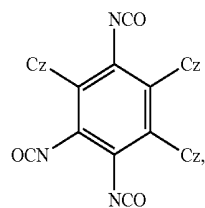


128

-continued

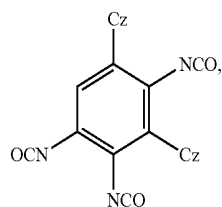
Compound 232

5



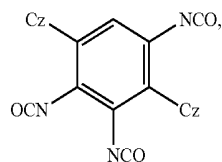
Compound 233

10



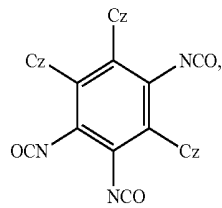
Compound 234

15



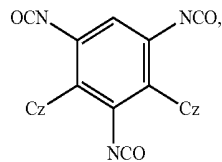
Compound 235

20



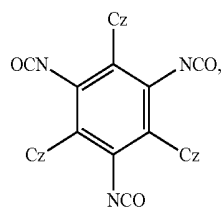
Compound 236

25



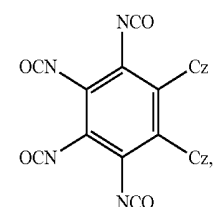
Compound 237

30



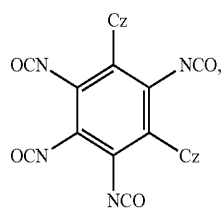
Compound 238

35



Compound 239

40



45

50

55

60

65

Compound 240

Compound 241

Compound 242

Compound 243

Compound 244

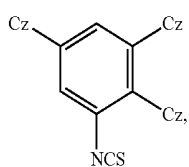
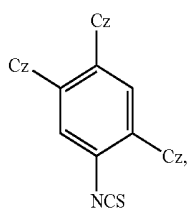
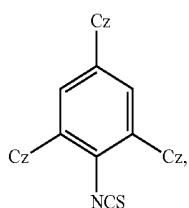
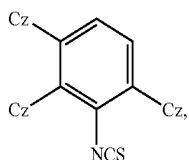
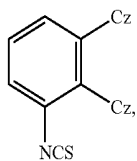
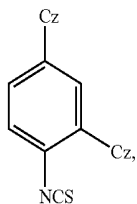
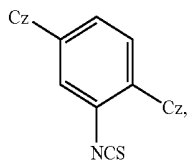
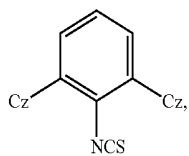
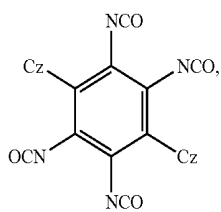
Compound 245

Compound 246

Compound 247

129

-continued

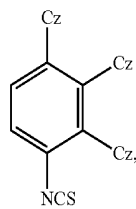


130

-continued

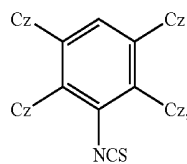
Compound 248

5



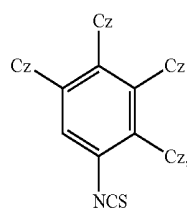
Compound 249

10



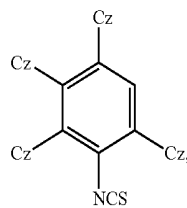
Compound 250

15



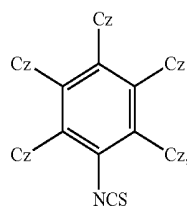
Compound 251

25



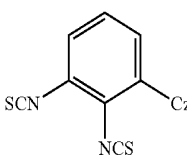
Compound 252

35



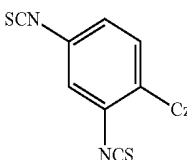
Compound 253

40



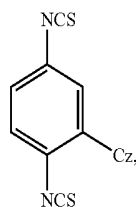
Compound 254

45



Compound 256

55



Compound 257

65

Compound 258

Compound 259

Compound 260

Compound 261

Compound 262

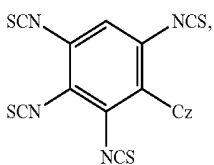
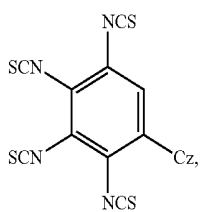
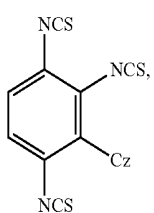
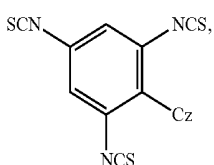
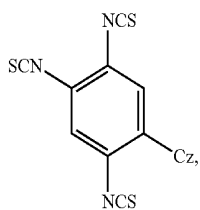
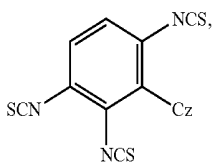
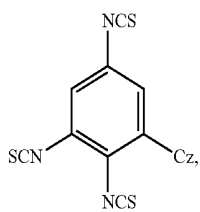
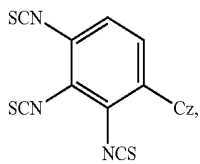
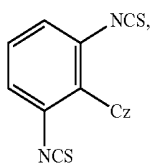
Compound 263

Compound 264

Compound 265

131

-continued

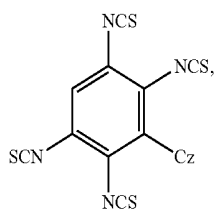


132

-continued

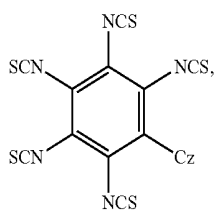
Compound 266

5



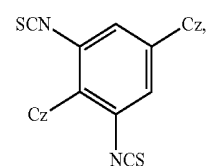
Compound 267

10



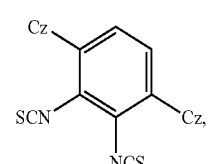
Compound 268

15



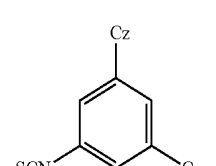
Compound 269

20



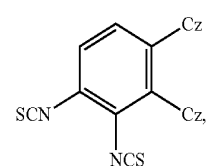
Compound 270

25



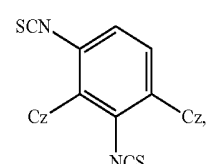
Compound 271

30



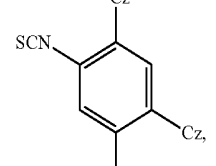
Compound 272

35



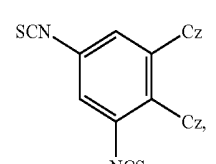
Compound 273

40



Compound 274

45



50

55

60

65

Compound 275

Compound 276

Compound 277

Compound 278

Compound 279

Compound 280

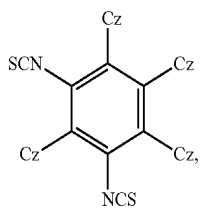
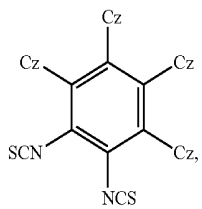
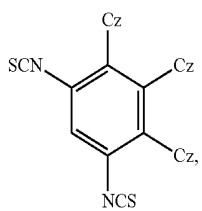
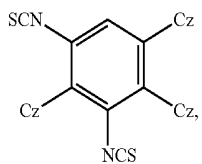
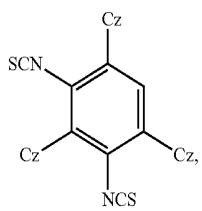
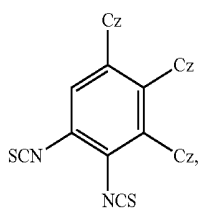
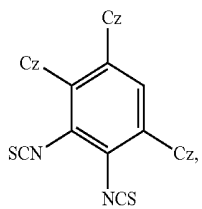
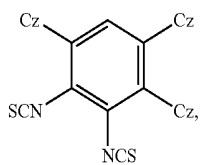
Compound 281

Compound 282

Compound 283

133

-continued

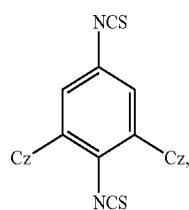


134

-continued

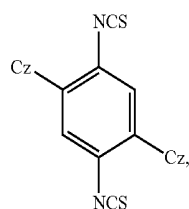
Compound 284

5



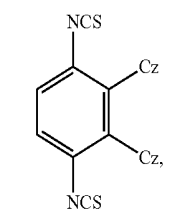
Compound 285

10



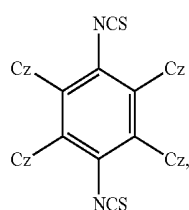
Compound 286

15



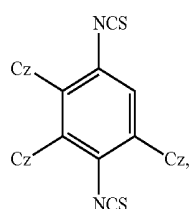
Compound 287

20



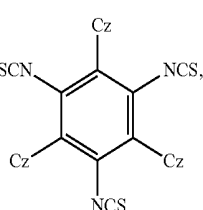
Compound 288

25



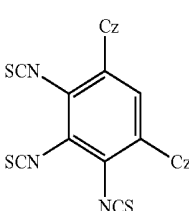
Compound 289

30



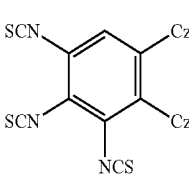
Compound 290

35



Compound 291

40



45

Compound 292

Compound 293

Compound 294

Compound 295

Compound 296

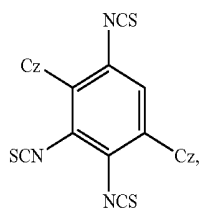
Compound 297

Compound 298

Compound 299

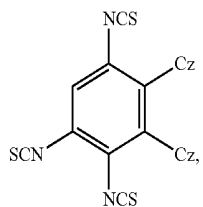
135

-continued



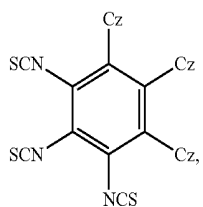
Compound 300

5



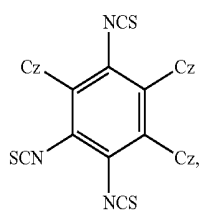
Compound 301

10



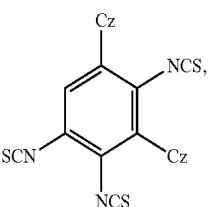
Compound 302

15



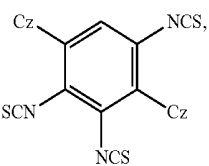
Compound 303

20



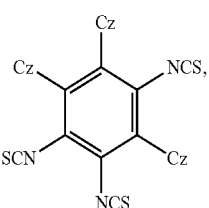
Compound 304

25



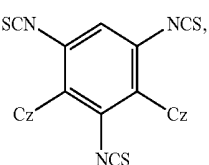
Compound 305

30



Compound 306

35

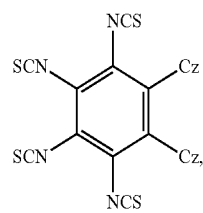


Compound 307

40

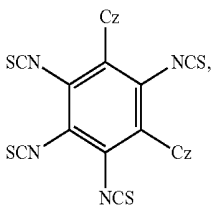
136

-continued



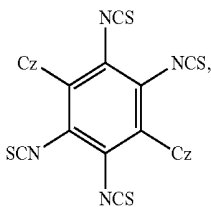
Compound 308

5



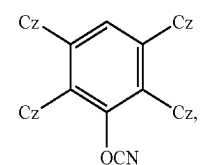
Compound 309

10



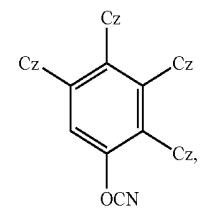
Compound 310

15



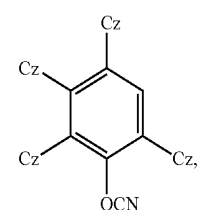
Compound 311

20



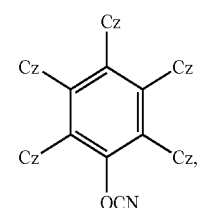
Compound 312

25



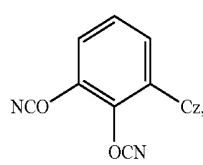
Compound 313

30



Compound 314

35



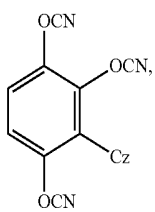
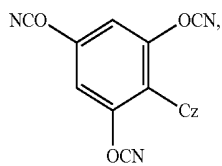
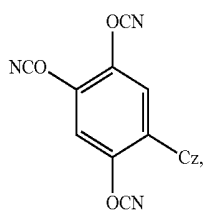
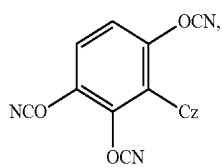
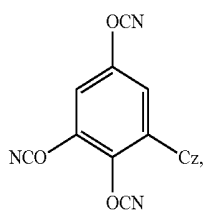
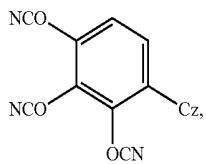
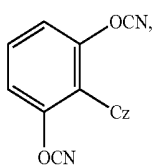
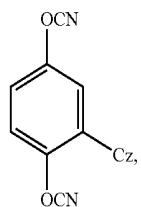
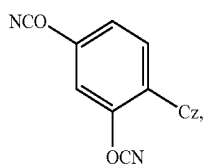
Compound 315

40

65

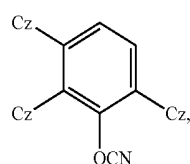
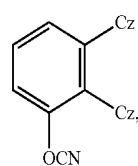
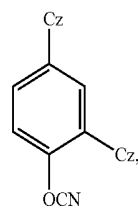
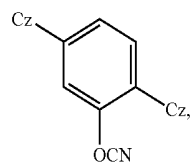
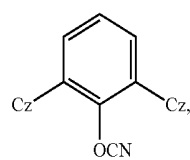
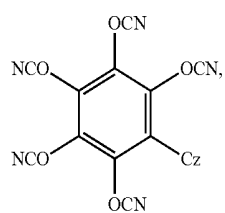
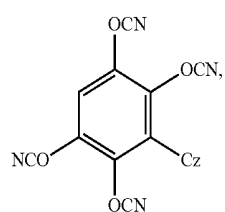
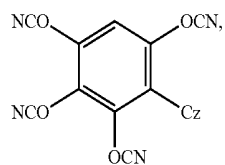
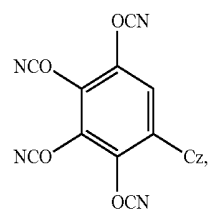
137

-continued



138

-continued



Compound 316

5

Compound 317

10

15

Compound 318

20

Compound 319

25

Compound 320

30

35

Compound 321

40

Compound 322

45

50

Compound 323

55

Compound 324

60

65

Compound 325

Compound 326

Compound 327

Compound 328

Compound 329

Compound 330

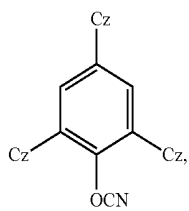
Compound 331

Compound 332

Compound 333

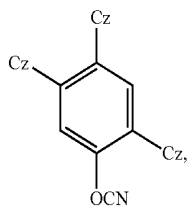
139

-continued



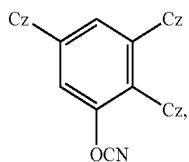
Compound 334

5



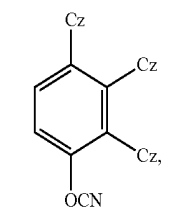
Compound 336

10



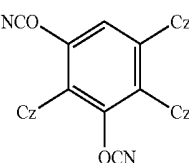
Compound 337

20



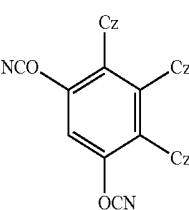
Compound 338

25



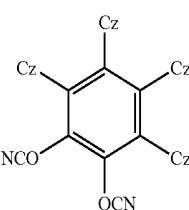
Compound 339

35



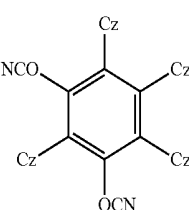
Compound 340

40



Compound 341

50



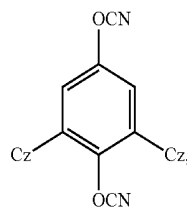
Compound 342

60

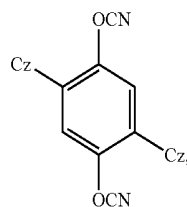
65

140

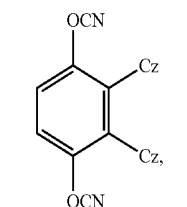
-continued



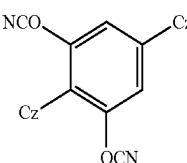
Compound 343



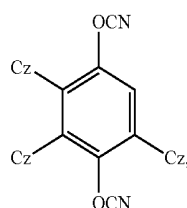
Compound 344



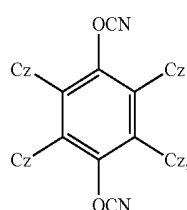
Compound 345



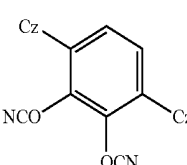
Compound 346



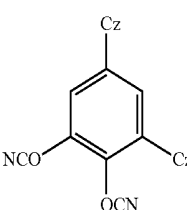
Compound 347



Compound 348



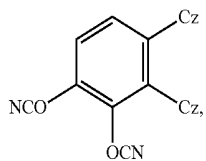
Compound 349



Compound 350

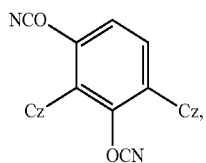
141

-continued



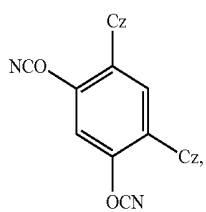
Compound 351

5



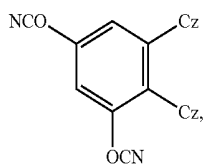
Compound 352

10



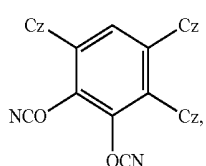
Compound 353

15



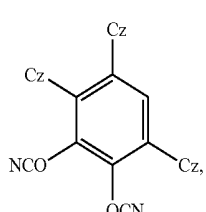
Compound 354

20



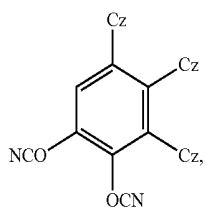
Compound 355

25



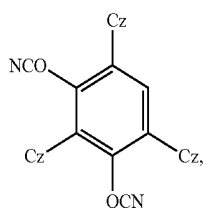
Compound 356

30



Compound 357

35



Compound 358

40

45

50

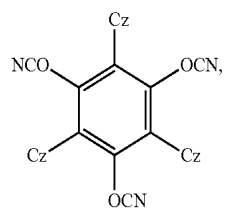
55

60

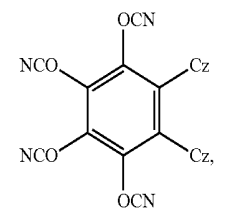
65

142

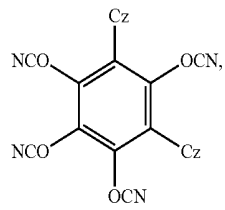
-continued



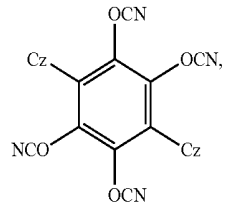
Compound 359



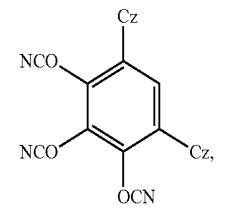
Compound 360



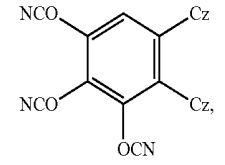
Compound 361



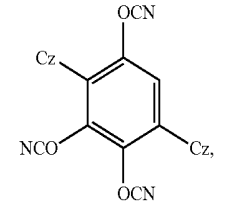
Compound 362



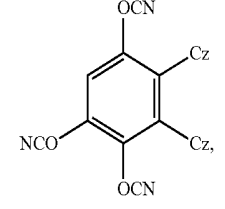
Compound 363



Compound 364



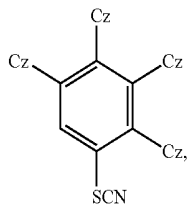
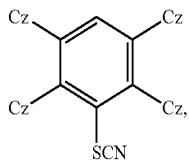
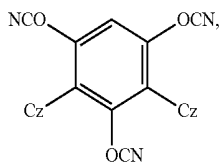
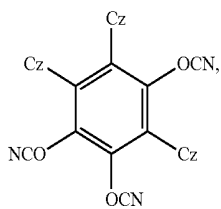
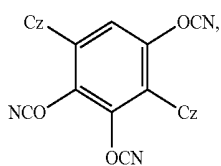
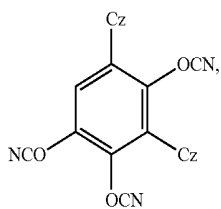
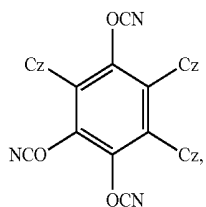
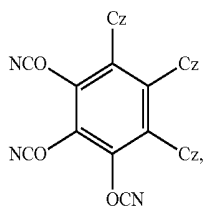
Compound 365



Compound 366

143

-continued

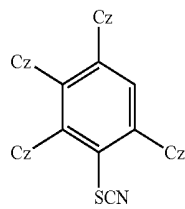


144

-continued

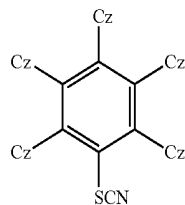
Compound 367

5



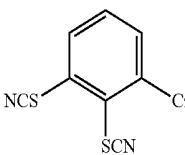
Compound 368

10



Compound 369

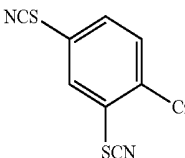
15



20

Compound 370

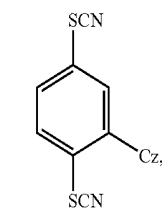
25



30

Compound 371

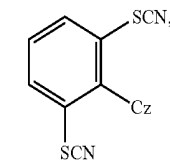
35



40

Compound 372

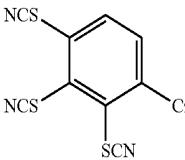
45



50

Compound 373

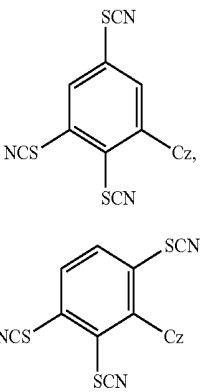
55



60

Compound 374

65



Compound 375

Compound 376

Compound 377

Compound 378

Compound 379

Compound 380

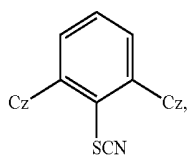
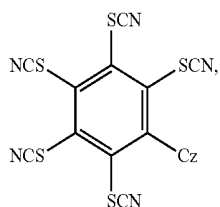
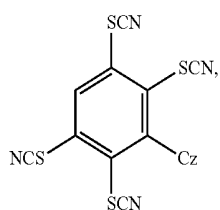
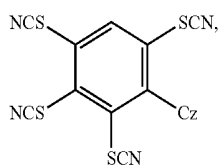
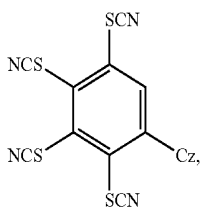
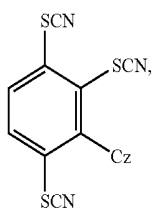
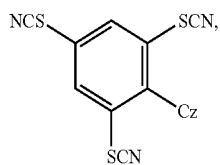
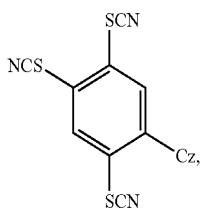
Compound 381

Compound 382

Compound 383

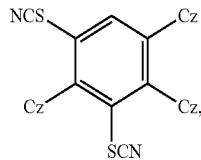
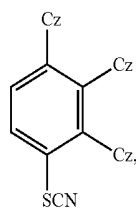
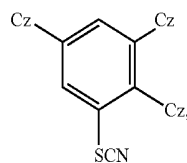
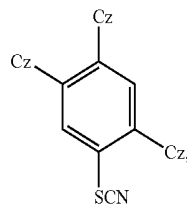
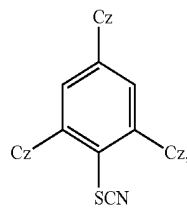
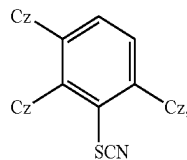
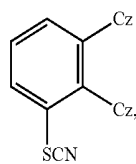
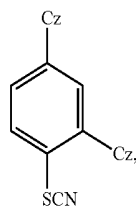
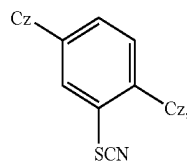
145

-continued



146

-continued



Compound 384

5

Compound 385

10

15

Compound 386

20

Compound 387

25

30

Compound 388

35

Compound 389

40

45

Compound 390

50

55

Compound 391

60

65

Compound 392

Compound 393

Compound 394

Compound 395

Compound 396

Compound 398

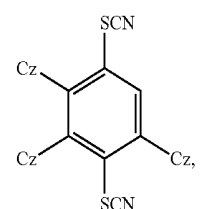
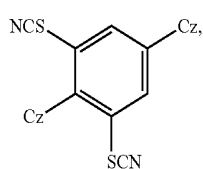
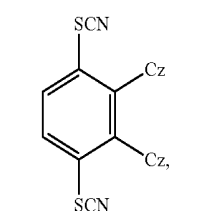
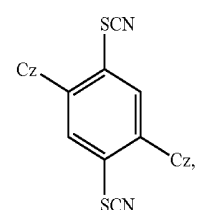
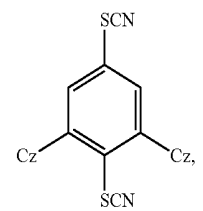
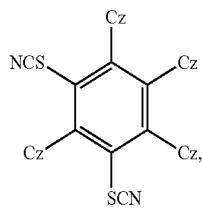
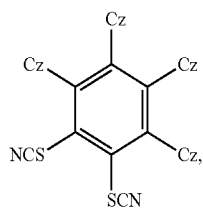
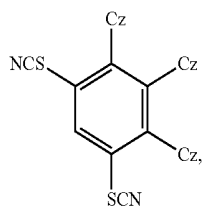
Compound 399

Compound 400

Compound 401

147

-continued

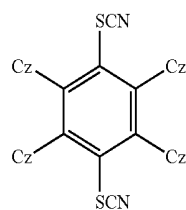


148

-continued

Compound 402

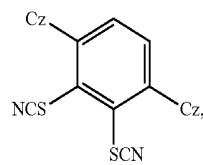
5



Compound 410

Compound 403

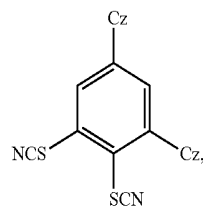
10



Compound 411

Compound 404

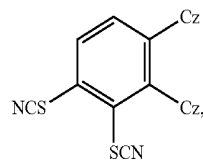
20



Compound 412

Compound 405

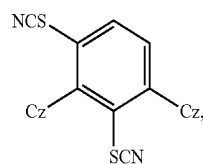
25



Compound 413

Compound 406

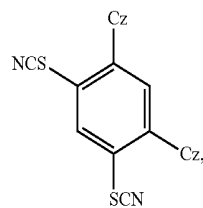
35



Compound 414

Compound 407

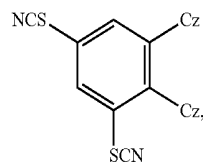
45



Compound 415

Compound 408

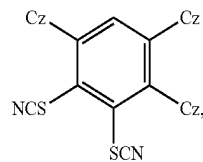
55



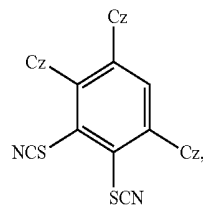
Compound 416

Compound 409

65



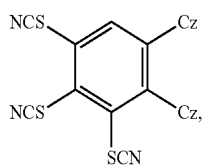
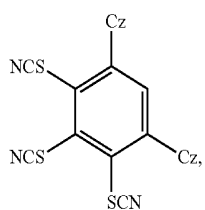
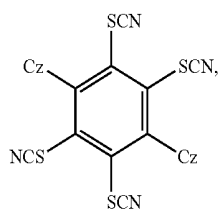
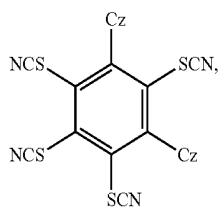
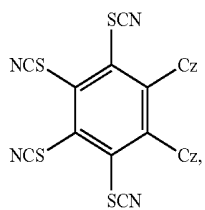
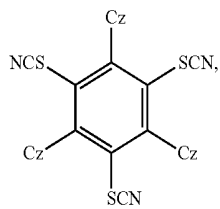
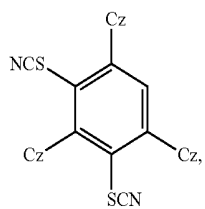
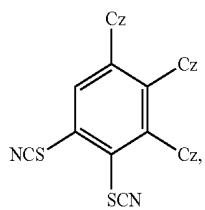
Compound 417



Compound 418

149

-continued

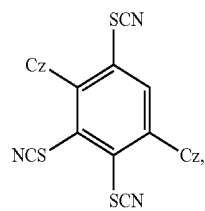


150

-continued

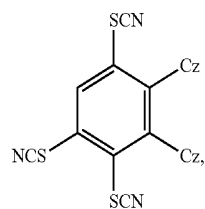
Compound 419

5



Compound 420

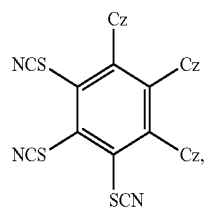
10



15

Compound 421

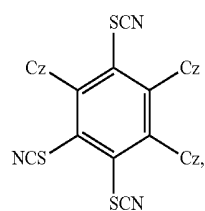
20



25

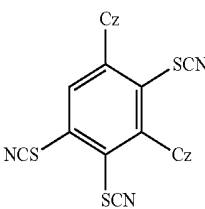
Compound 422

30



Compound 423

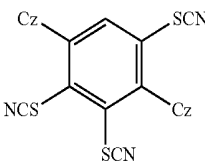
35



40

Compound 424

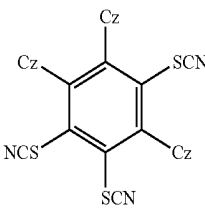
45



50

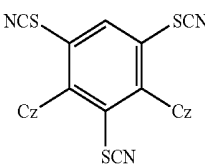
Compound 425

55



Compound 426

65



Compound 427

Compound 428

Compound 429

Compound 430

Compound 431

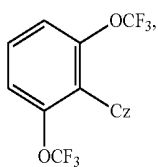
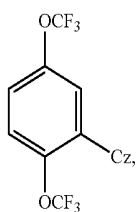
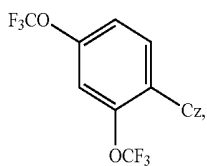
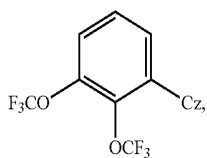
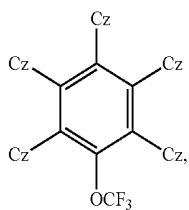
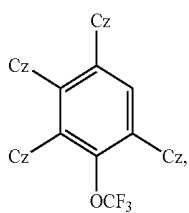
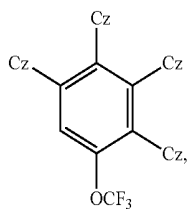
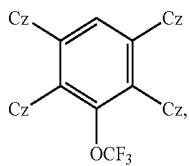
Compound 432

Compound 433

Compound 434

151

-continued

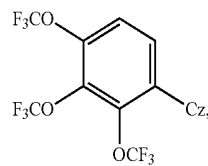


152

-continued

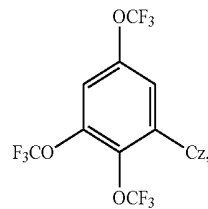
Compound 435

5



Compound 436

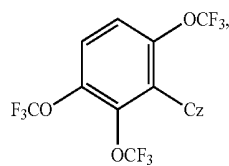
10



15

Compound 437

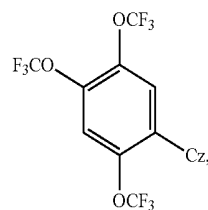
20



25

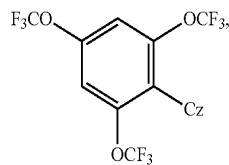
Compound 438

30



Compound 439

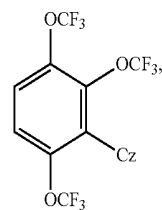
35



40

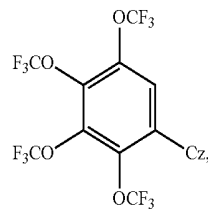
Compound 440

45



Compound 441

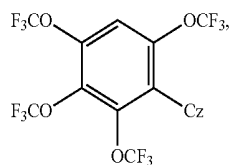
50



55

Compound 442

60



65

Compound 443

Compound 444

Compound 445

Compound 446

Compound 447

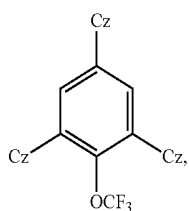
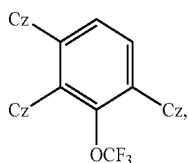
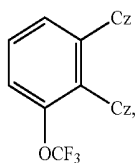
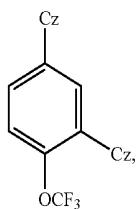
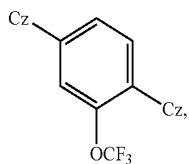
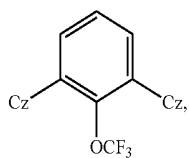
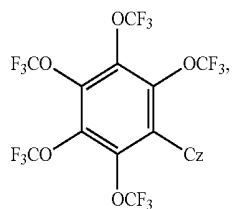
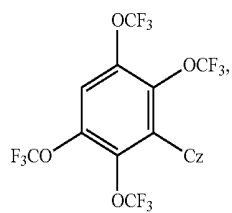
Compound 448

Compound 449

Compound 450

153

-continued



154

-continued

Compound 451

5

Compound 452

10

Compound 453

20

Compound 454

25

Compound 455

35

Compound 456

45

Compound 457

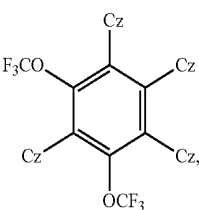
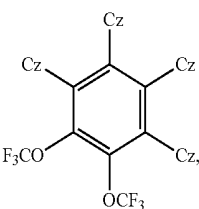
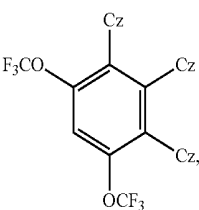
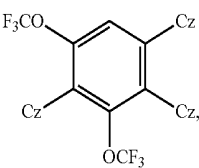
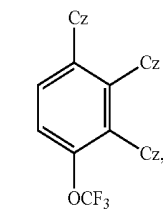
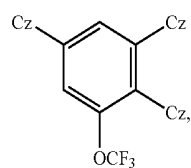
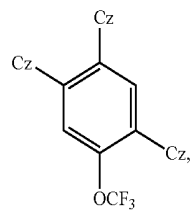
50

55

Compound 458

60

65



Compound 460

Compound 461

Compound 462

Compound 463

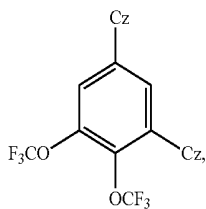
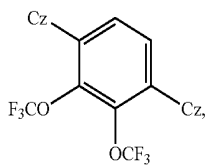
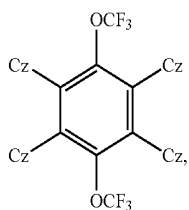
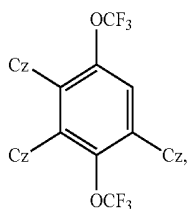
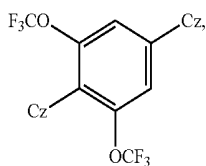
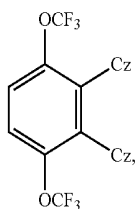
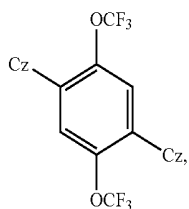
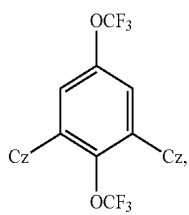
Compound 464

Compound 465

Compound 466

155

-continued

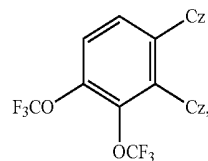


156

-continued

Compound 467

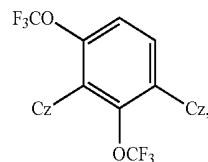
5



Compound 475

Compound 468

10

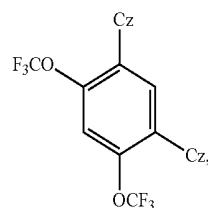


Compound 476

15

Compound 469

20

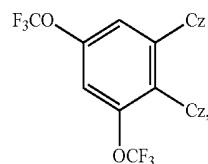


Compound 477

25

Compound 470

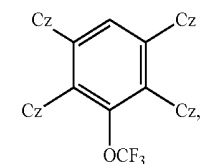
30



Compound 478

Compound 471

35

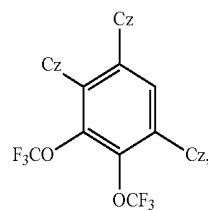


Compound 479

40

Compound 472

45

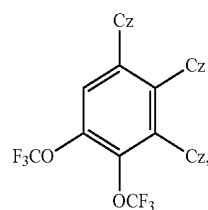


Compound 480

50

Compound 473

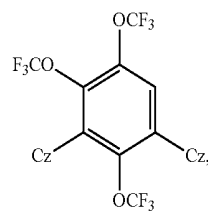
55



Compound 481

Compound 474

60

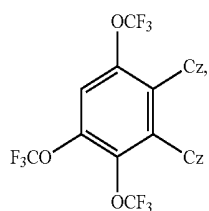
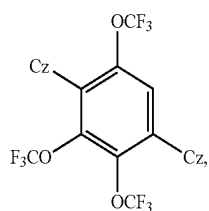
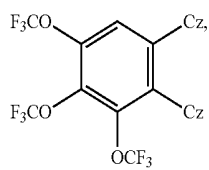
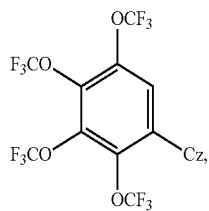
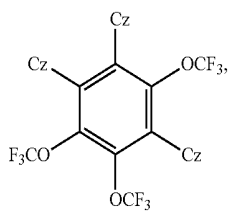
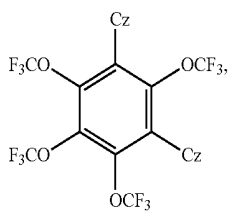
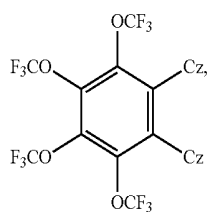
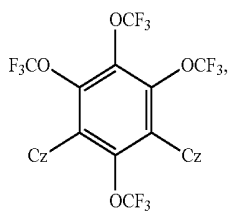


Compound 482

65

157

-continued

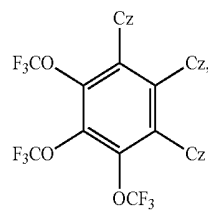


158

-continued

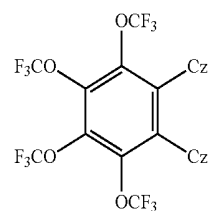
Compound 483

5



Compound 484

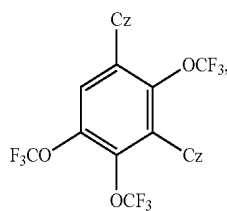
10



15

Compound 485

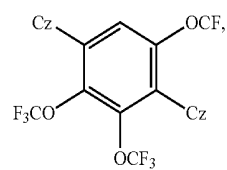
20



25

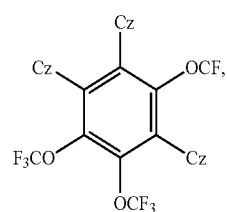
Compound 486

30



Compound 487

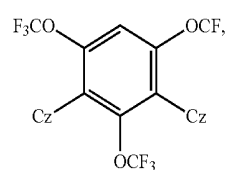
35



40

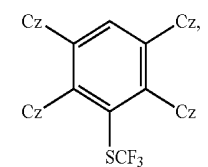
Compound 488

45



Compound 489

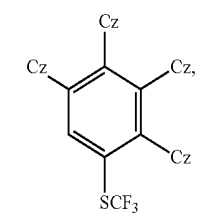
50



55

Compound 490

60



65

Compound 491

Compound 492

Compound 493

Compound 494

Compound 495

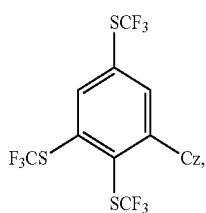
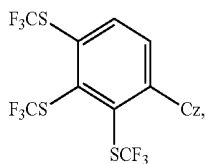
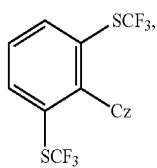
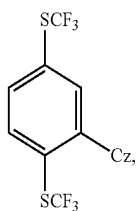
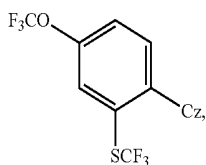
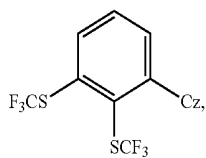
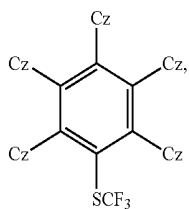
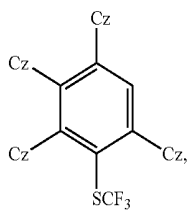
Compound 496

Compound 497

Compound 498

159

-continued

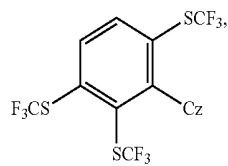


160

-continued

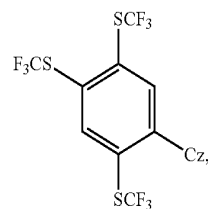
Compound 499

5



Compound 500

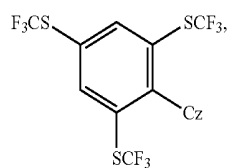
10



15

Compound 501

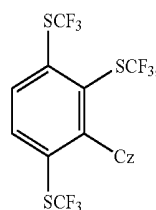
20



25

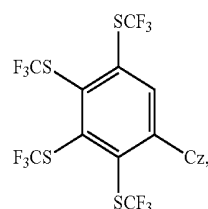
Compound 502

30



Compound 503

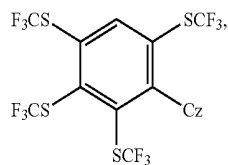
35



40

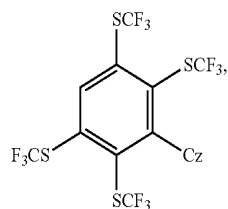
Compound 504

45



Compound 505

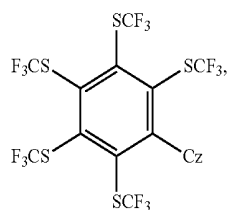
50



55

Compound 506

60



65

Compound 507

Compound 508

Compound 509

Compound 510

Compound 511

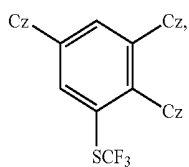
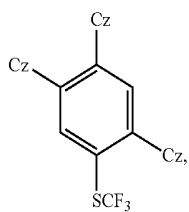
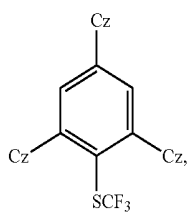
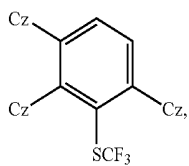
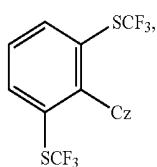
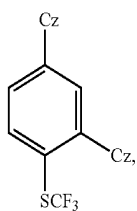
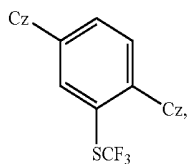
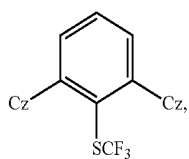
Compound 512

Compound 513

Compound 514

161

-continued

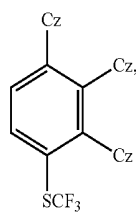


162

-continued

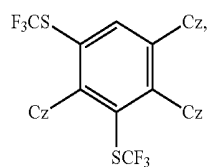
Compound 515

5



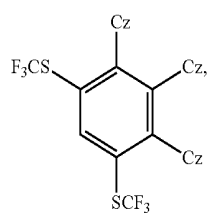
Compound 516

10



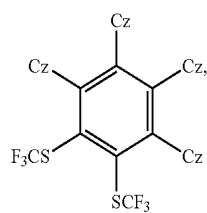
Compound 517

15



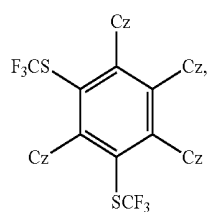
Compound 518

25



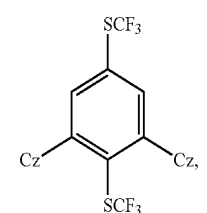
Compound 519

30



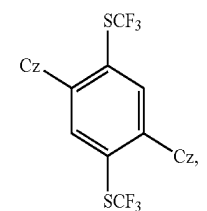
Compound 520

40



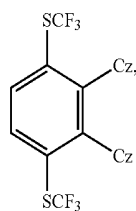
Compound 522

50



Compound 523

60



65

Compound 524

Compound 525

Compound 526

Compound 527

Compound 528

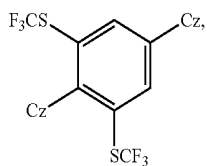
Compound 529

Compound 530

Compound 531

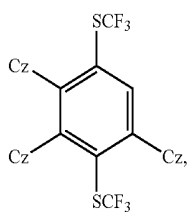
163

-continued



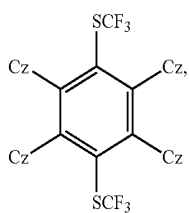
Compound 532

5



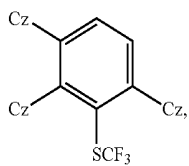
Compound 533

10



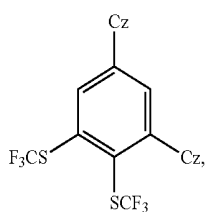
Compound 534

20



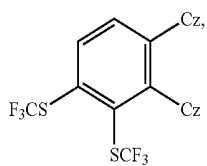
Compound 535

25



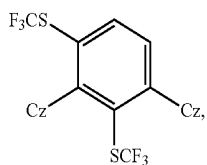
Compound 536

35



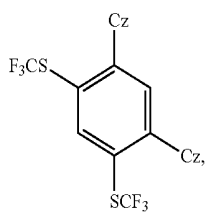
Compound 537

45



Compound 538

50



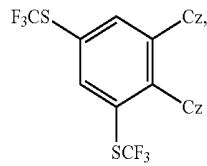
Compound 539

60

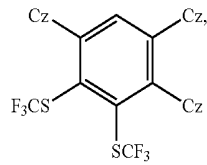
65

164

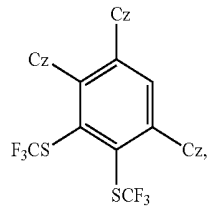
-continued



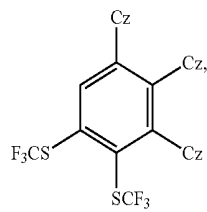
Compound 540



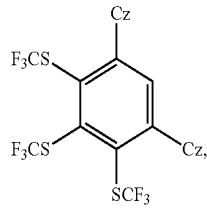
Compound 541



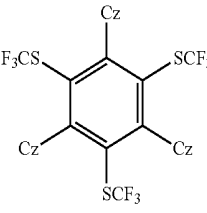
Compound 542



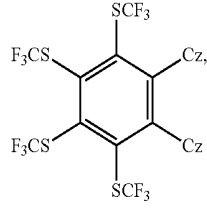
Compound 543



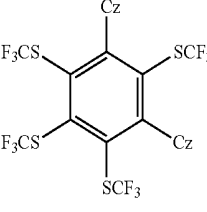
Compound 544



Compound 545



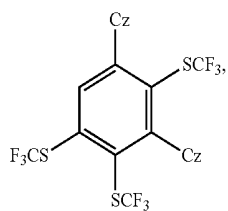
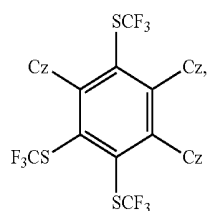
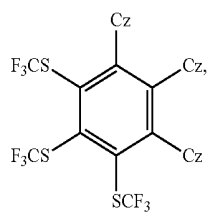
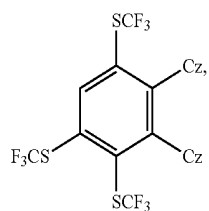
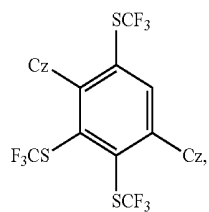
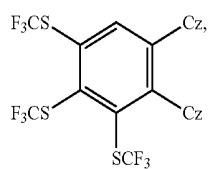
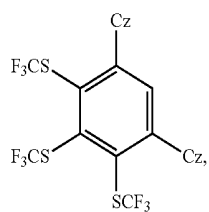
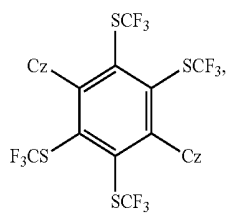
Compound 546



Compound 547

165

-continued

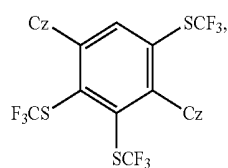


166

-continued

Compound 548

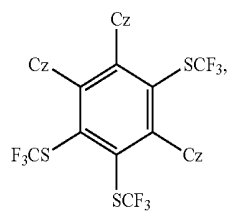
5



Compound 556

Compound 549

10

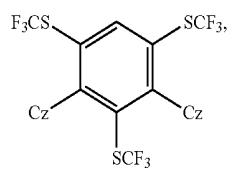


Compound 557

15

Compound 550

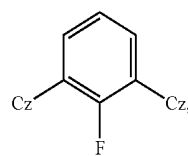
20



Compound 558

Compound 551

25

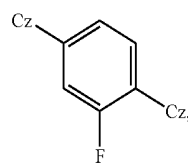


Compound 559

30

Compound 552

35

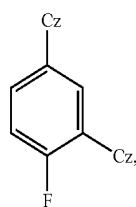


Compound 560

40

Compound 553

45

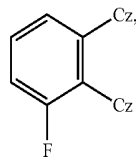


Compound 561

50

Compound 554

55

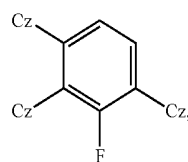


Compound 562

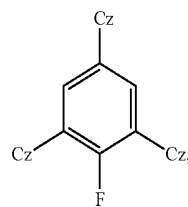
60

Compound 555

65



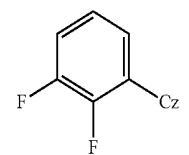
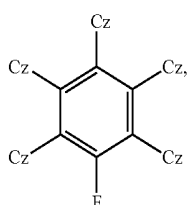
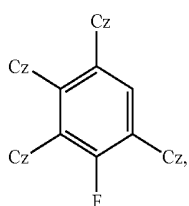
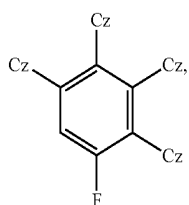
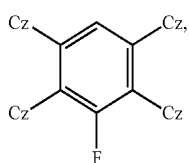
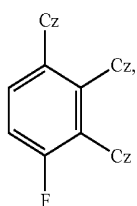
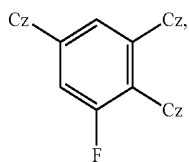
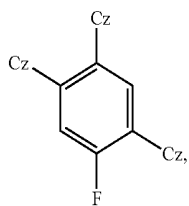
Compound 563



Compound 564

167

-continued

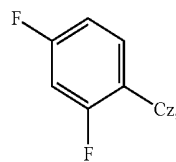


168

-continued

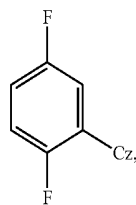
Compound 566

5



Compound 567

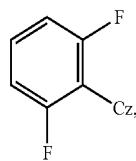
10



15

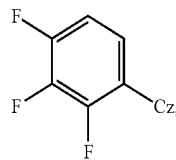
Compound 568

20



Compound 569

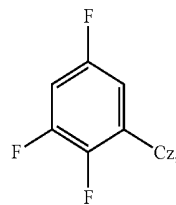
25



30

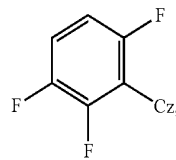
Compound 570

35



Compound 571

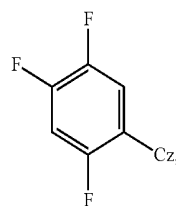
40



45

Compound 572

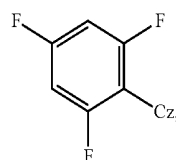
50



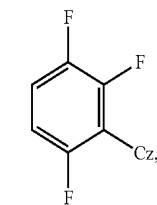
55

Compound 573

60



65



Compound 574

Compound 575

Compound 576

Compound 577

Compound 578

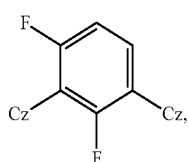
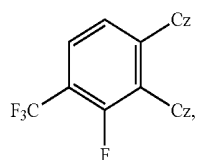
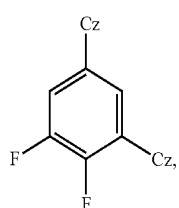
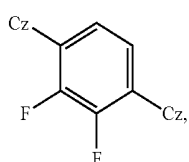
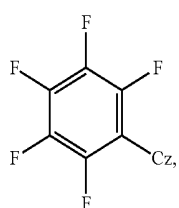
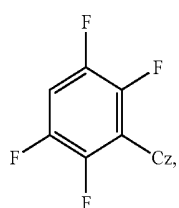
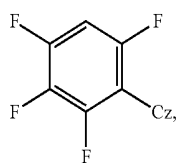
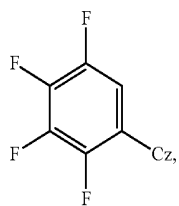
Compound 579

Compound 580

Compound 581

Compound 582

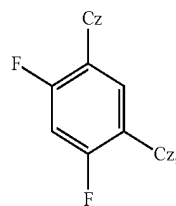
**169**  
-continued



**170**  
-continued

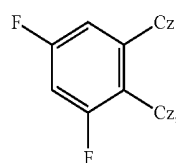
Compound 583

5



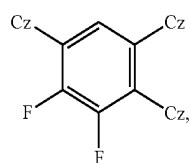
Compound 584

10



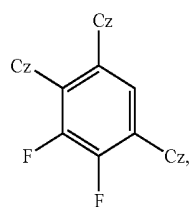
Compound 585

15



Compound 586

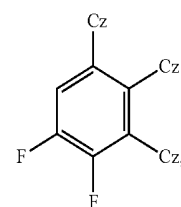
20



Compound 587

25

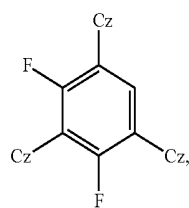
30



Compound 588

35

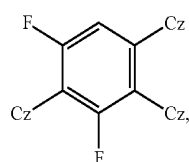
40



Compound 589

45

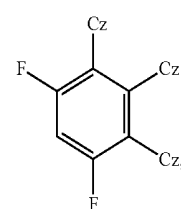
50



Compound 590

55

60



65

Compound 591

Compound 592

Compound 593

Compound 594

Compound 595

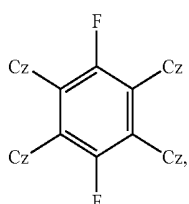
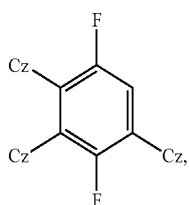
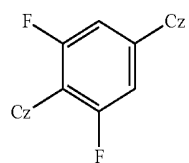
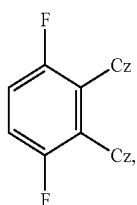
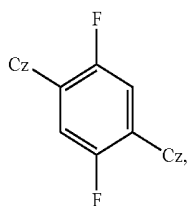
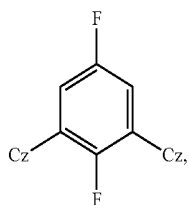
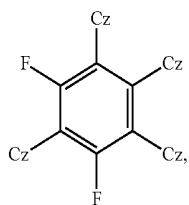
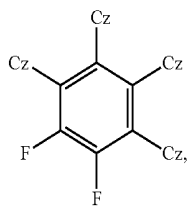
Compound 596

Compound 597

Compound 598

171

-continued

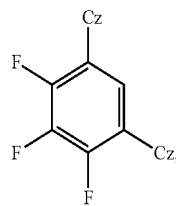


172

-continued

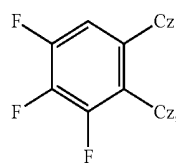
Compound 599

5



Compound 600

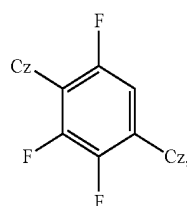
10



15

Compound 601

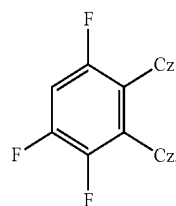
20



25

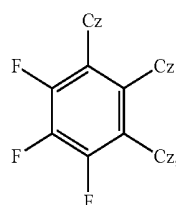
Compound 602

30



Compound 603

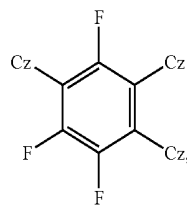
35



40

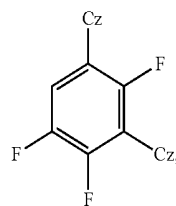
Compound 604

45



Compound 605

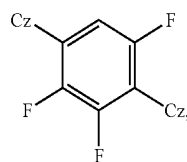
50



55

Compound 606

60



65

Compound 607

Compound 608

Compound 609

Compound 610

Compound 611

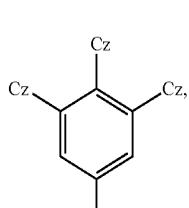
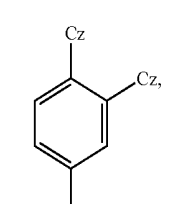
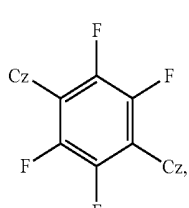
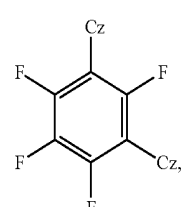
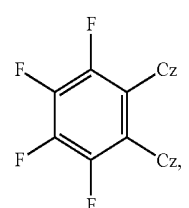
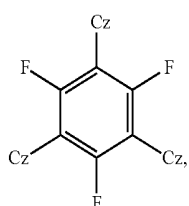
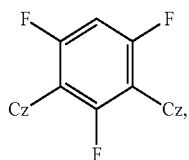
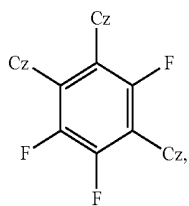
Compound 612

Compound 613

Compound 614

173

-continued

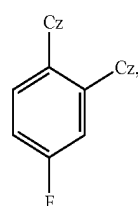


174

-continued

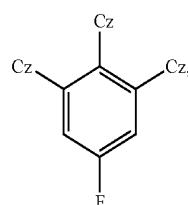
Compound 615

5



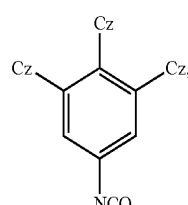
Compound 616

10



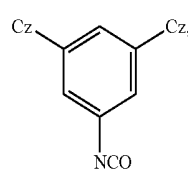
Compound 617

15



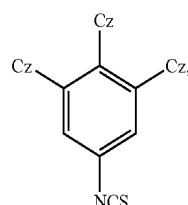
Compound 618

20



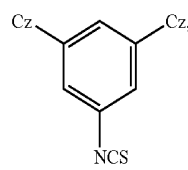
Compound 619

30



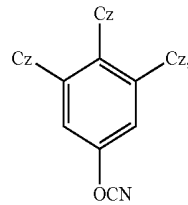
Compound 620

35



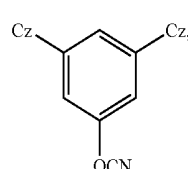
Compound 621

40



Compound 622

45



55

60

65

Compound 623

Compound 624

Compound 625

Compound 626

Compound 627

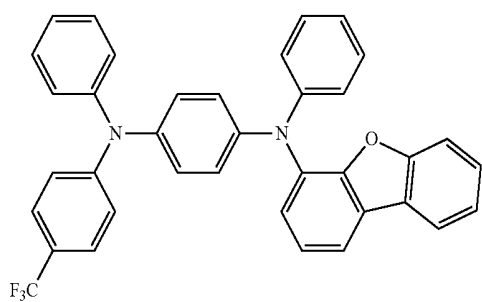
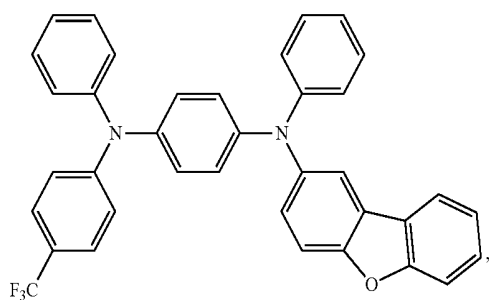
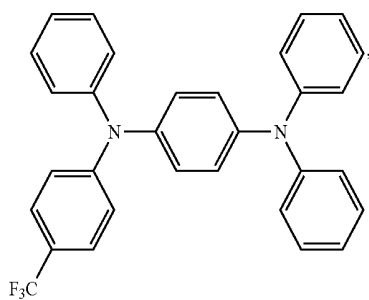
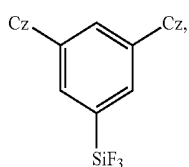
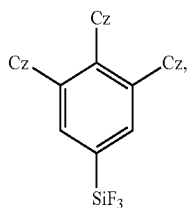
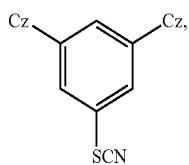
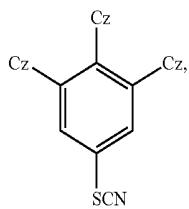
Compound 628

Compound 629

Compound 630

175

-continued

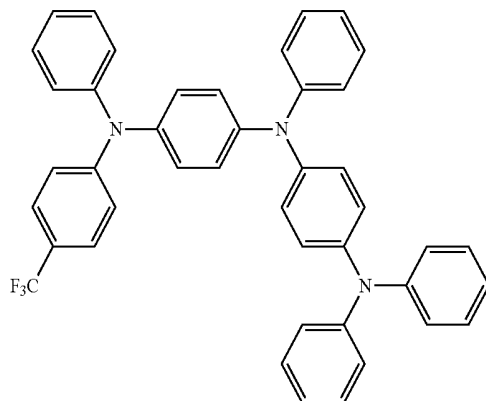


176

-continued

Compound 631

5



Compound 632

10

Compound 633

15

Compound 634

20

Compound 635

25

Compound 636

30

Compound 637

35

Compound 638

40

Compound 639

45

Compound 640

50

Compound 641

55

Compound 631

Compound 632

Compound 633

Compound 634

Compound 635

Compound 636

Compound 637

Compound 638

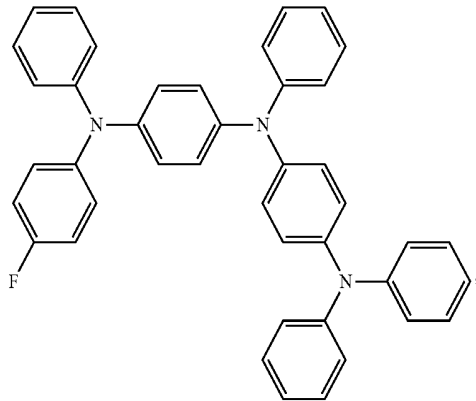
Compound 639

Compound 640

Compound 641

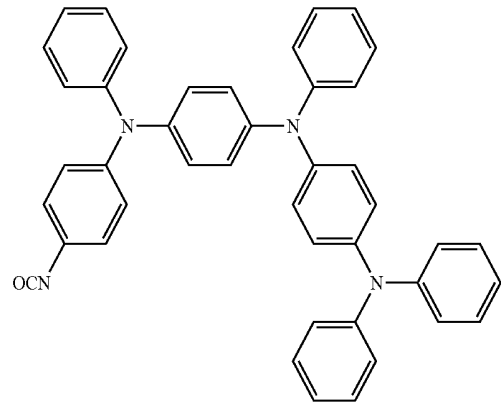
**177**  
-continued

Compound 642

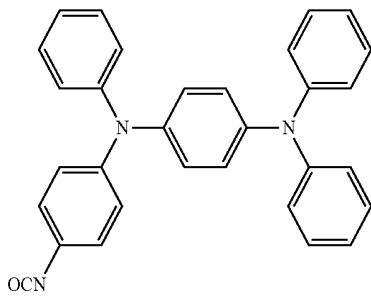


**178**  
-continued

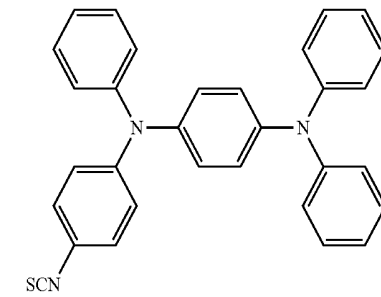
Compound 646



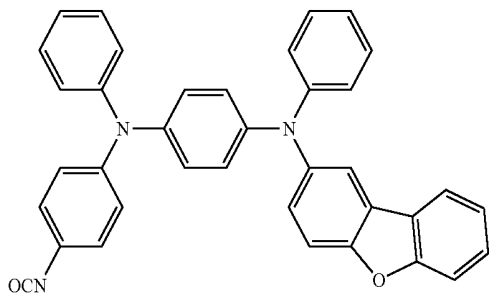
Compound 643



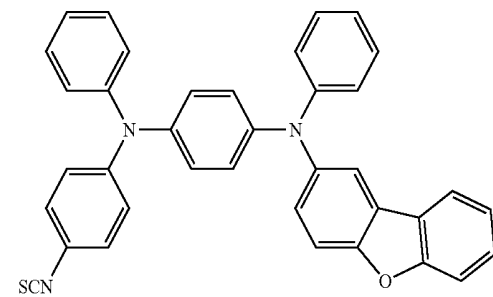
Compound 647



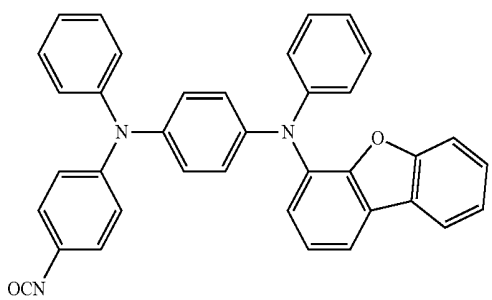
Compound 644



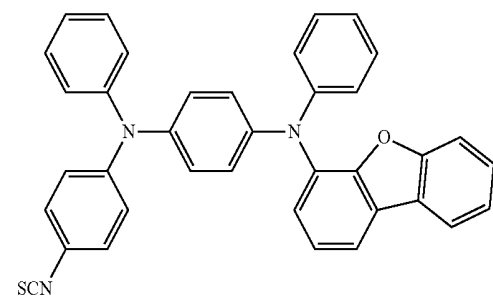
Compound 648



Compound 645



Compound 649



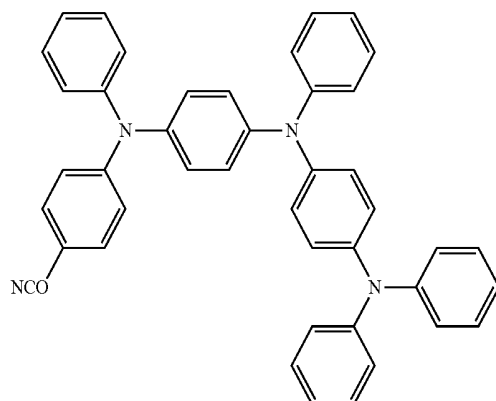
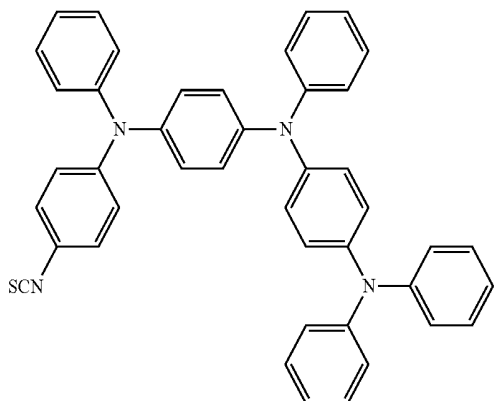
179

180

-continued

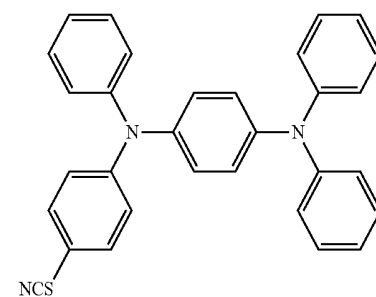
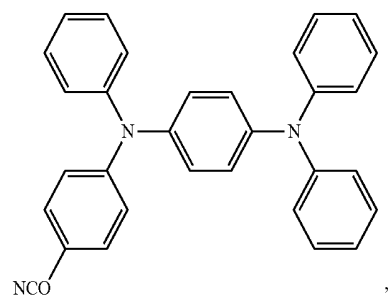
Compound 650

Compound 654



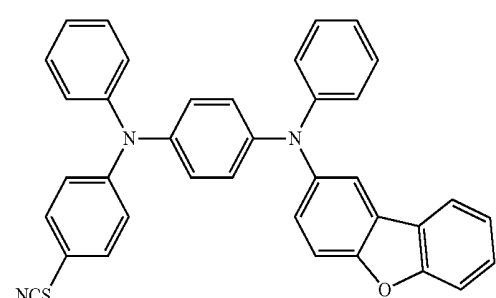
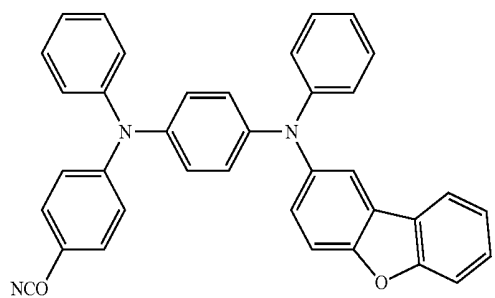
Compound 651

Compound 655



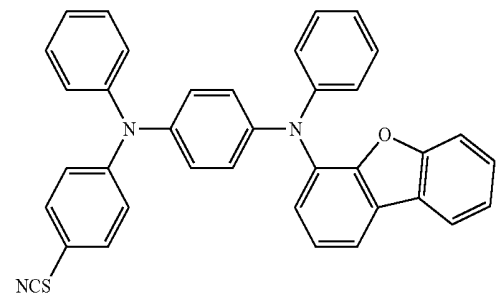
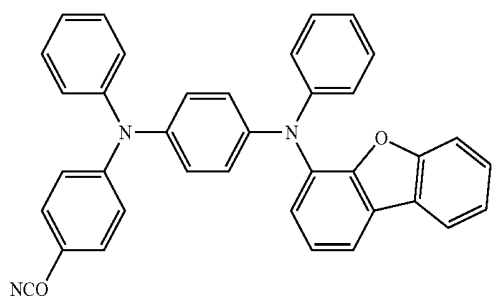
Compound 652

Compound 656



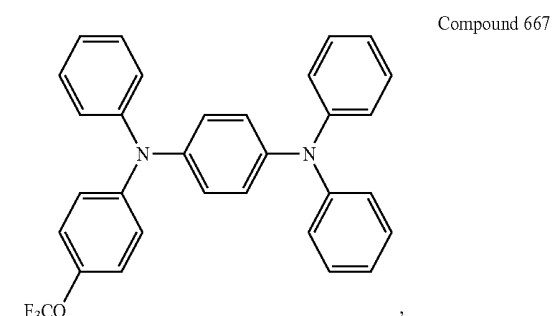
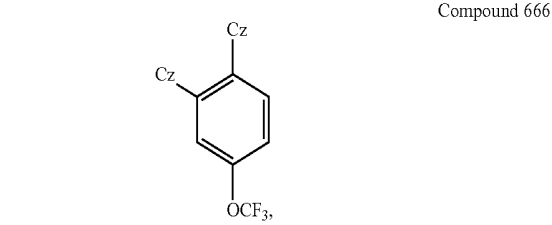
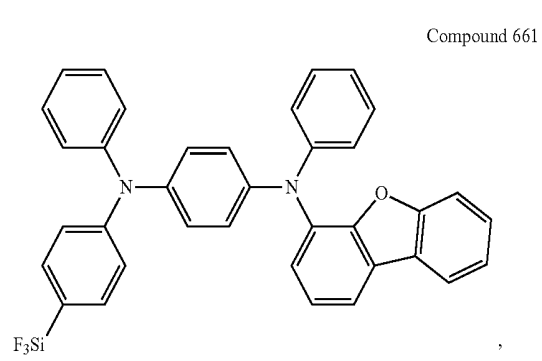
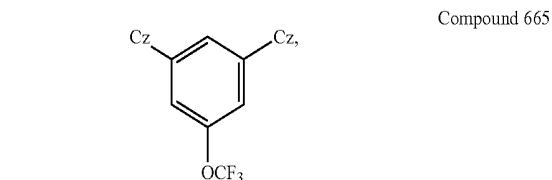
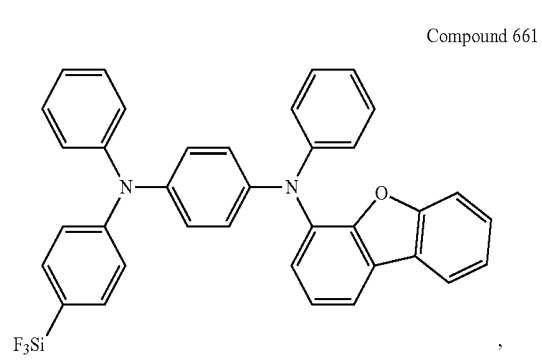
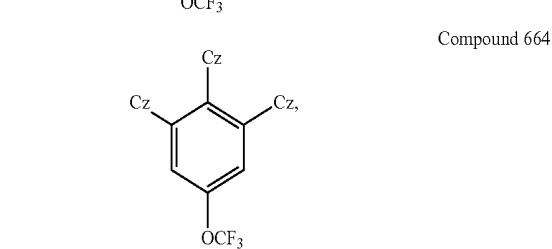
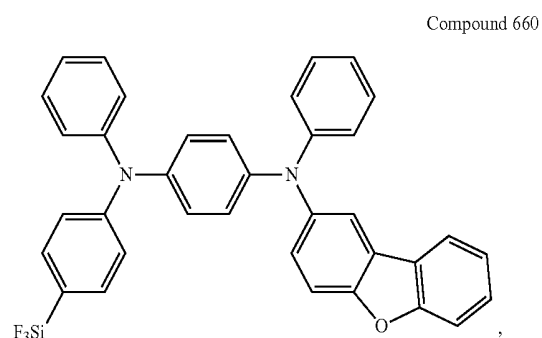
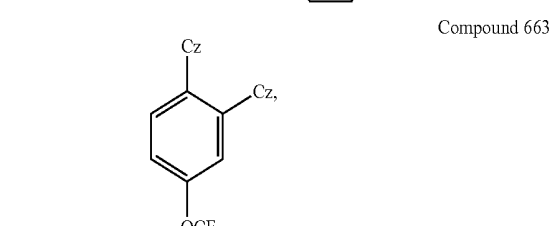
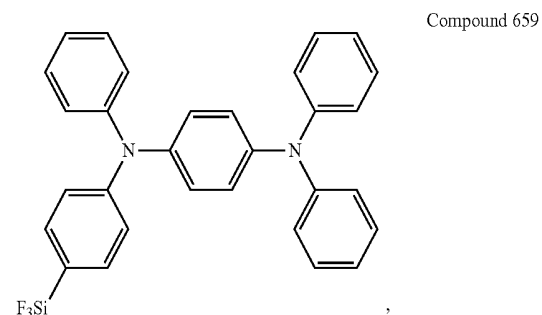
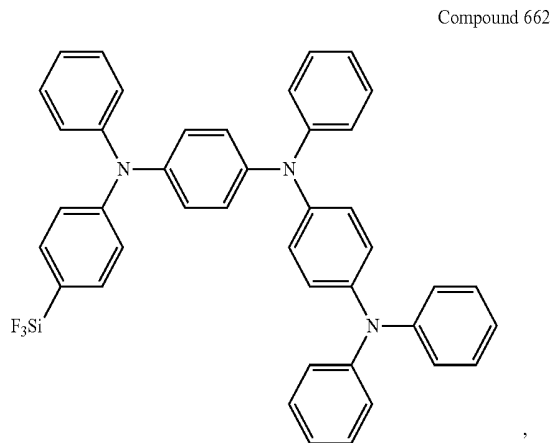
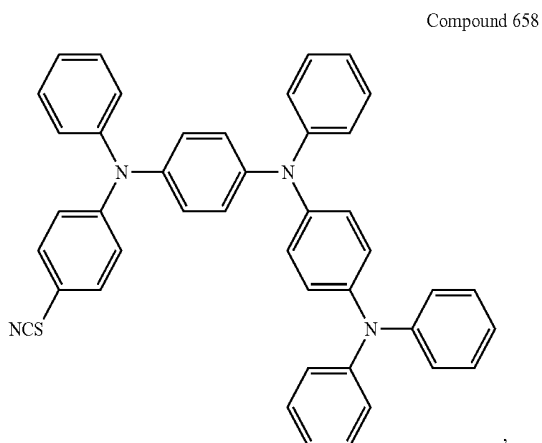
Compound 653

Compound 657



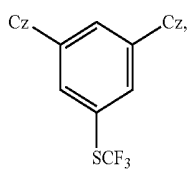
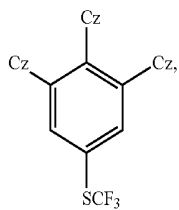
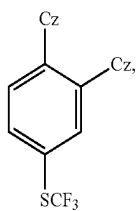
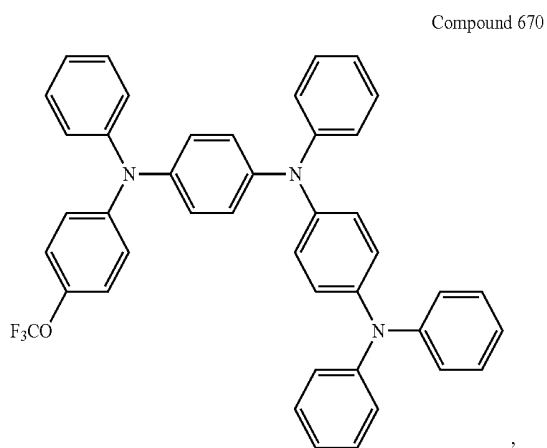
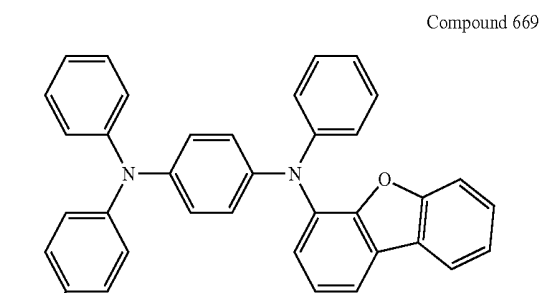
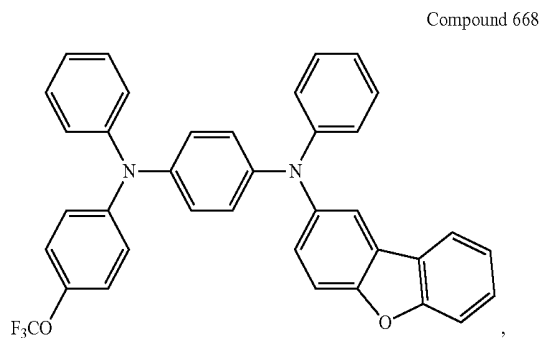
**181**  
-continued

**182**  
-continued



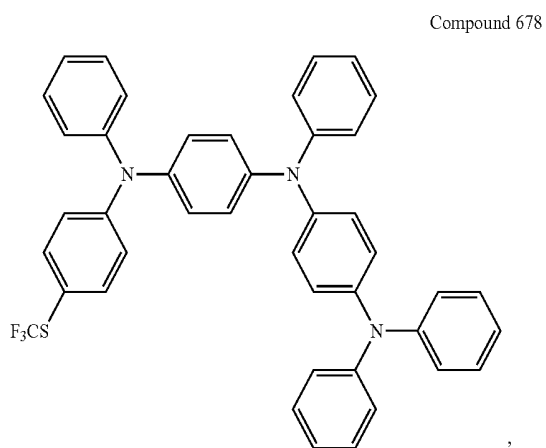
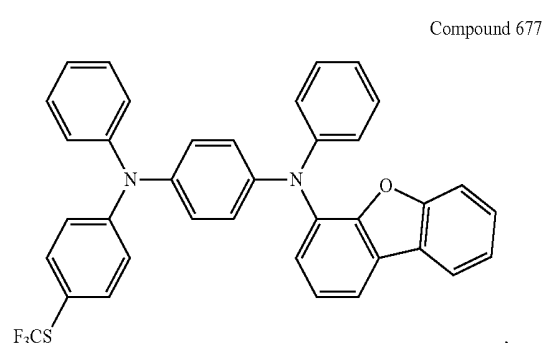
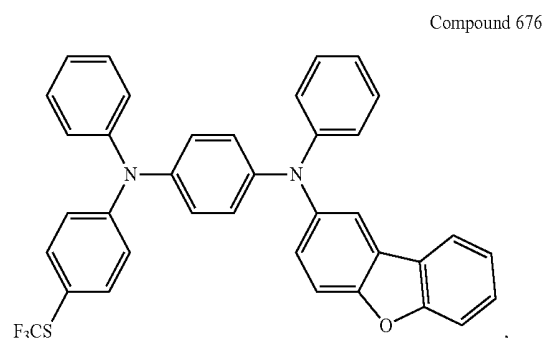
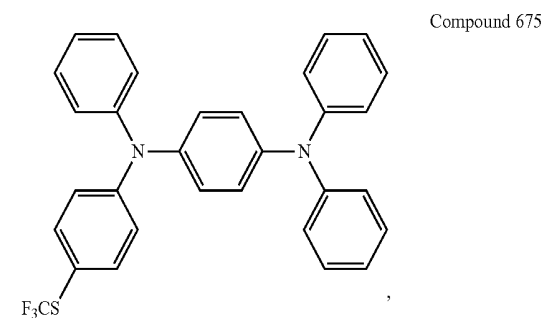
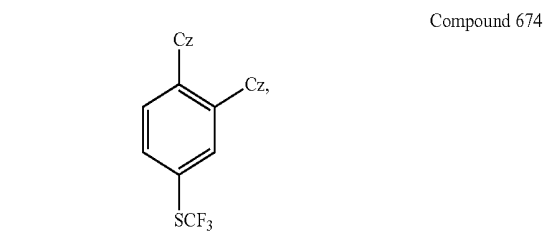
183

-continued



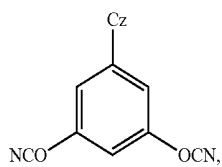
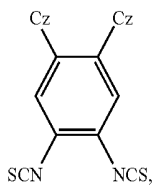
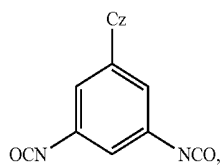
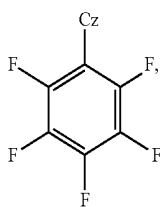
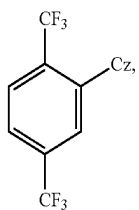
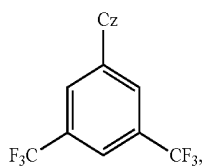
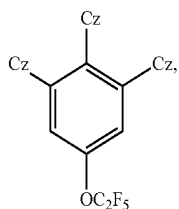
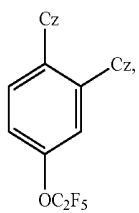
184

-continued



185

-continued

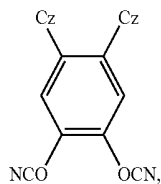


186

-continued

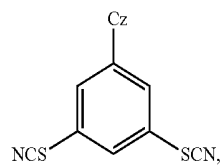
Compound 679

5



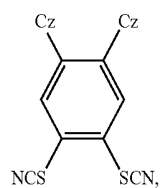
Compound 680

10



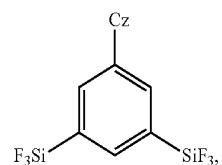
Compound 681

20



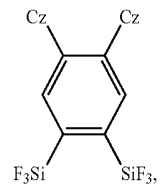
Compound 682

25



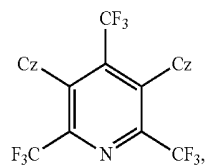
Compound 683

35



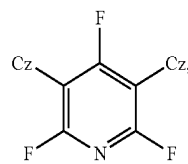
Compound 684

45



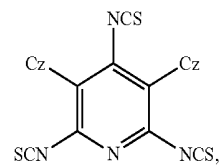
Compound 685

50

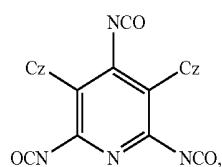


Compound 686

60



65



Compound 687

Compound 688

Compound 689

Compound 690

Compound 691

Compound 692

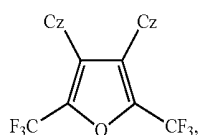
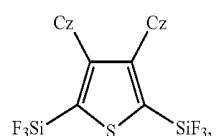
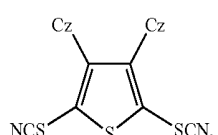
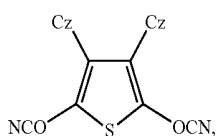
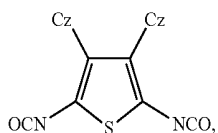
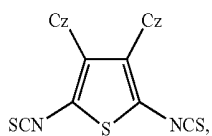
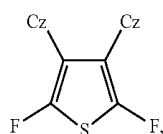
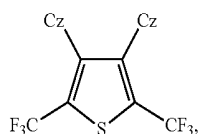
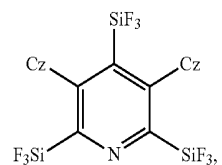
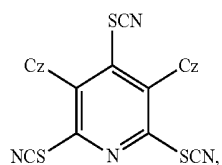
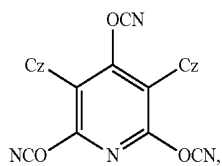
Compound 693

Compound 694

Compound 695

187

-continued

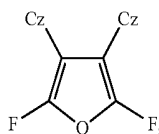


188

-continued

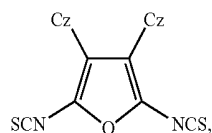
Compound 696

5



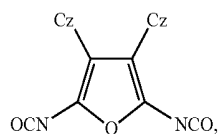
Compound 697

10



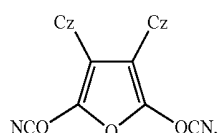
Compound 698

15



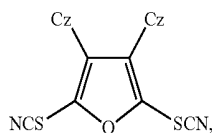
Compound 699

25



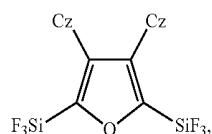
Compound 700

30



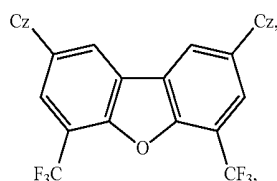
Compound 701

35



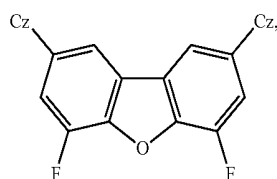
Compound 702

40



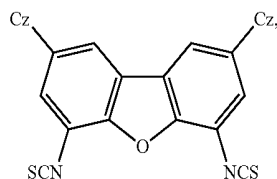
Compound 703

45



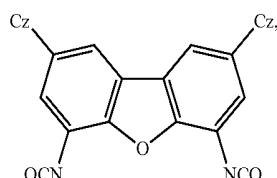
Compound 704

50



Compound 705

60



Compound 706

65

Compound 707

Compound 708

Compound 709

Compound 710

Compound 711

Compound 712

Compound 713

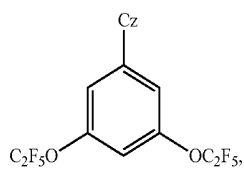
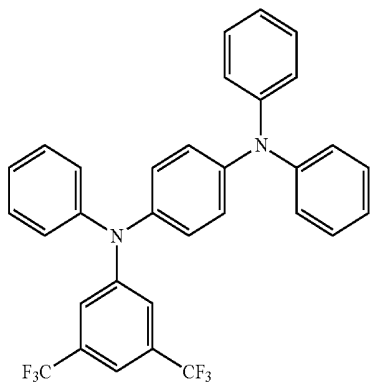
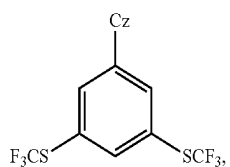
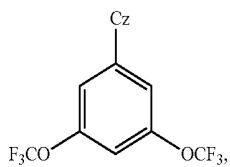
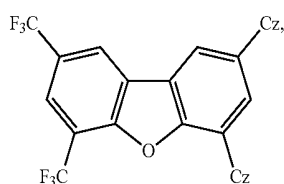
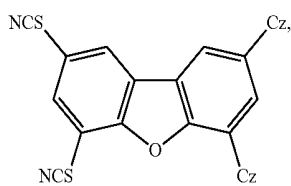
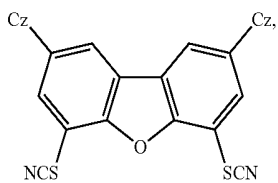
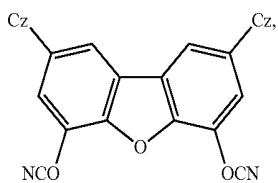
Compound 714

Compound 715

Compound 716

189

-continued



190

-continued

Compound 717

5

Compound 725

Compound 718

10

Compound 719

20

Compound 720

25

Compound 721

35

Compound 722

40

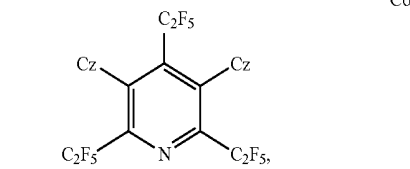
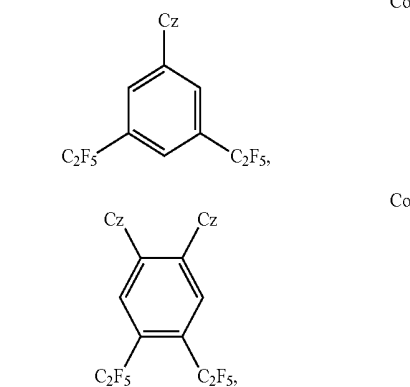
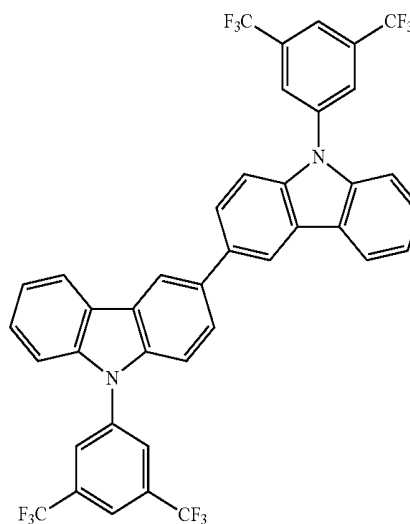
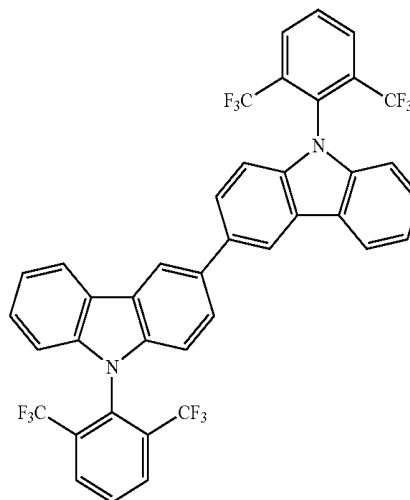
Compound 723

50

55

Compound 724

65

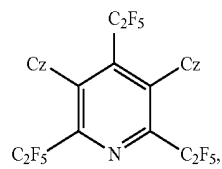
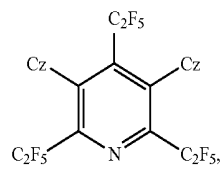
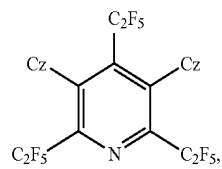
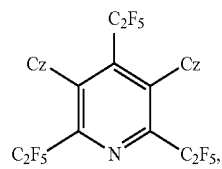


Compound 726

Compound 727

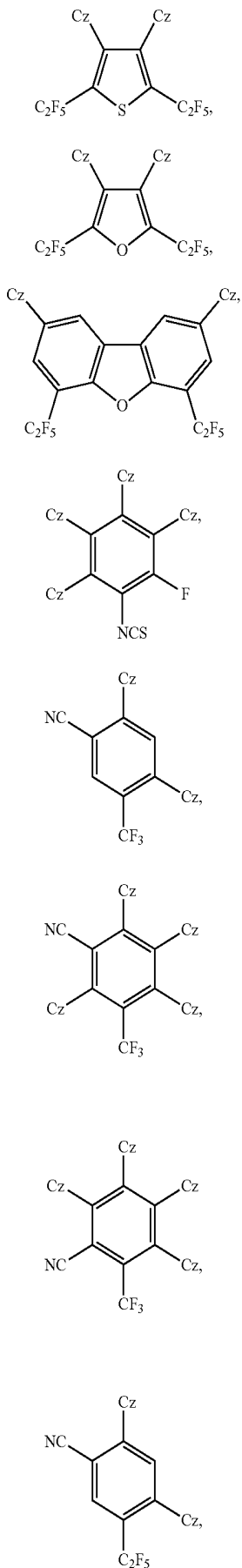
Compound 729

Compound 731



191

-continued



192

-continued

Compound 732

5

Compound 733

10

Compound 734

15

Compound 736

25

Compound 737

30

35 As used herein Cz is

Compound 738

40

45

Compound 739

50

55

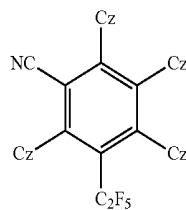
Compound 740

60

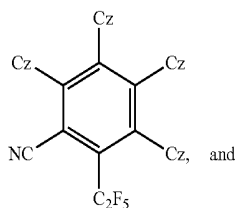
wherein R', R'', and R''' are independently aryl or heteroaryl. In some embodiments, at least one of R'' and R''' comprises a structure of Formula 2.

In some embodiments, the first device emits a luminescent radiation at room temperature when a voltage is applied across the organic light emitting device, and the luminescent radiation comprises a delayed fluorescence process.

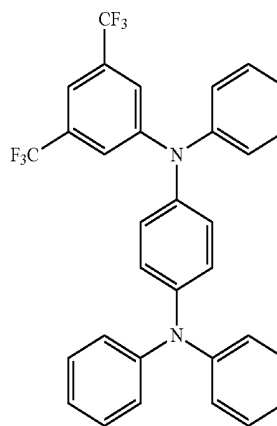
Compound 741



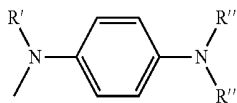
Compound 742



Compound 743



Formula 3



193

In some embodiments, the emissive layer further comprises a host material. In some embodiments, the emissive layer further comprises a first phosphorescent emitting material. In some embodiments, the emissive layer also includes a second phosphorescent emitting material. In some embodiments, the first device emits a white light at room temperature when a voltage is applied across the organic light emitting device.

In some embodiments, the compound comprising a structure according to Formula 2 emits a blue light with a peak wavelength of about 400 nm to about 500 nm. In some embodiments, the compound comprising a structure according to Formula 2 emits a yellow light with a peak wavelength of about 530 nm to about 580 nm.

In yet another aspect of the present disclosure, a formulation that comprises a compound according to Formula 1 is described. The formulation can include one or more components selected from the group consisting of a solvent, a host, a hole injection material, hole transport material, and an electron transport layer material, disclosed herein.

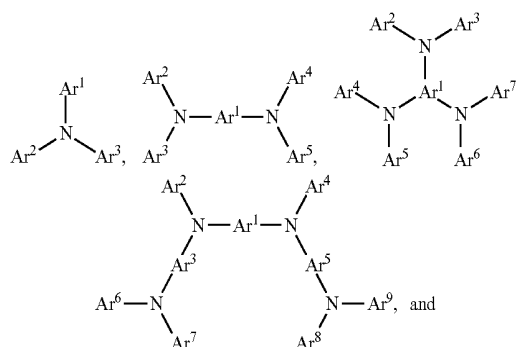
#### Combination with Other Materials

The materials described herein as useful for a particular layer in an organic light emitting device may be used in combination with a wide variety of other materials present in the device. For example, emissive dopants disclosed herein may be used in conjunction with a wide variety of hosts, transport layers, blocking layers, injection layers, electrodes and other layers that may be present. The materials described or referred to below are non-limiting examples of materials that may be useful in combination with the compounds disclosed herein, and one of skill in the art can readily consult the literature to identify other materials that may be useful in combination.

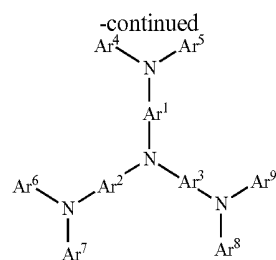
#### HIL/HTL:

A hole injecting/transporting material to be used in the present invention is not particularly limited, and any compound may be used as long as the compound is typically used as a hole injecting/transporting material. Examples of the material include, but not limit to: a phthalocyanine or porphyrin derivative; an aromatic amine derivative; an indolocarbazole derivative; a polymer containing fluorohydrocarbon; a polymer with conductivity dopants; a conducting polymer, such as PEDOT/PSS; a self-assembly monomer derived from compounds such as phosphonic acid and silane derivatives; a metal oxide derivative, such as MoO<sub>3</sub>; a p-type semiconducting organic compound, such as 1,4,5,8,9,12-Hexaazatriphenylenehexacarbonitrile; a metal complex, and a cross-linkable compounds.

Examples of aromatic amine derivatives used in HIL or HTL include, but not limit to the following general structures:

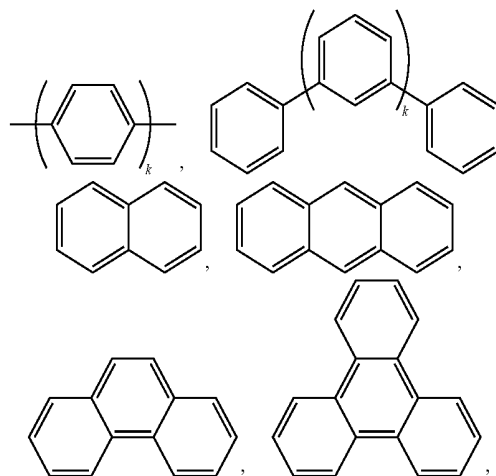


194



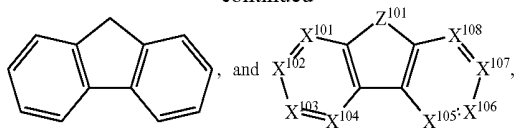
Each of Ar<sup>1</sup> to Ar<sup>9</sup> is selected from the group consisting of aromatic hydrocarbon cyclic compounds such as benzene, biphenyl, triphenyl, triphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, and azulene; the group consisting of aromatic heterocyclic compounds such as dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzoselenophene, carbazole, indolocarbazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuroppyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzoselenophenopyridine, and selenophenodipyridine; and the group consisting of 2 to 10 cyclic structural units which are groups of the same type or different types selected from the aromatic hydrocarbon cyclic group and the aromatic heterocyclic group and are bonded to each other directly or via at least one of oxygen atom, nitrogen atom, sulfur atom, silicon atom, phosphorus atom, boron atom, chain structural unit and the aliphatic cyclic group. Wherein each Ar is further substituted by a substituent selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

In one aspect, Ar<sup>1</sup> to Ar<sup>9</sup> is independently selected from the group consisting of:



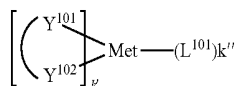
195

-continued



wherein k is an integer from 1 to 20; X<sup>101</sup> to X<sup>107</sup> is C (including CH) or N; Z<sup>101</sup> is NAr<sup>1</sup>, O, or S; Ar<sup>1</sup> has the same group defined above.

Examples of metal complexes used in HIL or HTL include, but not limit to the following general formula:

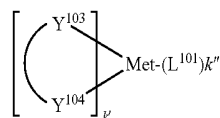


wherein Met is a metal, which can have an atomic weight greater than 40; (Y<sup>101</sup>-Y<sup>102</sup>) is a bidentate ligand, Y<sup>101</sup> and Y<sup>102</sup> are independently selected from C, N, O, P, and S; L<sup>101</sup> is an ancillary ligand; k' is an integer value from 1 to the maximum number of ligands that may be attached to the metal; and k'+k'' is the maximum number of ligands that may be attached to the metal.

In one aspect, (Y<sup>101</sup>-Y<sup>102</sup>) is a 2-phenylpyridine derivative. In another aspect, (Y<sup>101</sup>-Y<sup>102</sup>) is a carbene ligand. In another aspect, Met is selected from Ir, Pt, Os, and Zn. In a further aspect, the metal complex has a smallest oxidation potential in solution vs. Fc<sup>+</sup>/Fc couple less than about 0.6 V. Host:

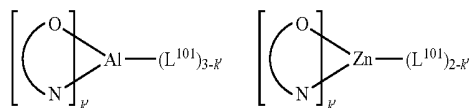
The light emitting layer of the organic EL device of the present invention preferably contains at least a metal complex as light emitting material, and may contain a host material using the metal complex as a dopant material. Examples of the host material are not particularly limited, and any metal complexes or organic compounds may be used as long as the triplet energy of the host is larger than that of the dopant. While the Table below categorizes host materials as preferred for devices that emit various colors, any host material may be used with any dopant so long as the triplet criteria is satisfied.

Examples of metal complexes used as host are preferred to have the following general formula:



wherein Met is a metal; (Y<sup>103</sup>-Y<sup>104</sup>) is a bidentate ligand, Y<sup>103</sup> and Y<sup>104</sup> are independently selected from C, N, O, P, and S; L<sup>101</sup> is an another ligand; k' is an integer value from 1 to the maximum number of ligands that may be attached to the metal; and k'+k'' is the maximum number of ligands that may be attached to the metal.

In one aspect, the metal complexes are:



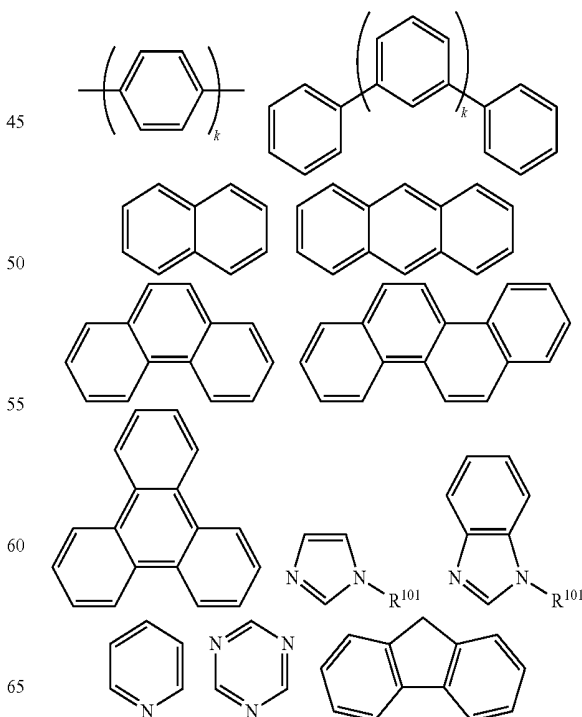
196

wherein (O—N) is a bidentate ligand, having metal coordinated to atoms O and N.

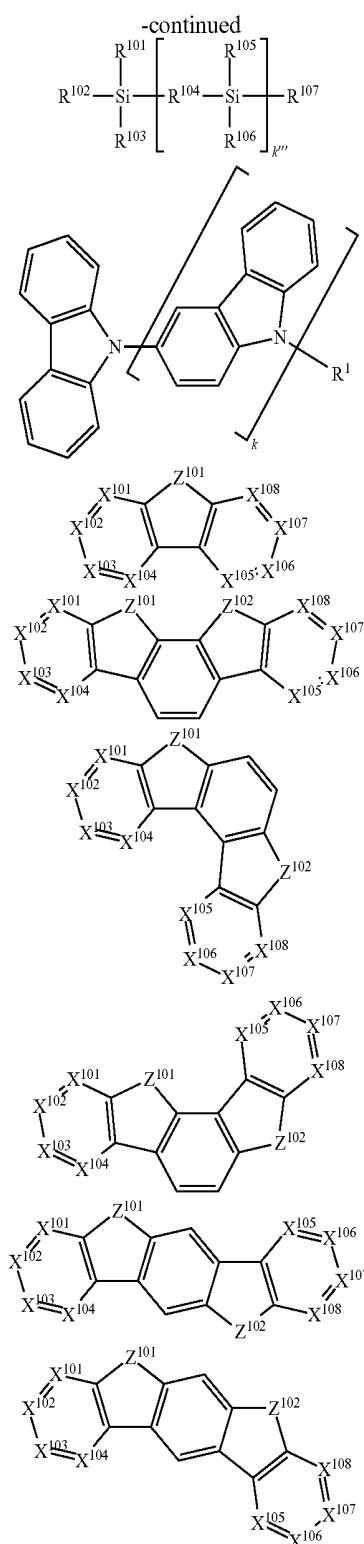
In another aspect, Met is selected from Ir and Pt. In a further aspect, (Y<sup>103</sup>-Y<sup>104</sup>) is a carbene ligand.

5 Examples of organic compounds used as host are selected from the group consisting of aromatic hydrocarbon cyclic compounds such as benzene, biphenyl, triphenyl, triphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, and azulene; the group  
10 consisting of aromatic heterocyclic compounds such as dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzosele-  
15 nophene, carbazole, indolocarbazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinoxaline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuro-pyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzo-  
20 selenophenopyridine, and selenophenodipyridine; and the group consisting of 2 to 10 cyclic structural units which are groups of the same type or different types selected from the aromatic hydrocarbon cyclic group and the aromatic hetero-  
25 cyclic group and are bonded to each other directly or via at least one of oxygen atom, nitrogen atom, sulfur atom, silicon atom, phosphorus atom, boron atom, chain structural unit and the aliphatic cyclic group. Wherein each group is further substituted by a substituent selected from the group consist-  
30 ing of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

In one aspect, host compound contains at least one of the following groups in the molecule:



197



wherein  $R^{101}$  to  $R^{107}$  is independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof, when it is aryl or heteroaryl, it has the similar definition as Ar's mentioned above.  $k$  is an integer from 0 to 20 or 1 to 20;  $k''$  is an integer from 0 to 20.  $X^{101}$  to  $X^{108}$  is selected from C (including CH) or N.  $Z^{101}$  and  $Z^{102}$  is selected from  $NR^{101}$ , O, or S.

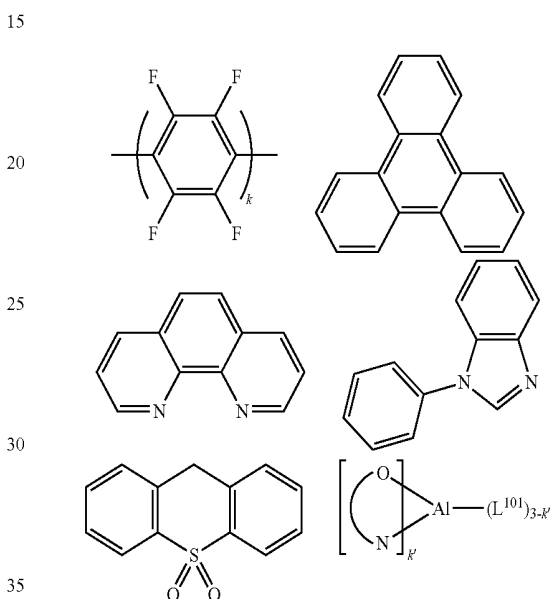
198

HBL:

A hole blocking layer (HBL) may be used to reduce the number of holes and/or excitons that leave the emissive layer. The presence of such a blocking layer in a device may result in substantially higher efficiencies as compared to a similar device lacking a blocking layer. Also, a blocking layer may be used to confine emission to a desired region of an OLED.

In one aspect, compound used in HBL contains the same molecule or the same functional groups used as host described above.

In another aspect, compound used in HBL contains at least one of the following groups in the molecule:

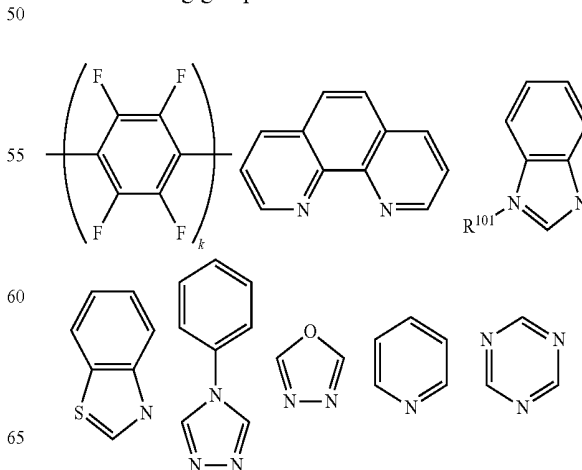


wherein  $k$  is an integer from 1 to 20;  $L^{101}$  is an another ligand,  $k'$  is an integer from 1 to 3.

ETL:

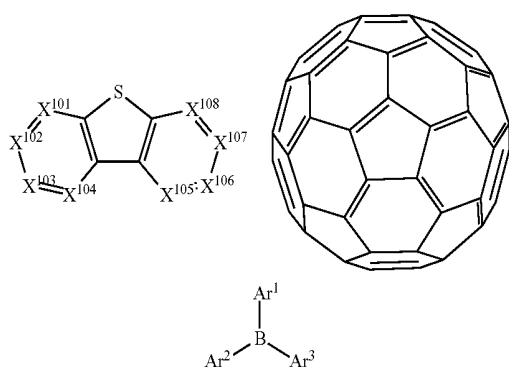
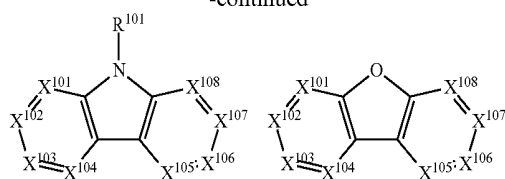
Electron transport layer (ETL) may include a material capable of transporting electrons. Electron transport layer may be intrinsic (undoped), or doped. Doping may be used to enhance conductivity. Examples of the ETL material are not particularly limited, and any metal complexes or organic compounds may be used as long as they are typically used to transport electrons.

In one aspect, compound used in ETL contains at least one of the following groups in the molecule:



199

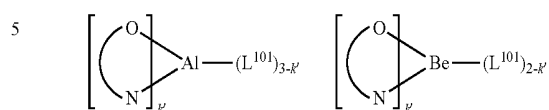
-continued



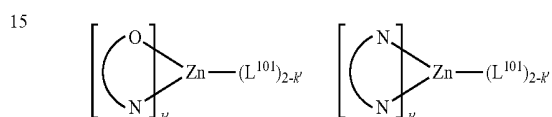
wherein  $R^{101}$  is selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, aryl-alkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof, when it is aryl or heteroaryl, it has the similar definition as  $Ar^s$  mentioned above.  $Ar^1$  to  $Ar^3$  has the similar definition as  $Ar^s$ 's mentioned above.  $k$  is an integer from 1 to 20.  $X^{101}$  to  $X^{108}$  is selected from C (including CH) or N.

200

In another aspect, the metal complexes used in ETL contains, but not limit to the following general formula:



10



20

wherein (O—N) or (N—N) is a bidentate ligand, having metal coordinated to atoms O, N or N, N;  $L^{101}$  is another ligand;  $k'$  is an integer value from 1 to the maximum number of ligands that may be attached to the metal.

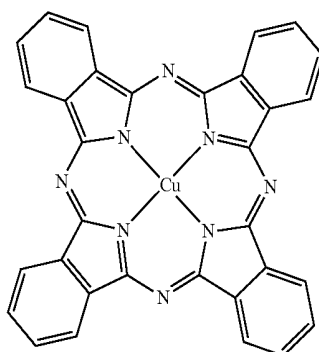
25 In any above-mentioned compounds used in each layer of the OLED device, the hydrogen atoms can be partially or fully deuterated. Thus, any specifically listed substituent, such as, without limitation, methyl, phenyl, pyridyl, etc. encompasses undeuterated, partially deuterated, and fully deuterated versions thereof. Similarly, classes of substituents such as, without limitation, alkyl, aryl, cycloalkyl, heteroaryl, etc. also encompass undeuterated, partially deuterated, and fully deuterated versions thereof.

30 In addition to and/or in combination with the materials disclosed herein, many hole injection materials, hole transporting materials, host materials, dopant materials, exciton/hole blocking layer materials, electron transporting and electron injecting materials may be used in an OLED. Non-limiting examples of the materials that may be used in an OLED in combination with materials disclosed herein are listed in Table A below. Table A lists non-limiting classes of materials, non-limiting examples of compounds for each class, and references that disclose the materials.

TABLE A

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Hole injection materials		

Phthalocyanine and porphyrin compounds



Appl. Phys. Lett. 69, 2160 (1996)

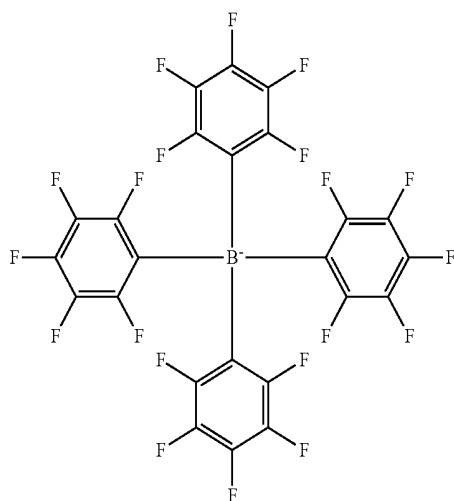
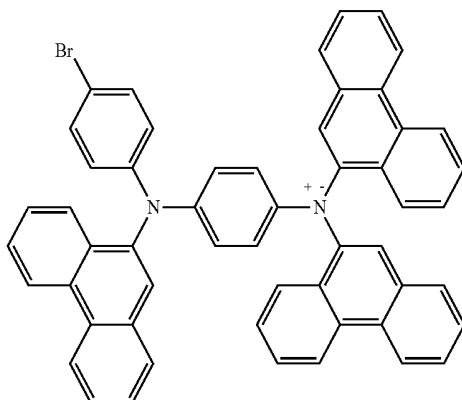
TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Starburst triarylaminines		J. Lumin. 72-74, 985 (1997)
CF <sub>x</sub> Fluorohydrocarbon polymer	$\text{---}[\text{CH}_2\text{CF}_y]_n\text{---}$	Appl. Phys. Lett. 78, 673 (2001)
Conducting polymers (e.g., PEDOT:PSS, polyaniline, polythiophene)		Synth. Met. 87, 171 (1997) WO2007002683
Phosphonic acid and silane SAMs	$\text{N} \left( \text{---} \text{C}_6\text{H}_4 \text{---} \text{SiCl}_3 \right)_3$	US20030162053
Triarylamine or polythiophene polymers with conductivity dopants		EP1725079A1

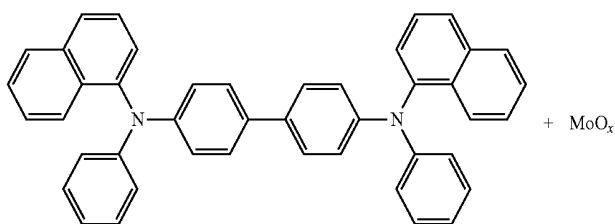
and

TABLE A-continued

MATERIAL                      EXAMPLES OF MATERIAL                      PUBLICATIONS

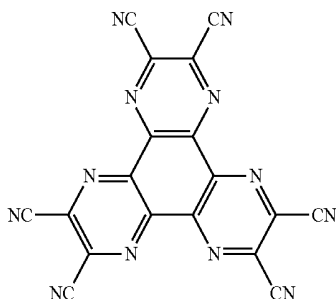


Organic compounds with conductive inorganic compounds, such as molybdenum tungsten oxides



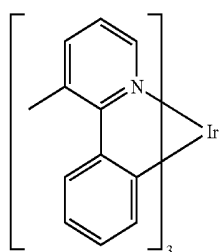
US20050123751  
SID Symposium  
Digest, 37, 923 (2006)  
WO2009018009

n-type semiconducting organic complexes



US20020158242

Metal organometallic complexes



US20060240279

TABLE A-continued

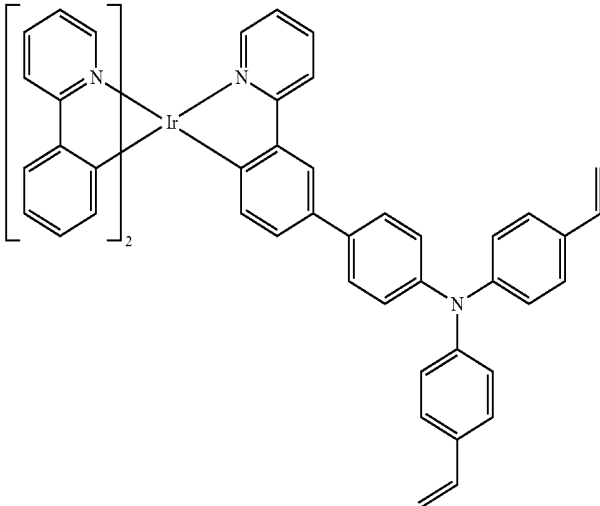
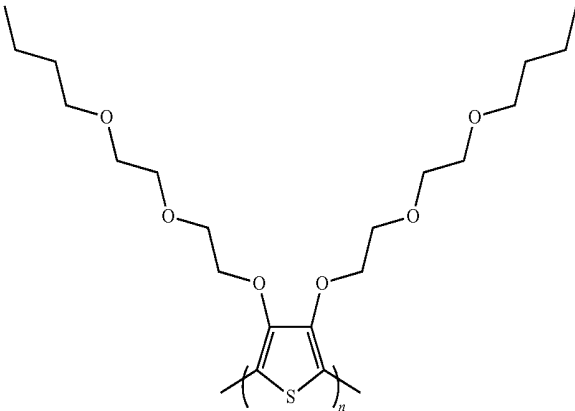
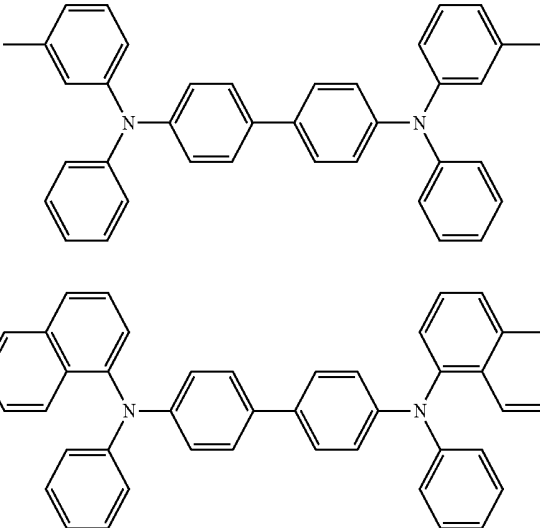
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Cross-linkable compounds	 <p>The structure shows an Iridium (Ir) center coordinated to two terpyridine ligands. Each terpyridine ligand is shown in brackets with a subscript of 2. Additionally, the Ir center is coordinated to two phenyl rings. Each phenyl ring is substituted at the para position with a styryl group (-CH=CH<sub>2</sub>).</p>	US20080220265
Polythiophene based polymers and copolymers	 <p>The structure shows a polythiophene backbone consisting of a chain of thiophene rings with a sulfur atom (S) in each ring. The backbone is terminated with a side chain containing two butoxy groups (-O(CH<sub>2</sub>)<sub>4</sub>CH<sub>3</sub>) attached to the polymer chain.</p>	WO 2011075644 EP2350216
Hole transporting materials		
Triarylamines (e.g., TPD, $\alpha$ -NPD)	 <p>Two chemical structures of triarylamines are shown. The first structure is Triphenylamine (TPA), where a central nitrogen atom is bonded to three phenyl rings. The second structure is N,N'-diphenyl-N,N'-diphenylbenzidine (TPD), where a central nitrogen atom is bonded to two phenyl rings and a diphenylbenzidine group (two phenyl rings connected by a methylene group).</p>	Appl. Phys. Lett. 51, 913 (1987)
		US5061569

TABLE A-continued

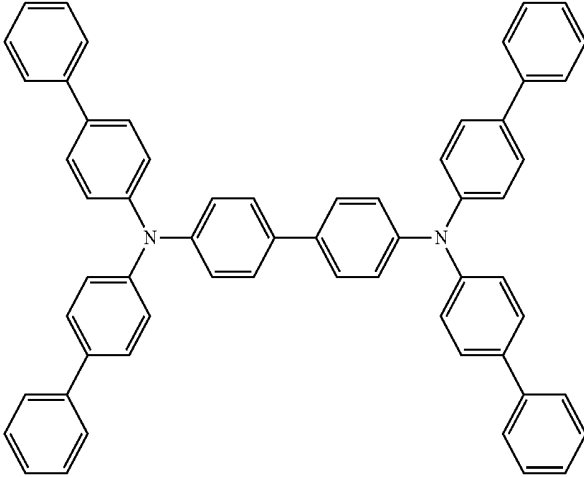
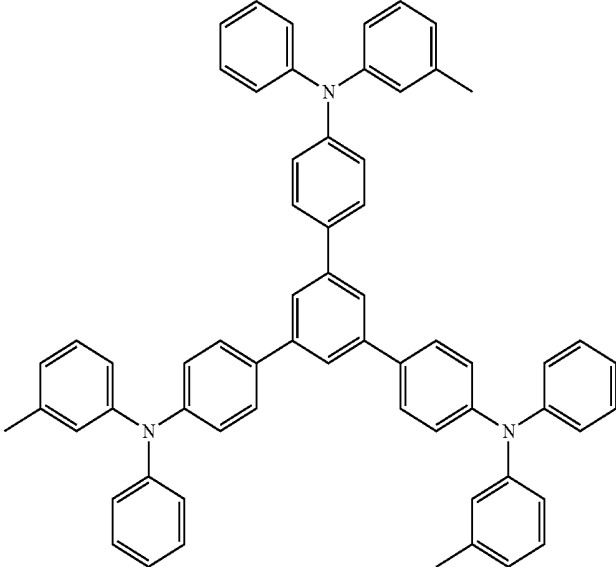
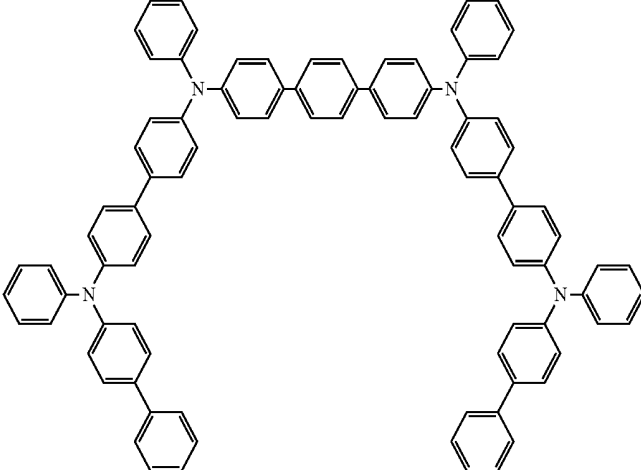
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		EP650955
		J. Mater. Chem. 3, 319 (1993)
		Appl. Phys. Lett. 90, 183503 (2007)

TABLE A-continued

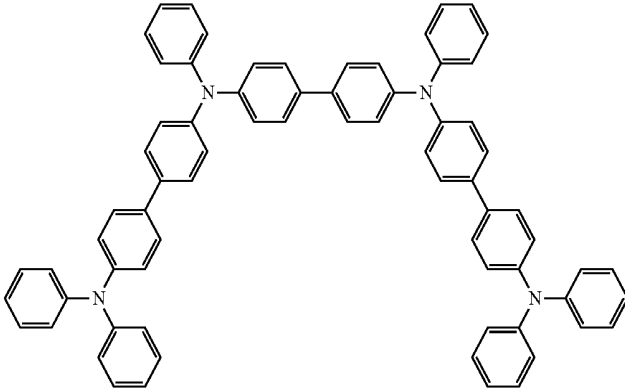
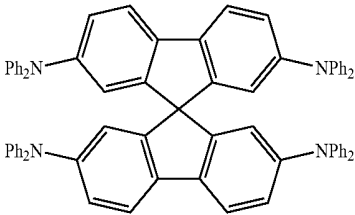
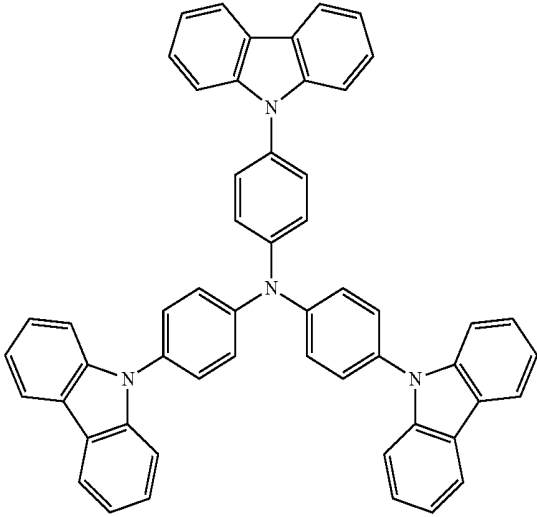
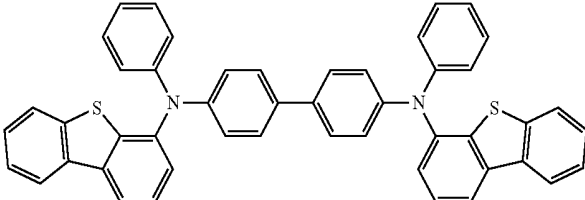
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Triarylamine on spirofluorene core		Appl. Phys. Lett. 90, 183503 (2007)
Arylamine carbazole compounds		Synth. Met. 91, 209 (1997)
Triarylamine with (di)benzothiophene/ (di)benzofuran		Adv. Mater. 6, 677 (1994), US20080124572
Triarylamine with (di)benzothiophene/ (di)benzofuran		US200702789238, US20080106190, US20110163302

TABLE A-continued

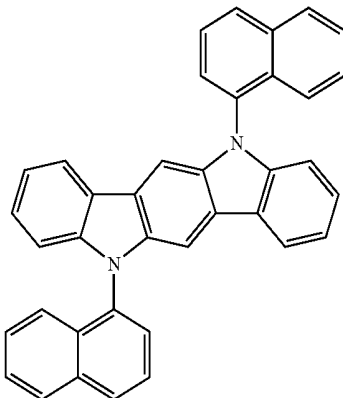
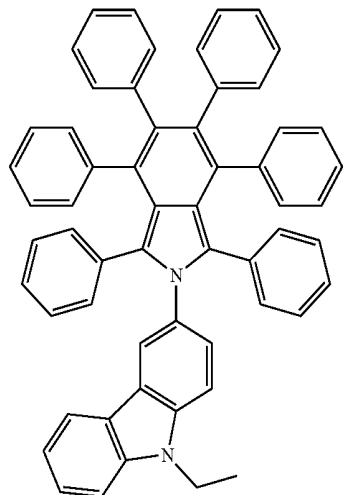
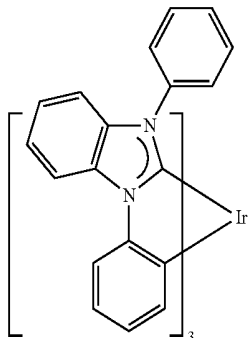
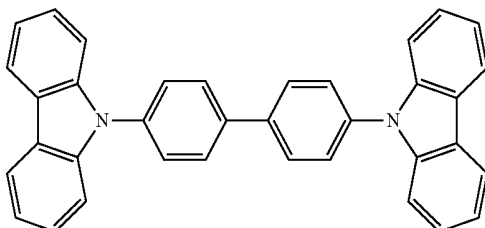
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Indolocarbazoles		Synth. Met. 111, 421 (2000)
Isoindole compounds		Chem. Mater. 15, 3148 (2003)
Metal carbene complexes		US20080018221
Phosphorescent OLED host materials	Red hosts	
Arylcarbazoles		Appl. Phys. Lett. 78, 1622 (2001)

TABLE A-continued

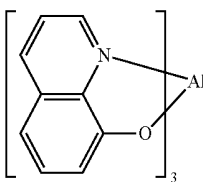
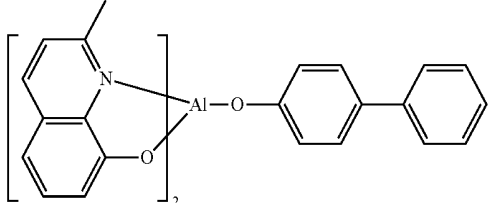
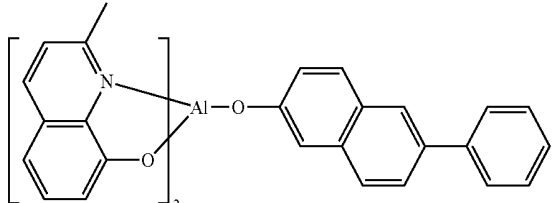
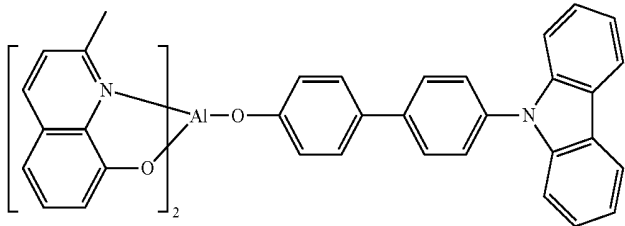
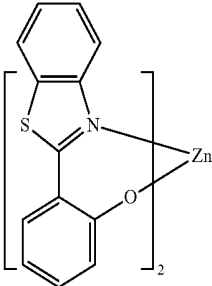
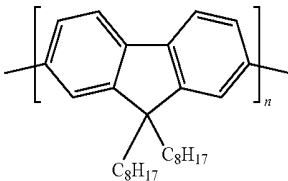
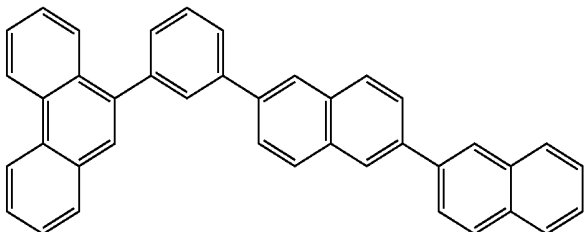
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Metal 8-hydroxyquinolates (e.g., Alq <sub>3</sub> , BAlq)		Nature 395, 151 (1998)
		US20060202194
		WO2005014551
		WO2006072002
Metal phenoxybenzothiazole compounds		Appl. Phys. Lett. 90, 123509 (2007)
Conjugated oligomers and polymers (e.g., polyfluorene)		Org. Electron. 1, 15 (2000)
Aromatic fused rings		WO2009066779, WO2009066778, WO2009063833, US20090045731, US20090045730, WO2009008311, US20090008605, US20090009065

TABLE A-continued

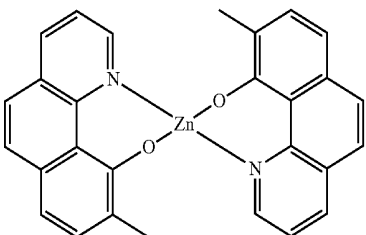
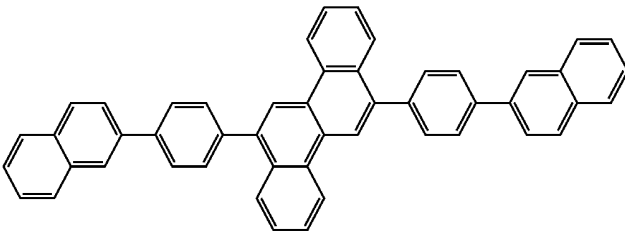
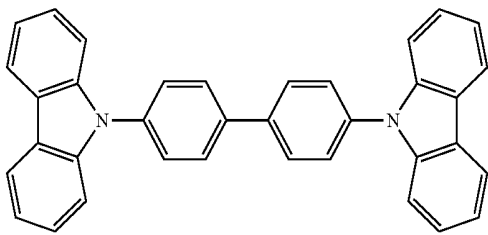
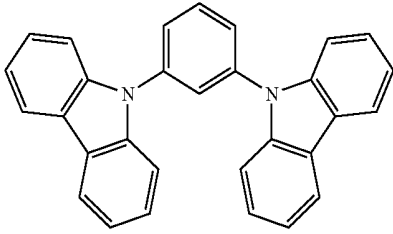
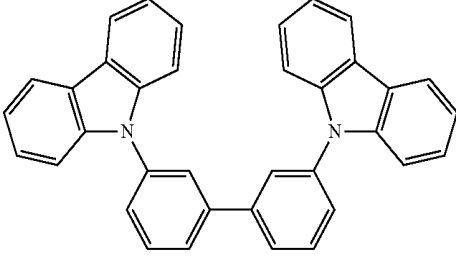
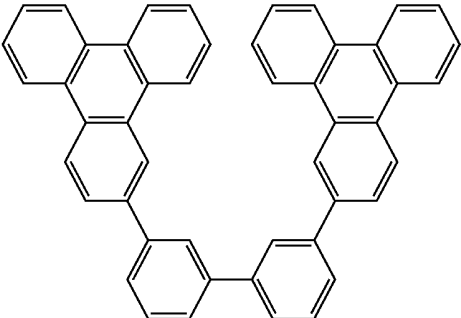
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Zinc complexes		WO2010056066
Chrysene based compounds		WO2011086863
Green hosts	Arylcarbazoles	Appl. Phys. Lett. 78, 1622 (2001)
		
		US20030175553
		WO2001039234
Aryltriphenylene compounds		US20060280965

TABLE A-continued

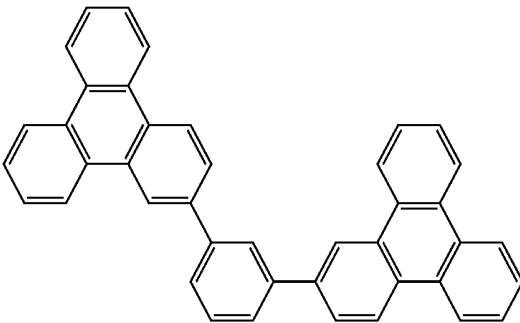
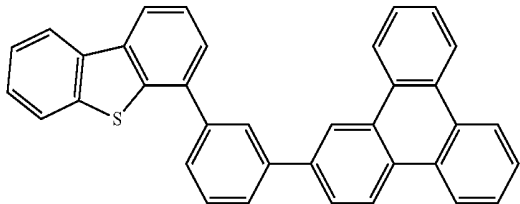
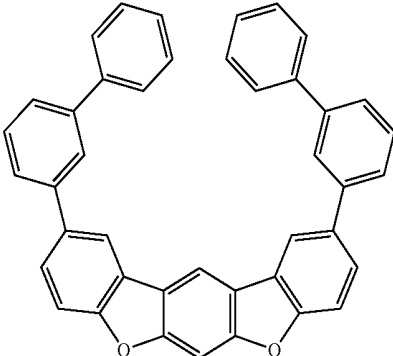
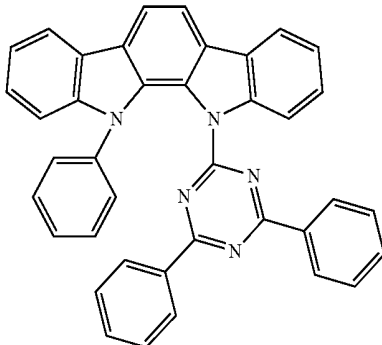
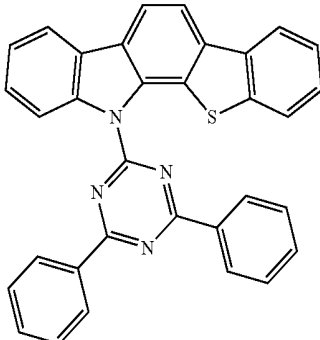
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US20060280965
		WO2009021126
Poly-fused heteroaryl compounds		US20090309488 US20090302743 US20100012931
Donor acceptor type molecules		WO2008056746
		WO2010107244

TABLE A-continued

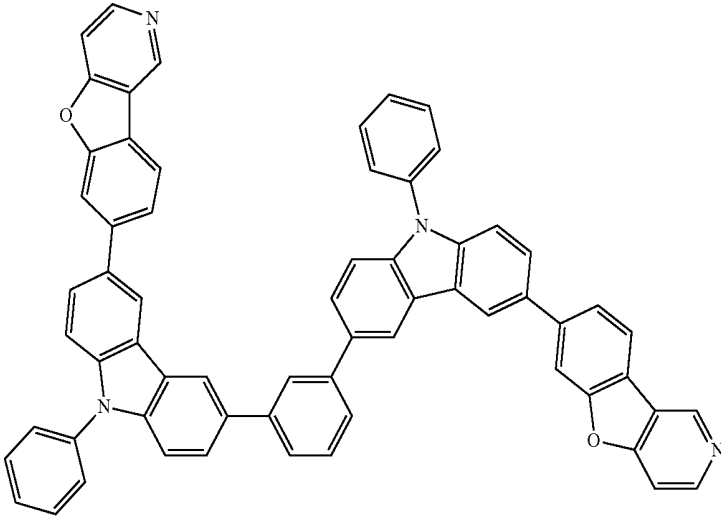
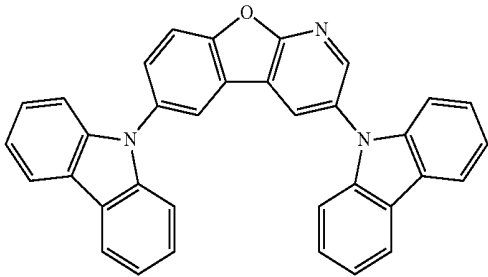
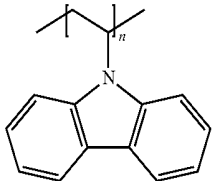
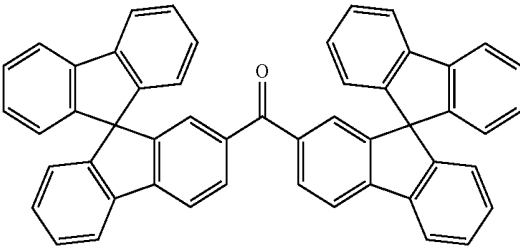
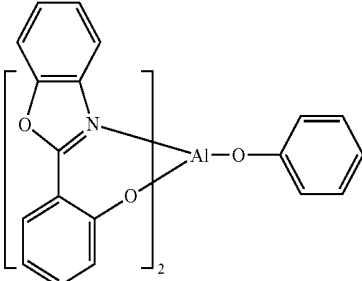
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Aza-carbazole/ DBT/DBF		JP2008074939
		US20100187984
Polymers (e.g., PVK)		Appl. Phys. Lett. 77, 2280 (2000)
Spirofluorene compounds		WO2004093207
Metal phenoxybenzoxazole compounds		WO2005089025

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		WO2006132173
		JP200511610
Spirofluorene-carbazole compounds		JP2007254297
		JP2007254297
Indolocarbazoles		WO2007063796

TABLE A-continued

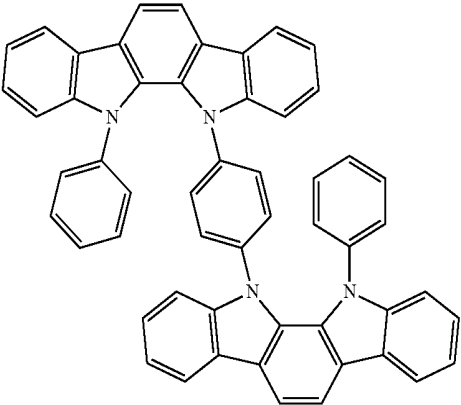
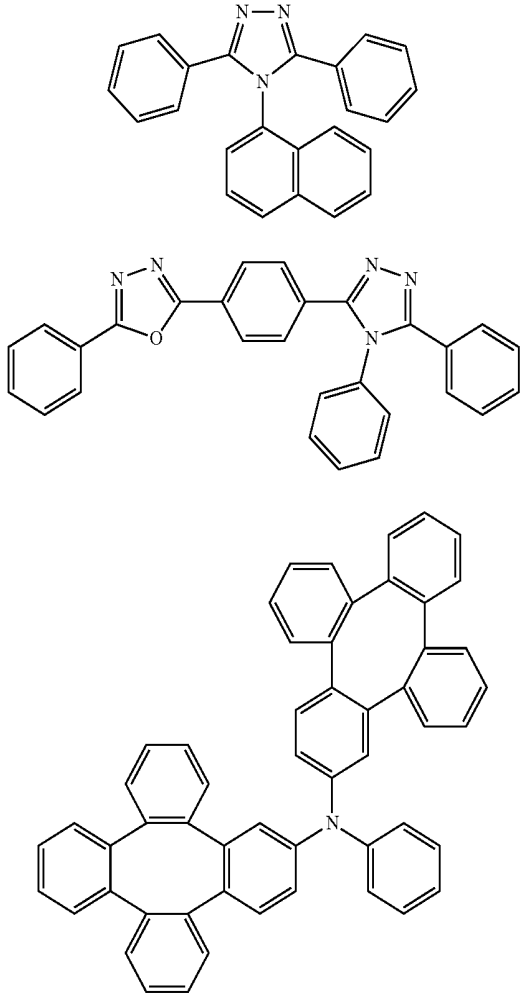
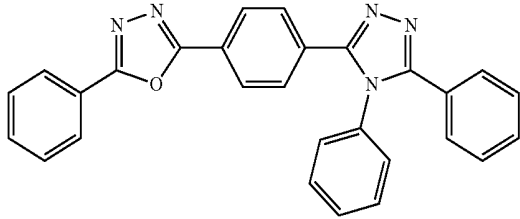
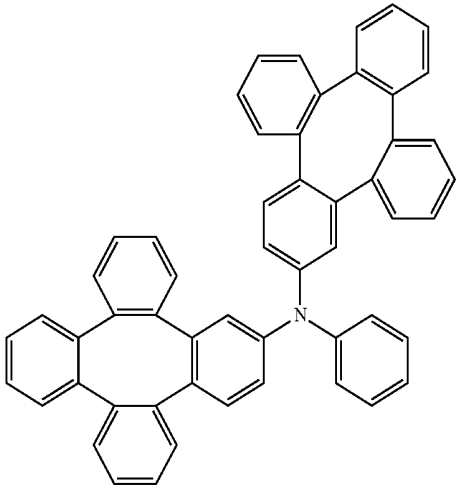
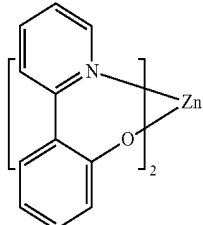
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
5-member ring electron deficient heterocycles (e.g., triazole, oxadiazole)		WO2007063754
Tetraphenylene complexes		J. Appl. Phys. 90, 5048 (2001)
Metal phenoxy pyridine compounds		WO2004107822
		US20050112407
		WO2005030900

TABLE A-continued

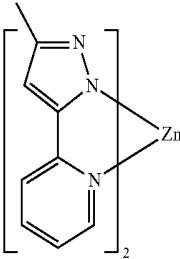
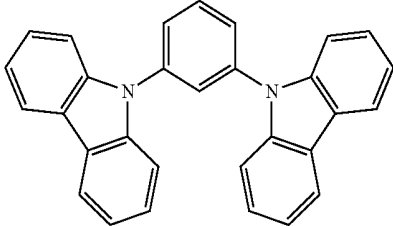
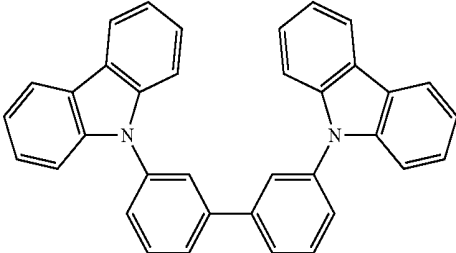
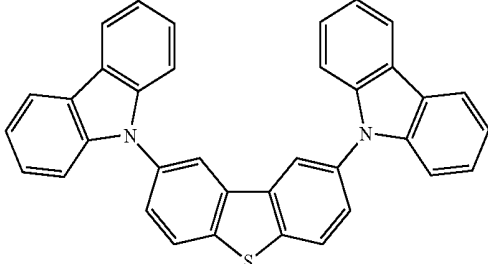
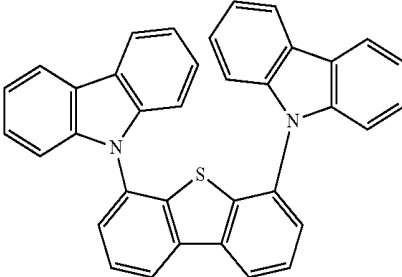
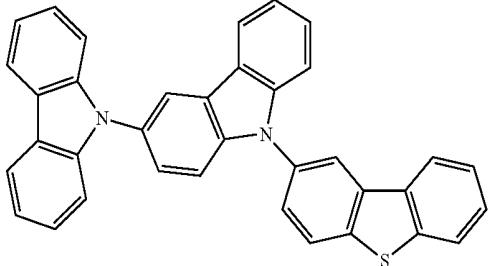
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Metal coordination complexes (e.g., Zn, Al with N-N ligands)		US20040137268, US20040137267
Blue hosts		
Arylcarbazoles		Appl. Phys. Lett., 82, 2422 (2003)
		US20070190359
Dibenzothiophene/ Dibenzofuran- carbazole compounds		WO2006114966, US20090167162
		US20090167162
		WO2009086028

TABLE A-continued

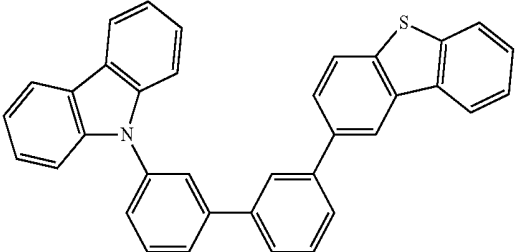
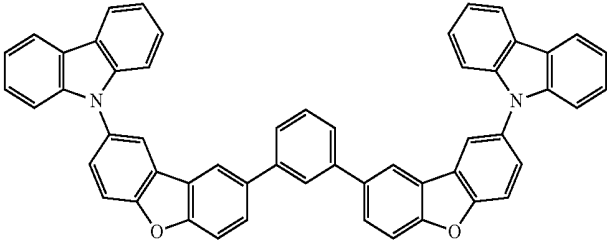
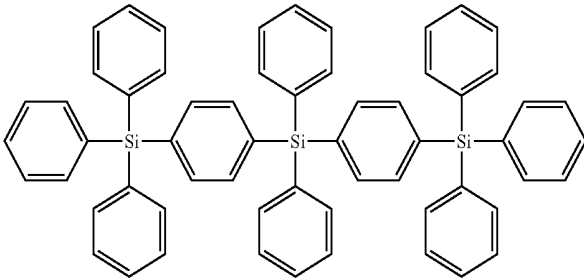
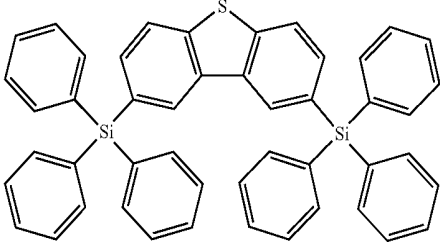
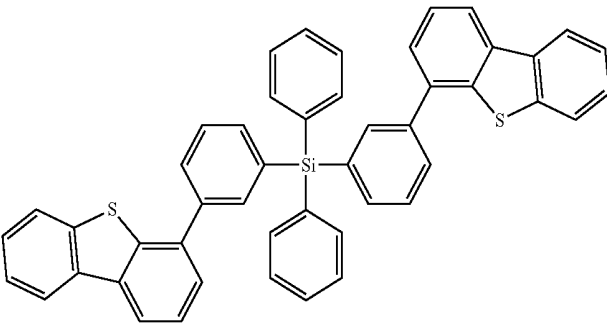
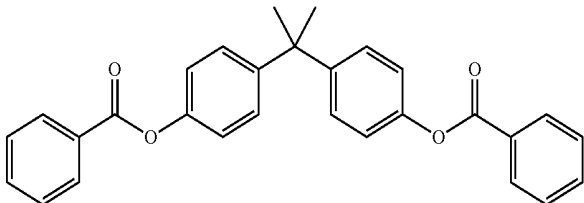
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US20090030202, US20090017330
		US20100084966
Silicon aryl compounds		US20050238919
		WO2009003898
Silicon/Germanium aryl compounds		EP2034538A
Aryl benzoyl ester		WO2006100298

TABLE A-continued

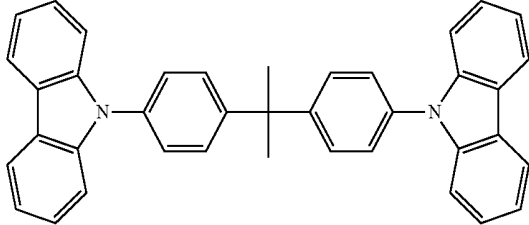
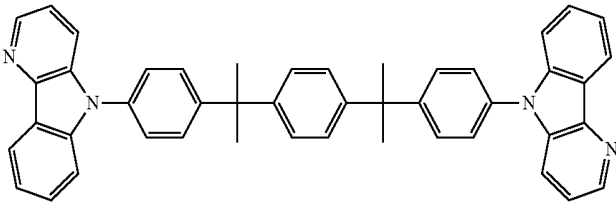
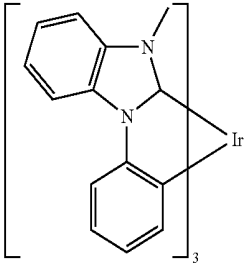
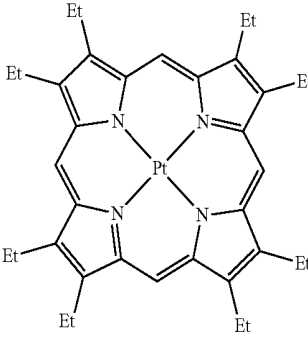
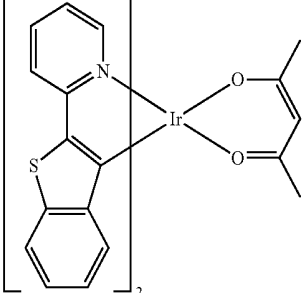
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Carbazole linked by non-conjugated groups		US20040115476
Aza-carbazoles		US20060121308
High triplet metal organometallic complex		US7154114
Phosphorescent dopants Red dopants		
Heavy metal porphyrins (e.g., PtOEP)		Nature 395, 151 (1998)
Iridium (III) organometallic complexes		Appl. Phys. Lett. 78, 1622 (2001)

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US20030072964
		US20030072964
		US20060202194
		US20060202194
		US20070087321

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US20080261076 US20100090591
		US20070087321
	<p>H<sub>17</sub>C<sub>8</sub></p>	Adv. Mater. 19, 739 (2007)
	<p>Ir(acac)</p>	WO2009100991
		WO2008101842

TABLE A-continued

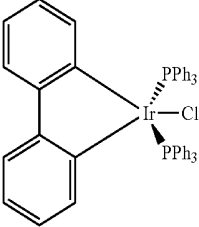
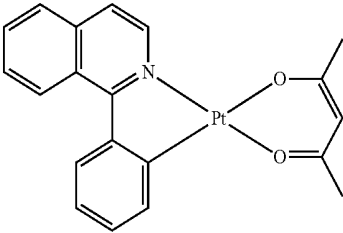
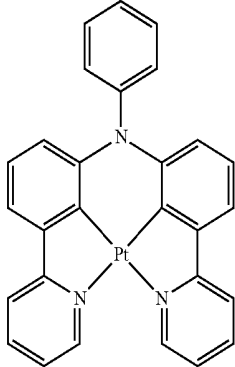
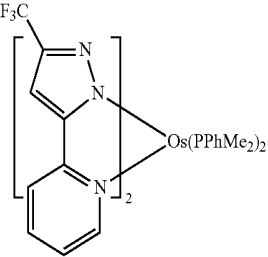
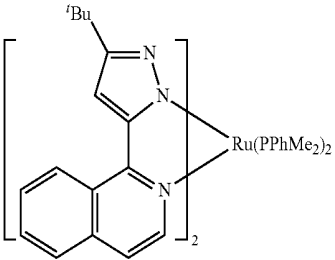
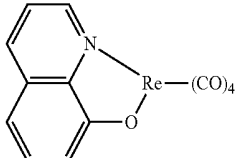
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Platinum (II) organometallic complexes	 	US7232618
Osmium (III) complexes	 	US20070103060
Ruthenium (II) complexes		Chem. Mater. 17, 3532 (2005)
Rhenium (I), (II), and (III) complexes		Adv. Mater. 17, 1059 (2005)
		US20050244673

TABLE A-continued

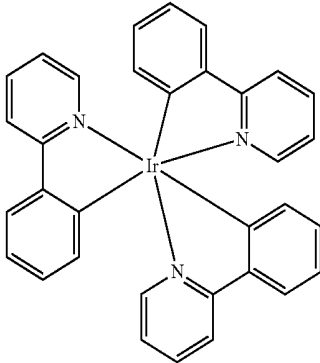
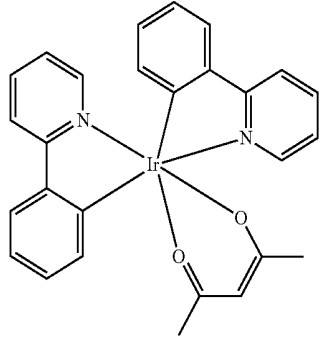
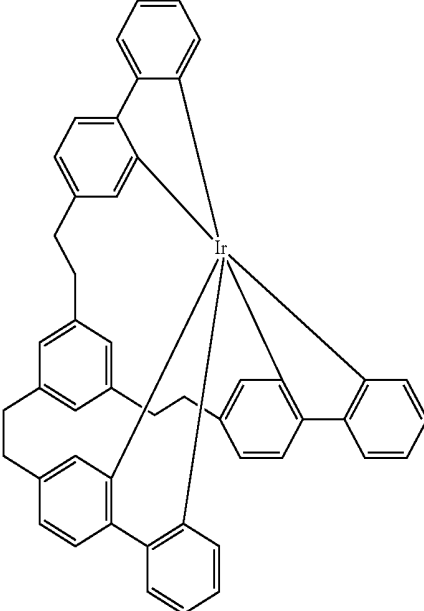
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Green dopants Iridium (III) organometallic complexes	 <p>and its derivatives</p>	Inorg. Chem. 40, 1704 (2001)
		US20020034656
		US7332232

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US20090108737
		WO2010028151
		EP1841834B
		US20060127696
		US20090039776

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US6921915
		US20100244004
		US6687266
		Chem. Mater. 16, 2480 (2004)
		US20070190359

TABLE A-continued

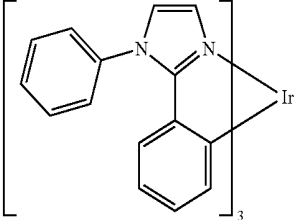
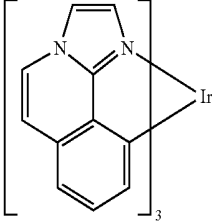
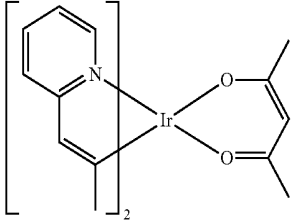
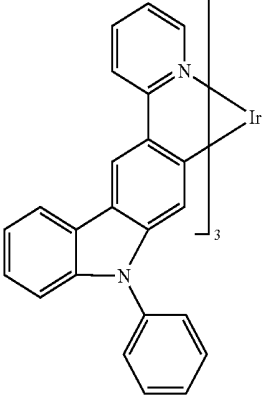
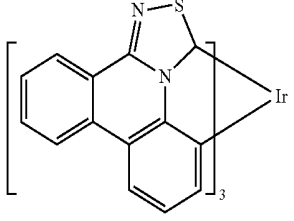
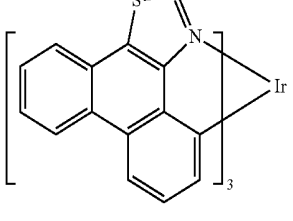
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US 2006008670 JP2007123392
		WO2010086089, WO2011044988
		Adv. Mater. 16, 2003 (2004)
		Angew. Chem. Int. Ed. 2006, 45, 7800
		WO2009050290
		US20090165846

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		US20080015355
		US20010015432
		US20100295032
Monomer for polymeric metal organometallic compounds		US7250226, US7396598
Pt (II) organometallic complexes, including polydentate ligands		Appl. Phys. Lett. 86, 153505 (2005)

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
	<p>The structure shows a central platinum atom coordinated to four nitrogen atoms of a porphyrin-like macrocyclic ligand. One of the nitrogen atoms is also coordinated to a phenyl group via an oxygen atom.</p>	Appl. Phys. Lett. 86, 153505 (2005)
	<p>The structure shows a central platinum atom coordinated to four nitrogen atoms of a porphyrin-like macrocyclic ligand. Two of the nitrogen atoms are also coordinated to pentafluorophenyl groups.</p>	Chem. Lett. 34, 592 (2005)
	<p>The structure shows a central platinum atom coordinated to four nitrogen atoms of a porphyrin-like macrocyclic ligand. One of the nitrogen atoms is also coordinated to a 2,6-dimethylpyridone group.</p>	WO2002015645
	<p>The structure shows a central platinum atom coordinated to four nitrogen atoms of a porphyrin-like macrocyclic ligand. Two of the nitrogen atoms are also coordinated to phenyl groups.</p>	US20060263635
	<p>The structure shows a central platinum atom coordinated to four nitrogen atoms of a porphyrin-like macrocyclic ligand. One of the nitrogen atoms is also coordinated to a phenyl group.</p>	US20060182992 US20070103060

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Cu complexes		WO2009000673
		US20070111026
Gold complexes		Chem. Commun. 2906 (2005)
Rhenium (III) complexes		Inorg. Chem. 42, 1248 (2003)

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Osmium (II) complexes		US7279704
Deuterated organometallic complexes		US20030138657
Organometallic complexes with two or more metal centers		US20030152802
		US7090928

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Blue dopants		
Iridium (III) organometallic complexes		WO2002002714
		WO2006009024
		US20060251923 US20110057559 US20110204333
		US7393599, WO2006056418, US20050260441, WO2005019373
		US7534505

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		WO2011051404
		US7445855
		US20070190359, US20080297033 US20100148663
		US7338722
		US20020134984

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		Angew. Chem. Int. Ed. 47, 4542 (2008)
		Chem. Mater. 18, 5119 (2006)
		Inorg. Chem. 46, 4308 (2007)
		WO2005123873
		WO2005123873

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
		WO2007004380
		WO2006082742
Osmium (II) complexes		US7279704
		Organometallics 23, 3745 (2004)
Gold complexes		Appl. Phys. Lett. 74, 1361 (1999)
Platinum (II) complexes		WO2006098120, WO2006103874

TABLE A-continued

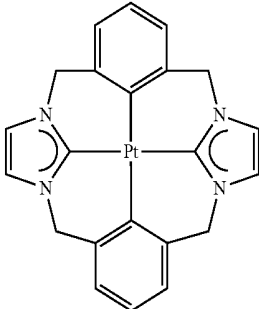
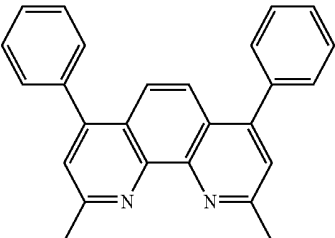
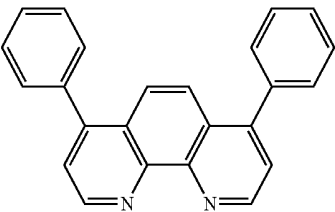
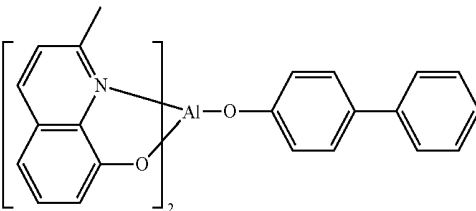
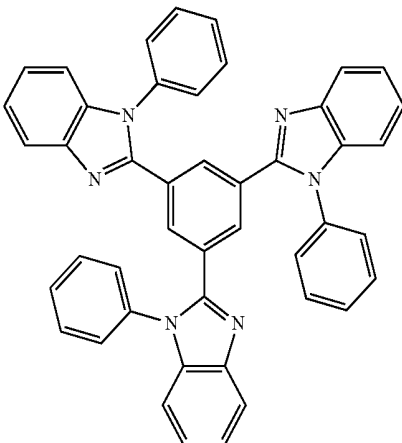
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Pt tetradenate complexes with at least one metal-carbene bond		US7655323
Exciton/hole blocking layer materials		
Bathocuprine compounds (e.g., BCP, BPhen)		Appl. Phys. Lett. 75, 4 (1999)
		Appl. Phys. Lett. 79, 449 (2001)
Metal 8-hydroxyquinolates (e.g., BA1q)		Appl. Phys. Lett. 81, 162 (2002)
5-member ring electron deficient heterocycles such as triazole, oxadiazole, imidazole, benzoimidazole		Appl. Phys. Lett. 81, 162 (2002)

TABLE A-continued

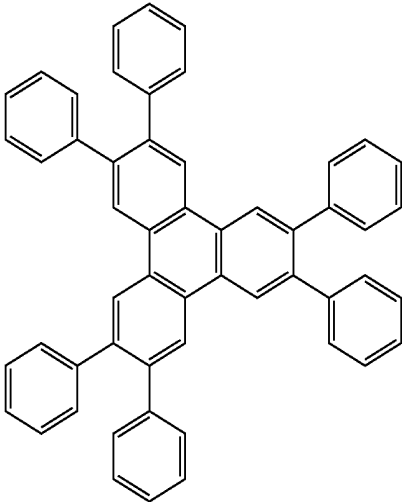
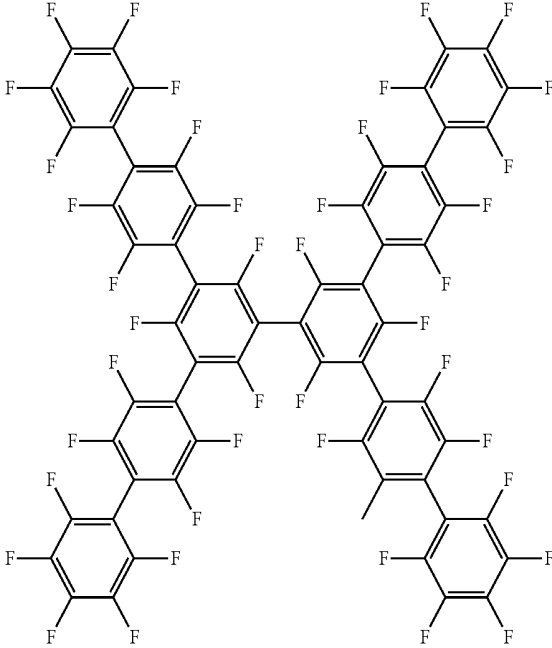
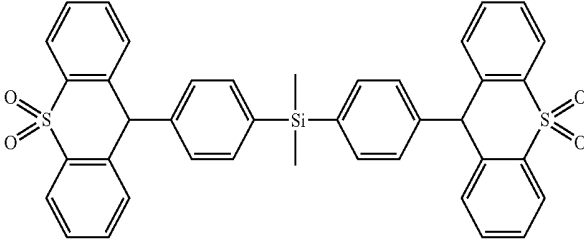
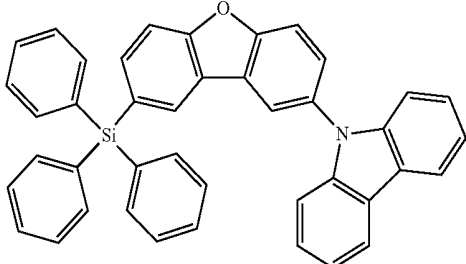
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Triphenylene compounds		US20050025993
Fluorinated aromatic compounds		Appl. Phys. Lett. 79, 156 (2001)
Phenothiazine-S-oxide		WO20080132085
Silylated five-membered nitrogen, oxygen, sulfur or phosphorus dibenzoheterocycles		WO2010079051

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Aza-carbazoles		US20060121308
Electron transporting materials		
Anthracene-benzimidazole compounds		WO2003060956
		US20090179554
Aza triphenylene derivatives		US20090115316
Anthracene-benzothiazole compounds		Appl. Phys. Lett. 89, 063504 (2006)

TABLE A-continued

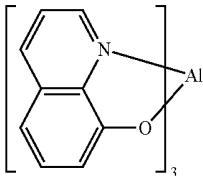
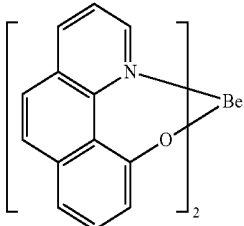
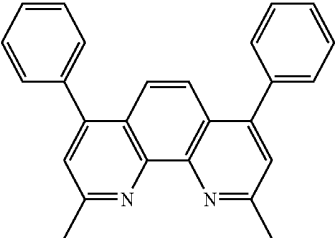
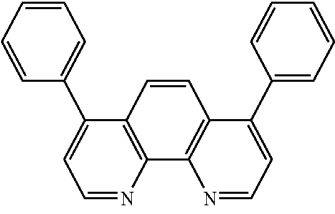
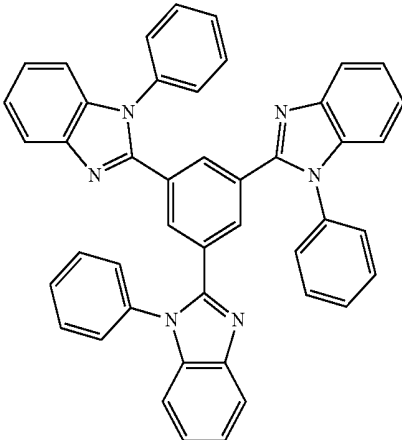
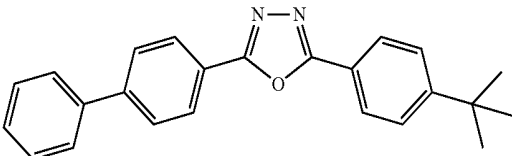
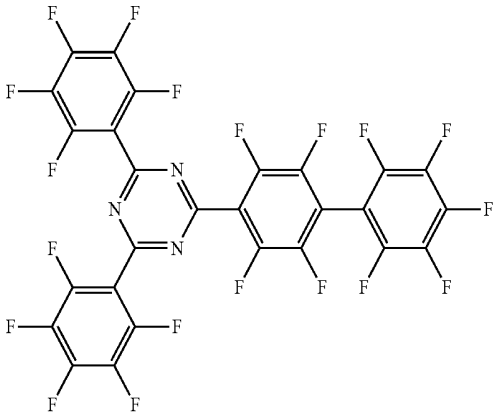
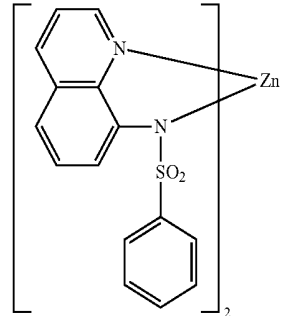
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Metal 8-hydroxyquinolates (e.g., Alq <sub>3</sub> , Zrq <sub>4</sub> )		Appl. Phys. Lett. 51, 913 (1987) US7230107
Metal hydroxy-benzoquinolates		Chem. Lett. 5, 905 (1993)
Bathocuprine compounds such as BCP, BPhen, etc		Appl. Phys. Lett. 91, 263503 (2007)
		Appl. Phys. Lett. 79, 449 (2001)
5-member ring electron deficient heterocycles (e.g., triazole, oxadiazole, imidazole, benzimidazole)		Appl. Phys. Lett. 74, 865 (1999)
		Appl. Phys. Lett. 55, 1489 (1989)

TABLE A-continued

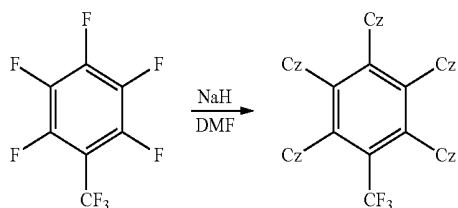
MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Silole compounds		Jpn. J. Apply. Phys. 32, L917 (1993)
Arylborane compounds		Org. Electron. 4, 113 (2003)
Fluorinated aromatic compounds		J. Am. Chem. Soc. 120, 9714 (1998)
Fullerene (e.g., C60)		J. Am. Chem. Soc. 122, 1832 (2000)
Fullerene (e.g., C60)		US20090101870

TABLE A-continued

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Triazine complexes		US20040036077
Zn (N^N) complexes		US6528187

## EXPERIMENTAL

## Synthesis of Compound 14



Carbazole (5.3 g, 32.0 mmol) and sodium hydride (1.9 g, 47.0 mmol) were mixed in 50 mL of dry (i.e., anhydrous) dimethylformamide (DMF). The solution was stirred for 1 hour at room temperature. Octafluorotoluene (0.5 g, 2.2 mmol) was added to the solution. The mixture was then stirred for 3 days under nitrogen. The reaction mixture was poured into water and the precipitate was filtered. The residue was then suspended in tetrahydrofuran (THF):heptane (1:3, v/v) and heated for 1 hour. After cooling, 1.3 g (61%) of compound 14 was obtained as a pale yellow solid by filtration.

## Synthesis of Compound 12

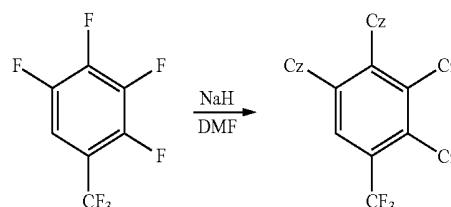
35

40

45

50

55

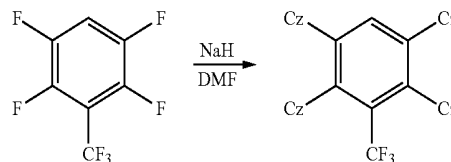


Carbazole (2.9 g, 17 mmol) and sodium hydride (1 g, 25 mmol) were mixed in 30 mL of dry DMF. The solution was stirred for 1 hour at room temperature. 2,3,4,5-tetrafluorobenzotrifluoride (0.38 g, 1.7 mmol) was then added to the mixture. The mixture was then stirred for 3 days under nitrogen. The reaction mixture was poured into water and the precipitate was filtered. The residue was then suspended in THF:heptane (1:3, v/v) and heated for 1 hour. Upon cooling, 1.0 g (71%) of compound 12 was obtained as a white solid by filtration.

## Synthesis of Compound 11

60

65



## 273

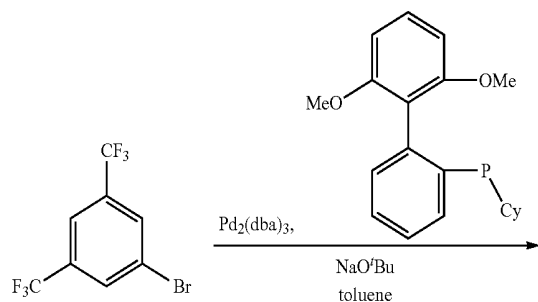
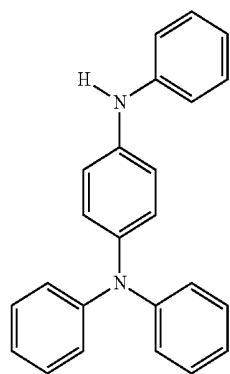
Carbazole (2.9 g, 17 mmol) and sodium hydride (1 g, 25 mmol) were mixed in 30 mL of dry DMF. The solution was stirred for 1 hour at room temperature. 2,3,5,6-tetrafluorobenzotrifluoride (0.38 g, 1.7 mmol) was then added to the mixture. The mixture was stirred for 3 days under nitrogen. The reaction mixture was poured into water and the precipitate was filtered. The residue was then suspended in THF:heptane (1:3, v/v) and heated for 1 hour. Upon cooling, 1.0 g (71%) of compound 12 was obtained as a white solid by filtration.

## Synthesis of Compound 32



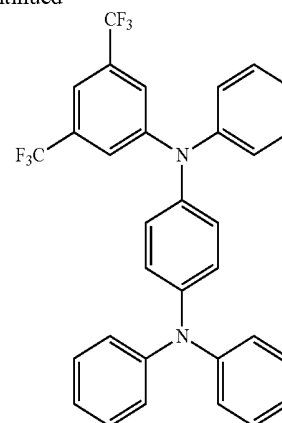
Carbazole (0.53 g, 3.2 mmol) and sodium hydride (0.2 g, 4.7 mmol) were mixed in 10 mL of dry DMF. The solution was stirred for 1 hour at room temperature. 1,5-dichloro-2,4-bis(trifluoromethyl)benzene (0.3 g, 1.1 mmol) was then added to the mixture. The mixture was stirred for 3 days under nitrogen. The reaction mixture was poured into water and the precipitate was filtered. The residue was then suspended in THF:heptane (1:3, v/v) and heated for 1 hour. Upon cooling, 0.35 g (59%) of compound 32 was obtained as a white solid by filtration.

## Synthesis of Compound 743



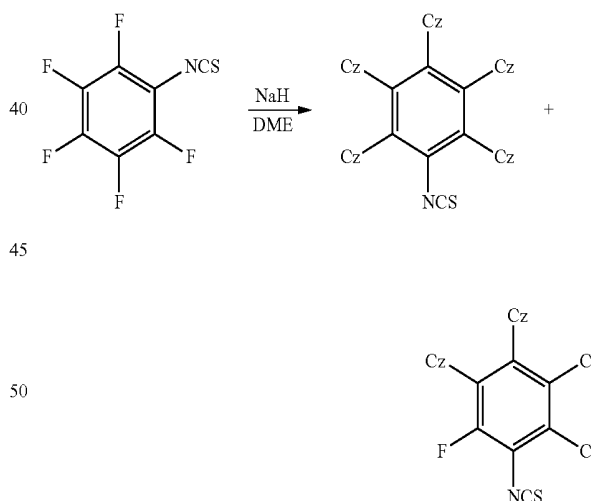
## 274

-continued



$N^1,N^1,N^4$ -triphenylbenzene-1,4-diamine (1.0 g, 3.0 mmol) and 1-bromo-3,5-bis(trifluoromethyl)benzene (1.15 g, 3.9 mmol) were mixed in 70 mL of dry xylene. The solution was bubbled with nitrogen for 15 min.  $Pd_2(dba)_3$  (0.29 g, 0.32 mmol), 2-dicyclohexylphosphino-2',6'-dimethoxybiphenyl (0.58 g, 1.20 mmol) and  $tBuONa$  (0.44 g, 4.50 mmol) were then added to the solution. The mixture was refluxed overnight under nitrogen. After cooling, the reaction mixture was filtered through a celite/silica pad and the filtrate was concentrated. The residue was then purified by column chromatography using DCM:hexane (1:4, v/v) as the eluent. 1.3 g (80%) of compound 743 was collected.

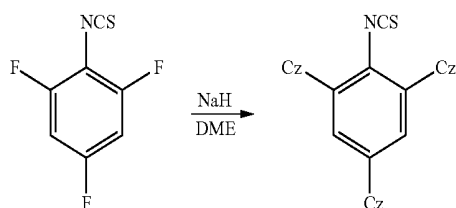
## Synthesis of Compound 262 and Compound 736



Carbazole (19.6 g, 117.6 mmol) and sodium hydride (7.0 g, 176.4 mmol) were mixed in 300 mL of dry 1,2-dimethoxyethane. The solution was stirred for 2 hours and 1,2,3,4,5-pentafluoro-6-isothiocyanatobenzene (2.0 g, 7.8 mmol) was added. The mixture was stirred under nitrogen for 1 week at room temperature. The reaction mixture was poured into water and the precipitate was filtered. The residue was then purified by column chromatography using gradient from hexane to toluene:hexane (1:1, v/v) as the eluent. 1.9 g (25%) of Compound 262 and 0.3 g (5%) of Compound 736 were collected.

275

## Synthesis of Compound 254



Carbazole (4.0 g, 23.8 mmol) and sodium hydride (1.4 g, 35.7 mmol) were mixed in 60 mL of dry 1,2-dimethoxyethane. The solution was stirred for 2 hours, then 1,3,5-trifluoro-2-isothiocyanatobenzene (0.5 g, 2.6 mmol) was added to the solution. The mixture was stirred under nitrogen for 4 days at room temperature. The reaction mixture was poured into water and the precipitate was filtered. The

276

from non-polar to polar solvents, suggesting the charge transfer nature of the emission. The PLQY of the  $\text{CF}_3$  acceptor compounds reach as high as 55% in the blue region.

5

## Device Examples

In the OLED experiments, all device examples were fabricated by high vacuum (<10-Torr) thermal evaporation. The anode electrode is ~800 Å of indium tin oxide (ITO). The cathode was 10 Å of LiF followed by 1,000 Å of Al. All devices were encapsulated with a glass lid sealed with an epoxy resin in a nitrogen glove box (<1 ppm of  $\text{H}_2\text{O}$  and  $\text{O}_2$ ) and a moisture getter was incorporated inside the package.

The organic stack of the Device Examples in Table 3 consists of, sequentially from the ITO surface, 100 Å of LG101 as the hole injection layer (HIL), 300 Å of TAPC as the hole transporting layer (HTL), 300 Å of mCP doped with 10% or 15% or neat of dopant Compound 11 or 12 or 14 as the emissive layer (EML), 0 or 50 Å of Compound A or B as the ETL2, and 400 Å of TmPyPB or LG201 as the ETL1.

TABLE 3

Example	EML		ETL1 400Å	1931 CIE				At 1,000 nits				
	Host 300Å	dopant [conc. %]		ETL250Å	CIE x	CIE y	$\text{Em}_{\text{max}}$ [nm]	FWHM [nm]	V [V]	LE [cd/A]	EQE [%]	PE [lm/W]
Device 1	Cmpd 14 [100]	A	TmPyPB	0.215	0.393	490	88	7.4	6.6	2.8	2.8	
Device 2	Cmpd 14 [100]	—	TmPyPB	0.211	0.392	490	86	7.0	7.8	3.3	3.5	
Device 3	mCP	Cmpd 14 [0]	A	TmPyPB	0.177	0.319	482	78	8.0	16.3	8.1	6.4
Device 4	mCP	Cmpd 14 [0]	—	TmPyPB	0.174	0.295	482	76	8.3	11.0	5.7	4.2
Device 5	Cmpd 12 [100]	A	TmPyPB	0.191	0.197	458	88	12.6	0.8	0.6	0.2	

residue was then purified by column chromatography using gradient from hexane to toluene:hexane (1:1, v/v) as the eluent. 57 mg (3%) of Compound 254 was isolated.

The photoluminescence quantum yields of the synthesized compounds are summarized in Table 1 (below):

TABLE 1

Cmpd	PLQY in PMMA (5 wt % of Cmpd)	$\text{Em}_{\text{max}}$ in PMMA [nm]
14	53%	475
743	5%	493
262	16%	489
736	10%	406
12	21%	423
11	55%	436
254	5%	406
32	42%	433

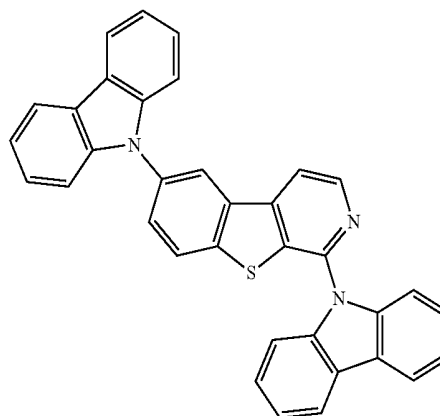
The photoluminescence data in 2-methylTHF (2Me-THF), toluene, and 3-methylpentane (3-MP) are summarized in Table 2 (below):

TABLE 2

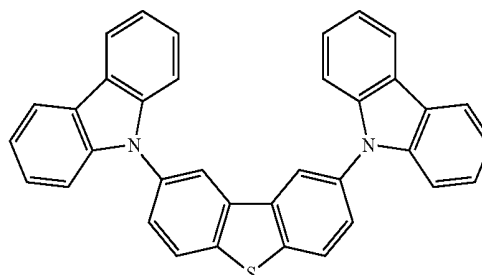
Cmpd	$\text{Em}_{\text{max}}$ at RT in 2Me-THF [nm]	$\text{Em}_{\text{max}}$ at RT in toluene [nm]	$\text{Em}_{\text{max}}$ at RT in 3-MP [nm]	$\text{Em}_{\text{max}}$ at 77 K in 3-MP [nm]
14	494	487	459	452
743	522	510	468	458
12	443	431	421	440
11	446	441	432	436
32	448	430	403	439

The photoluminescence in 2-methylTHF (2Me-THF), toluene, and 3-methylpentane shows significant redshift

Compound A



Compound B



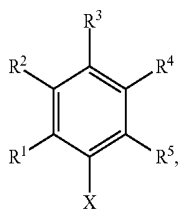
Device 3 with Compound 14 as the emitter has an external quantum efficiency of 10% at 100  $\text{cd}/\text{m}^2$  and 8.1% at 100  $\text{cd}/\text{m}^2$ . The result demonstrates that charge transfer luminescent compounds with strong acceptors as emitters in

OLED can lead to device efficiency higher than the theoretical limit of fluorescent OLED, by harvesting the triplet through delayed fluorescence.

It is understood that the various embodiments described herein are by way of example only, and are not intended to limit the scope of the invention. For example, many of the materials and structures described herein may be substituted with other materials and structures without deviating from the spirit of the invention. The present invention as claimed may therefore include variations from the particular examples and preferred embodiments described herein, as will be apparent to one of skill in the art. It is understood that various theories as to why the invention works are not intended to be limiting.

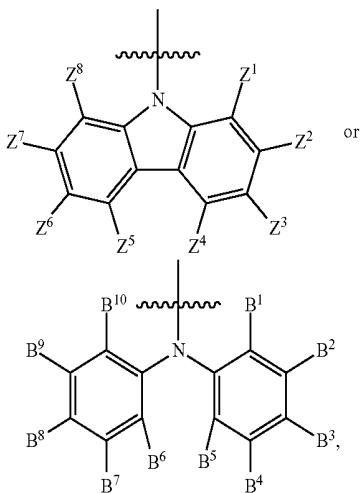
We claim:

1. A compound comprising a structure according to Formula 1:



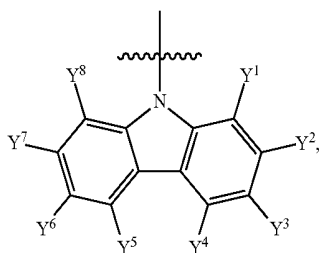
Formula 1

wherein R<sup>5</sup> is

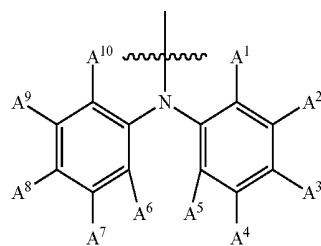


and

wherein (a) at least one of R<sup>1</sup>-R<sup>4</sup> is



or (b) R<sup>1</sup> is



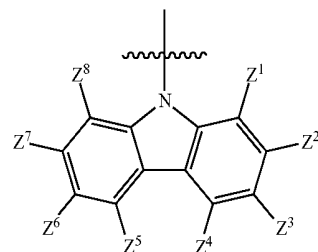
wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, A<sup>1</sup>, A<sup>2</sup>, A<sup>3</sup>, A<sup>4</sup>, A<sup>5</sup>, A<sup>6</sup>, A<sup>7</sup>, A<sup>8</sup>, A<sup>9</sup>, A<sup>10</sup>, B<sup>1</sup>, B<sup>2</sup>, B<sup>3</sup>, B<sup>4</sup>, B<sup>5</sup>, B<sup>6</sup>, B<sup>7</sup>, B<sup>8</sup>, B<sup>9</sup>, B<sup>10</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup>, and Z<sup>8</sup>, are each independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, —SC<sub>m</sub>F<sub>2m+1</sub>, and combinations thereof;

wherein m ≥ 1;

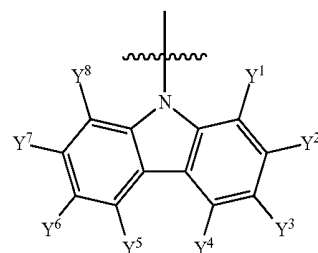
wherein adjacent A, B, Y, and Z groups are, optionally, joined to form a fused ring structure; and

wherein X comprises an acceptor group selected from the group consisting of —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

2. The compound of claim 1, wherein R<sup>5</sup> is

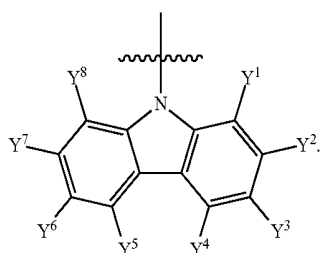


and at least one of R<sup>1</sup>-R<sup>4</sup> is



279

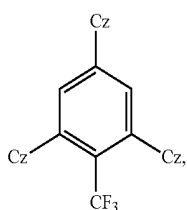
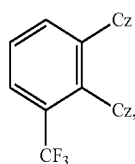
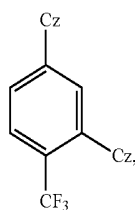
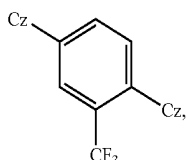
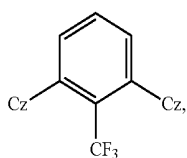
3. The compound according to claim 2, wherein at least two of R<sup>1</sup>-R<sup>4</sup> are



4. The compound of claim 2, wherein at least one of R<sup>1</sup>-R<sup>4</sup> comprises an acceptor group selected from the group consisting of —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

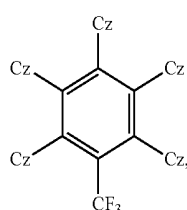
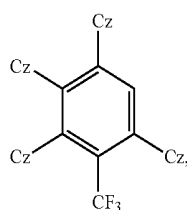
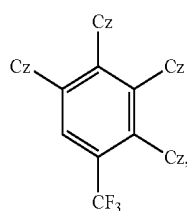
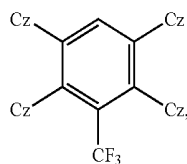
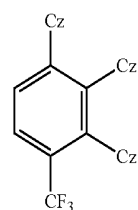
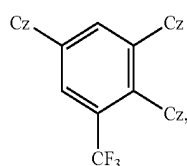
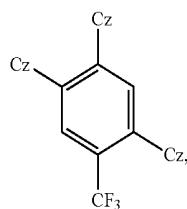
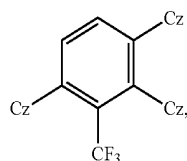
5. The compound of claim 2, wherein at least one of R<sup>1</sup>-R<sup>4</sup> is an electron withdrawing group with a Hammett value ( $\sigma_{para}$ ) of at least 0.05.

6. The compound of claim 2, wherein the compound is selected from the group consisting of:



280

-continued



Compound 7

Compound 8

Compound 9

Compound 10

Compound 1

Compound 2

Compound 3

Compound 4

Compound 6

Compound 11

Compound 12

Compound 13

Compound 14

5

10

15

20

25

30

35

40

45

50

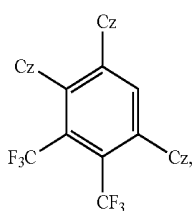
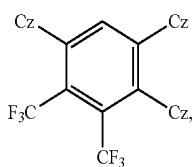
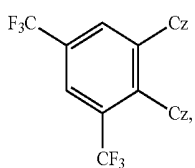
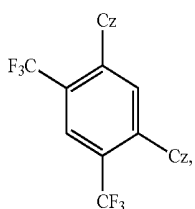
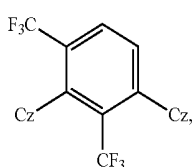
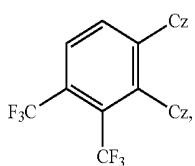
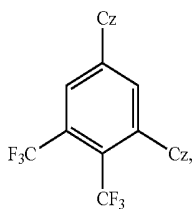
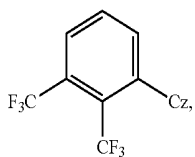
55

60

65

281

-continued

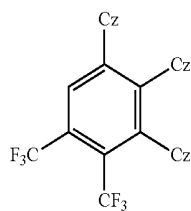


282

-continued

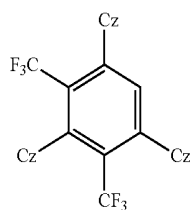
Compound 15

5



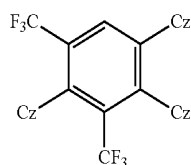
Compound 29

10



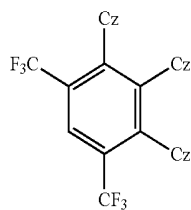
Compound 30

15



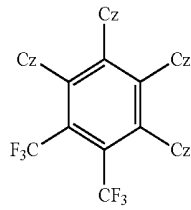
Compound 30

20



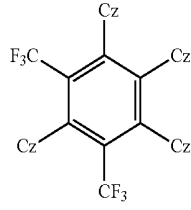
Compound 31

25



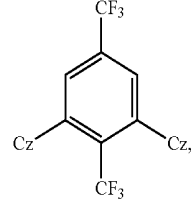
Compound 32

30



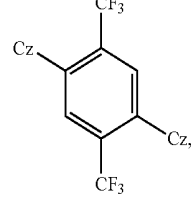
Compound 33

35



Compound 33

40



Compound 34

45

Compound 34

50

Compound 35

55

Compound 35

60

65

Compound 36

Compound 37

Compound 38

Compound 39

Compound 40

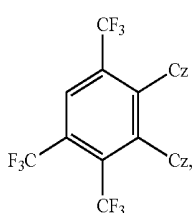
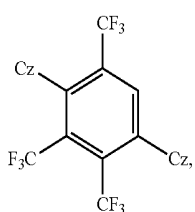
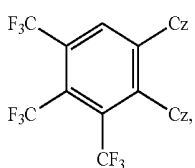
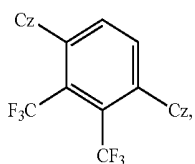
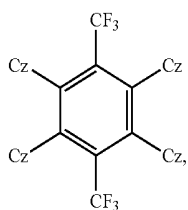
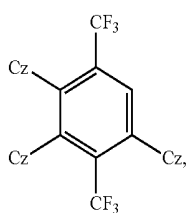
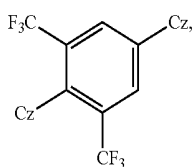
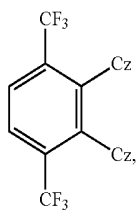
Compound 41

Compound 42

Compound 43

283

-continued



284

-continued

Compound 44

5

10

Compound 45

15

Compound 46

20

25

Compound 47

30

Compound 48

35

40

Compound 49

45

Compound 50

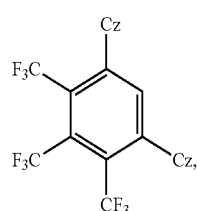
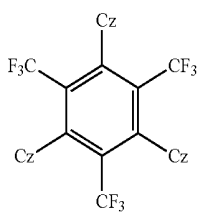
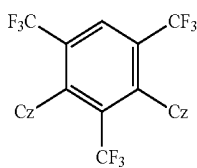
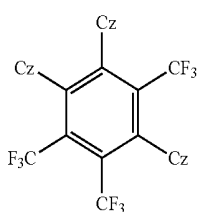
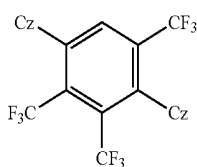
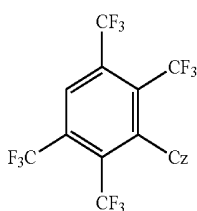
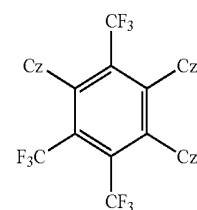
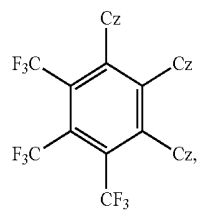
50

55

Compound 51

60

65



Compound 52

Compound 53

Compound 54

Compound 55

Compound 56

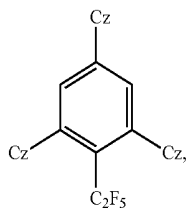
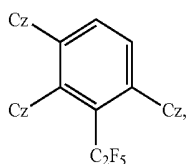
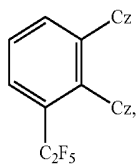
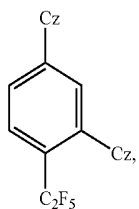
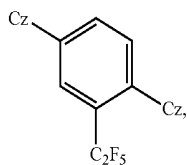
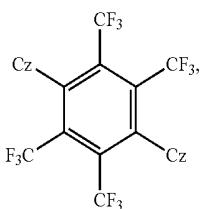
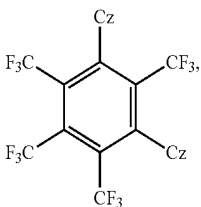
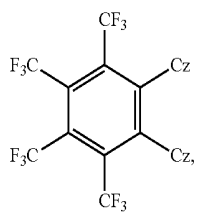
Compound 57

Compound 58

Compound 59

285

-continued



286

-continued

Compound 60

5

Compound 61

15

Compound 62

20

Compound 63

30

Compound 64

35

Compound 65

45

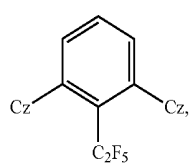
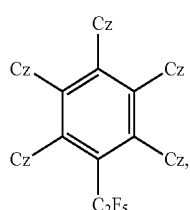
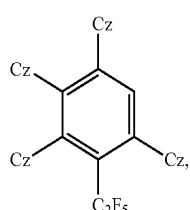
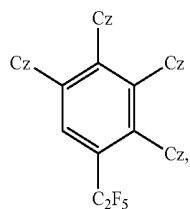
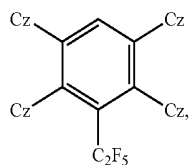
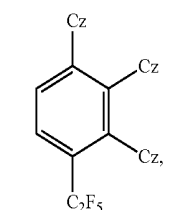
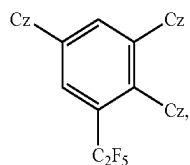
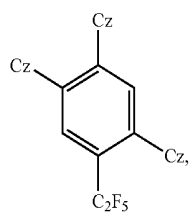
Compound 66

50

Compound 67

60

65



Compound 69

Compound 70

Compound 71

Compound 72

Compound 73

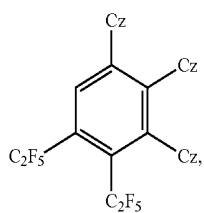
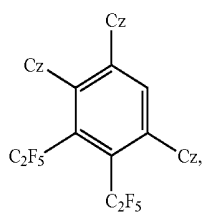
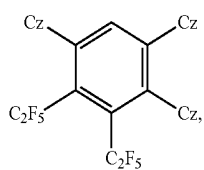
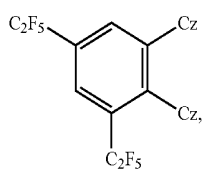
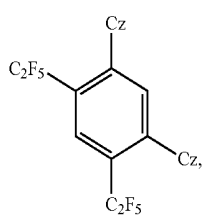
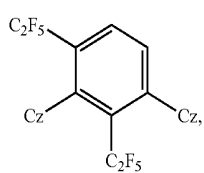
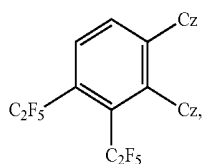
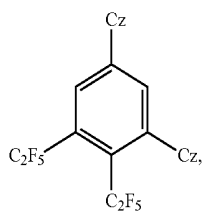
Compound 74

Compound 75

Compound 76

287

-continued

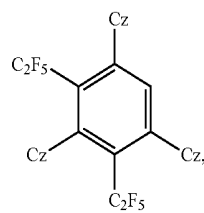


288

-continued

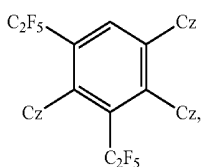
Compound 91

5



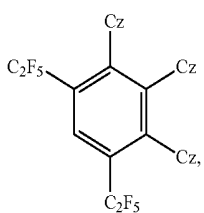
Compound 92

10



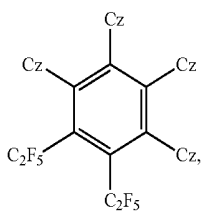
Compound 93

20



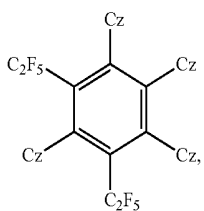
Compound 94

25



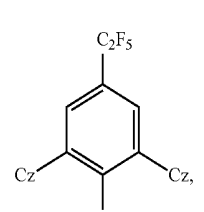
Compound 95

35



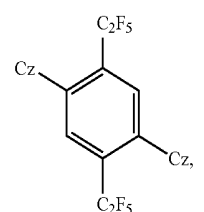
Compound 96

40



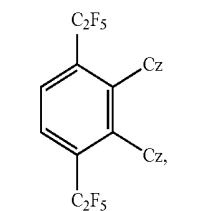
Compound 97

50



Compound 98

60



Compound 99

Compound 100

Compound 101

Compound 102

Compound 103

Compound 104

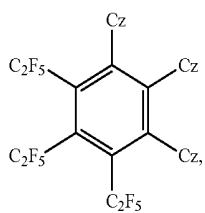
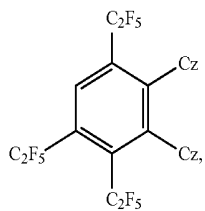
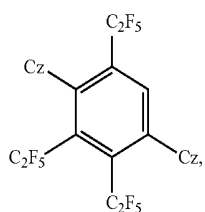
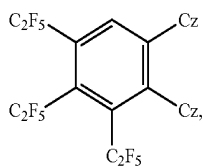
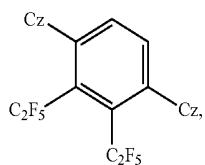
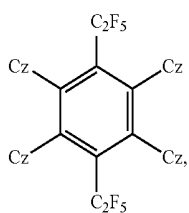
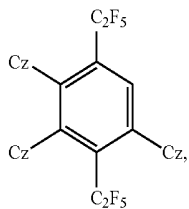
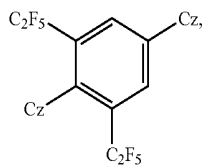
Compound 105

Compound 106

65

289

-continued

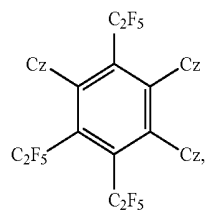


290

-continued

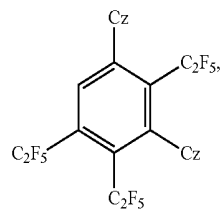
Compound 107

5



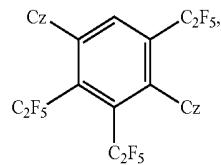
Compound 108

10



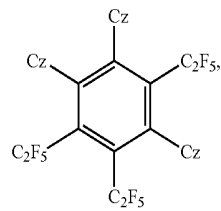
Compound 109

20



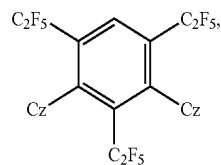
Compound 110

30



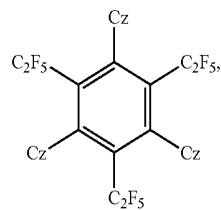
Compound 111

35



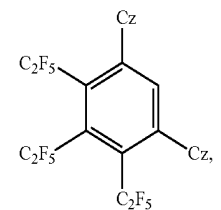
Compound 112

40



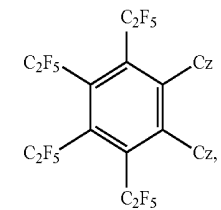
Compound 113

50



Compound 114

60



65

Compound 115

Compound 116

Compound 117

Compound 118

Compound 119

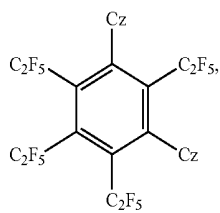
Compound 120

Compound 121

Compound 122

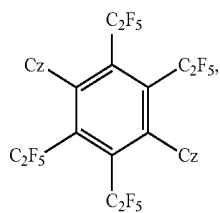
291

-continued



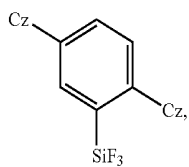
Compound 123

5



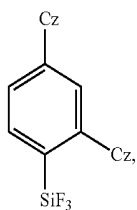
Compound 124

10



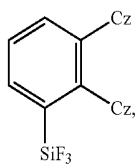
Compound 125

20



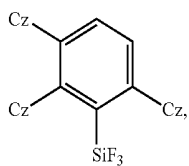
Compound 126

30



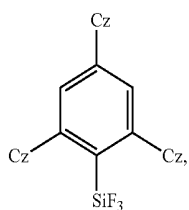
Compound 127

40



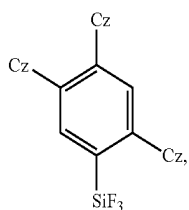
Compound 128

45



Compound 129

50



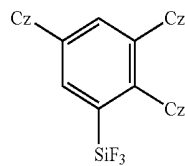
Compound 131

60

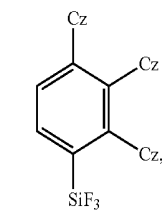
65

292

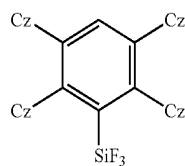
-continued



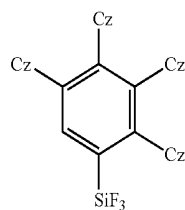
Compound 132



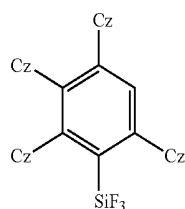
Compound 133



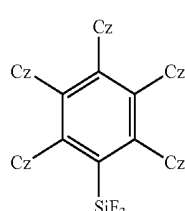
Compound 134



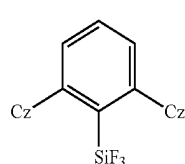
Compound 135



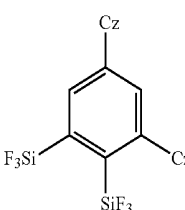
Compound 136



Compound 137



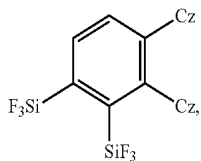
Compound 138



Compound 153

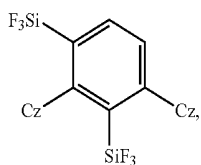
293

-continued



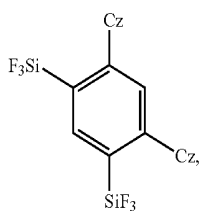
Compound 154

5



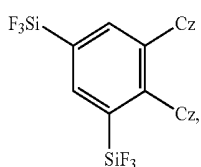
Compound 155

10



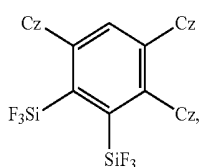
Compound 156

15



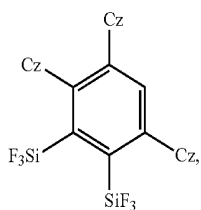
Compound 157

25



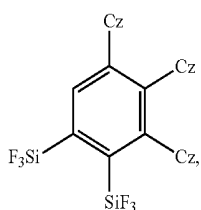
Compound 158

30



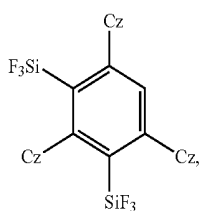
Compound 159

40



Compound 160

50



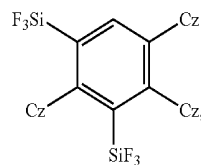
Compound 161

60

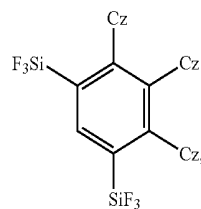
65

294

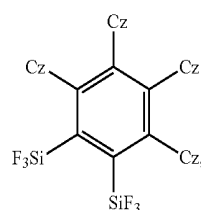
-continued



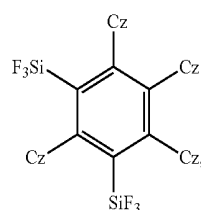
Compound 162



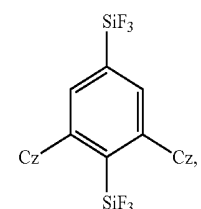
Compound 163



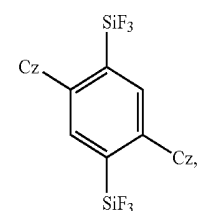
Compound 164



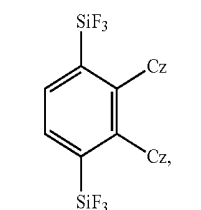
Compound 165



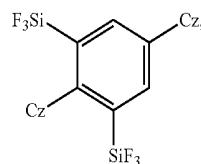
Compound 166



Compound 167



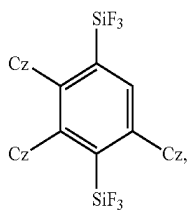
Compound 168



Compound 169

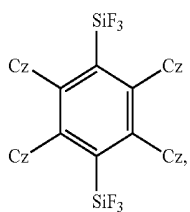
295

-continued



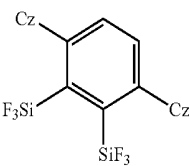
Compound 170

5



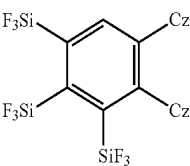
Compound 171

10



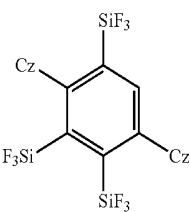
Compound 172

20



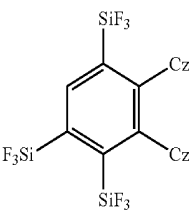
Compound 173

25



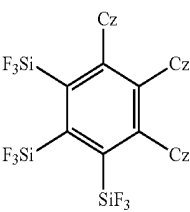
Compound 174

35



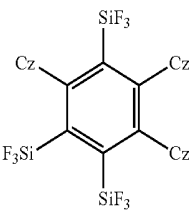
Compound 175

45



Compound 176

50



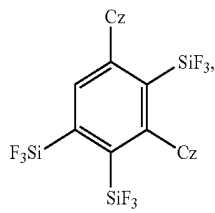
Compound 177

60

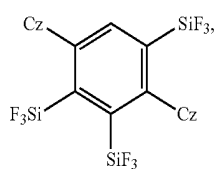
65

296

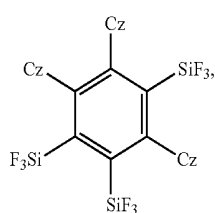
-continued



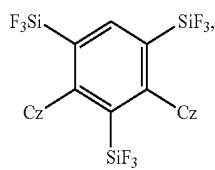
Compound 178



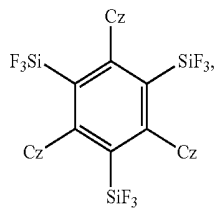
Compound 179



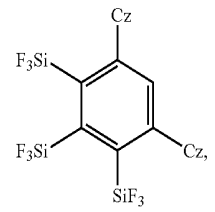
Compound 180



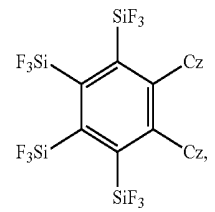
Compound 181



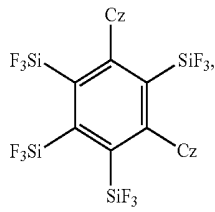
Compound 182



Compound 183



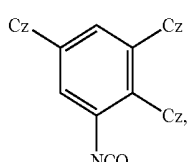
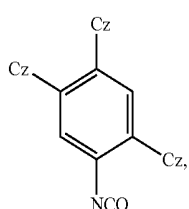
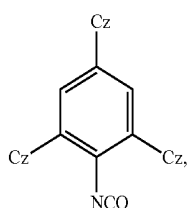
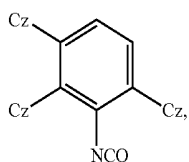
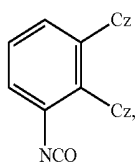
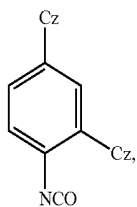
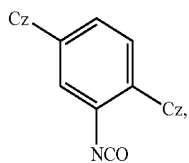
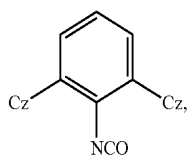
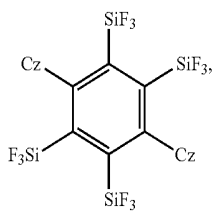
Compound 184



Compound 185

297

-continued

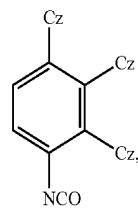


298

-continued

Compound 186

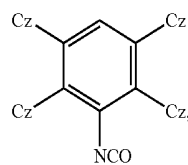
5



Compound 196

Compound 187

10

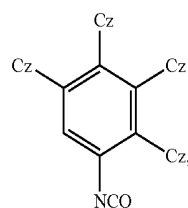


Compound 197

15

Compound 188

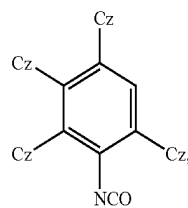
20



Compound 198

Compound 189

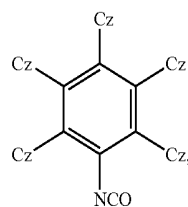
25



Compound 199

Compound 190

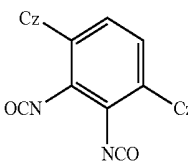
35



Compound 200

Compound 191

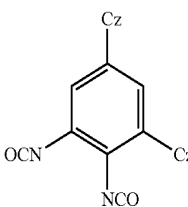
40



Compound 215

Compound 192

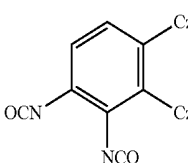
45



Compound 216

Compound 194

55



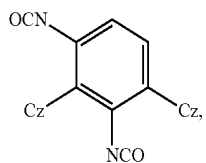
Compound 217

Compound 195

65

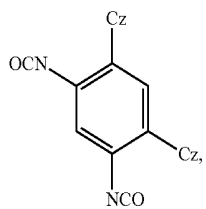
**299**

-continued



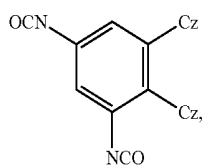
Compound 218

5



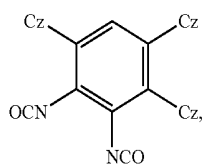
Compound 219

10



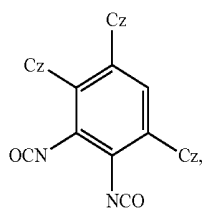
Compound 220

20



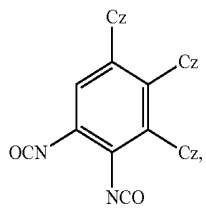
Compound 221

25



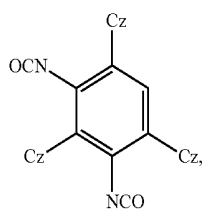
Compound 222

35



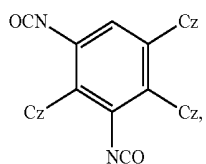
Compound 223

40



Compound 224

50

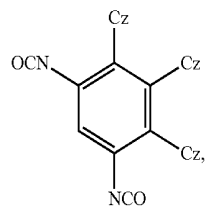


Compound 225

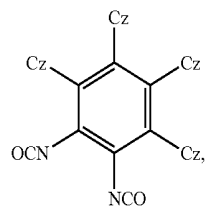
65

**300**

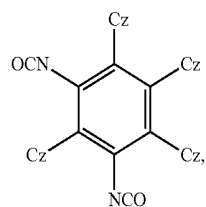
-continued



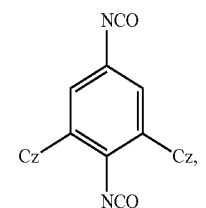
Compound 226



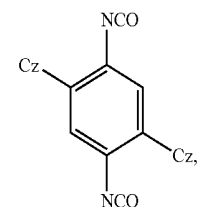
Compound 227



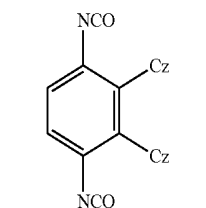
Compound 228



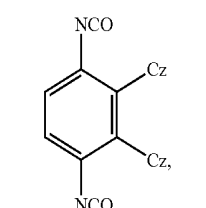
Compound 229



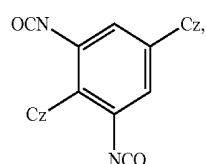
Compound 230



Compound 231



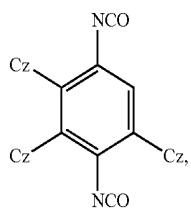
Compound 231



Compound 232

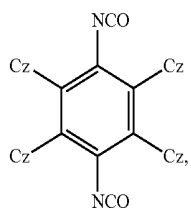
**301**

-continued



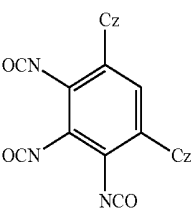
Compound 233

5



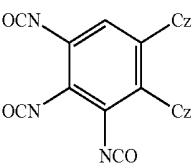
Compound 234

10



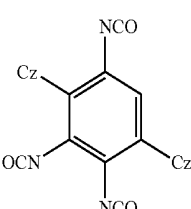
Compound 235

20



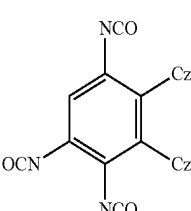
Compound 236

30



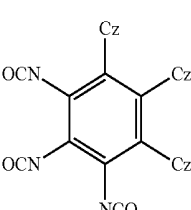
Compound 237

35



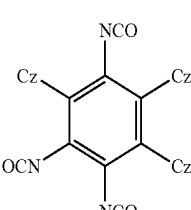
Compound 238

45



Compound 239

50



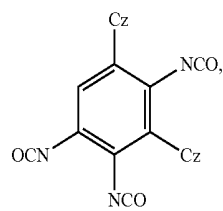
Compound 240

60

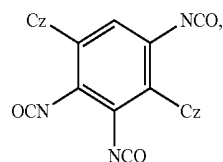
65

**302**

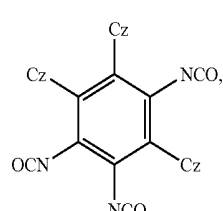
-continued



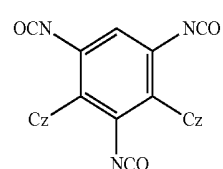
Compound 241



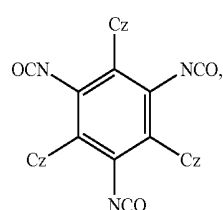
Compound 242



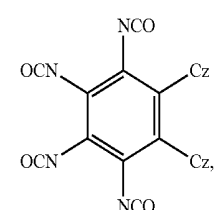
Compound 243



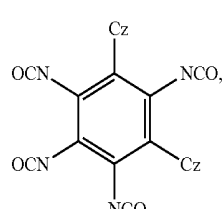
Compound 244



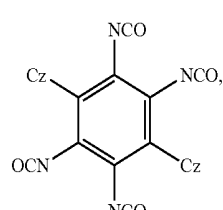
Compound 245



Compound 246



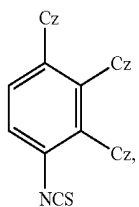
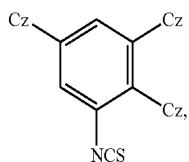
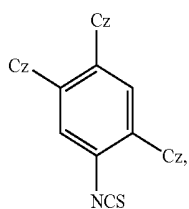
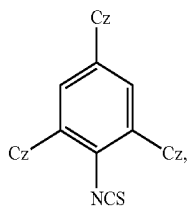
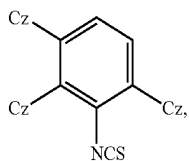
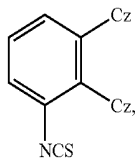
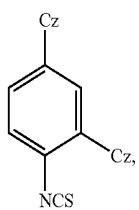
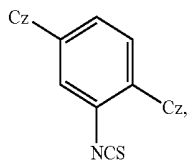
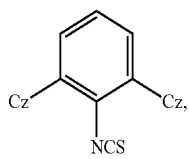
Compound 247



Compound 248

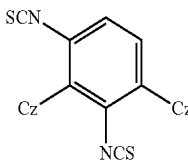
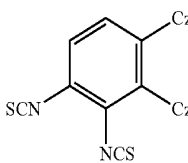
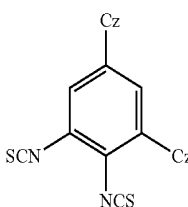
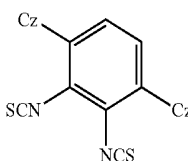
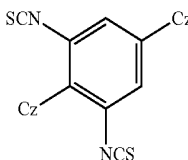
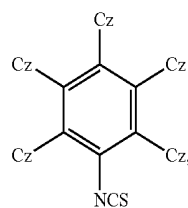
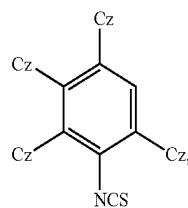
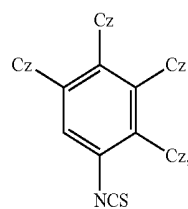
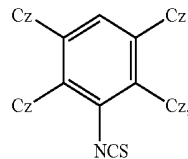
303

-continued



304

-continued



Compound 249

5

Compound 250

10

Compound 251

15

20

Compound 252

25

Compound 253

30

Compound 254

35

Compound 256

45

Compound 257

55

Compound 258

60

65

Compound 259

Compound 260

Compound 261

Compound 262

Compound 277

Compound 278

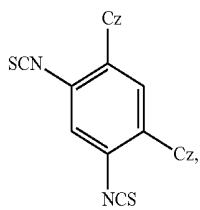
Compound 279

Compound 280

Compound 281

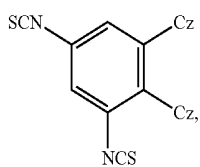
**305**

-continued



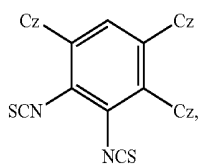
Compound 282

5



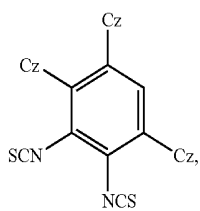
Compound 283

10



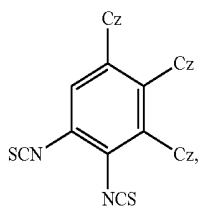
Compound 284

15



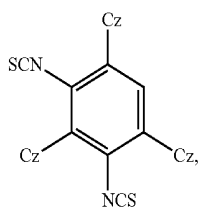
Compound 285

25



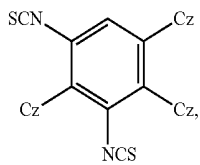
Compound 286

30



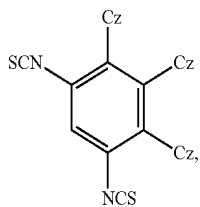
Compound 287

35



Compound 288

40



Compound 289

45

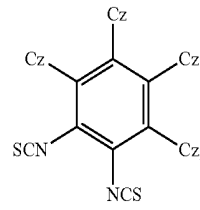
55

60

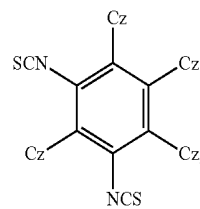
65

**306**

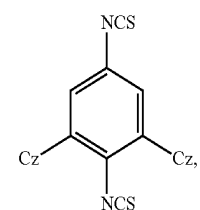
-continued



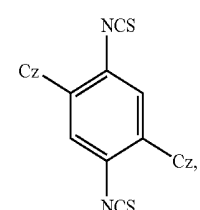
Compound 290



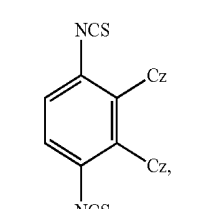
Compound 291



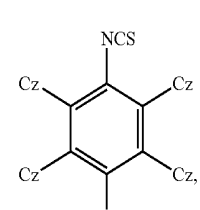
Compound 292



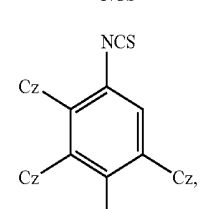
Compound 293



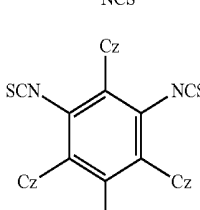
Compound 294



Compound 295



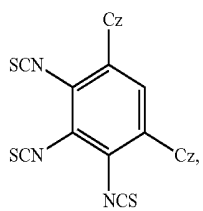
Compound 296



Compound 297

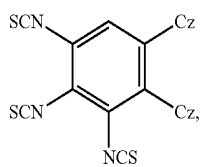
307

-continued



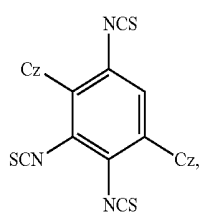
Compound 298

5



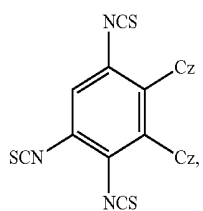
Compound 299

10



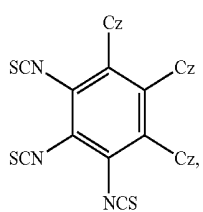
Compound 300

20



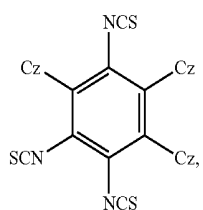
Compound 301

30



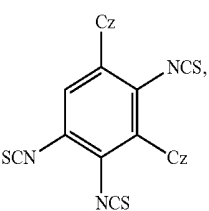
Compound 302

40



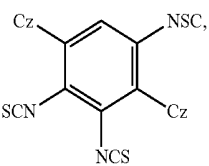
Compound 303

45



Compound 304

55

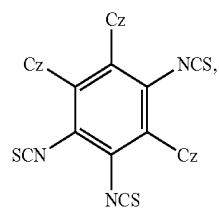


Compound 305

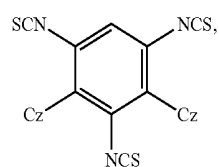
65

308

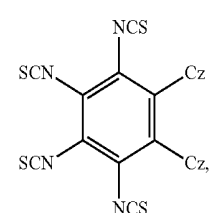
-continued



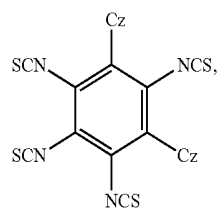
Compound 306



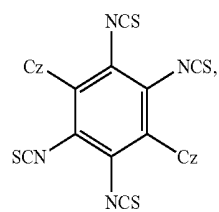
Compound 307



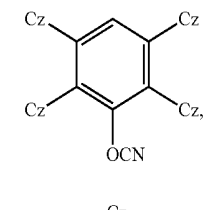
Compound 308



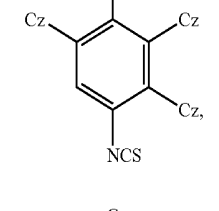
Compound 309



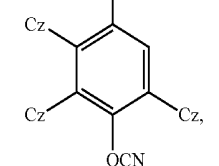
Compound 310



Compound 311



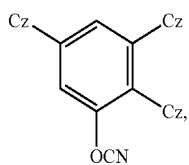
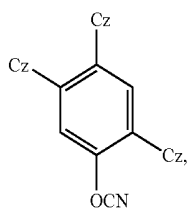
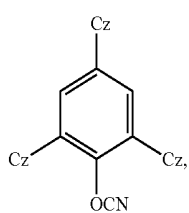
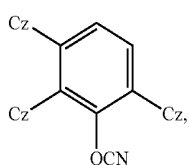
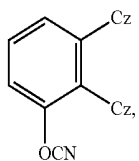
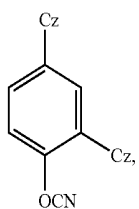
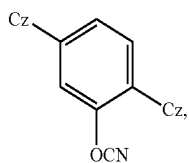
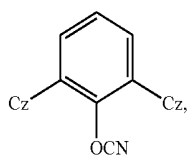
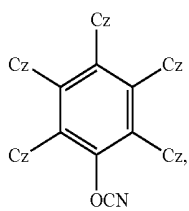
Compound 312



Compound 313

309

-continued

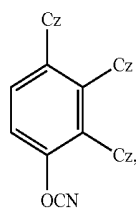


310

-continued

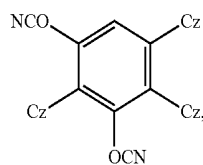
Compound 314

5



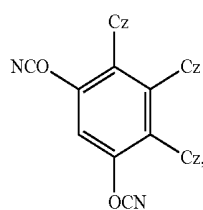
Compound 329 10

15



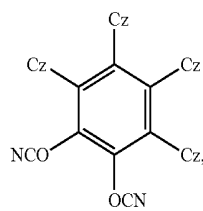
Compound 330

20



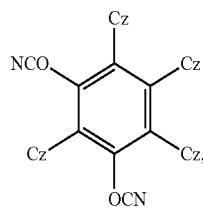
Compound 331

25



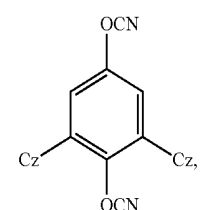
Compound 332

35



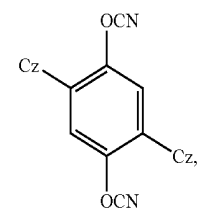
Compound 333

40



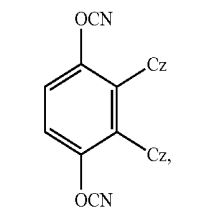
Compound 334

45



Compound 336

55



Compound 337

60

Compound 338

Compound 339

Compound 340

Compound 341

Compound 342

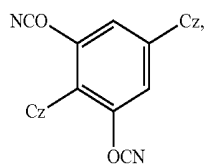
Compound 343

Compound 344

Compound 345

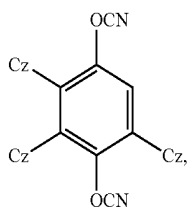
311

-continued



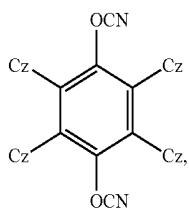
Compound 346

5



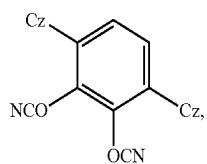
Compound 347

10



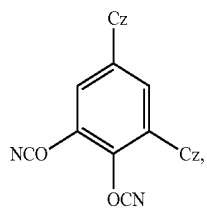
Compound 348

15



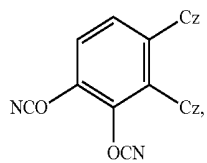
Compound 349

20



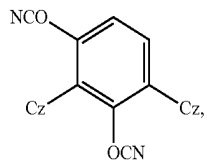
Compound 350

25



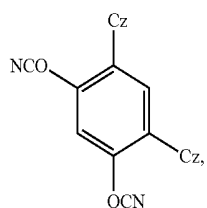
Compound 351

30



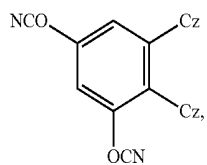
Compound 352

35



Compound 353

40

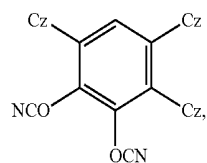


Compound 354

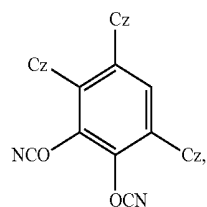
45

312

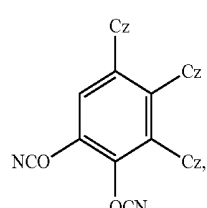
-continued



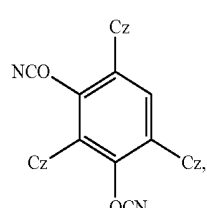
Compound 355



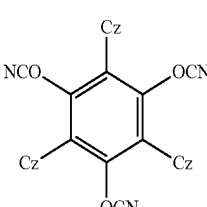
Compound 356



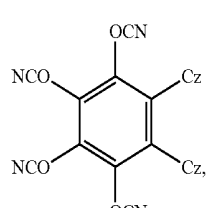
Compound 357



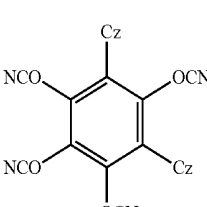
Compound 358



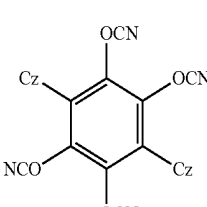
Compound 359



Compound 360



Compound 361



Compound 362

50

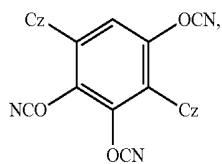
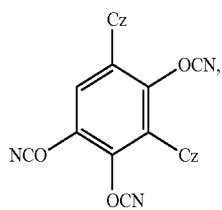
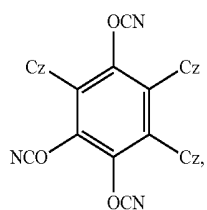
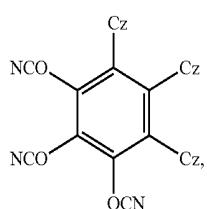
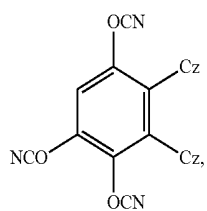
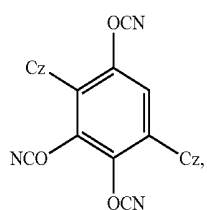
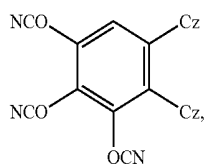
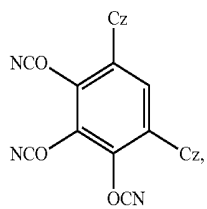
55

60

65

313

-continued

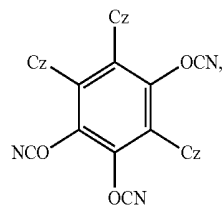


314

-continued

Compound 363

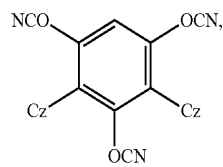
5



Compound 371

Compound 364

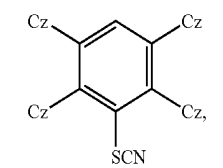
10



Compound 372

Compound 365

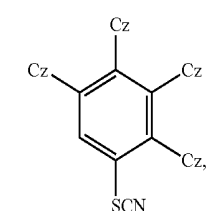
15



Compound 373

Compound 366

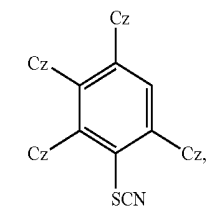
25



Compound 374

Compound 367

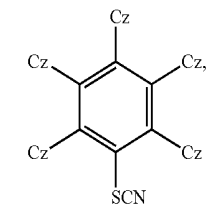
35



Compound 375

Compound 368

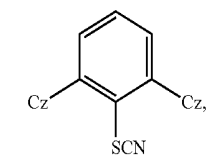
45



Compound 376

Compound 369

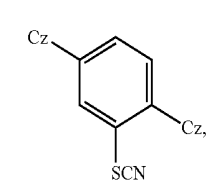
50



Compound 391

Compound 370

60

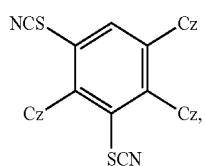
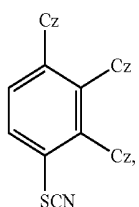
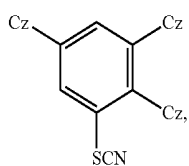
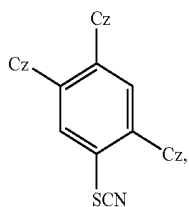
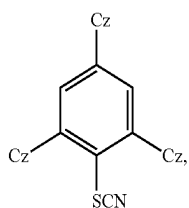
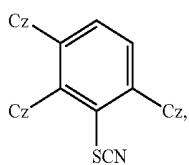
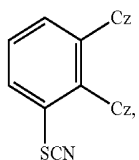
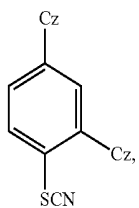


Compound 392

65

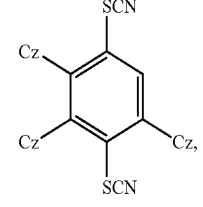
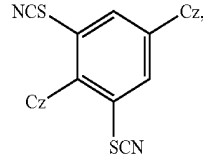
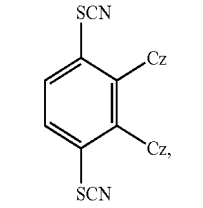
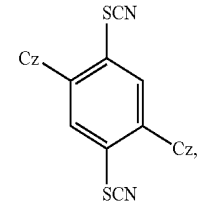
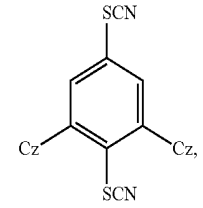
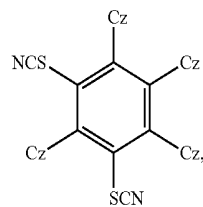
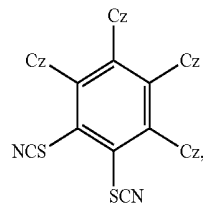
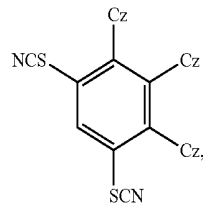
315

-continued



316

-continued



Compound 393

5

Compound 394

10

Compound 395

15

Compound 396

20

Compound 398

25

Compound 399

30

Compound 400

35

Compound 401

40

45

50

55

60

65

Compound 402

Compound 403

Compound 404

Compound 405

Compound 406

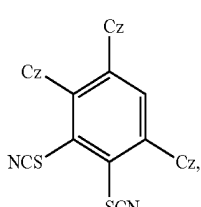
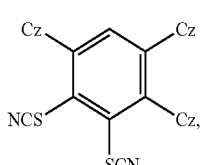
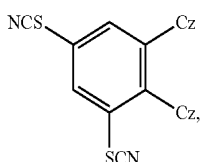
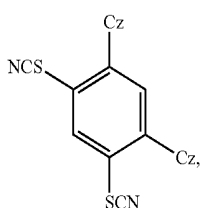
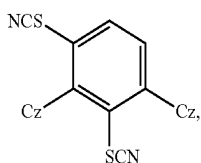
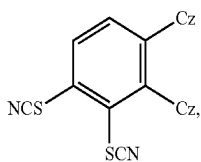
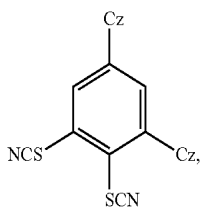
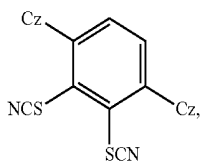
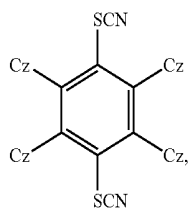
Compound 407

Compound 408

Compound 409

317

-continued

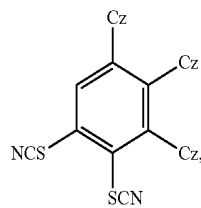


318

-continued

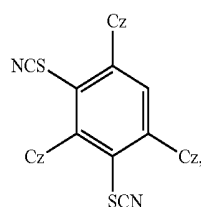
Compound 410

5



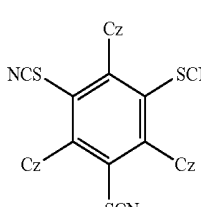
Compound 411

10



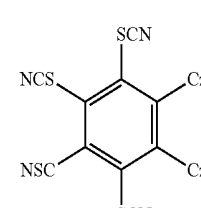
Compound 412

15



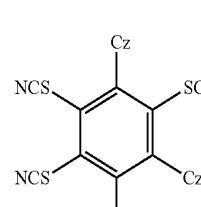
Compound 413

20



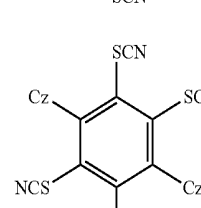
Compound 414

25



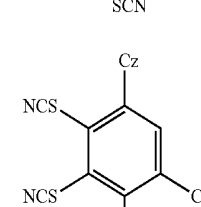
Compound 415

30



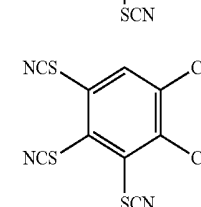
Compound 416

35



Compound 417

40



Compound 418

45



50

55

60

65

Compound 419

Compound 420

Compound 421

Compound 422

Compound 423

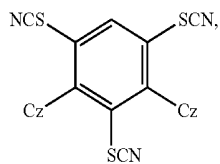
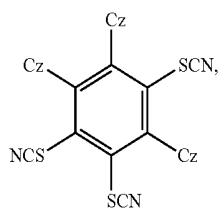
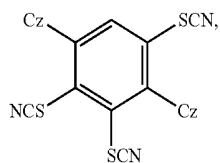
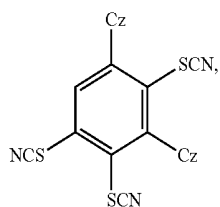
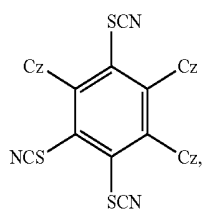
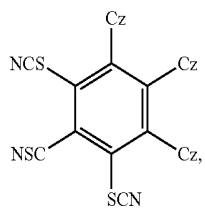
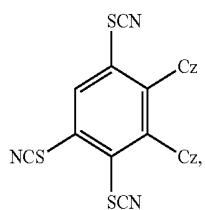
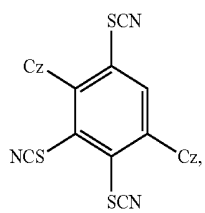
Compound 424

Compound 425

Compound 426

319

-continued

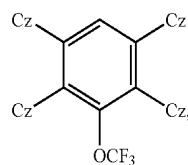


320

-continued

Compound 427

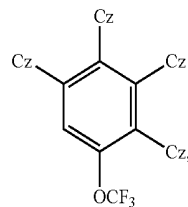
5



Compound 435

Compound 428

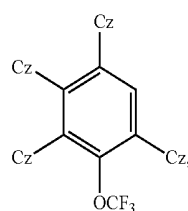
10



Compound 436

Compound 429

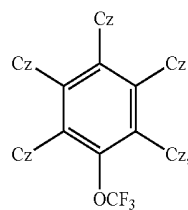
20



Compound 437

Compound 430

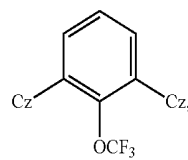
25



Compound 438

Compound 431

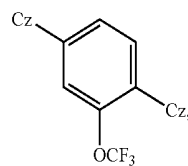
30



Compound 439

Compound 432

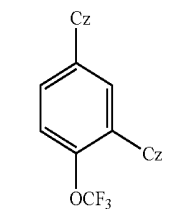
40



Compound 440

Compound 433

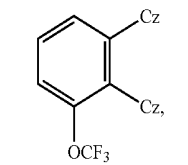
45



Compound 441

Compound 434

50



Compound 442

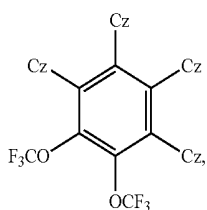
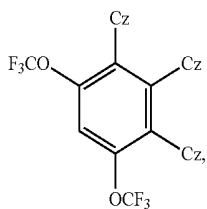
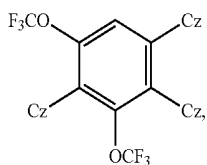
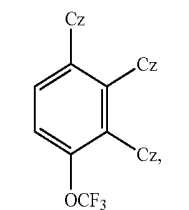
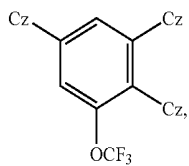
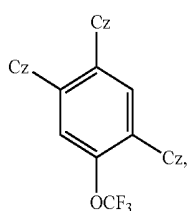
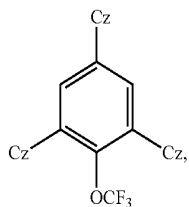
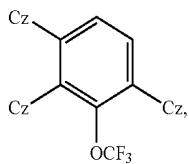
55

60

65

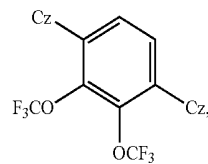
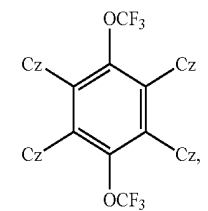
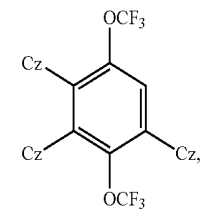
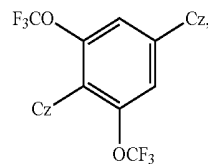
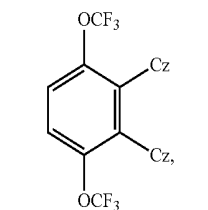
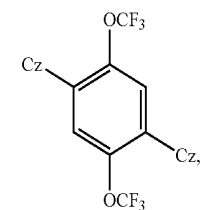
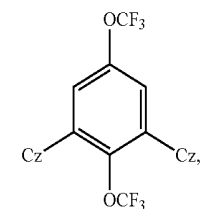
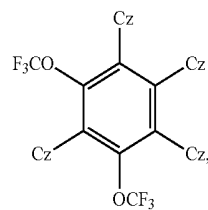
321

-continued



322

-continued



Compound 457

5

Compound 458

10

15

Compound 460

20

25

Compound 461

30

Compound 462

35

40

Compound 463

45

Compound 464

50

55

Compound 465

60

65

Compound 466

Compound 467

Compound 468

Compound 469

Compound 470

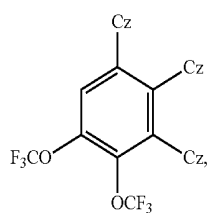
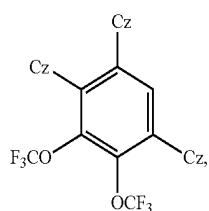
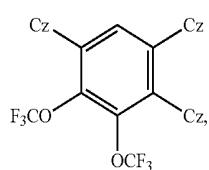
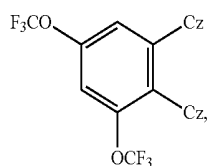
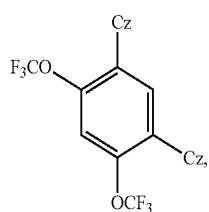
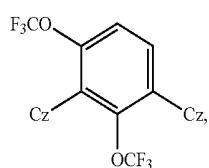
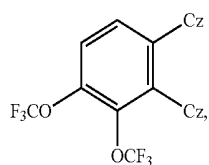
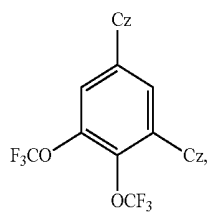
Compound 471

Compound 472

Compound 473

323

-continued

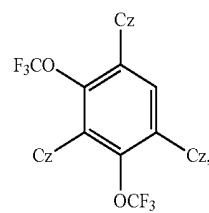


324

-continued

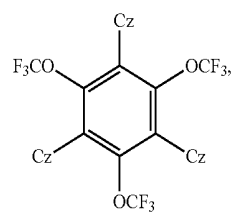
Compound 474

5



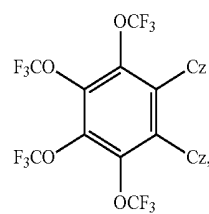
Compound 475

10



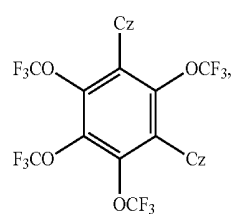
Compound 476

15



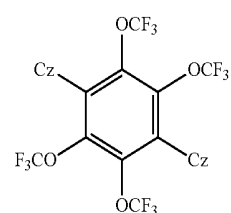
Compound 477

25



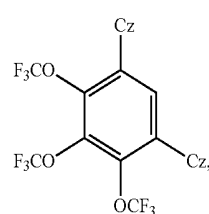
Compound 478

30



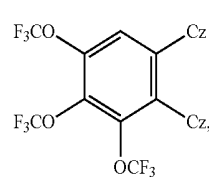
Compound 479

35



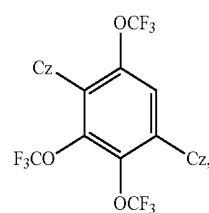
Compound 480

45



Compound 481

55



65

Compound 482

Compound 483

Compound 484

Compound 485

Compound 486

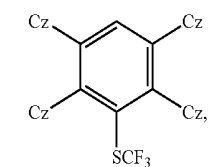
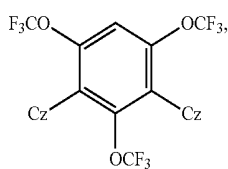
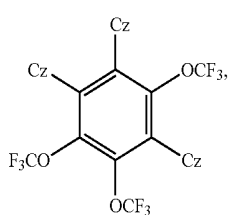
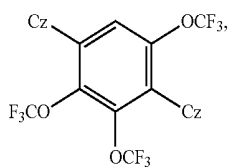
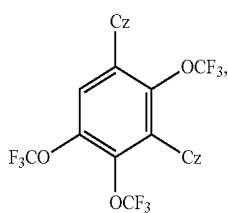
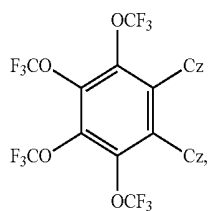
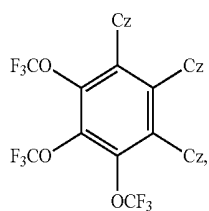
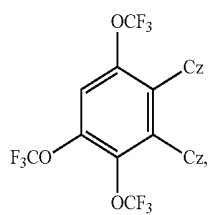
Compound 487

Compound 488

Compound 489

325

-continued

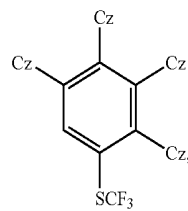


326

-continued

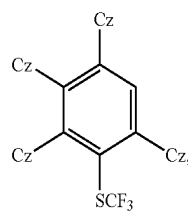
Compound 490

5



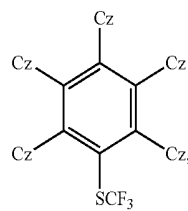
Compound 491

10



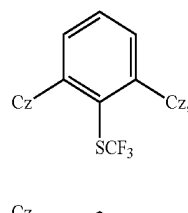
Compound 492

15



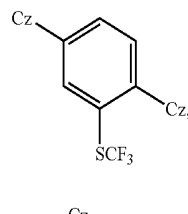
Compound 493

20



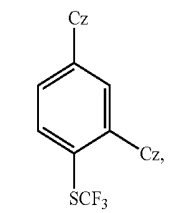
Compound 494

25



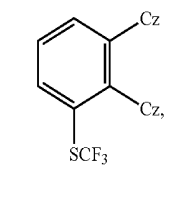
Compound 495

30



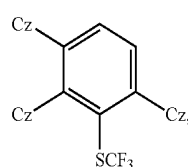
Compound 496

35



Compound 497

40



45

Compound 498

Compound 499

Compound 500

Compound 515

Compound 516

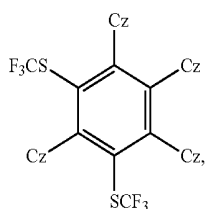
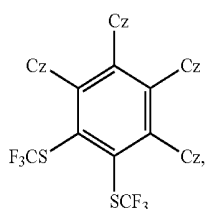
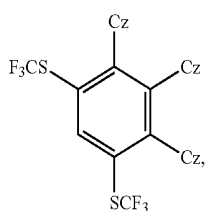
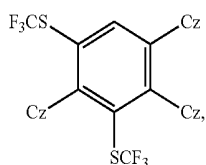
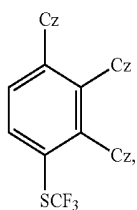
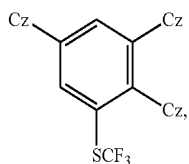
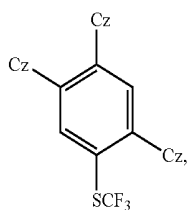
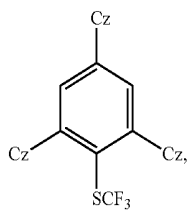
Compound 517

Compound 518

Compound 519

327

-continued

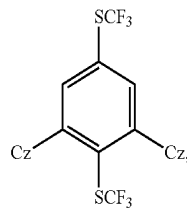


328

-continued

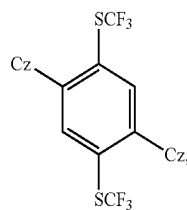
Compound 520

5



Compound 522

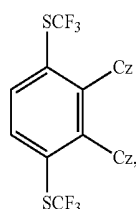
10



15

Compound 523

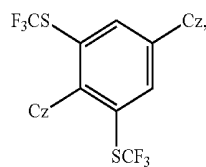
20



25

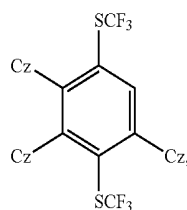
Compound 524

30



Compound 525

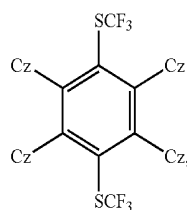
35



40

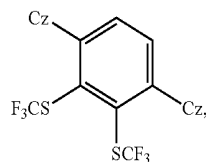
Compound 526

45



Compound 527

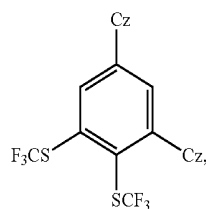
50



55

Compound 528

60



65

Compound 529

Compound 530

Compound 531

Compound 532

Compound 533

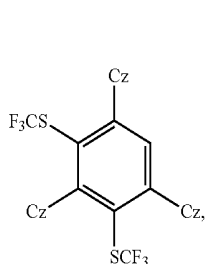
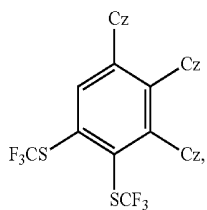
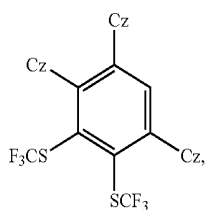
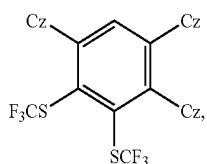
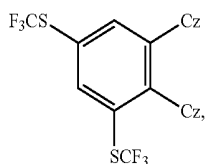
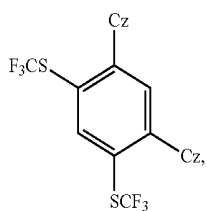
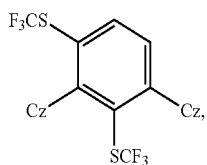
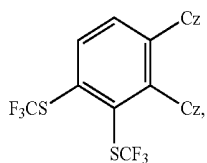
Compound 534

Compound 535

Compound 536

329

-continued

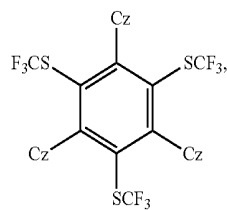


330

-continued

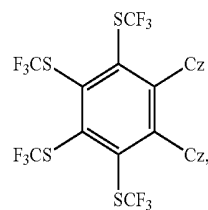
Compound 537

5



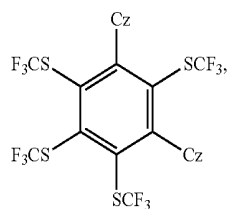
Compound 538

10



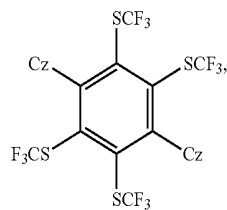
Compound 539

15



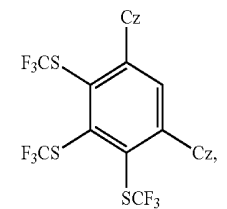
Compound 540

25



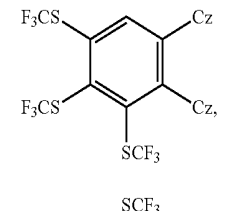
Compound 541

35



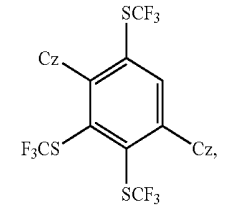
Compound 542

40



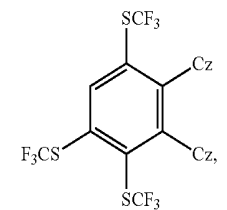
Compound 543

50



Compound 544

60



65

Compound 545

Compound 546

Compound 547

Compound 548

Compound 549

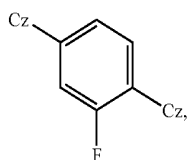
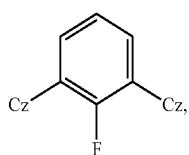
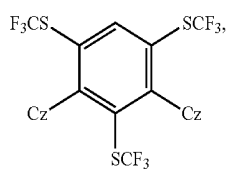
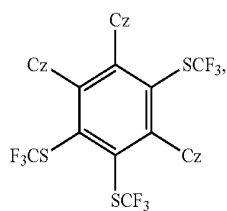
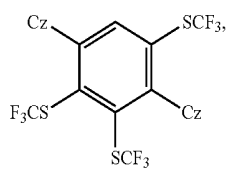
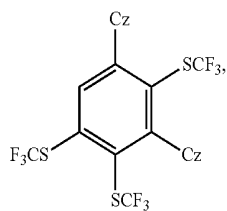
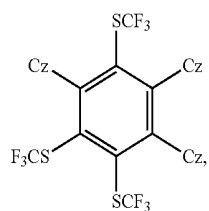
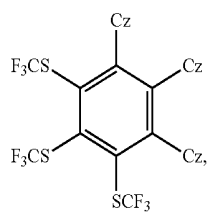
Compound 550

Compound 551

Compound 552

331

-continued

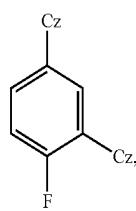


332

-continued

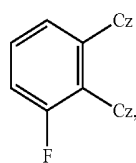
Compound 553

5



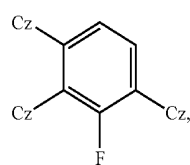
Compound 554

10



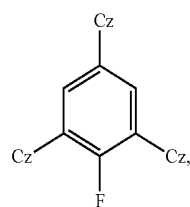
Compound 555

20



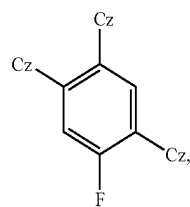
Compound 556

30



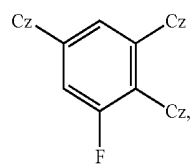
Compound 557

35



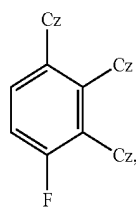
Compound 558

45



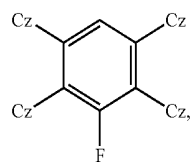
Compound 559

55



Compound 560

60



65

Compound 561

Compound 562

Compound 563

Compound 564

Compound 566

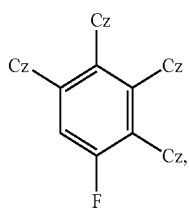
Compound 567

Compound 568

Compound 569

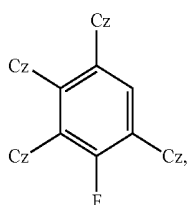
333

-continued



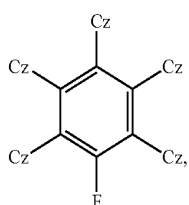
Compound 570

5



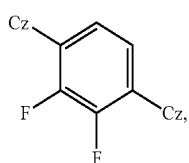
Compound 571

10



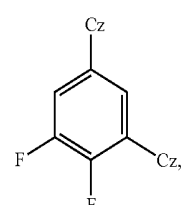
Compound 572

20



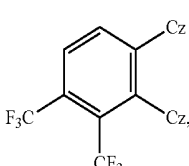
Compound 587

30



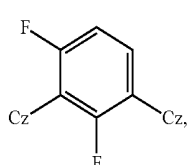
Compound 588

40



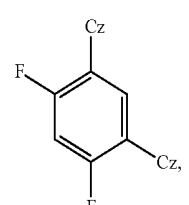
Compound 589

45



Compound 590

55

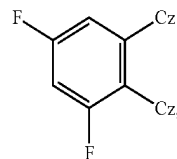


Compound 591

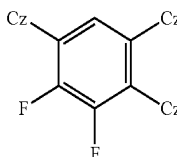
65

334

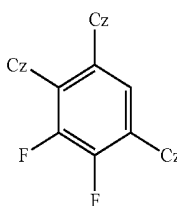
-continued



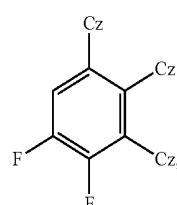
Compound 592



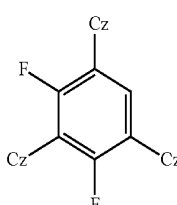
Compound 593



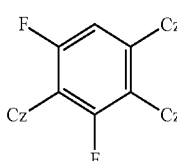
Compound 594



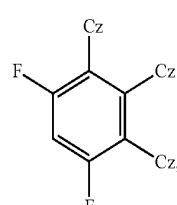
Compound 595



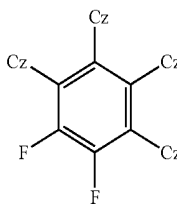
Compound 596



Compound 597



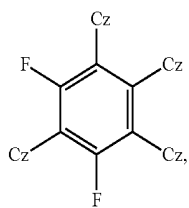
Compound 598



Compound 599

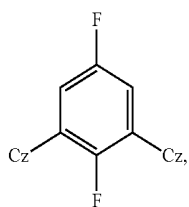
335

-continued



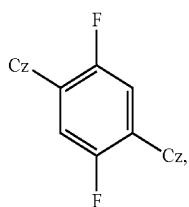
Compound 600

5



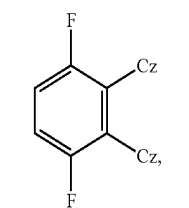
Compound 601

10



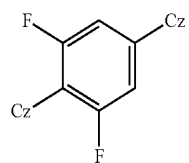
Compound 602

20



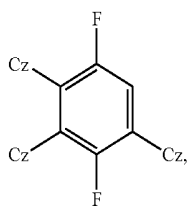
Compound 603

30



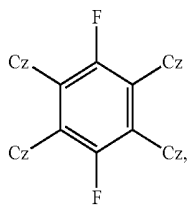
Compound 604

40



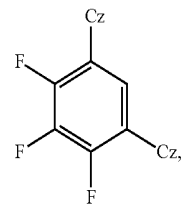
Compound 605

45



Compound 606

55

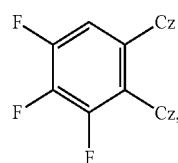


Compound 607

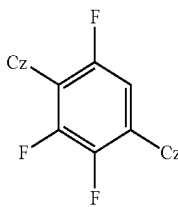
65

336

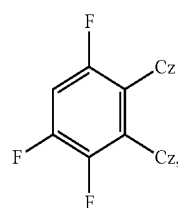
-continued



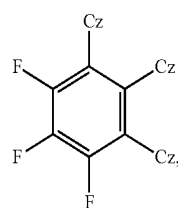
Compound 608



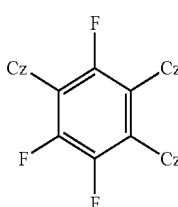
Compound 609



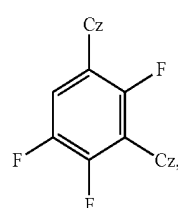
Compound 610



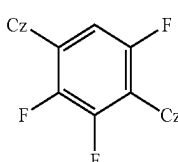
Compound 611



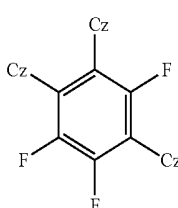
Compound 612



Compound 613



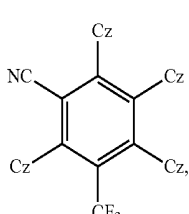
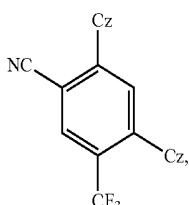
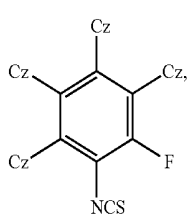
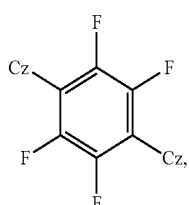
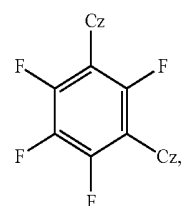
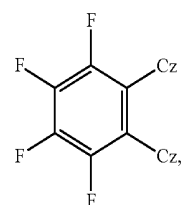
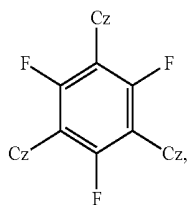
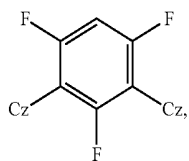
Compound 614



Compound 615

337

-continued

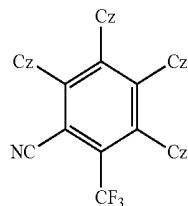


338

-continued

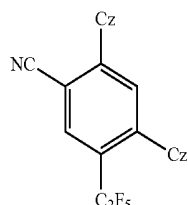
Compound 616

5



Compound 617

10



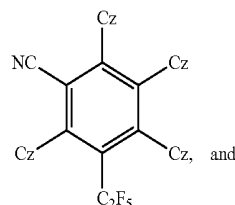
Compound 618

15

20

Compound 619

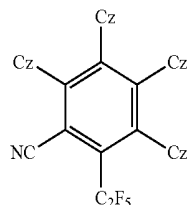
25



30

Compound 620

35

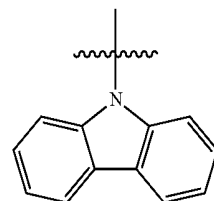


40

Compound 736

wherein Cz is

45



Compound 737

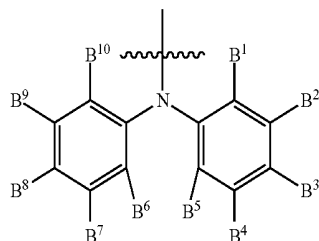
50

7. The compound of claim 1, wherein R<sup>5</sup> is

55

Compound 738

60



65

Compound 739

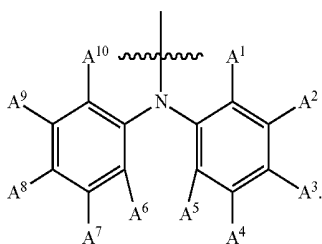
Compound 740

Compound 741

Compound 742

339

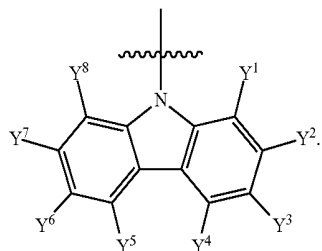
and R<sup>1</sup> is



8. The compound of claim 7, wherein A<sup>5</sup> and A<sup>6</sup> are joined by a single bond.

9. The compound of claim 7, wherein A<sup>5</sup> and A<sup>6</sup> are joined by a single bond; and wherein B<sup>5</sup> and B<sup>6</sup> are joined by a single bond.

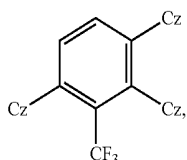
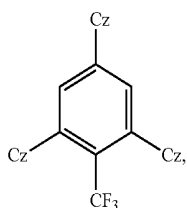
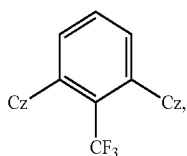
10. The compound of claim 7, wherein at least one of R<sup>2</sup>-R<sup>4</sup> is



11. The compound of claim 7, wherein at least one of R<sup>2</sup>-R<sup>4</sup> comprises an acceptor group selected from the group consisting of -C<sub>m</sub>F<sub>2m+1</sub>, -Si<sub>m</sub>F<sub>2m+1</sub>, -NCO, -NCS, -OCN, -SCN, -OC<sub>m</sub>F<sub>2m+1</sub>, and -SC<sub>m</sub>F<sub>2m+1</sub>.

12. The compound of claim 7 wherein at least one R<sup>1</sup>-R<sup>4</sup> is an electron withdrawing group with a Hammett value ( $\sigma_{para}$ ) of at least 0.05.

13. The compound of claim 7, wherein the compound is selected from the group consisting of:



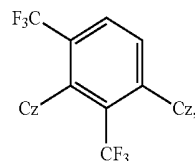
Compound 1

Compound 6

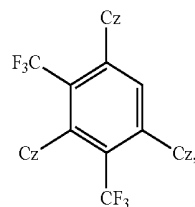
Compound 7

340

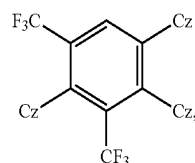
-continued



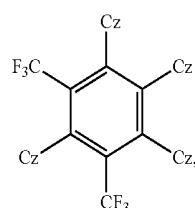
Compound 31



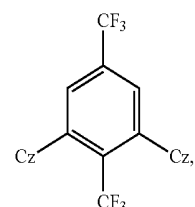
Compound 37



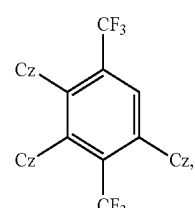
Compound 38



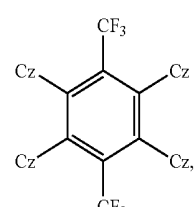
Compound 41



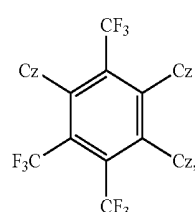
Compound 42



Compound 46



Compound 47



Compound 53

5

10

15

20

25

30

35

40

45

50

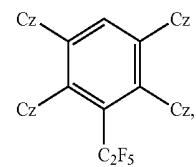
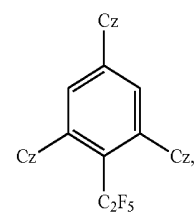
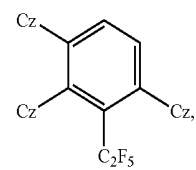
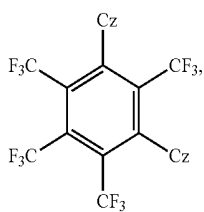
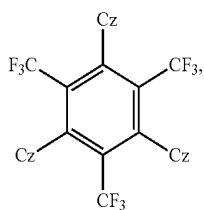
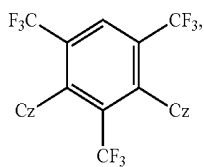
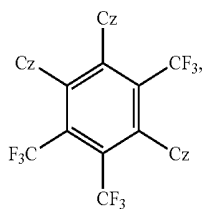
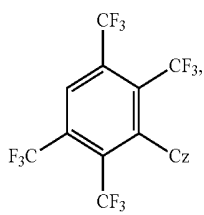
55

60

65

341

-continued



342

-continued

Compound 54

5

Compound 56

10

Compound 57

20

Compound 58

25

Compound 61

35

Compound 66

45

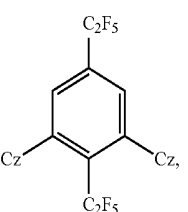
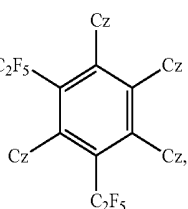
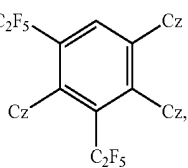
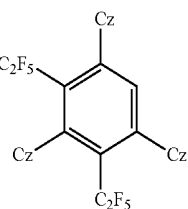
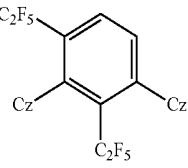
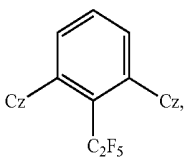
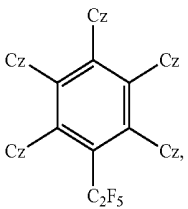
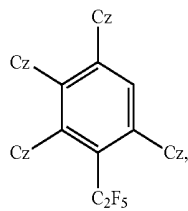
Compound 67

50

Compound 72

60

65



Compound 74

Compound 75

Compound 76

Compound 93

Compound 99

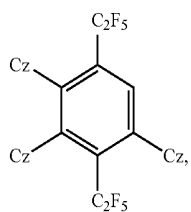
Compound 100

Compound 103

Compound 104

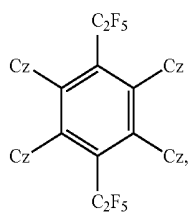
343

-continued



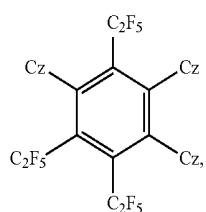
Compound 108

5



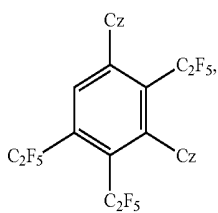
Compound 109

10



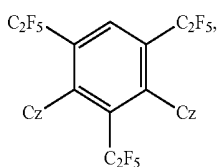
Compound 115

20



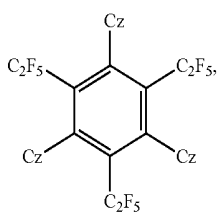
Compound 116

30



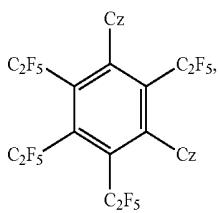
Compound 119

40



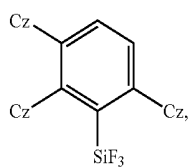
Compound 120

45



Compound 123

55

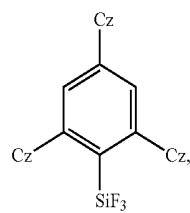


Compound 128

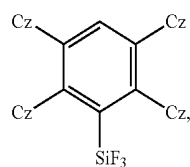
65

344

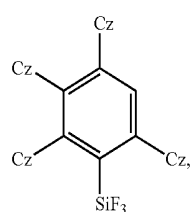
-continued



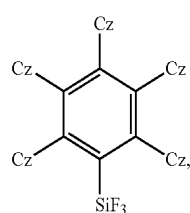
Compound 129



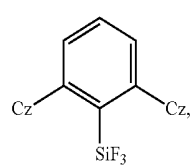
Compound 134



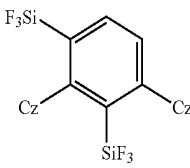
Compound 136



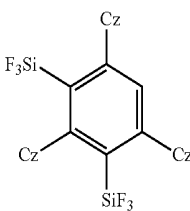
Compound 137



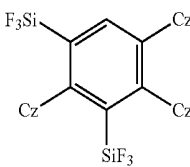
Compound 138



Compound 155



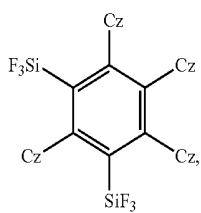
Compound 161



Compound 162

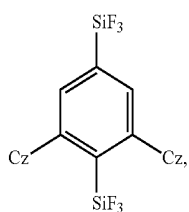
345

-continued



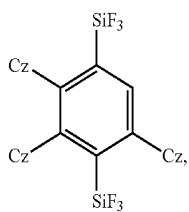
Compound 165

5



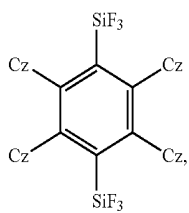
Compound 166

10



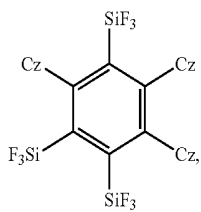
Compound 170

15



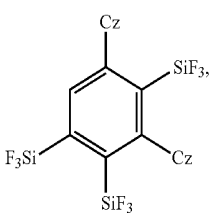
Compound 171

20



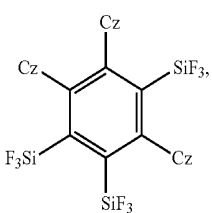
Compound 177

25



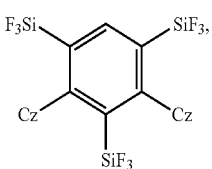
Compound 178

30



Compound 180

35

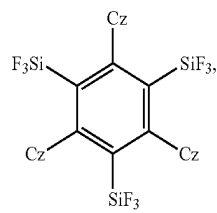


Compound 181

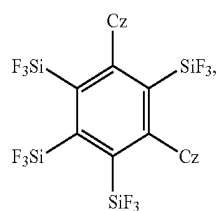
40

346

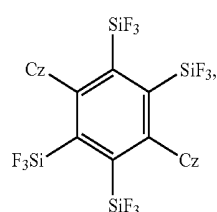
-continued



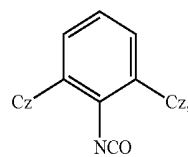
Compound 182



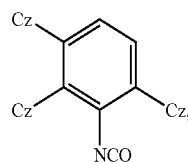
Compound 185



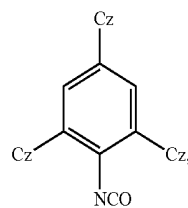
Compound 186



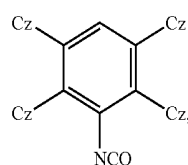
Compound 187



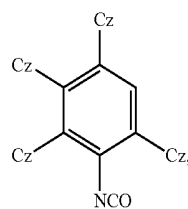
Compound 191



Compound 192



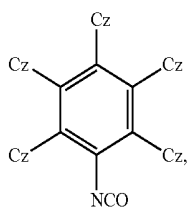
Compound 197



Compound 199

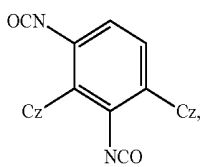
347

-continued



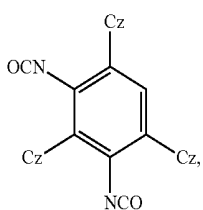
Compound 200

5



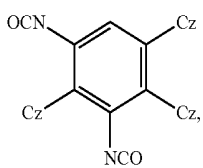
Compound 218

10



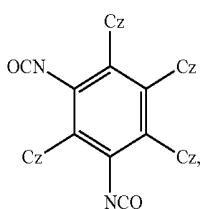
Compound 224

15



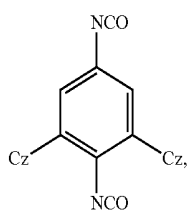
Compound 225

20



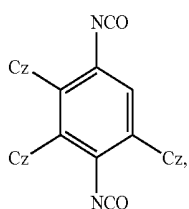
Compound 228

25



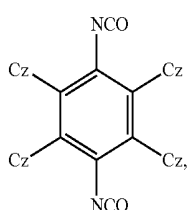
Compound 229

30



Compound 233

35

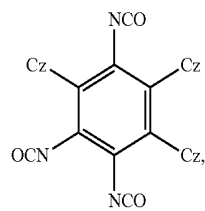


Compound 234

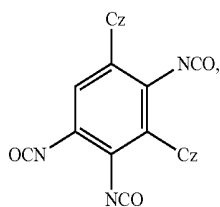
40

348

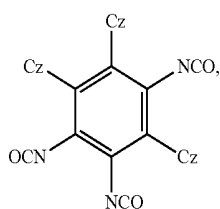
-continued



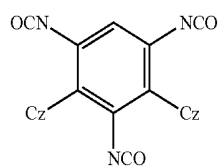
Compound 240



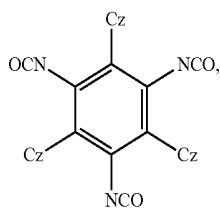
Compound 241



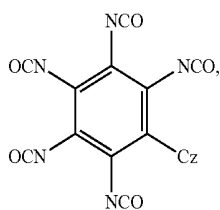
Compound 243



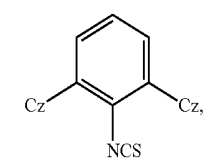
Compound 244



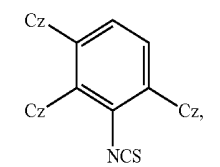
Compound 245



Compound 247



Compound 249



Compound 253

45

50

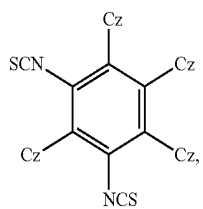
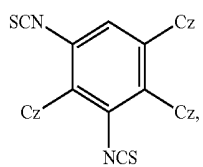
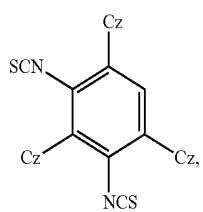
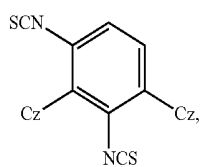
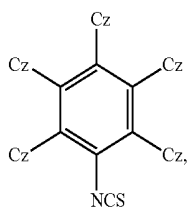
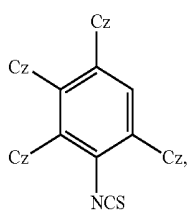
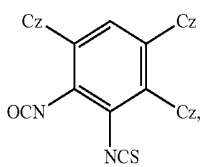
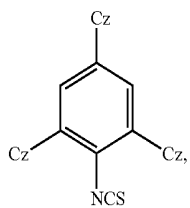
55

60

65

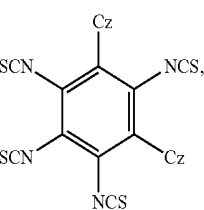
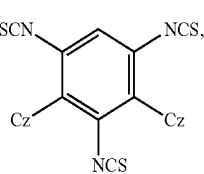
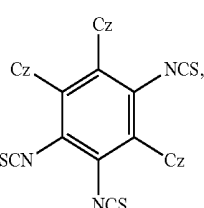
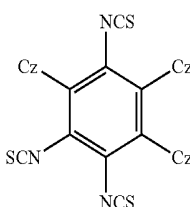
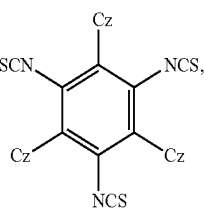
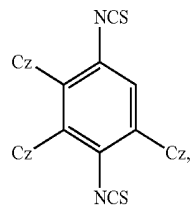
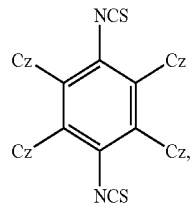
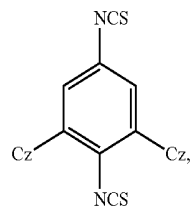
349

-continued



350

-continued



Compound 254

5

Compound 259

10

Compound 261

15

Compound 262

20

Compound 281

25

Compound 287

30

Compound 288

35

Compound 291

40

45

50

55

60

65

Compound 292

Compound 295

Compound 296

Compound 297

Compound 303

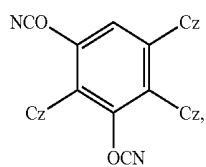
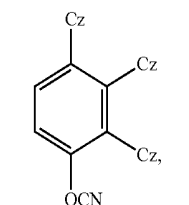
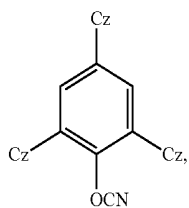
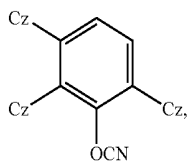
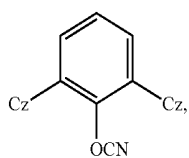
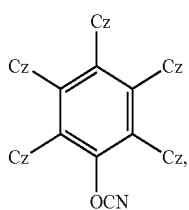
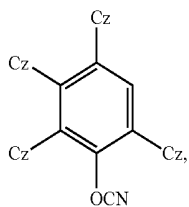
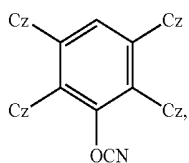
Compound 306

Compound 307

Compound 309

351

-continued



352

-continued

Compound 311

5

Compound 313

10

15

Compound 314

20

25

Compound 329

30

Compound 333

35

Compound 334

40

45

Compound 338

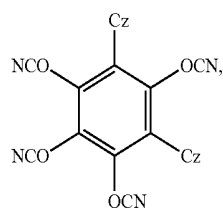
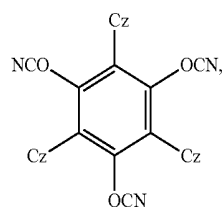
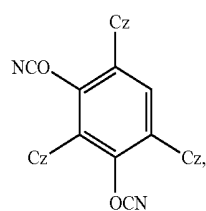
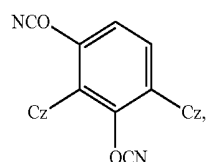
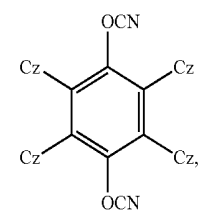
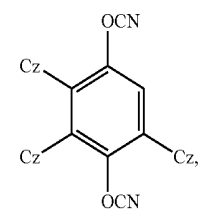
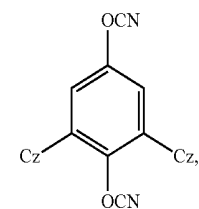
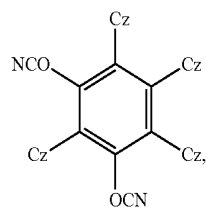
50

55

Compound 339

60

65



Compound 342

Compound 343

Compound 347

Compound 348

Compound 352

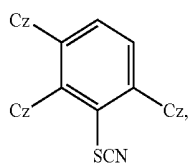
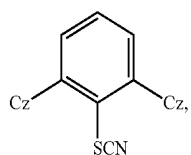
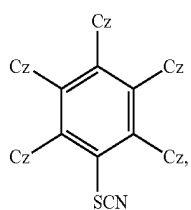
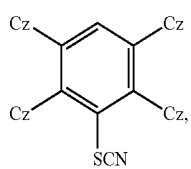
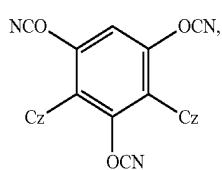
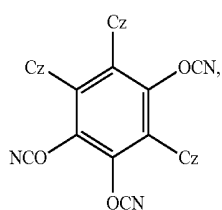
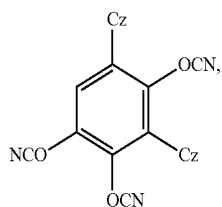
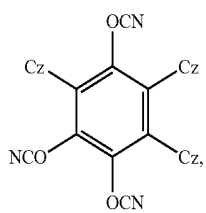
Compound 358

Compound 359

Compound 361

353

-continued

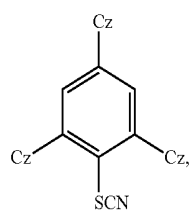


354

-continued

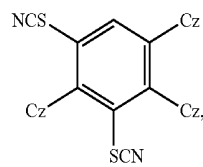
Compound 368

5



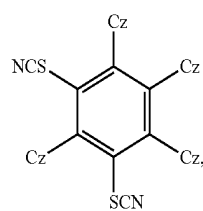
Compound 369

10



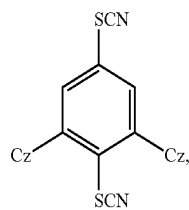
Compound 371

20



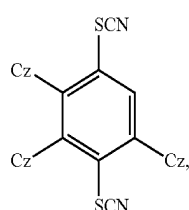
Compound 372

30



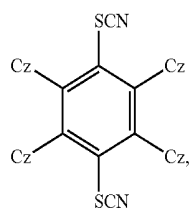
Compound 373

35



Compound 376

40

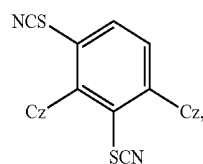


45

50

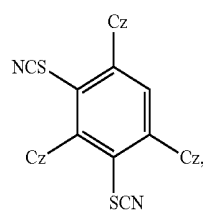
Compound 391

55



Compound 395

60



65

Compound 396

Compound 401

Compound 404

Compound 405

Compound 409

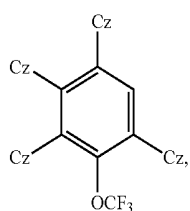
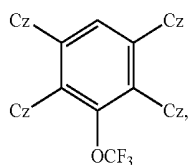
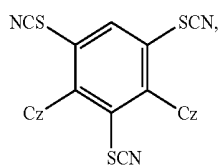
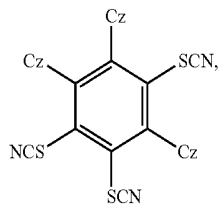
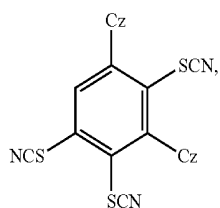
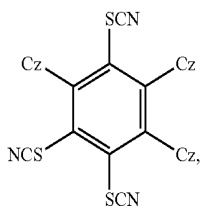
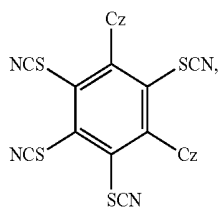
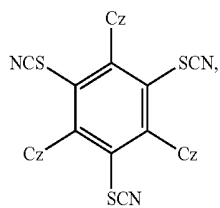
Compound 410

Compound 414

Compound 420

355

-continued

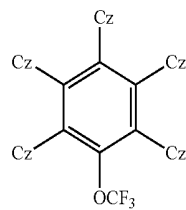


356

-continued

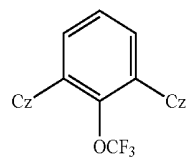
Compound 421

5



Compound 423

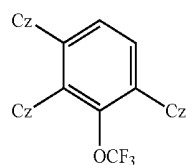
10



15

Compound 430

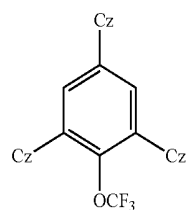
20



25

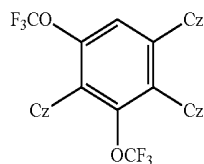
Compound 431

30



Compound 433

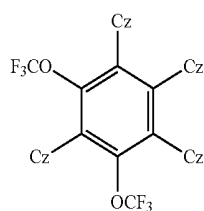
35



40

Compound 434

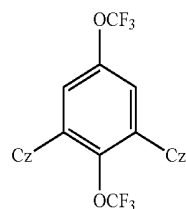
45



50

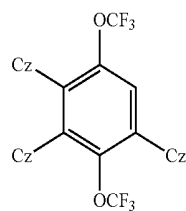
Compound 435

55



Compound 437

60



65

Compound 438

Compound 453

Compound 457

Compound 458

Compound 463

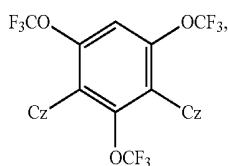
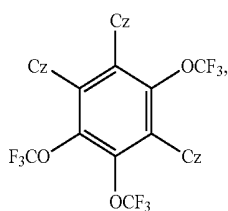
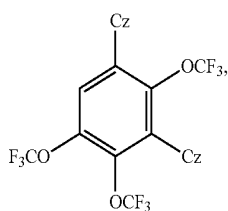
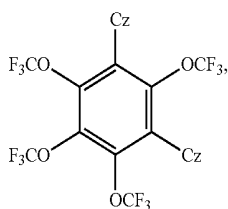
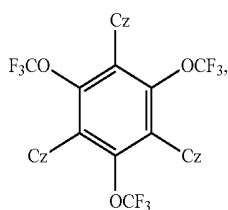
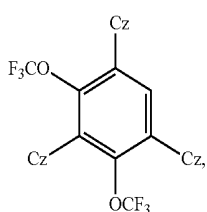
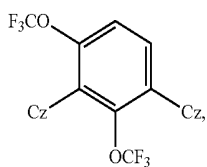
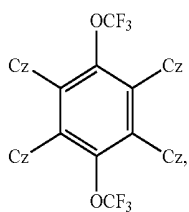
Compound 466

Compound 467

Compound 471

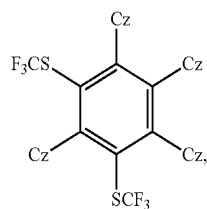
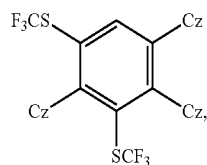
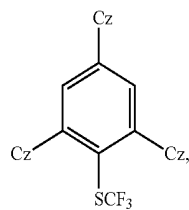
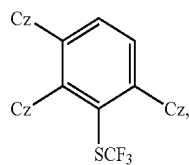
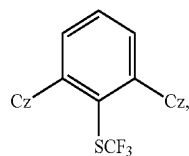
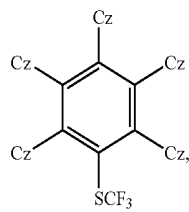
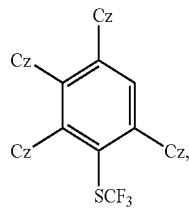
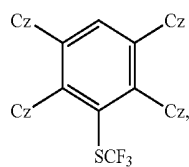
**357**

-continued



**358**

-continued



Compound 472

5

Compound 476

10

15

Compound 482

20

25

Compound 483

30

Compound 485

35

40

Compound 493

45

50

Compound 495

55

Compound 496

60

65

Compound 497

Compound 499

Compound 500

Compound 515

Compound 519

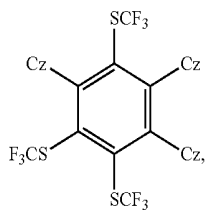
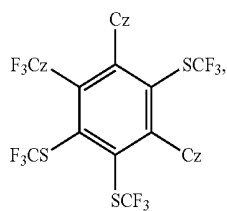
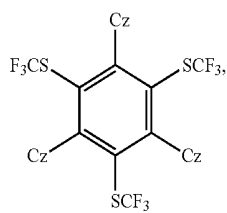
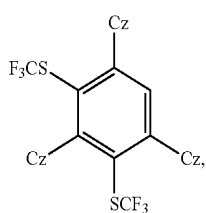
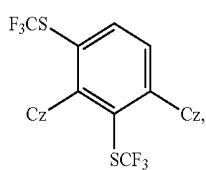
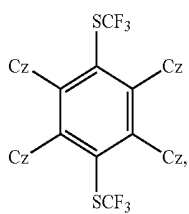
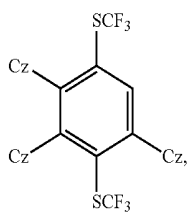
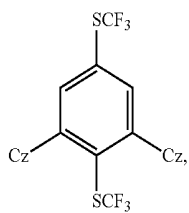
Compound 520

Compound 525

Compound 528

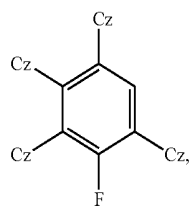
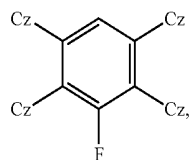
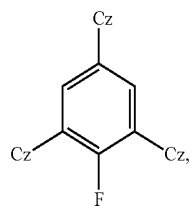
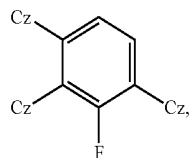
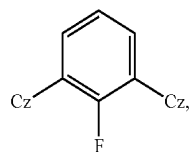
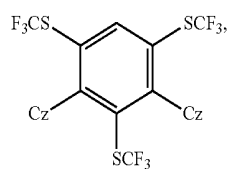
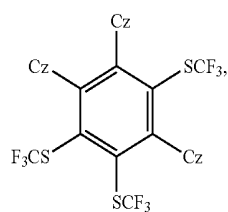
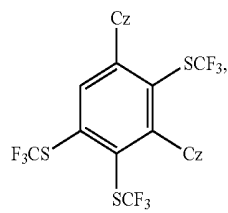
359

-continued



360

-continued



Compound 529

5

Compound 533

10

15

Compound 534

20

25

Compound 538

30

Compound 544

35

40

Compound 545

45

Compound 547

50

55

Compound 554

60

65

Compound 555

Compound 557

Compound 558

Compound 559

Compound 563

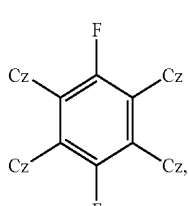
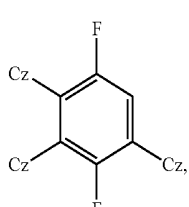
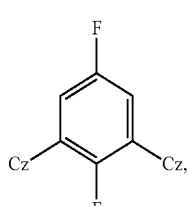
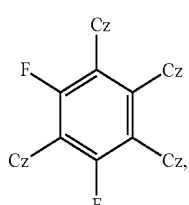
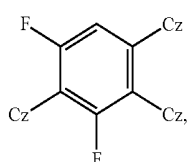
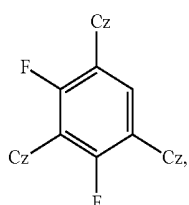
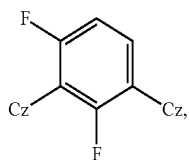
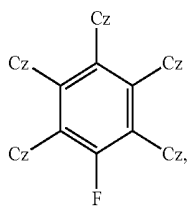
Compound 564

Compound 569

Compound 571

361

-continued

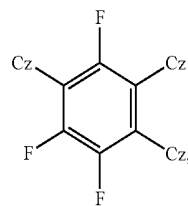


362

-continued

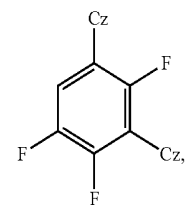
Compound 572

5



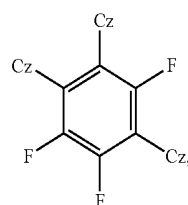
Compound 590

10



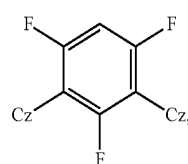
Compound 596

15



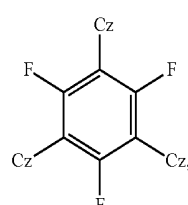
Compound 597

20



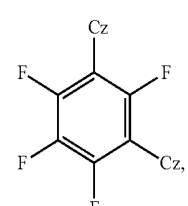
Compound 600

25



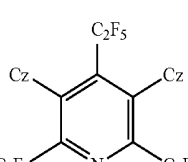
Compound 601

35



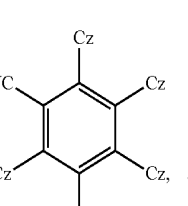
Compound 605

45



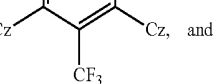
Compound 606

55



Compound 612

60



65

Compound 612

Compound 613

Compound 615

Compound 616

Compound 617

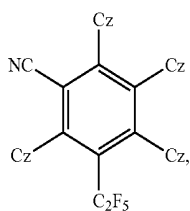
Compound 619

Compound 731

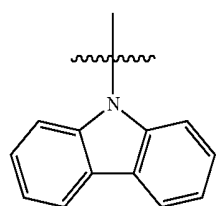
Compound 738

363

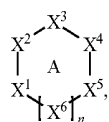
-continued



wherein Cz is



14. A first device comprising a first organic light emitting device, the first organic light emitting device comprising:  
 an anode;  
 a cathode; and  
 an emissive layer, disposed between the anode and the cathode;  
 wherein the emissive layer comprises a host material doped with a first emitting compound comprising a structure according to Formula 2:



Formula 2

wherein ring A is an aromatic or heteroaromatic ring;  
 wherein n is 0 or 1;  
 wherein, when n is 0, X<sup>1</sup>, X<sup>2</sup>, X<sup>3</sup>, X<sup>4</sup>, and X<sup>5</sup> are independently selected from the group consisting of CR, N, NR, O, S, and Se, and at least one of X<sup>1</sup> to X<sup>5</sup> is CR;  
 wherein, when n is 1, X<sup>1</sup>, X<sup>2</sup>, X<sup>3</sup>, X<sup>4</sup>, X<sup>5</sup>, and X<sup>6</sup> are independently selected from the group consisting of CR and N, and at least one of X<sup>1</sup> to X<sup>6</sup> is CR;  
 wherein each R is independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, —SC<sub>m</sub>F<sub>2m+1</sub>, and combinations thereof;  
 wherein adjacent R groups are, optionally, joined to form a fused ring structure;  
 wherein m ≥ 1;  
 wherein at least one R group comprises a donor group with at least one electron-donating nitrogen; and  
 wherein at least one R group comprises an acceptor group selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>,

364

—Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

15. The first device of claim 14, wherein at least two R groups comprise a donor group with at least one electron-donating nitrogen.

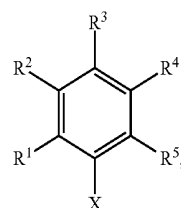
16. The first device of claim 14, wherein at least two R groups comprise an acceptor group selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>.

17. The first device of claim 14, wherein n=1, wherein at least two of X<sup>1</sup> to X<sup>6</sup> are CR, and wherein at least two R groups are independently selected from the group consisting of F, C<sub>m</sub>F<sub>2m+1</sub>, Si<sub>m</sub>F<sub>2m+1</sub>, NCO, NCS, OCN, SCN, OC<sub>m</sub>F<sub>2m+1</sub> and SC<sub>m</sub>F<sub>2m+1</sub>.

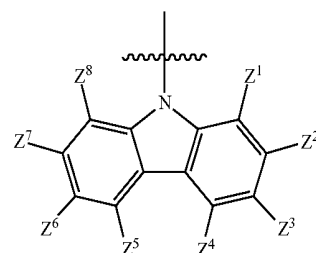
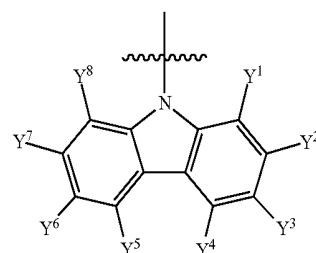
18. The first device of claim 14, wherein n=1, wherein at least two of X<sup>1</sup> to X<sup>6</sup> are CR, wherein at least one R group is selected from the group consisting of —F, —C<sub>m</sub>F<sub>2m+1</sub>, —Si<sub>m</sub>F<sub>2m+1</sub>, —NCO, —NCS, —OCN, —SCN, —OC<sub>m</sub>F<sub>2m+1</sub>, and —SC<sub>m</sub>F<sub>2m+1</sub>, and

wherein at least one R is an electron withdrawing group with a Hammett value ( $\sigma_{para}$ ) of at least 0.05.

19. The first device of claim 14, wherein the compound comprises a structure according to Formula 1:



Formula 1

wherein R<sup>5</sup> iswherein at least one of R<sup>1</sup>-R<sup>4</sup> is

wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup> and Z<sup>8</sup>, are each independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, het-

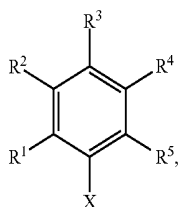
## 365

eroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfonyl, sulfonyl, phosphine,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ ,  $-SC_mF_{2m+1}$ , and combinations thereof;

wherein adjacent Y, and Z groups are, optionally, joined to form a fused ring structure; and

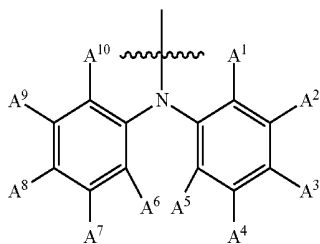
wherein X comprises an acceptor group selected from the group consisting of F,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ .

20. The first device of claim 14, wherein the compound comprises a structure according to Formula 1:

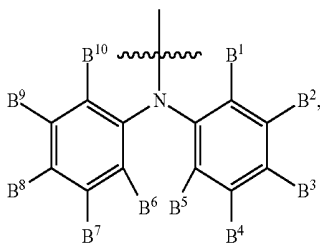


Formula 1

wherein  $R^1$  is



and  $R^5$  is



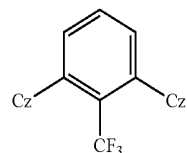
wherein  $R^2$ ,  $R^3$ ,  $A^1$ ,  $A^2$ ,  $A^3$ ,  $A^4$ ,  $A^5$ ,  $A^6$ ,  $A^7$ ,  $A^8$ ,  $A^9$ ,  $A^{10}$ ,  $B^1$ ,  $B^2$ ,  $B^3$ ,  $B^4$ ,  $B^5$ ,  $B^6$ ,  $B^7$ ,  $B^8$ ,  $B^9$ , and  $B^{10}$ , are each independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryloxy, thioaryloxy, amino, arylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfonyl, sulfonyl, phosphino,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ ,  $-SC_mF_{2m+1}$ , and combinations thereof,

wherein adjacent R, A, and B groups are, optionally, joined to form a fused ring structure; and

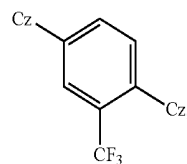
## 366

wherein X is  $-F$ ,  $-C_mF_{2m+1}$ ,  $-Si_mF_{2m+1}$ ,  $-NCO$ ,  $-NCS$ ,  $-OCN$ ,  $-SCN$ ,  $-OC_mF_{2m+1}$ , and  $-SC_mF_{2m+1}$ .

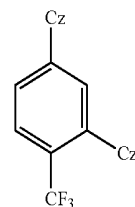
21. The first device of claim 14, wherein the compound is selected from the group consisting of:



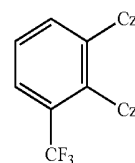
Compound 1



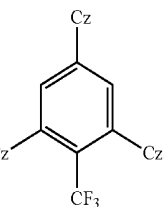
Compound 2



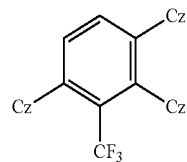
Compound 3



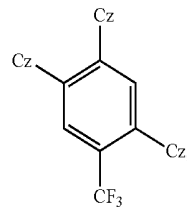
Compound 4



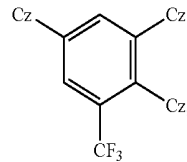
Compound 6



Compound 7



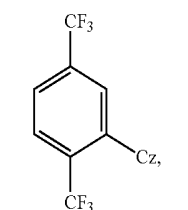
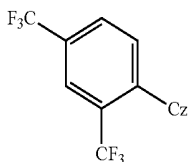
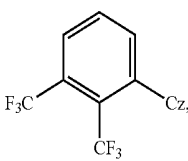
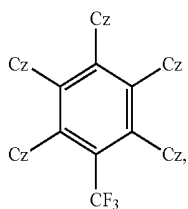
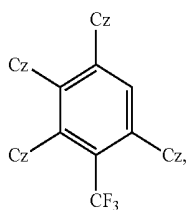
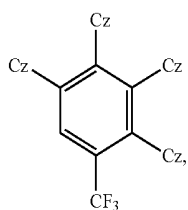
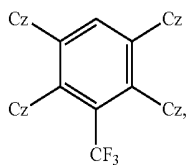
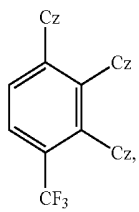
Compound 8



Compound 9

367

-continued

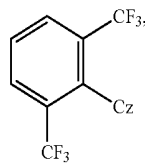


368

-continued

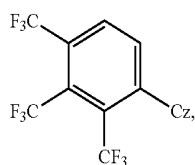
Compound 10

5



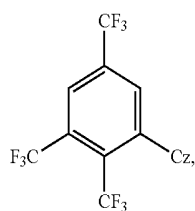
Compound 11

10



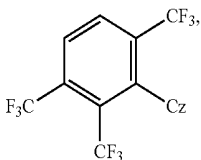
Compound 12

20



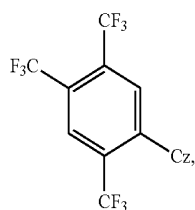
Compound 13

25



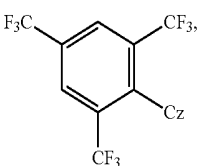
Compound 14

35



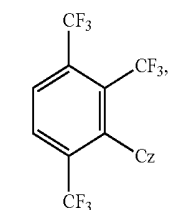
Compound 15

45



Compound 16

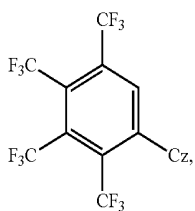
50



55

Compound 17

60



65

Compound 18

Compound 19

Compound 20

Compound 21

Compound 22

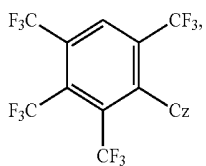
Compound 23

Compound 24

Compound 25

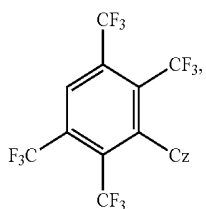
**369**

-continued



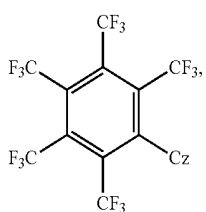
Compound 26

5



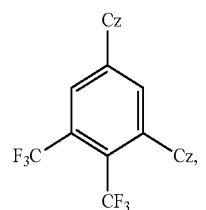
Compound 27

10



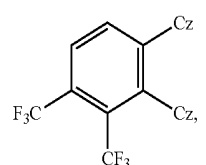
Compound 28

20



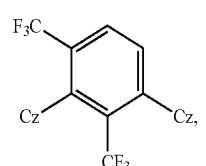
Compound 29

25



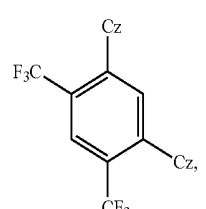
Compound 30

35



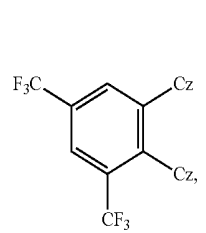
Compound 31

45



Compound 32

50



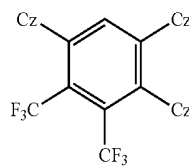
Compound 33

60

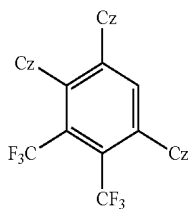
65

**370**

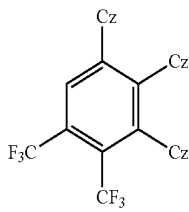
-continued



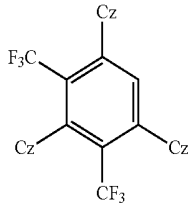
Compound 34



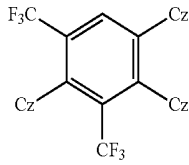
Compound 35



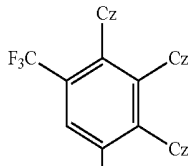
Compound 36



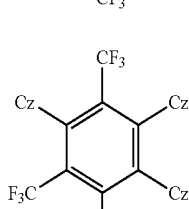
Compound 37



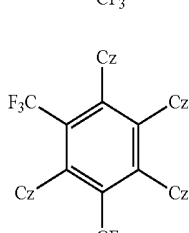
Compound 38



Compound 39



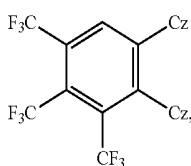
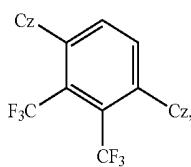
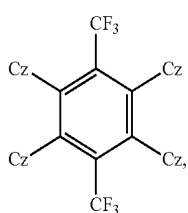
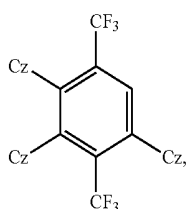
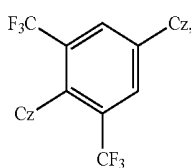
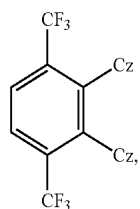
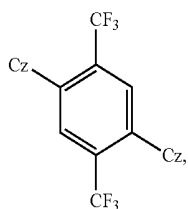
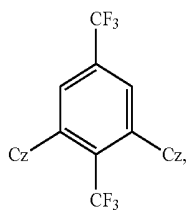
Compound 40



Compound 41

371

-continued

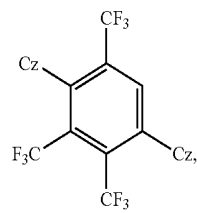


372

-continued

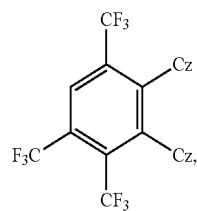
Compound 42

5



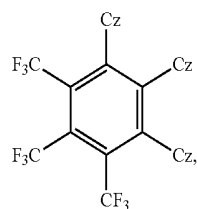
Compound 43

10



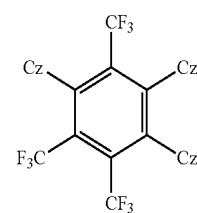
Compound 44

15



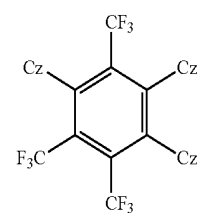
Compound 45

20



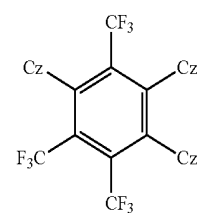
Compound 45

25



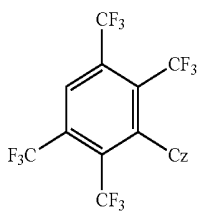
Compound 46

30



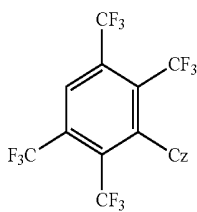
Compound 47

35



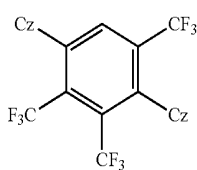
Compound 47

40



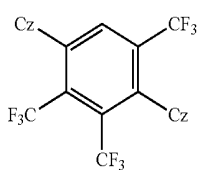
Compound 47

45



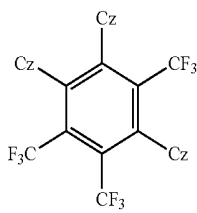
Compound 48

50



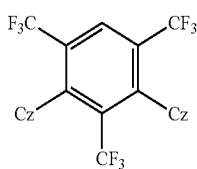
Compound 48

55



Compound 49

60



65

Compound 50

Compound 51

Compound 52

Compound 53

Compound 54

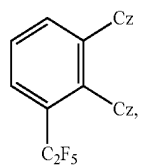
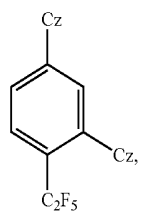
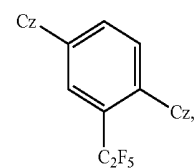
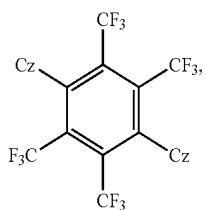
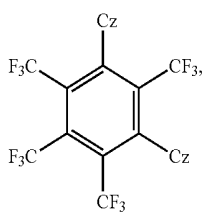
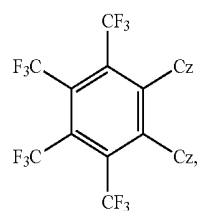
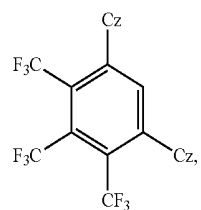
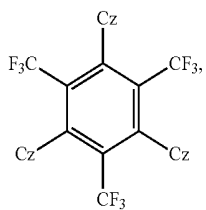
Compound 55

Compound 56

Compound 57

373

-continued

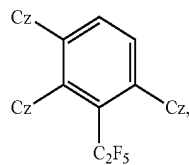


374

-continued

Compound 58

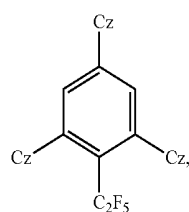
5



Compound 66

Compound 59

10

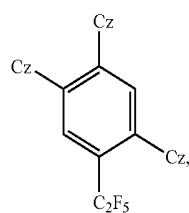


Compound 67

15

Compound 60

20

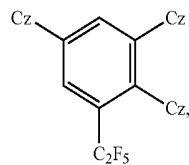


Compound 69

25

Compound 61

30

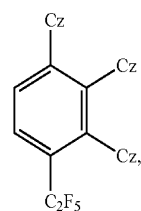


Compound 70

35

Compound 62

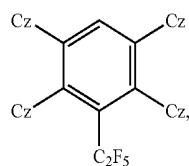
40



Compound 71

45

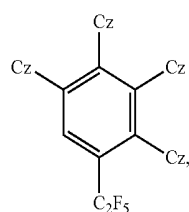
Compound 63



Compound 72

50

Compound 64

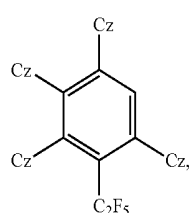


Compound 73

55

Compound 65

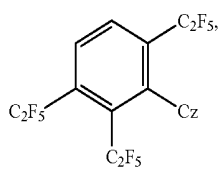
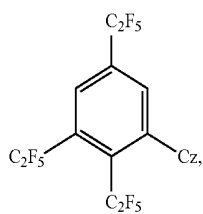
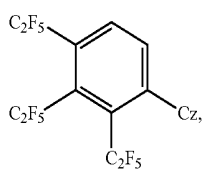
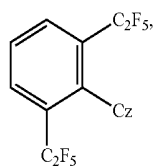
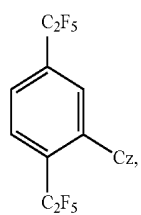
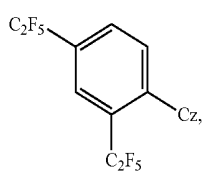
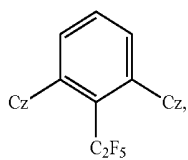
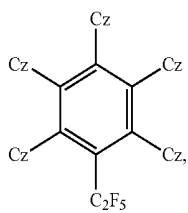
65



Compound 74

375

-continued

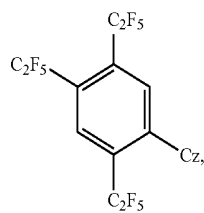


376

-continued

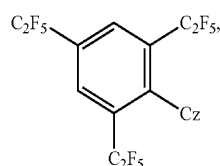
Compound 75

5



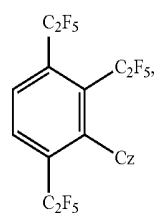
Compound 76

10



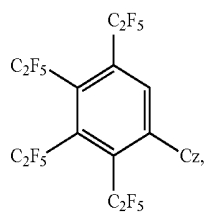
Compound 77

20



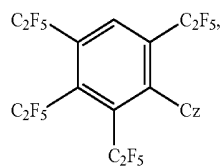
Compound 78

25



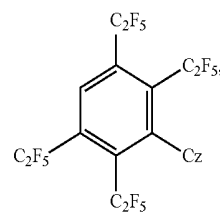
Compound 79

35



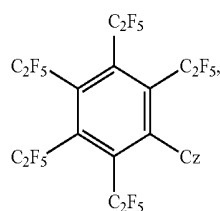
Compound 80

40



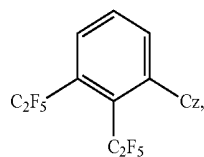
Compound 81

50



Compound 82

60



65

Compound 83

Compound 84

Compound 85

Compound 86

Compound 87

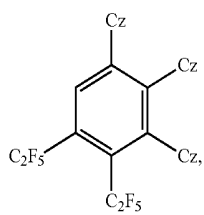
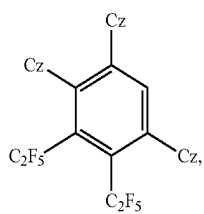
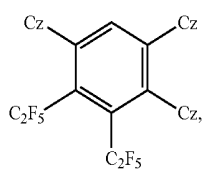
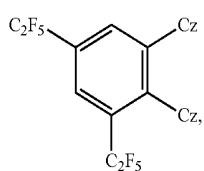
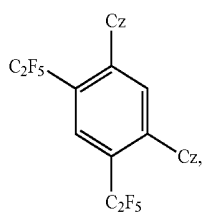
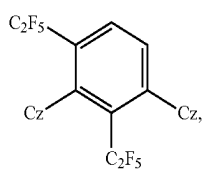
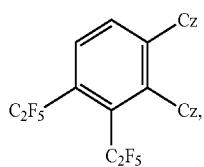
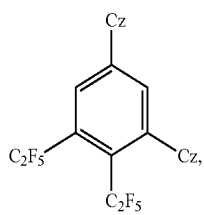
Compound 88

Compound 89

Compound 90

377

-continued

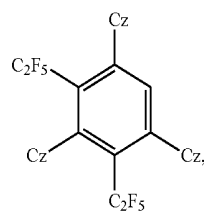


378

-continued

Compound 91

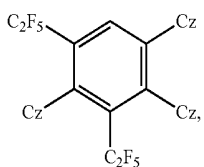
5



Compound 99

Compound 92

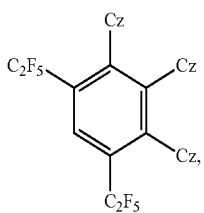
10



Compound 100

Compound 93

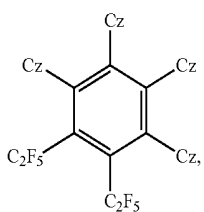
20



Compound 101

Compound 94

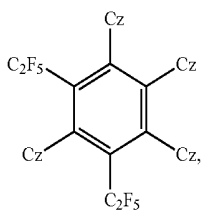
25



Compound 102

Compound 95

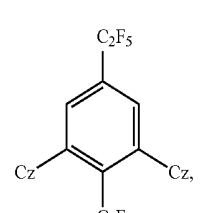
35



Compound 103

Compound 96

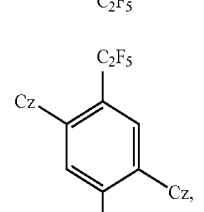
40



Compound 104

Compound 97

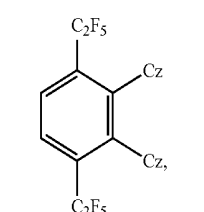
45



Compound 105

Compound 98

55

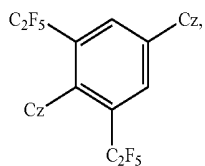


Compound 106

65

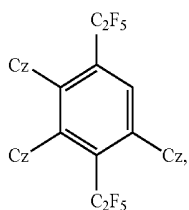
379

-continued



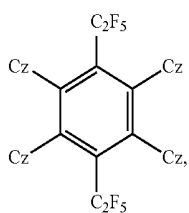
Compound 107

5



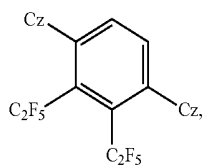
Compound 108

10



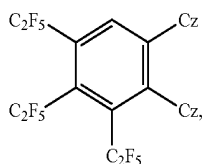
Compound 109

20



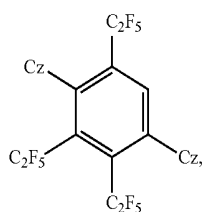
Compound 110

25



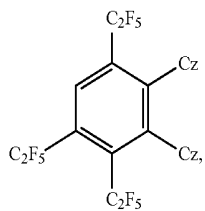
Compound 111

35



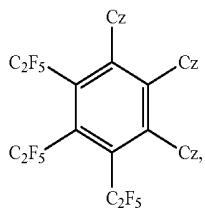
Compound 112

40



Compound 113

50



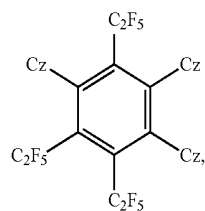
Compound 114

60

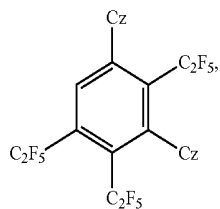
65

380

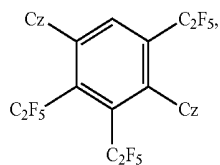
-continued



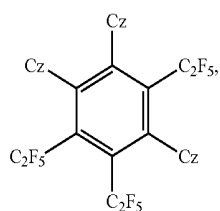
Compound 115



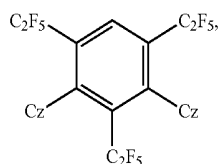
Compound 116



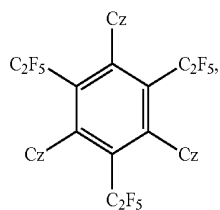
Compound 117



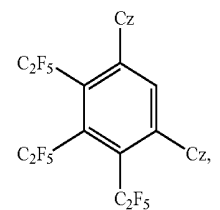
Compound 118



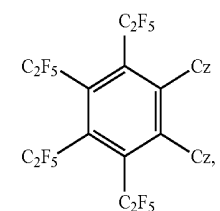
Compound 119



Compound 120



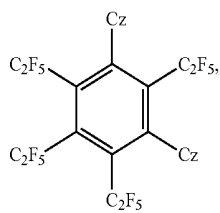
Compound 121



Compound 122

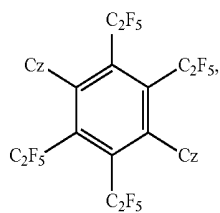
381

-continued



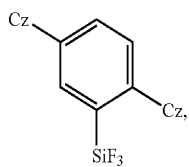
Compound 123

5



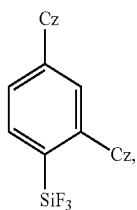
Compound 124

10



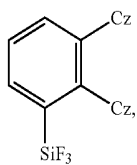
Compound 125

20



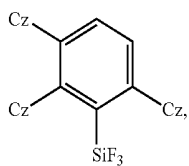
Compound 126

25



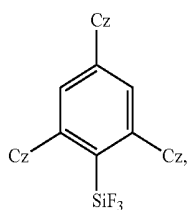
Compound 127

40



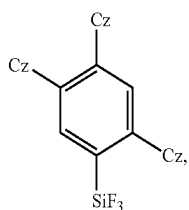
Compound 128

45



Compound 129

50



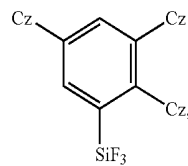
Compound 131

60

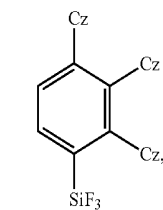
65

382

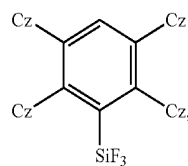
-continued



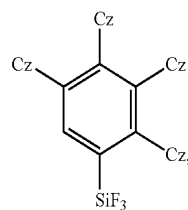
Compound 132



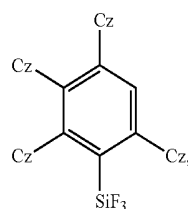
Compound 133



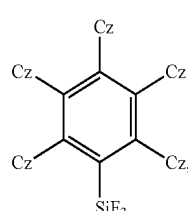
Compound 134



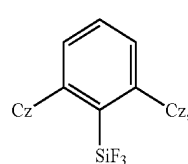
Compound 135



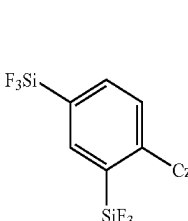
Compound 136



Compound 137



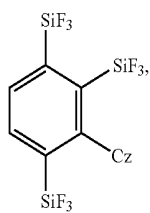
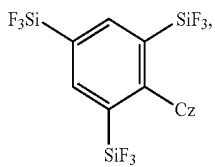
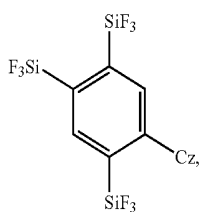
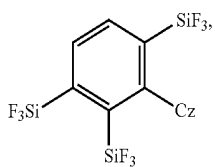
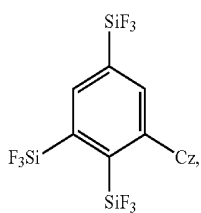
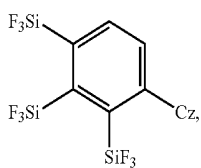
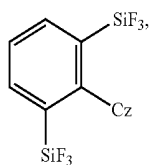
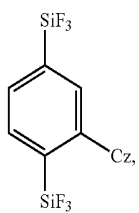
Compound 138



Compound 139

383

-continued

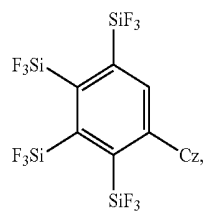


384

-continued

Compound 140

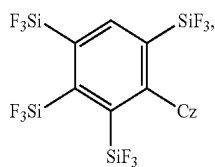
5



10

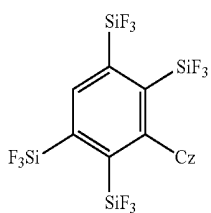
Compound 141

15



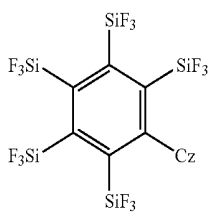
Compound 142

20



Compound 143

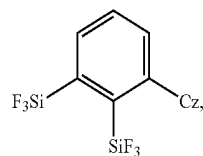
25



30

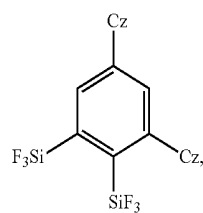
Compound 144

35



Compound 145

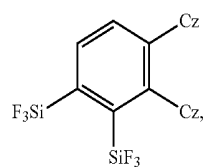
40



45

Compound 146

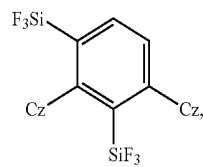
50



55

Compound 147

60



65

Compound 148

Compound 149

Compound 150

Compound 151

Compound 152

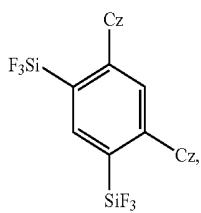
Compound 153

Compound 154

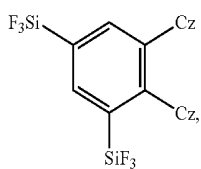
Compound 155

385

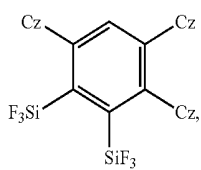
-continued



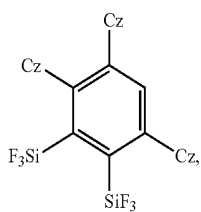
5



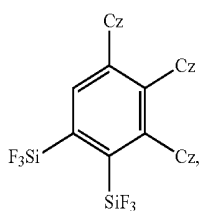
10



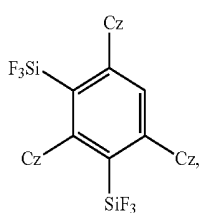
15



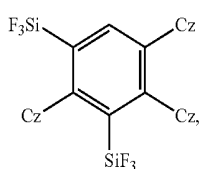
20



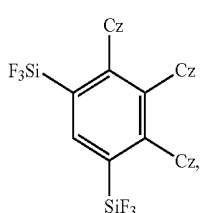
25



30



35



40

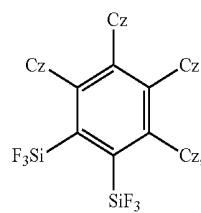
50

55

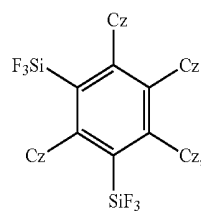
65

386

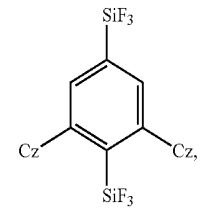
-continued



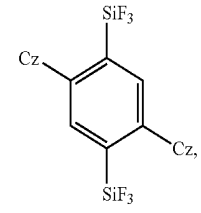
Compound 164



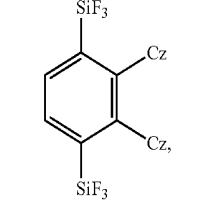
Compound 165



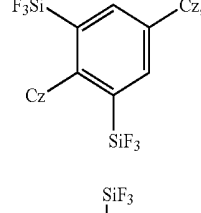
Compound 166



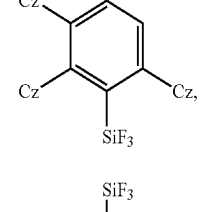
Compound 167



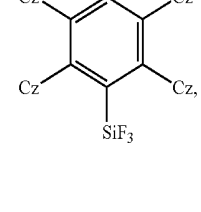
Compound 168



Compound 169



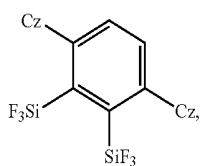
Compound 170



Compound 171

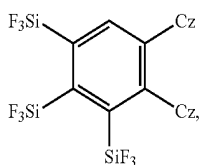
**387**

-continued



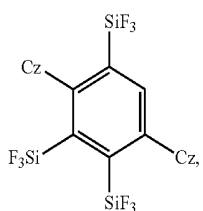
Compound 172

5



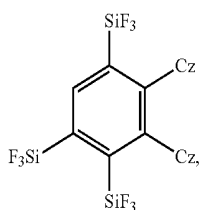
Compound 173

10



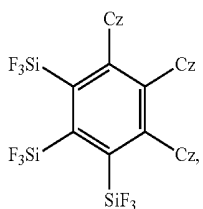
Compound 174

15



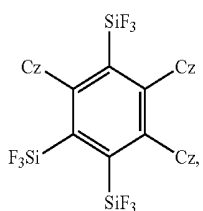
Compound 175

25



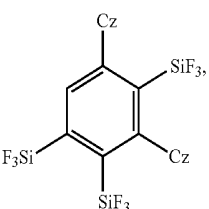
Compound 176

35



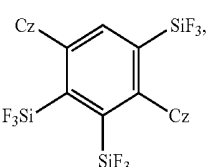
Compound 177

45



Compound 178

55



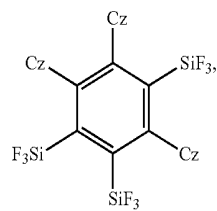
Compound 179

60

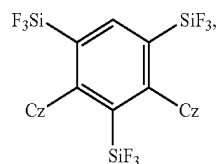
65

**388**

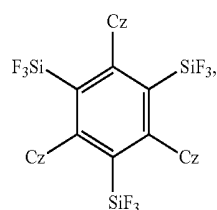
-continued



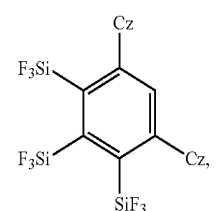
Compound 180



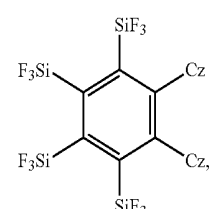
Compound 181



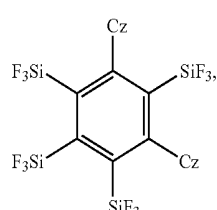
Compound 182



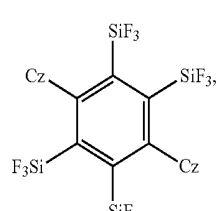
Compound 183



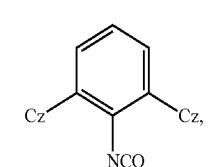
Compound 184



Compound 185



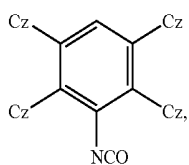
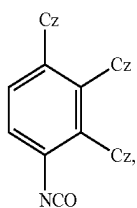
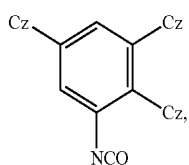
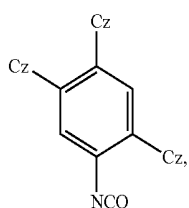
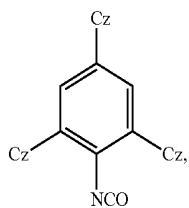
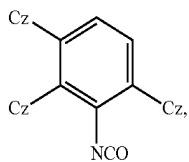
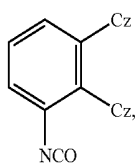
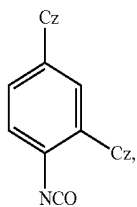
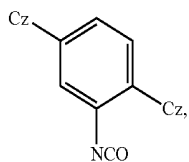
Compound 186



Compound 187

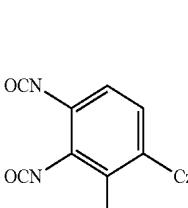
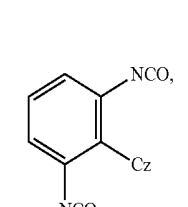
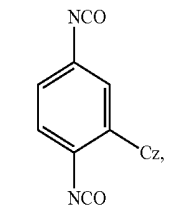
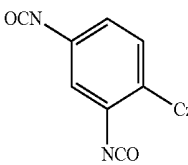
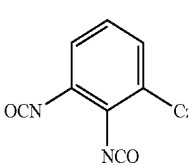
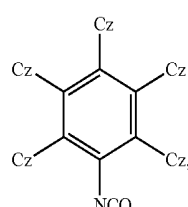
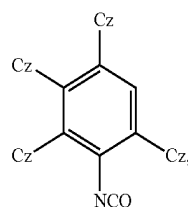
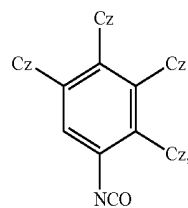
**389**

-continued



**390**

-continued



Compound 188

5

Compound 189

10

Compound 190

15

Compound 191

20

Compound 192

25

Compound 194

30

Compound 195

35

Compound 196

40

Compound 197

45

50

55

60

65

Compound 198

Compound 199

Compound 200

Compound 201

Compound 202

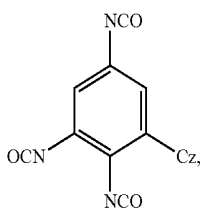
Compound 203

Compound 204

Compound 205

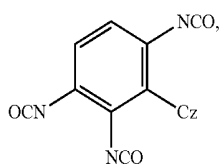
391

-continued



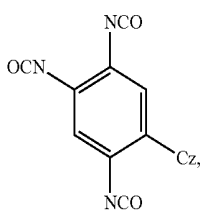
Compound 206

5



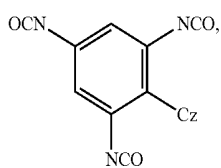
Compound 207

10



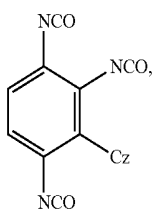
Compound 208

15



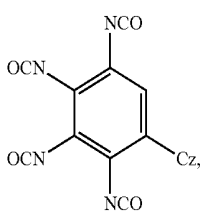
Compound 209

20



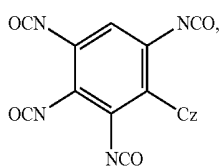
Compound 210

25



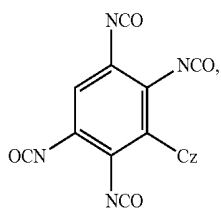
Compound 211

30



Compound 212

35

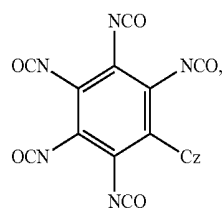


Compound 213

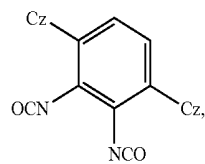
40

392

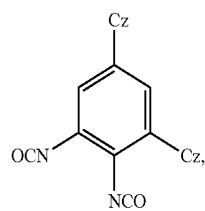
-continued



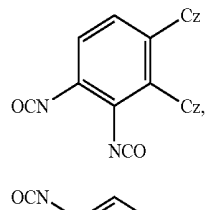
Compound 214



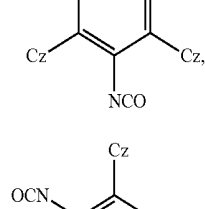
Compound 215



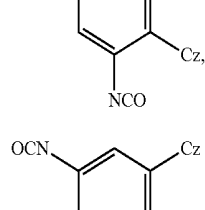
Compound 216



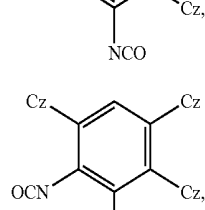
Compound 217



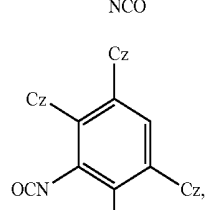
Compound 218



Compound 219



Compound 220



Compound 221

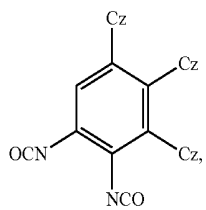


Compound 222

65

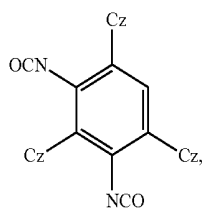
393

-continued



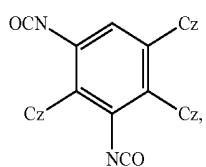
Compound 223

5



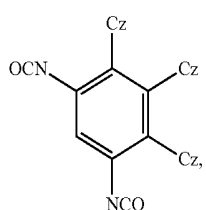
Compound 224

10



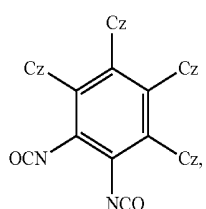
Compound 225

20



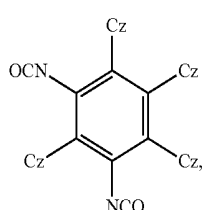
Compound 226

25



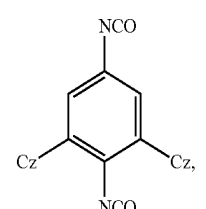
Compound 227

35



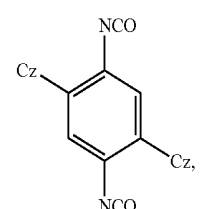
Compound 228

45



Compound 229

50



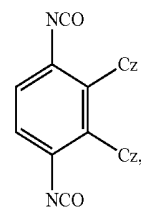
Compound 230

60

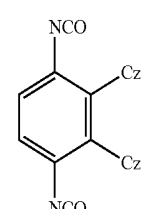
65

394

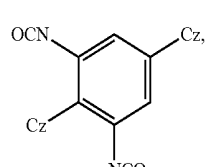
-continued



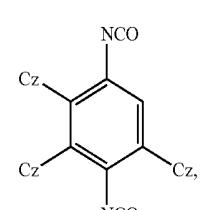
Compound 231



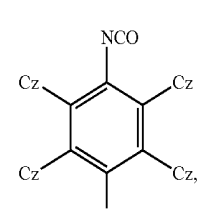
Compound 231



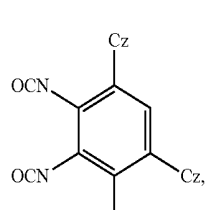
Compound 232



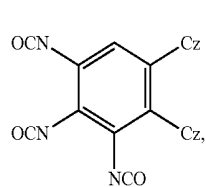
Compound 233



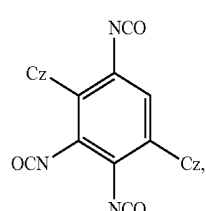
Compound 234



Compound 235



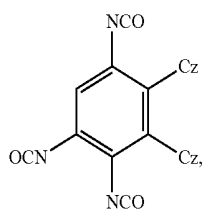
Compound 236



Compound 237

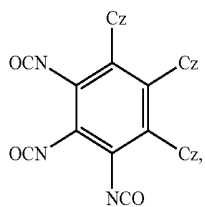
**395**

-continued



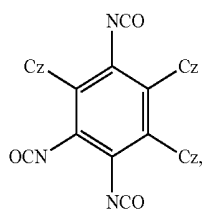
Compound 238

5



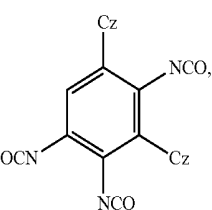
Compound 239

10



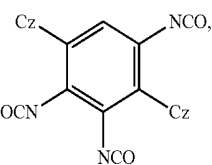
Compound 240

15



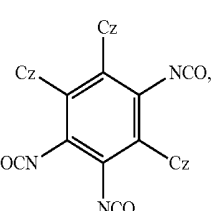
Compound 241

20



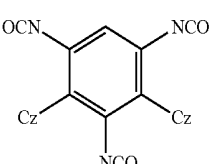
Compound 242

25



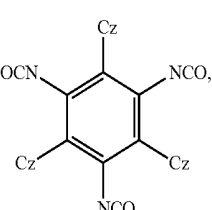
Compound 243

30



Compound 244

35

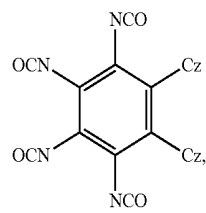


Compound 245

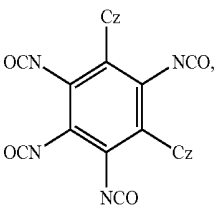
40

**396**

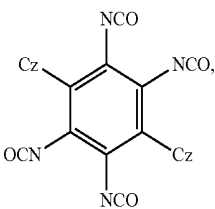
-continued



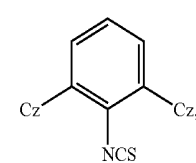
Compound 246



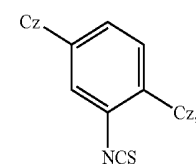
Compound 247



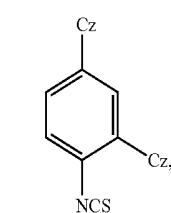
Compound 248



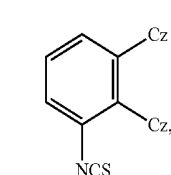
Compound 249



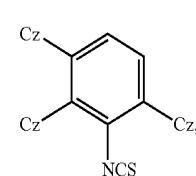
Compound 250



Compound 251



Compound 252



Compound 253

50

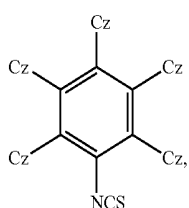
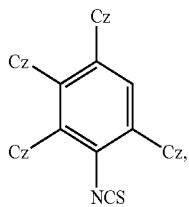
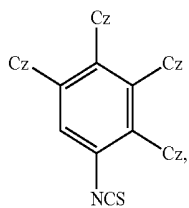
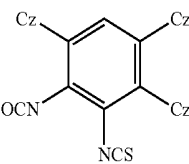
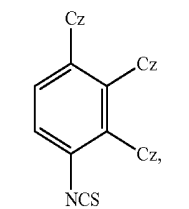
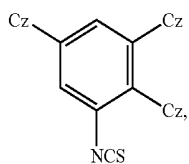
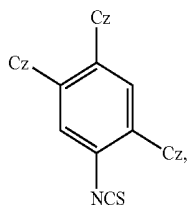
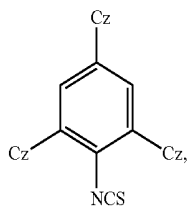
55

60

65

397

-continued

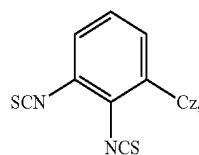


398

-continued

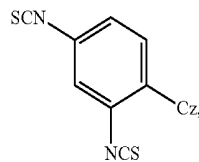
Compound 254

5



Compound 256

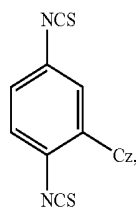
10



15

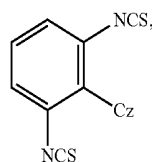
Compound 257

20



Compound 258

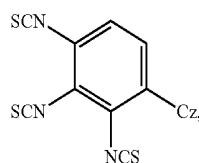
25



30

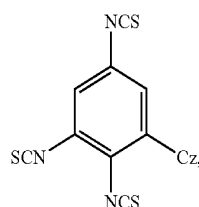
Compound 259

35



Compound 260

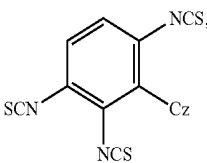
40



45

Compound 261

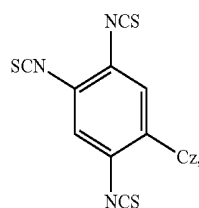
50



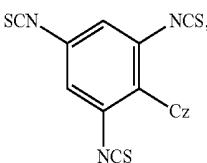
55

Compound 262

60



65



Compound 263

Compound 264

Compound 265

Compound 266

Compound 267

Compound 268

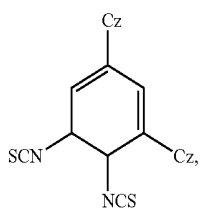
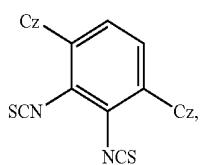
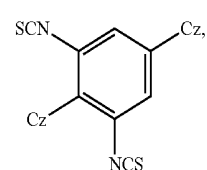
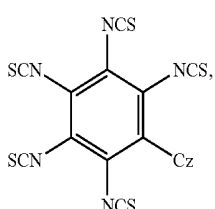
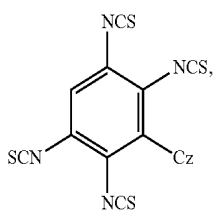
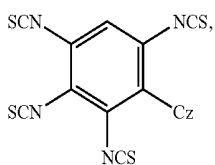
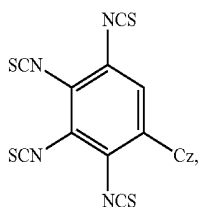
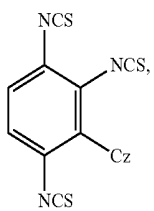
Compound 269

Compound 270

Compound 271

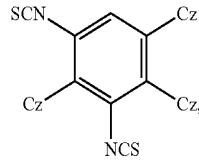
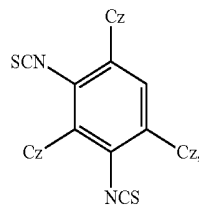
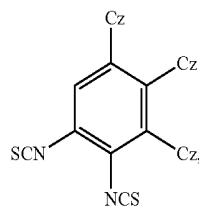
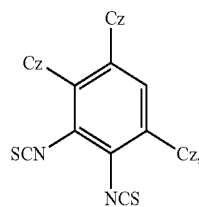
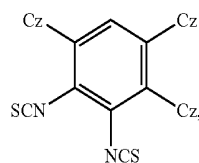
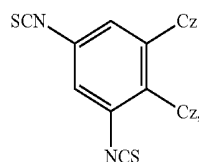
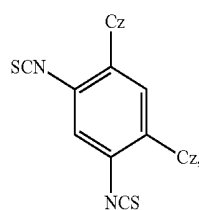
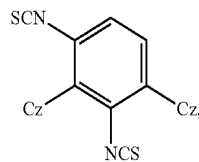
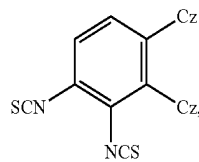
399

-continued



400

-continued



Compound 272

5

Compound 273

10

15

Compound 274

20

Compound 275

25

30

Compound 276

35

40

Compound 277

45

Compound 278

50

55

Compound 279

60

65

Compound 280

Compound 281

Compound 282

Compound 283

Compound 284

Compound 285

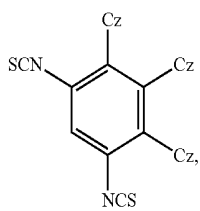
Compound 286

Compound 287

Compound 288

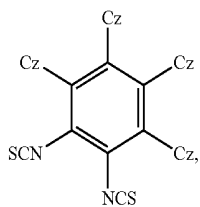
401

-continued



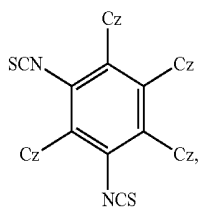
Compound 289

5



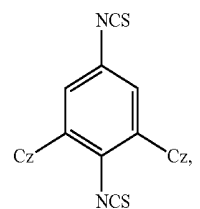
Compound 290

10



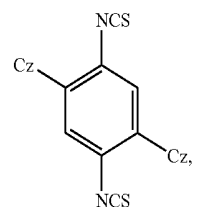
Compound 291

15



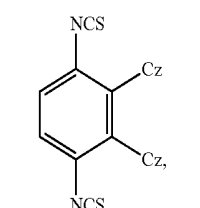
Compound 292

20



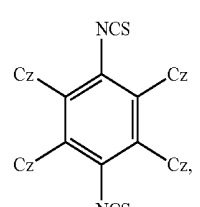
Compound 293

25



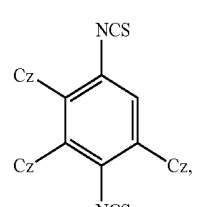
Compound 294

30



Compound 295

35

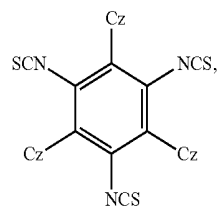


Compound 296

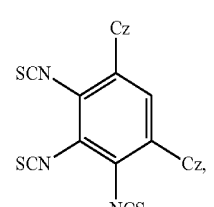
40

402

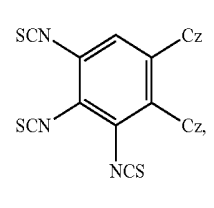
-continued



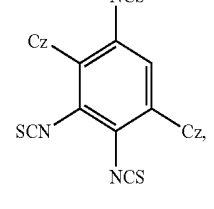
Compound 297



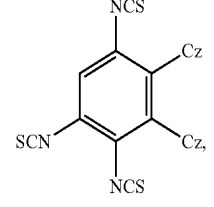
Compound 298



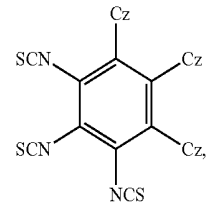
Compound 299



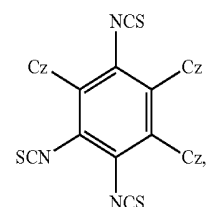
Compound 300



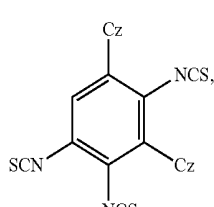
Compound 301



Compound 302



Compound 303



Compound 304

45

50

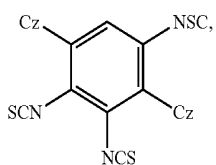
55

60

65

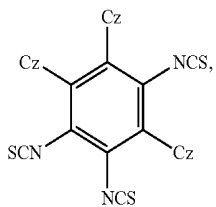
403

-continued



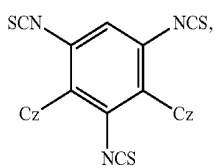
Compound 305

5



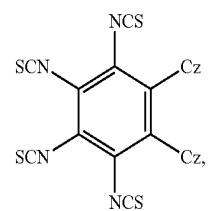
Compound 306

10



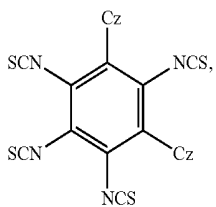
Compound 307

20



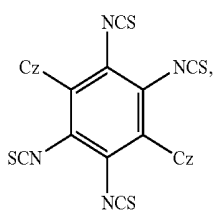
Compound 308

25



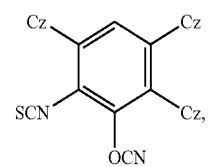
Compound 309

35



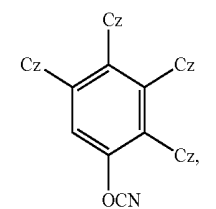
Compound 310

45



Compound 311

50

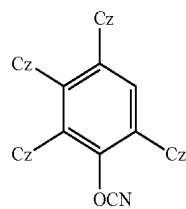


Compound 312

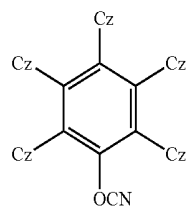
60

404

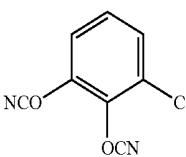
-continued



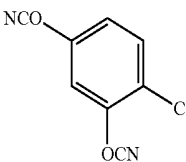
Compound 313



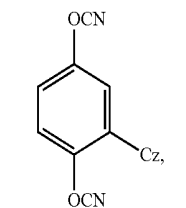
Compound 314



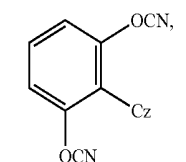
Compound 315



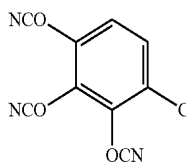
Compound 316



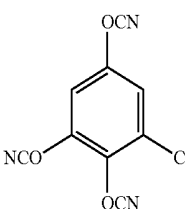
Compound 317



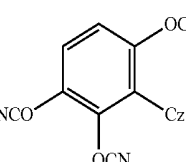
Compound 318



Compound 319



Compound 320

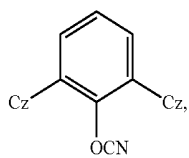
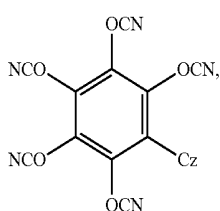
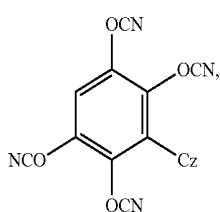
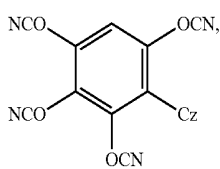
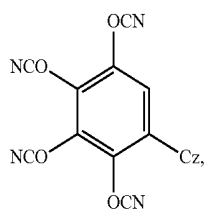
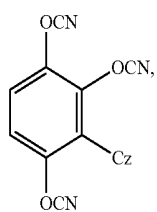
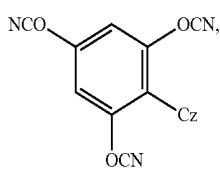
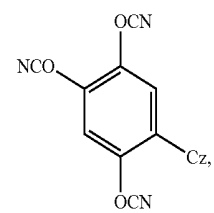


Compound 321

65

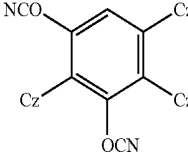
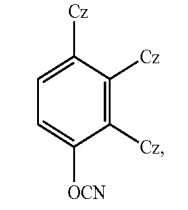
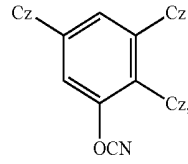
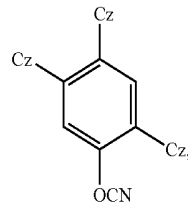
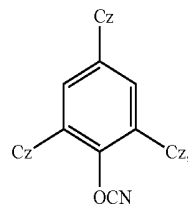
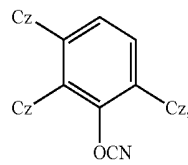
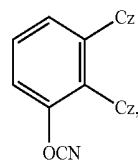
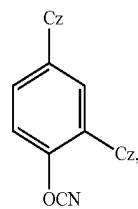
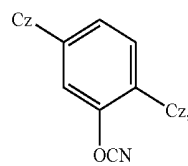
405

-continued



406

-continued



Compound 322

5

Compound 323

10

15

Compound 324

20

Compound 325

25

30

Compound 326

35

Compound 327

40

45

Compound 328

50

55

Compound 329

60

65

Compound 330

Compound 331

Compound 332

Compound 333

Compound 334

Compound 336

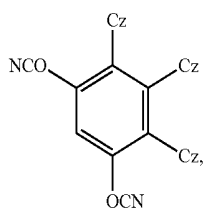
Compound 337

Compound 338

Compound 339

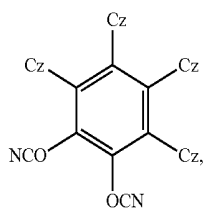
407

-continued



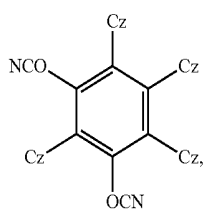
Compound 340

5



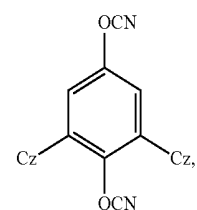
Compound 341

10



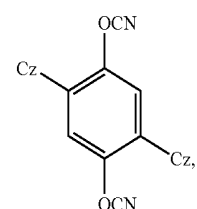
Compound 342

20



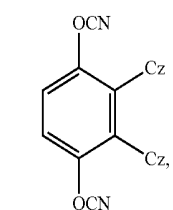
Compound 343

30



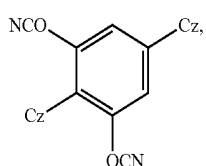
Compound 344

35



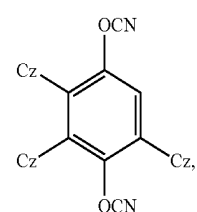
Compound 345

45



Compound 346

55



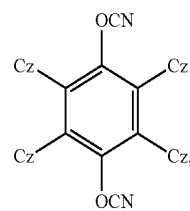
Compound 347

60

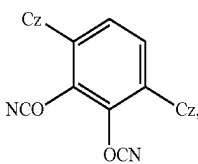
65

408

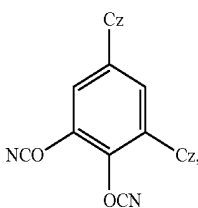
-continued



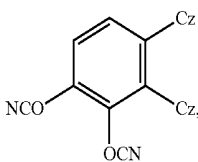
Compound 348



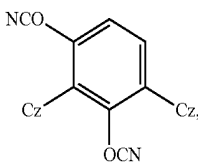
Compound 349



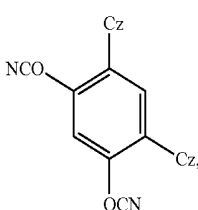
Compound 350



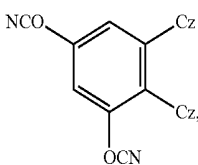
Compound 351



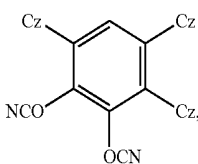
Compound 352



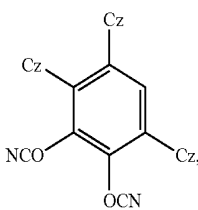
Compound 353



Compound 354



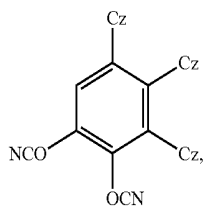
Compound 355



Compound 356

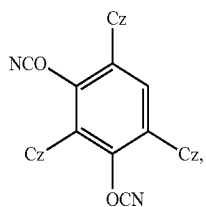
409

-continued



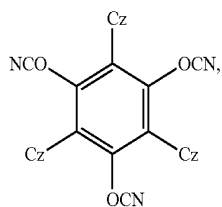
Compound 357

5



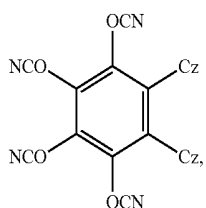
Compound 358

10



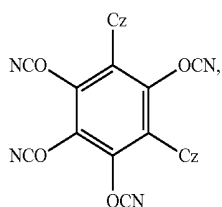
Compound 359

20



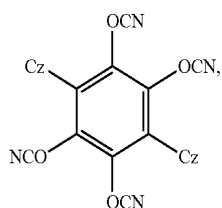
Compound 360

25



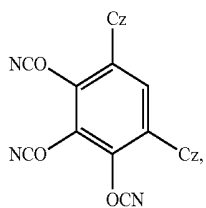
Compound 361

35



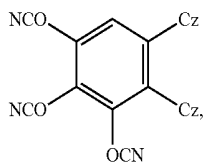
Compound 362

45



Compound 363

55

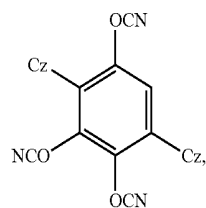


Compound 364

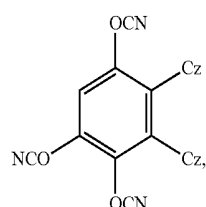
65

410

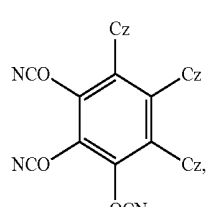
-continued



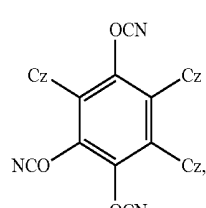
Compound 365



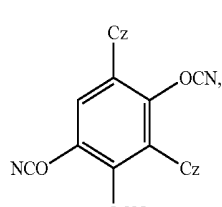
Compound 366



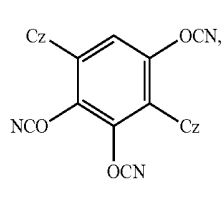
Compound 367



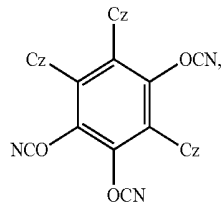
Compound 368



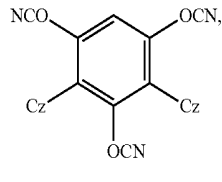
Compound 369



Compound 370



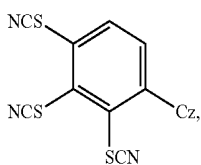
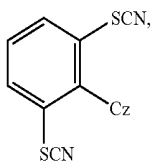
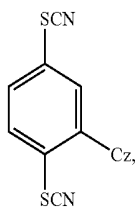
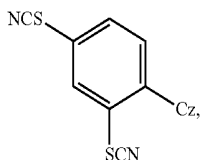
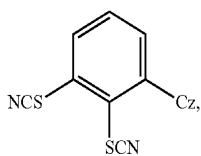
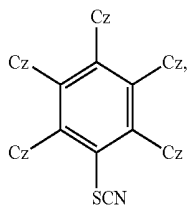
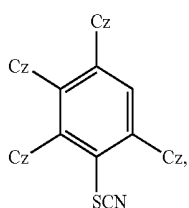
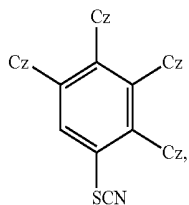
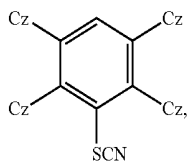
Compound 371



Compound 372

411

-continued

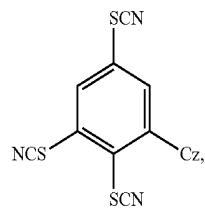


412

-continued

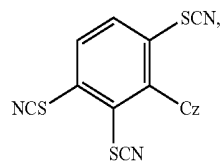
Compound 373

5



Compound 374

10

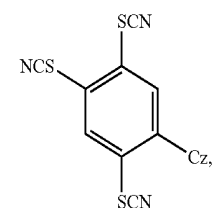


Compound 375

15

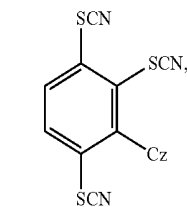
Compound 376

25



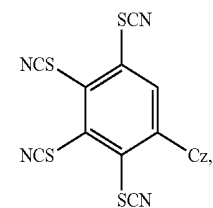
Compound 377

35



Compound 378

40

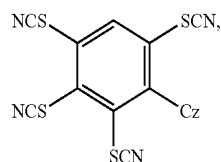


Compound 379

45

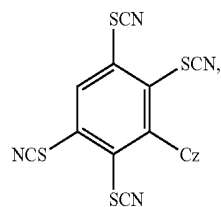
Compound 380

55



Compound 381

65



Compound 382

Compound 383

Compound 384

Compound 385

Compound 386

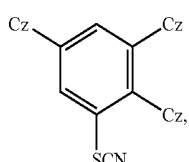
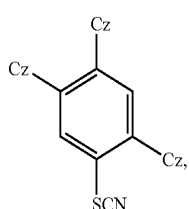
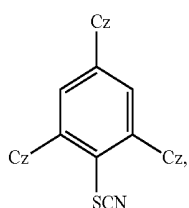
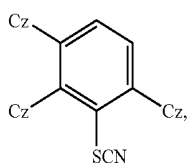
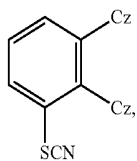
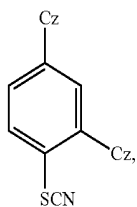
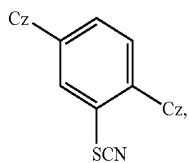
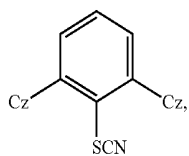
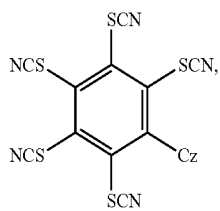
Compound 387

Compound 388

Compound 389

413

-continued

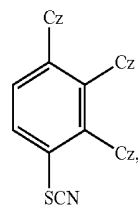


414

-continued

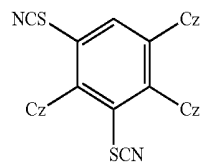
Compound 390

5



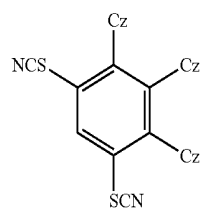
Compound 391

10



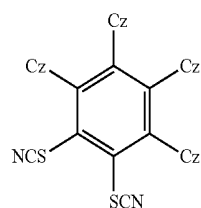
Compound 392

15



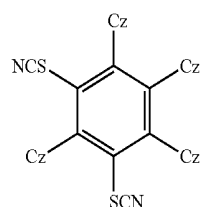
Compound 393

25



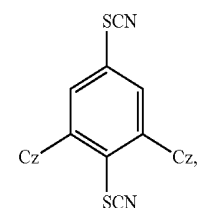
Compound 394

35



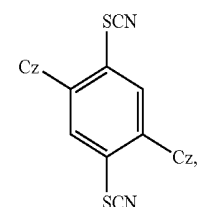
Compound 395

40



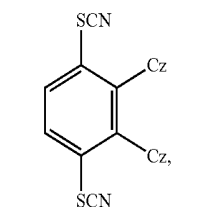
Compound 396

45



Compound 398

55



Compound 399

65

Compound 400

Compound 401

Compound 402

Compound 403

Compound 404

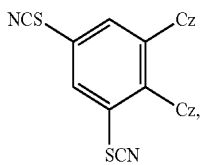
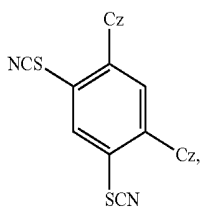
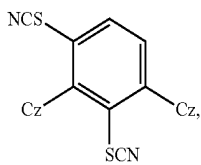
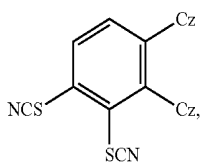
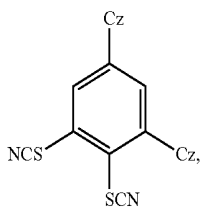
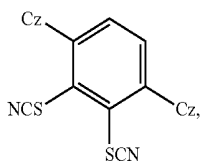
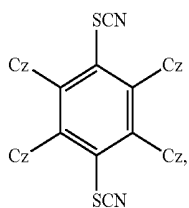
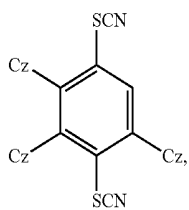
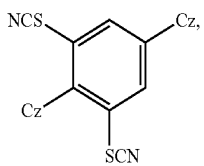
Compound 405

Compound 406

Compound 407

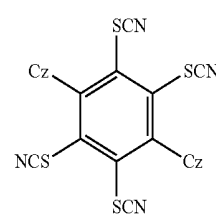
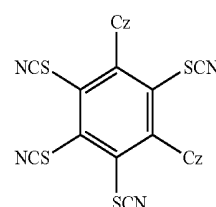
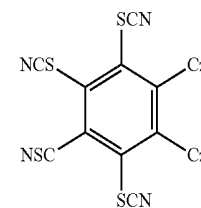
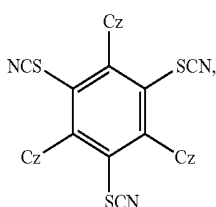
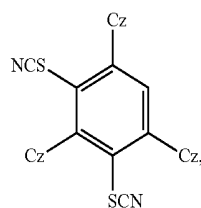
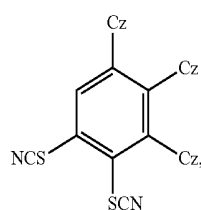
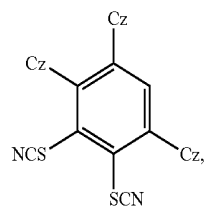
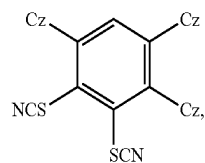
**415**

-continued



**416**

-continued



Compound 408

5

Compound 409

10

Compound 410

15

Compound 411

20

Compound 412

25

Compound 413

30

Compound 414

35

Compound 415

40

Compound 416

45

50

Compound 416

55

60

65

Compound 417

Compound 418

Compound 419

Compound 420

Compound 421

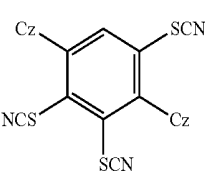
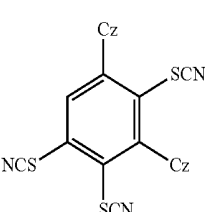
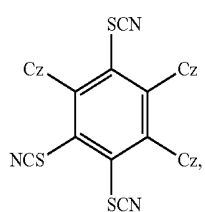
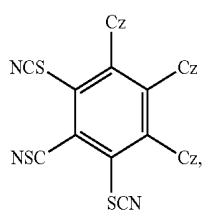
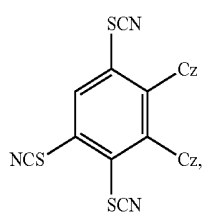
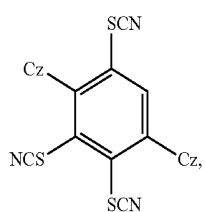
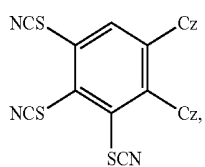
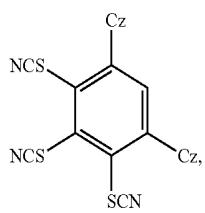
Compound 422

Compound 423

Compound 424

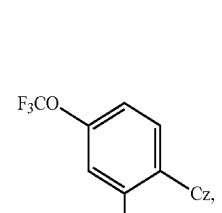
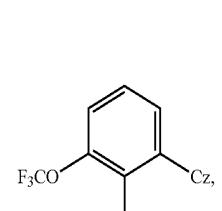
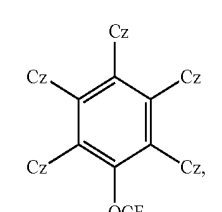
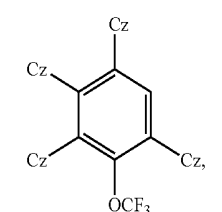
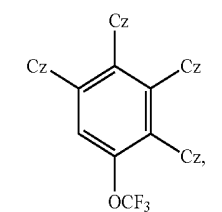
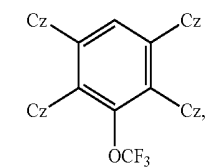
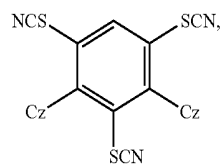
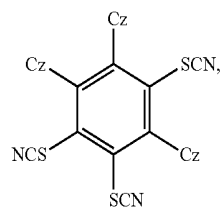
417

-continued



418

-continued



Compound 425

5

Compound 426

10

15

Compound 427

20

Compound 428

25

30

Compound 429

35

40

Compound 430

45

50

Compound 431

55

Compound 432

60

65

Compound 433

Compound 434

Compound 435

Compound 436

Compound 437

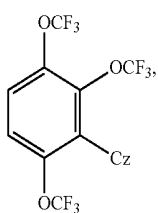
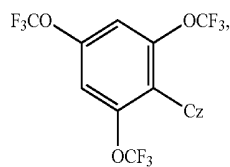
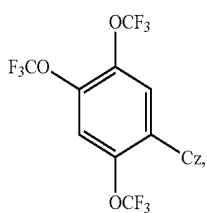
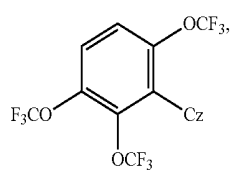
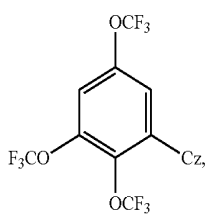
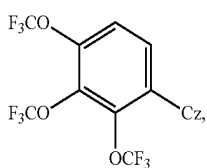
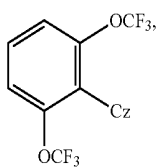
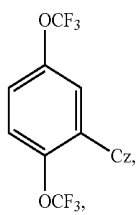
Compound 438

Compound 439

Compound 440

419

-continued

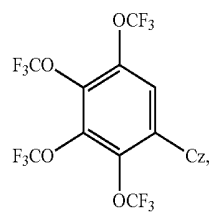


420

-continued

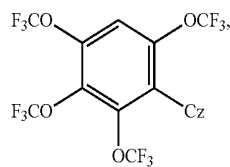
Compound 441

5



Compound 442

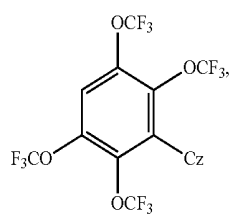
10



Compound 443

15

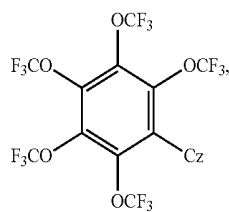
20



Compound 444

25

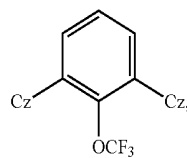
30



Compound 445

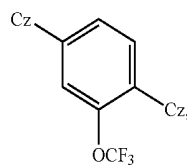
35

40



Compound 446

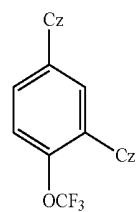
45



Compound 447

50

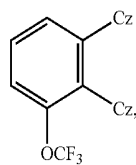
55



Compound 448

60

65



Compound 449

Compound 450

Compound 451

Compound 452

Compound 453

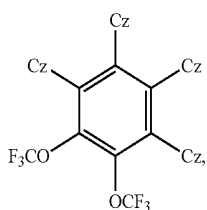
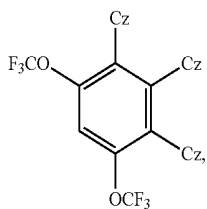
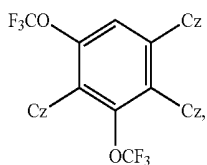
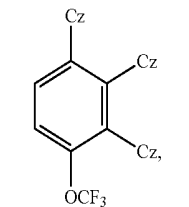
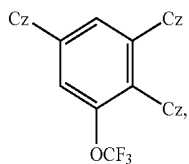
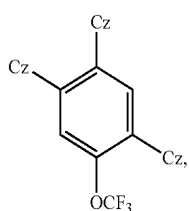
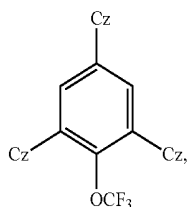
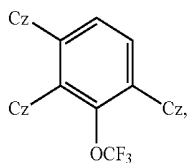
Compound 454

Compound 455

Compound 456

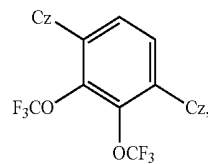
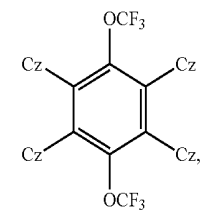
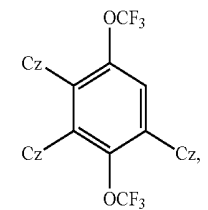
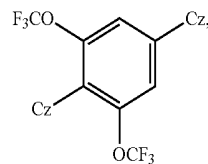
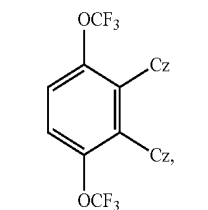
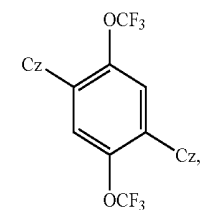
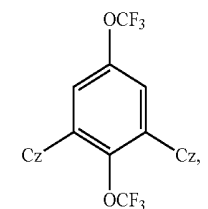
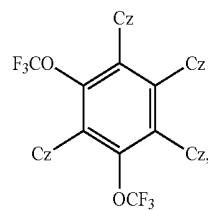
421

-continued



422

-continued



Compound 457

5

Compound 458

10

15

Compound 460

20

25

Compound 461

30

Compound 462

35

40

Compound 463

45

Compound 464

50

55

Compound 465

60

65

Compound 466

Compound 467

Compound 468

Compound 469

Compound 470

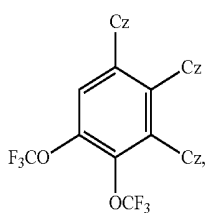
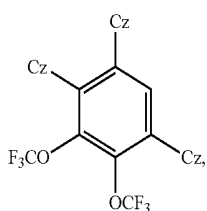
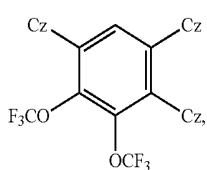
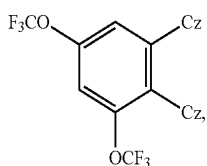
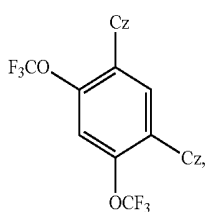
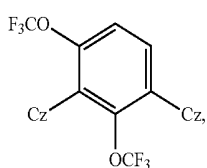
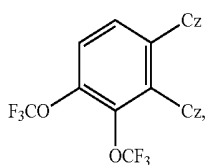
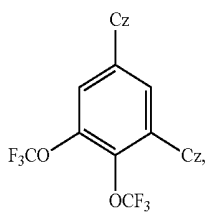
Compound 471

Compound 472

Compound 473

423

-continued

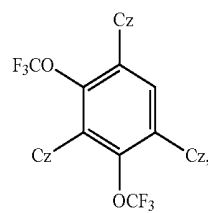


424

-continued

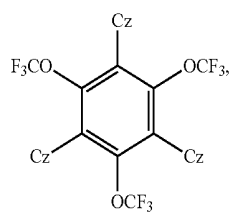
Compound 474

5



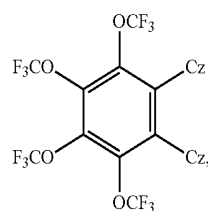
Compound 475

10



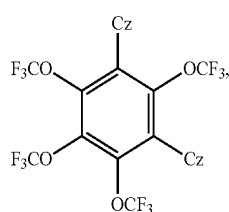
Compound 476

15



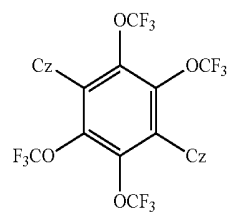
Compound 477

25



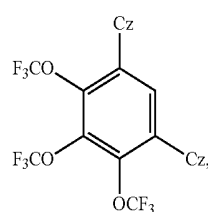
Compound 478

35



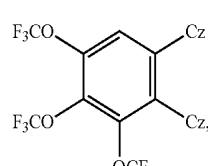
Compound 479

40



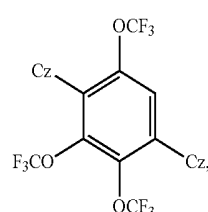
Compound 480

45



Compound 481

55



65

Compound 482

Compound 483

Compound 484

Compound 485

Compound 486

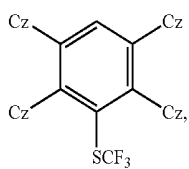
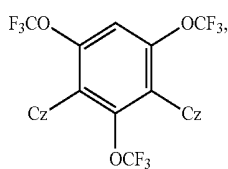
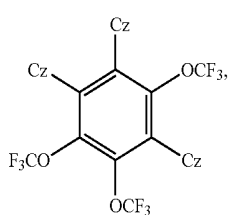
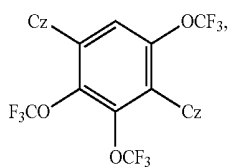
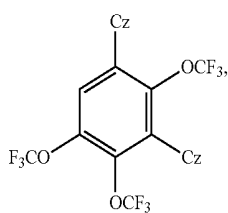
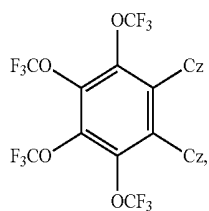
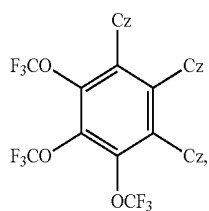
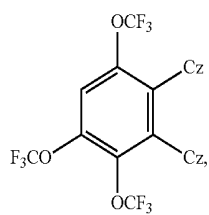
Compound 487

Compound 488

Compound 489

425

-continued

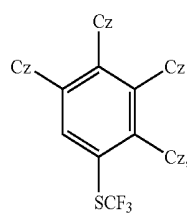


426

-continued

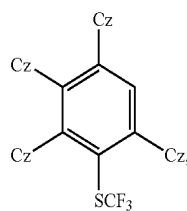
Compound 490

5



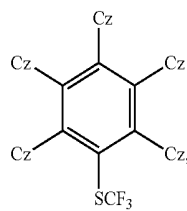
Compound 491

10



Compound 492

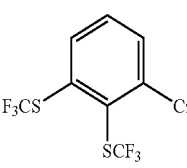
15



20

Compound 493

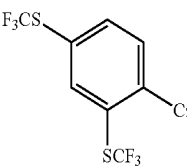
25



30

Compound 494

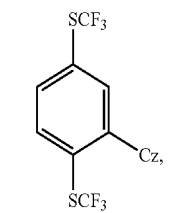
35



40

Compound 495

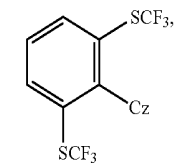
45



50

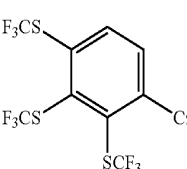
Compound 496

55



Compound 497

60



65

Compound 498

Compound 499

Compound 500

Compound 501

Compound 502

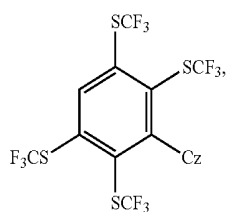
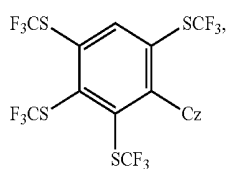
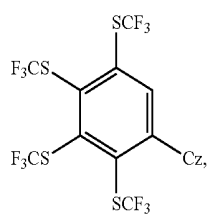
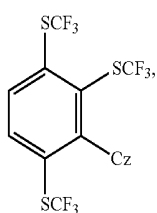
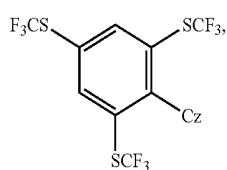
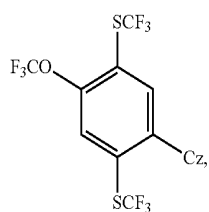
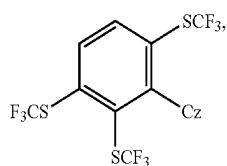
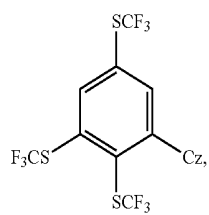
Compound 503

Compound 504

Compound 505

427

-continued

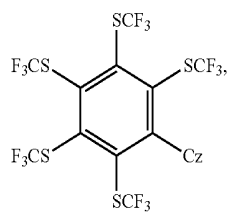


428

-continued

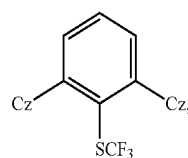
Compound 506

5



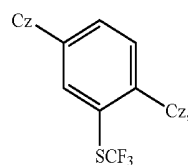
Compound 507

10



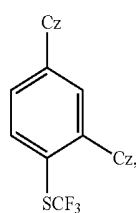
Compound 508

15



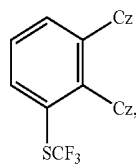
Compound 509

20



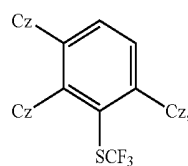
Compound 510

25



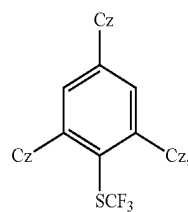
Compound 511

30



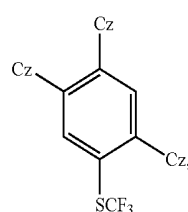
Compound 512

35



Compound 513

40



45

Compound 514

Compound 515

Compound 516

Compound 517

Compound 518

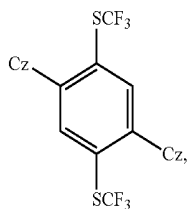
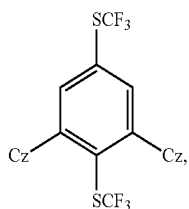
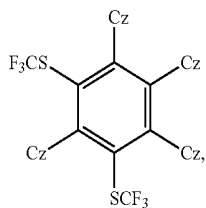
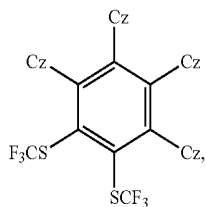
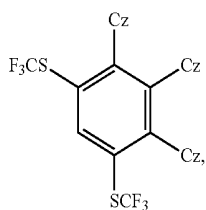
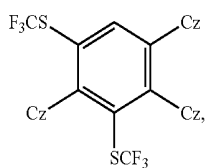
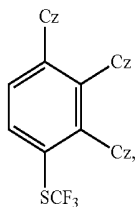
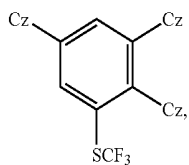
Compound 519

Compound 520

Compound 522

429

-continued

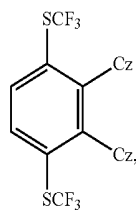


430

-continued

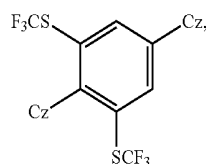
Compound 523

5



Compound 524

10

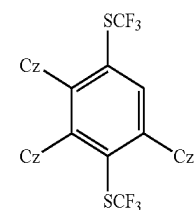


Compound 525

15

Compound 525

20

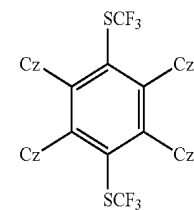


Compound 526

25

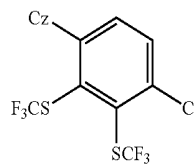
Compound 527

35



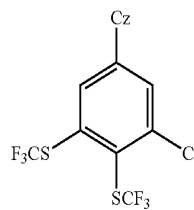
Compound 528

40



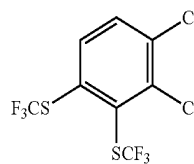
Compound 529

50

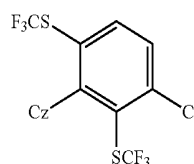


Compound 530

60



65



Compound 531

Compound 532

Compound 533

Compound 534

Compound 535

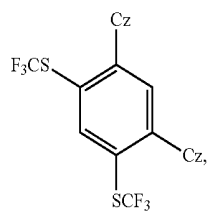
Compound 536

Compound 537

Compound 538

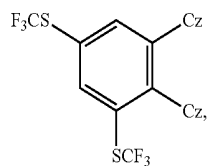
431

-continued



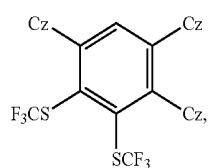
Compound 539

5



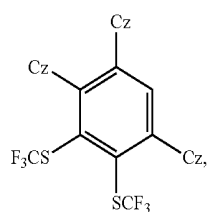
Compound 540

10



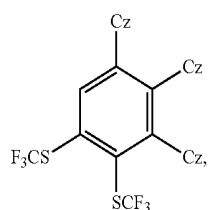
Compound 541

15



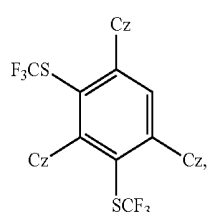
Compound 542

20



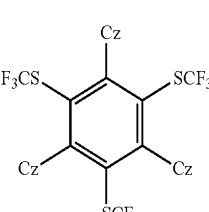
Compound 543

25



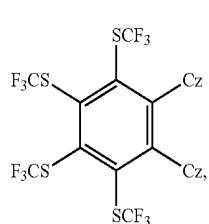
Compound 544

30



Compound 545

35

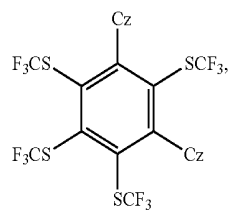


Compound 546

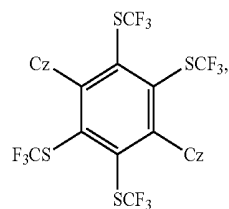
40

432

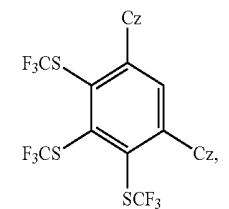
-continued



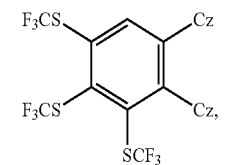
Compound 547



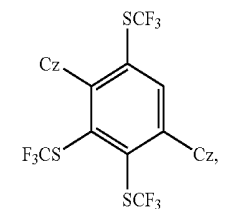
Compound 548



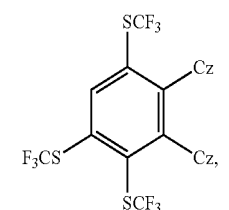
Compound 549



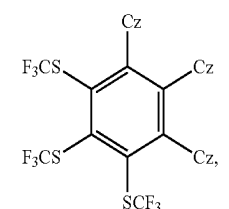
Compound 550



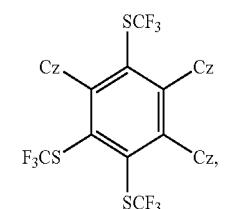
Compound 551



Compound 552



Compound 553



Compound 554

45

50

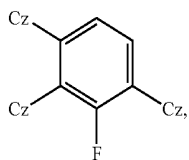
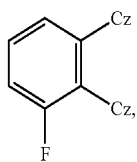
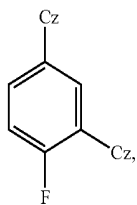
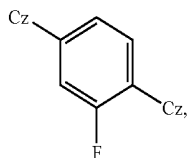
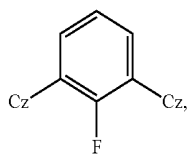
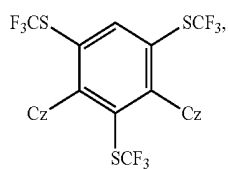
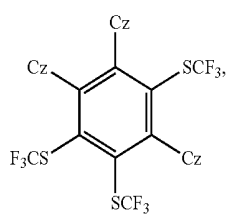
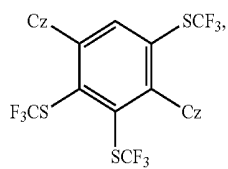
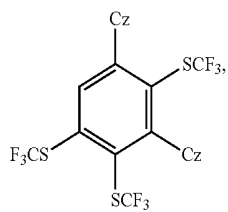
55

60

65

433

-continued

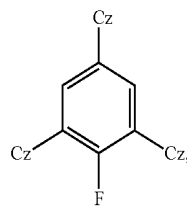


434

-continued

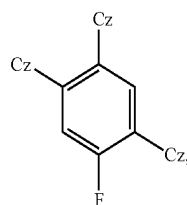
Compound 555

5



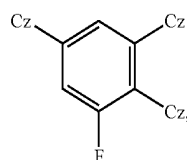
Compound 556

10



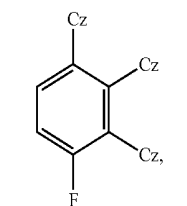
Compound 557

15



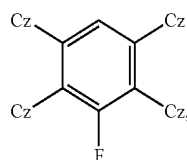
Compound 558

25



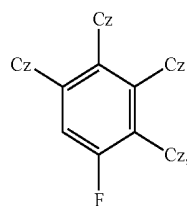
Compound 559

30



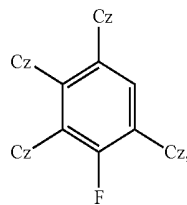
Compound 560

40



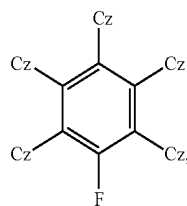
Compound 561

45



Compound 562

55



Compound 563

60

Compound 564

Compound 566

Compound 567

Compound 568

Compound 569

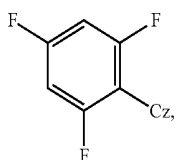
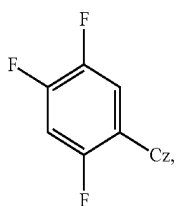
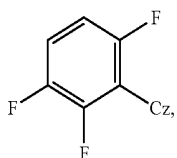
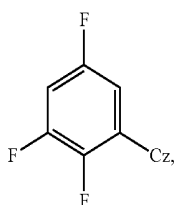
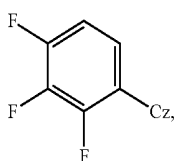
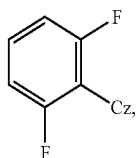
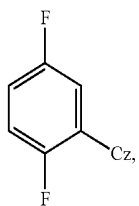
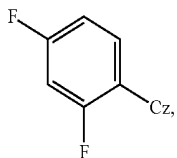
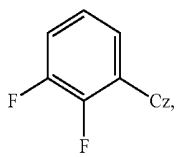
Compound 570

Compound 571

Compound 572

435

-continued



436

-continued

Compound 573

5

Compound 574

10

Compound 575

15

Compound 576

20

Compound 577

25

Compound 578

30

Compound 579

35

Compound 580

40

Compound 581

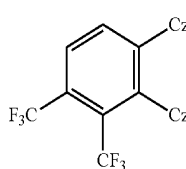
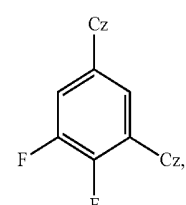
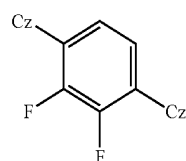
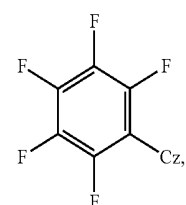
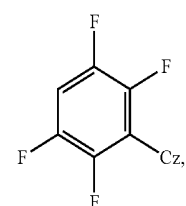
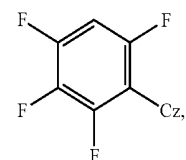
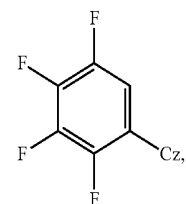
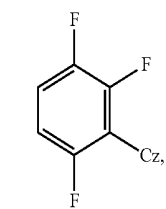
45

50

55

60

65



Compound 582

Compound 583

Compound 584

Compound 585

Compound 586

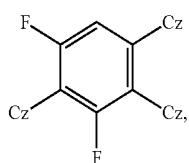
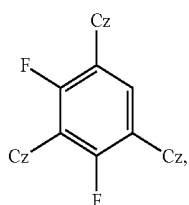
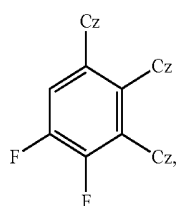
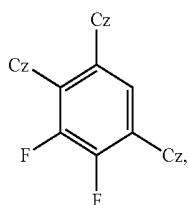
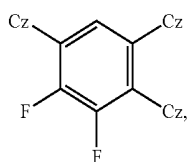
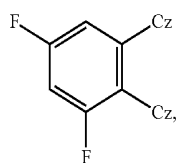
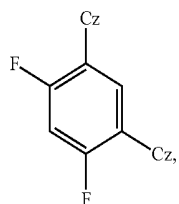
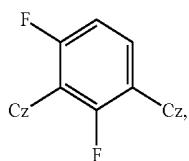
Compound 587

Compound 588

Compound 589

437

-continued



438

-continued

Compound 590

5

Compound 591

10

Compound 592

15

Compound 593

20

Compound 594

25

Compound 595

30

Compound 596

35

Compound 597

40

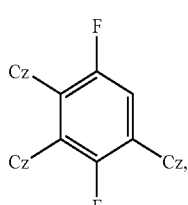
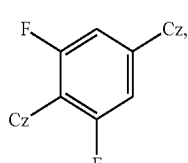
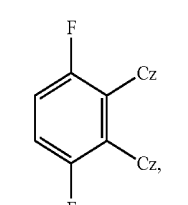
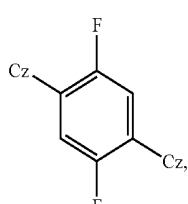
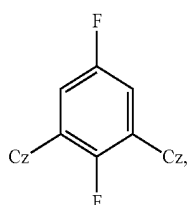
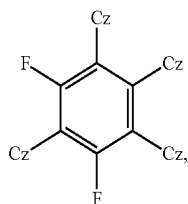
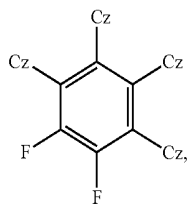
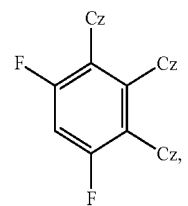
45

50

55

60

65



Compound 598

Compound 599

Compound 600

Compound 601

Compound 602

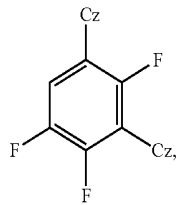
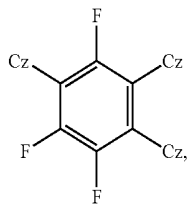
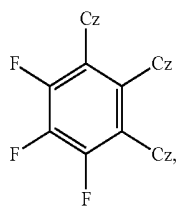
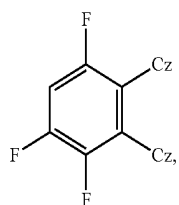
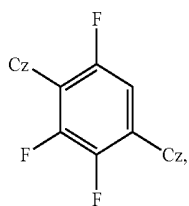
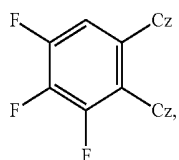
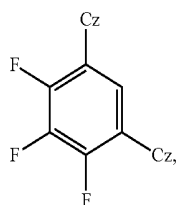
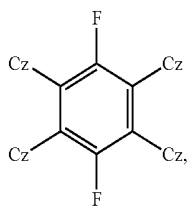
Compound 603

Compound 604

Compound 605

439

-continued

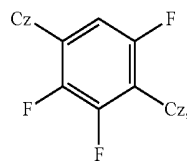


440

-continued

Compound 606

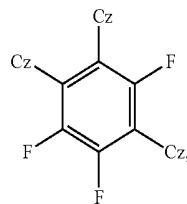
5



Compound 614

Compound 607

10

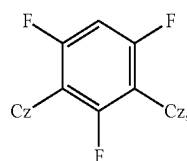


Compound 615

15

Compound 608

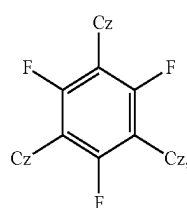
20



Compound 616

Compound 609

25

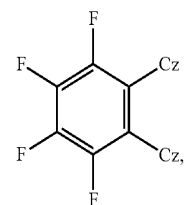


Compound 617

30

Compound 610

35

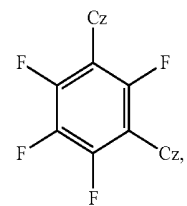


Compound 618

40

Compound 611

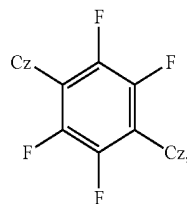
45



Compound 619

Compound 612

50

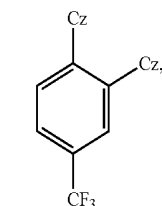


Compound 620

55

Compound 613

60

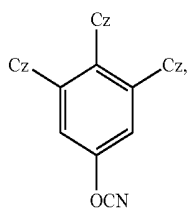
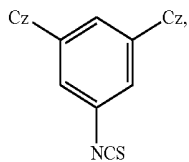
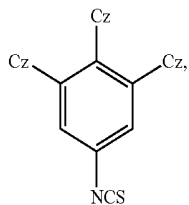
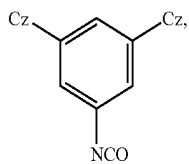
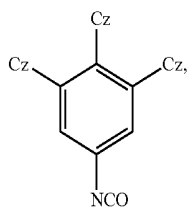
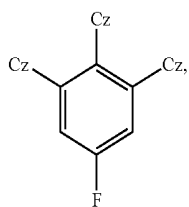
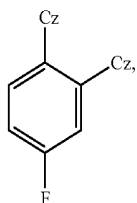
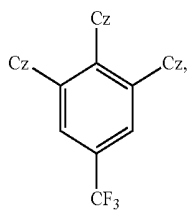


Compound 621

65

441

-continued

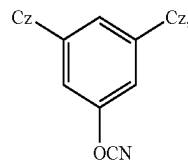


442

-continued

Compound 622

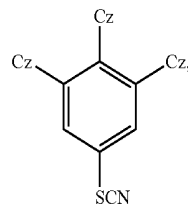
5



Compound 630

Compound 623

10

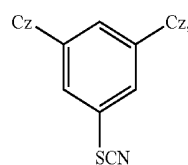


Compound 631

15

Compound 624

20

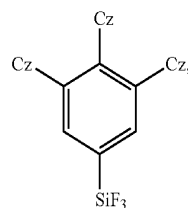


Compound 632

25

Compound 625

30

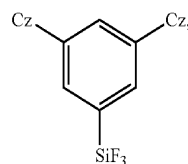


Compound 633

35

Compound 626

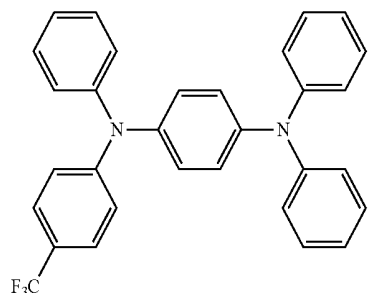
40



Compound 634

Compound 627

45



Compound 635

50

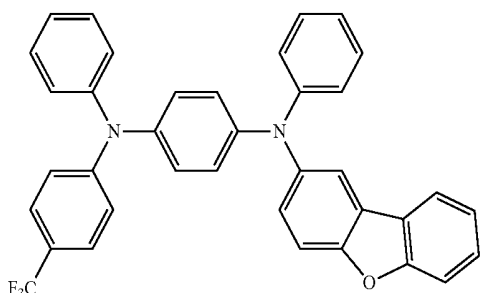
Compound 628

55

Compound 636

Compound 629

60

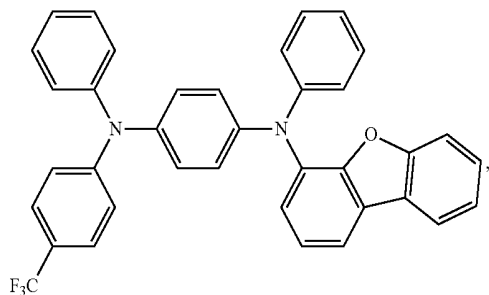


65

443

-continued

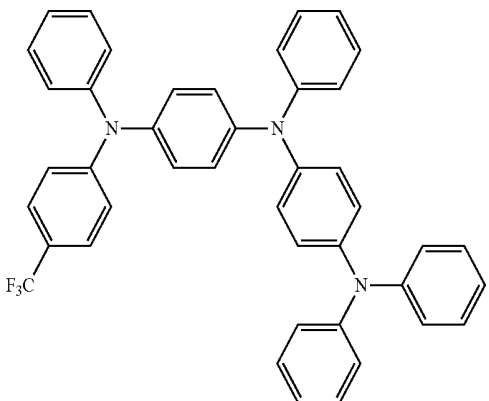
Compound 637



5

10

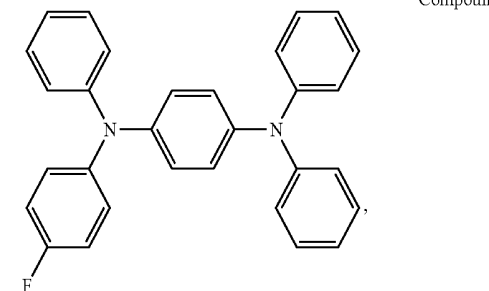
Compound 638



15

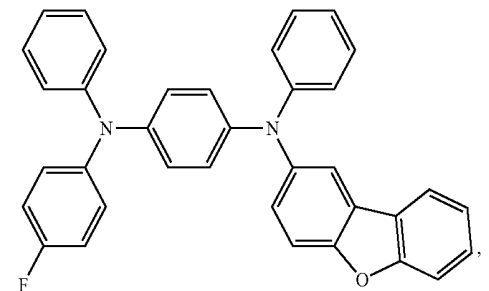
20

Compound 639



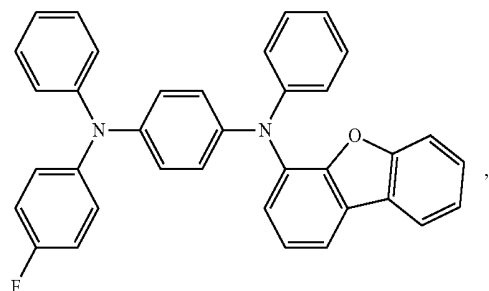
35

Compound 640



50

Compound 641



55

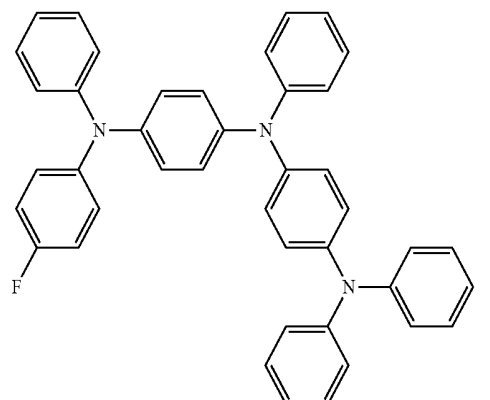
60

65

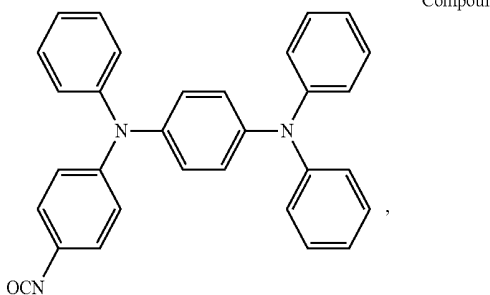
444

-continued

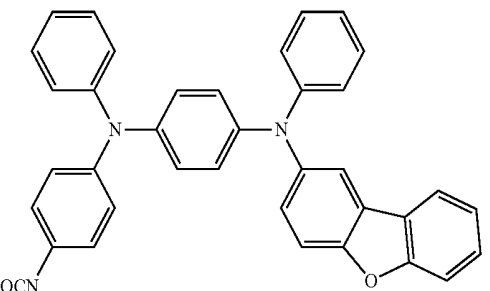
Compound 642



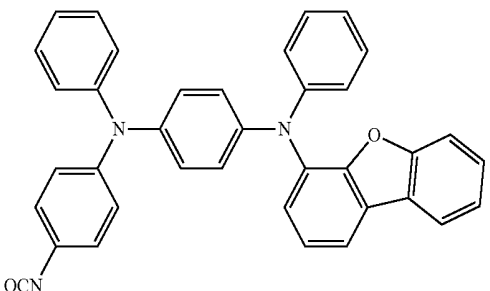
Compound 643



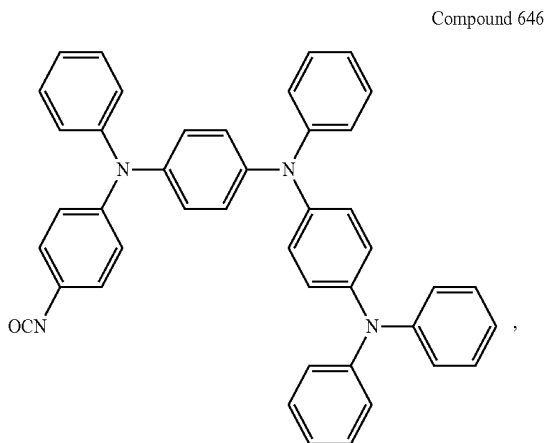
Compound 644



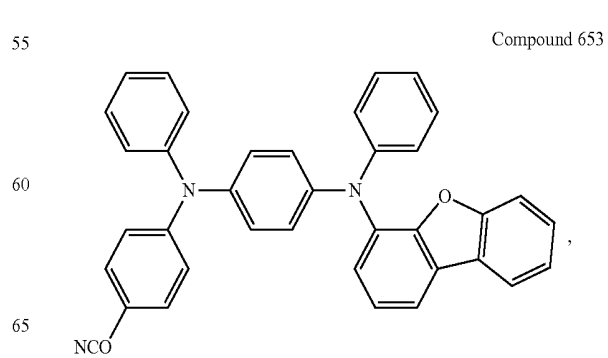
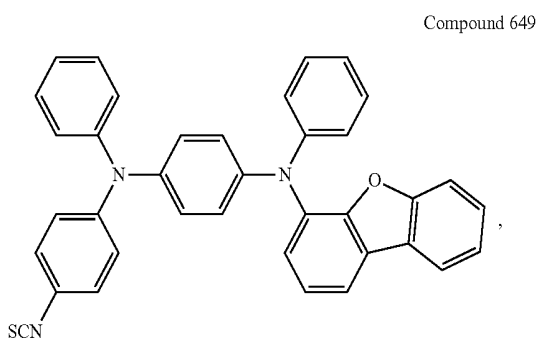
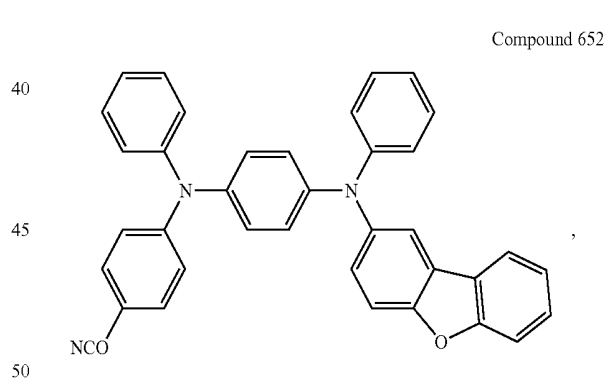
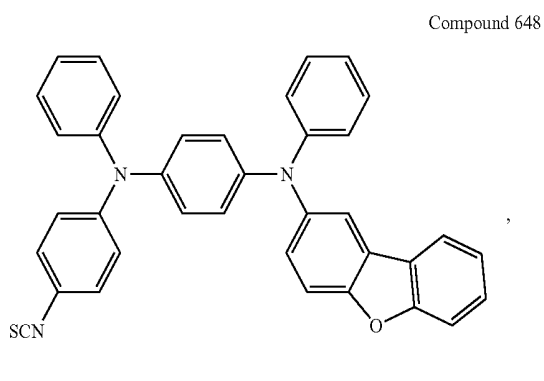
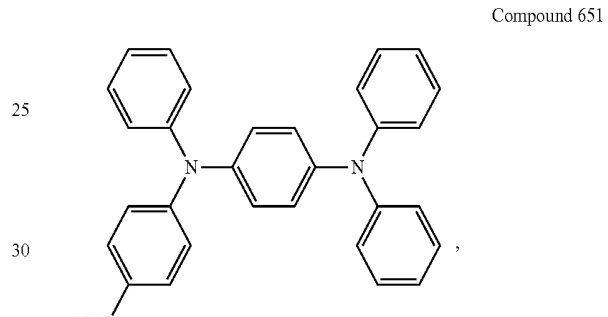
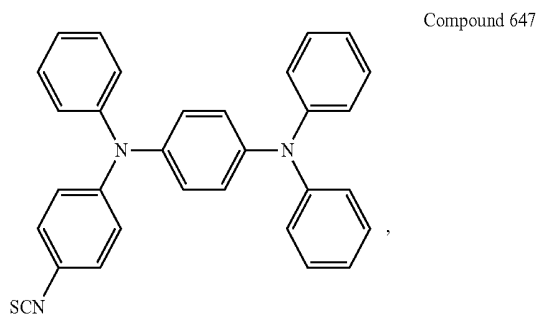
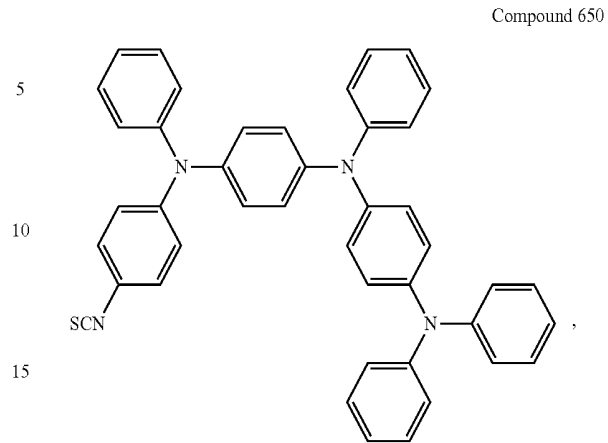
Compound 645



**445**  
-continued

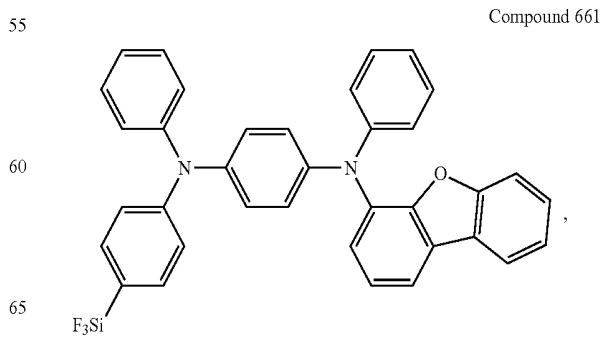
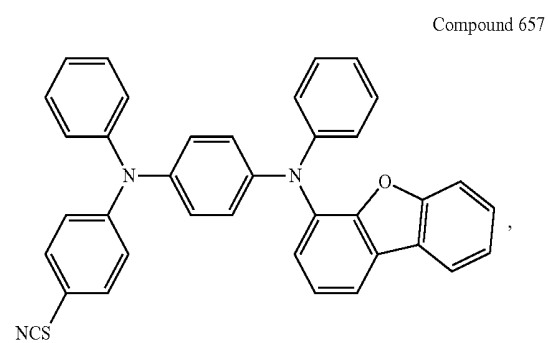
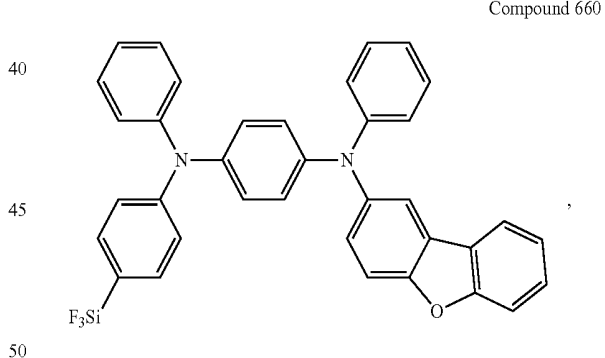
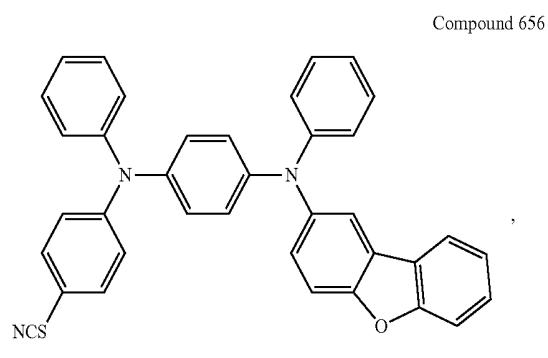
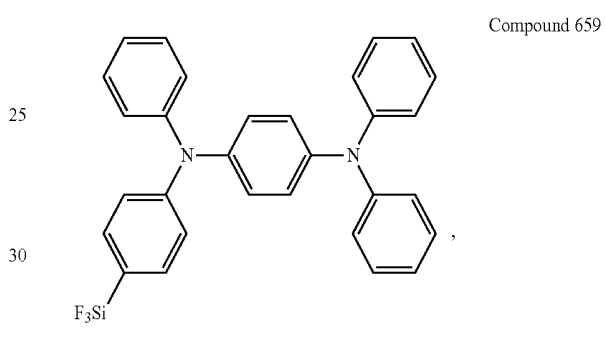
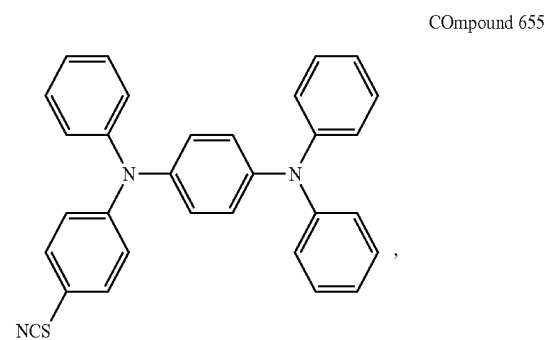
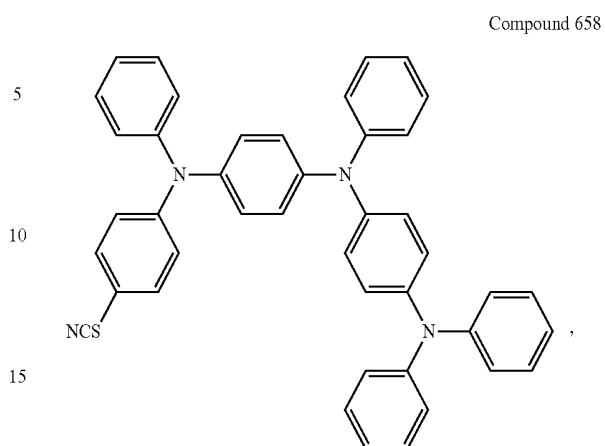
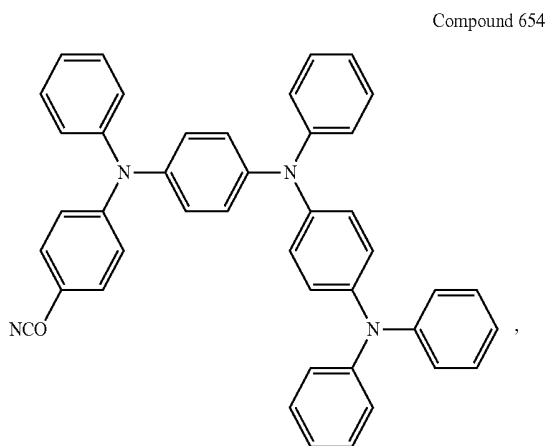


**446**  
-continued



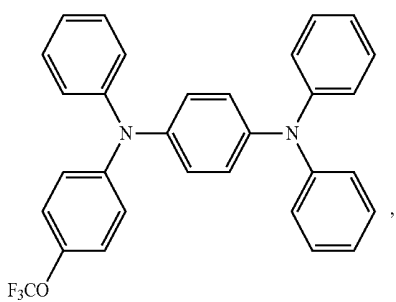
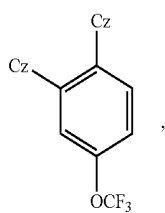
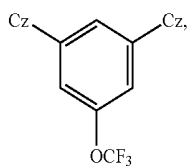
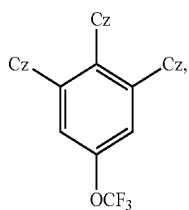
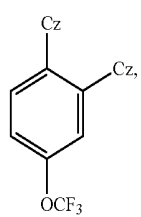
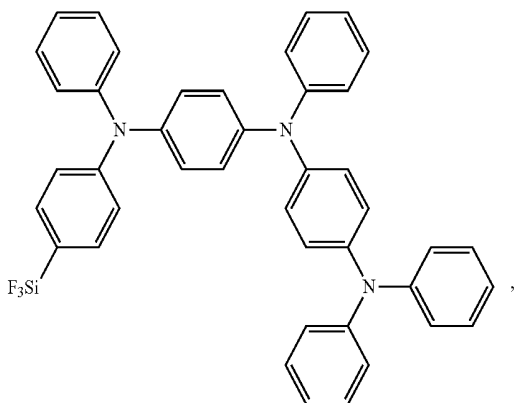
**447**  
-continued

**448**  
-continued



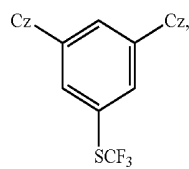
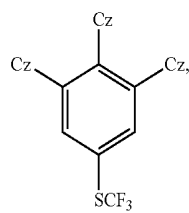
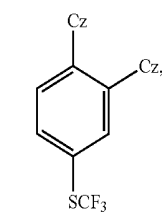
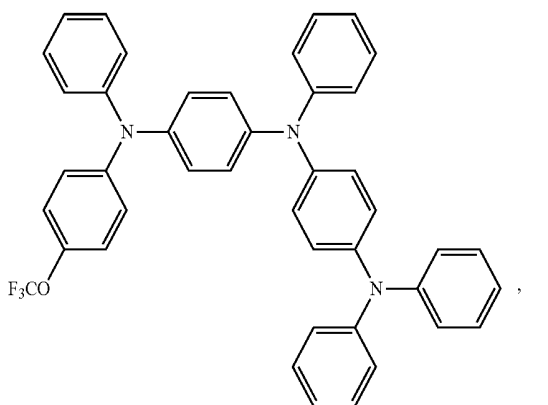
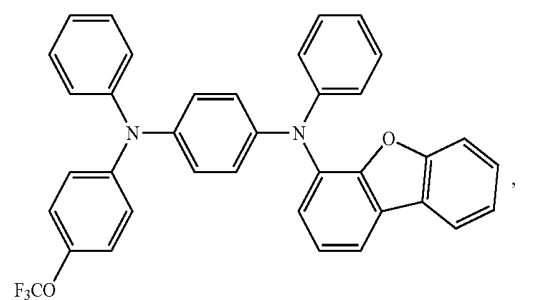
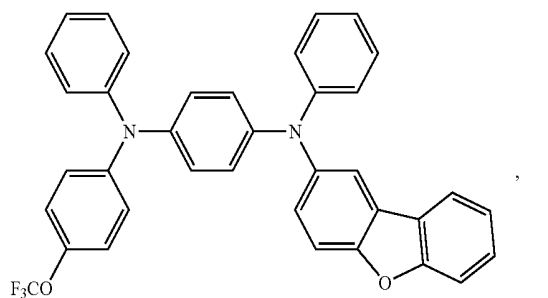
449

-continued

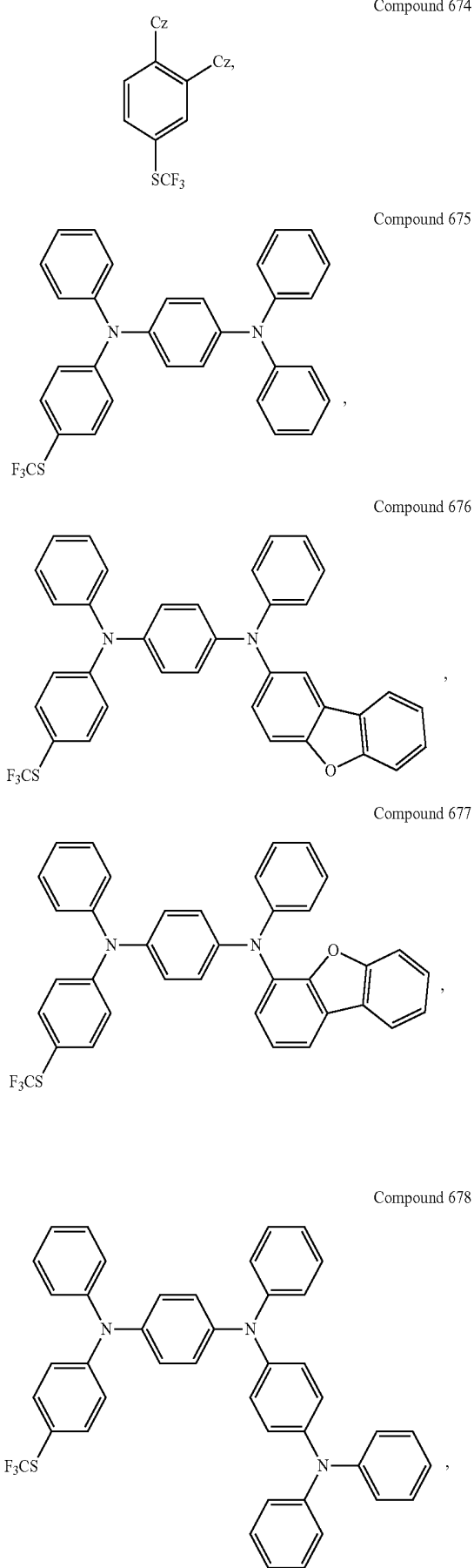


450

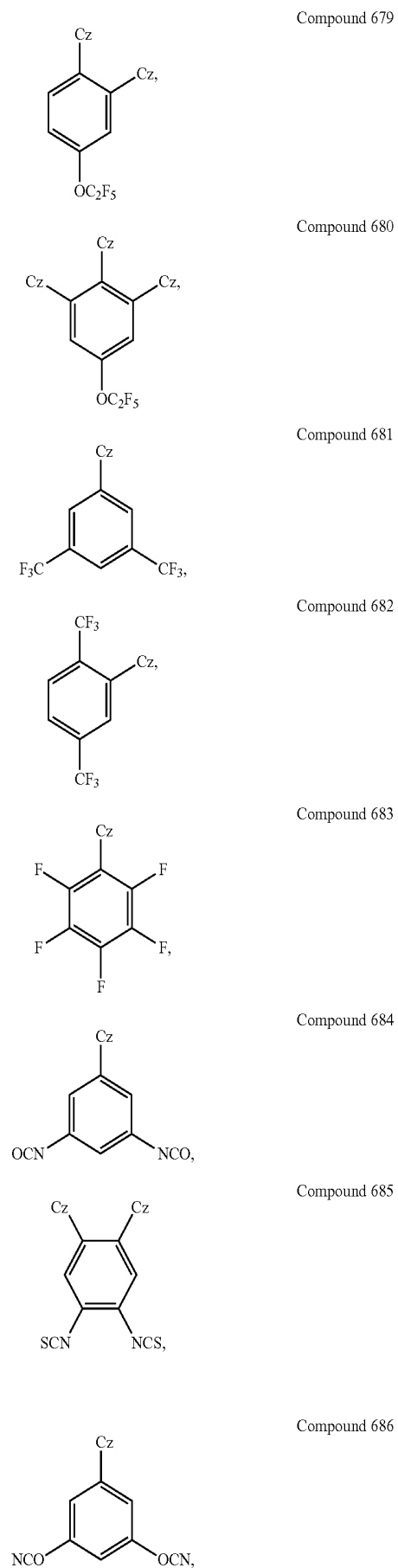
-continued



**451**  
-continued

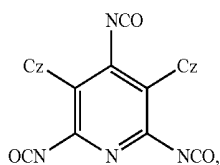
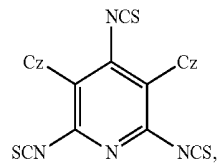
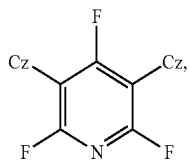
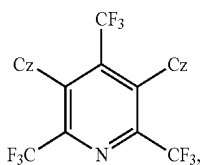
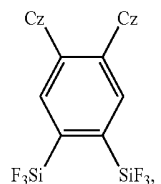
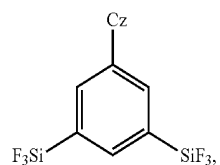
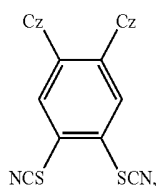
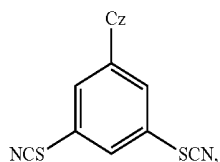
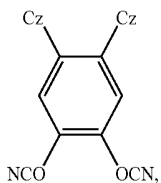


**452**  
-continued



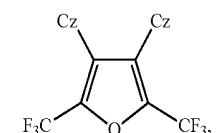
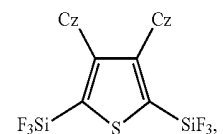
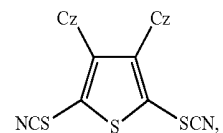
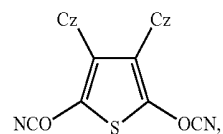
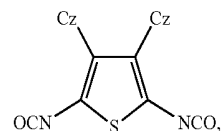
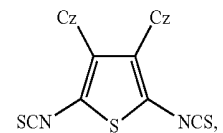
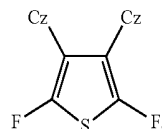
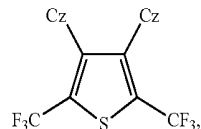
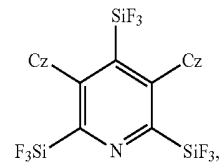
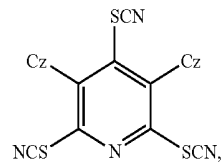
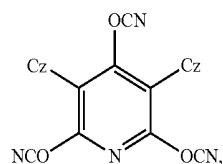
453

-continued



454

-continued



Compound 687

5

Compound 688 10

15

Compound 689

20

Compound 690 25

30

Compound 691

35

Compound 692 40

45

Compound 693

50

Compound 694

55

Compound 695 60

65

Compound 696

Compound 697

Compound 698

Compound 699

Compound 700

Compound 701

Compound 702

Compound 703

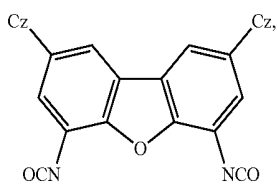
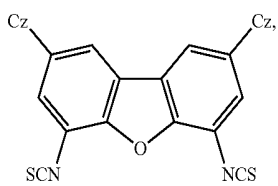
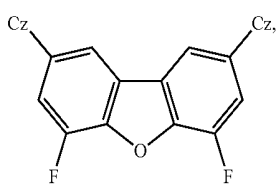
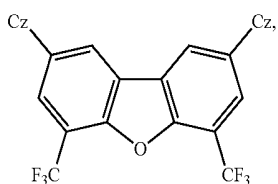
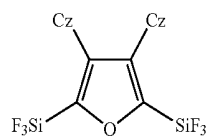
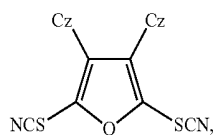
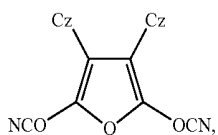
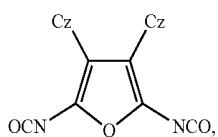
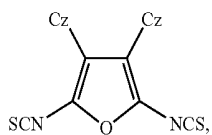
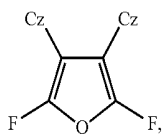
Compound 704

Compound 705

Compound 706

455

-continued

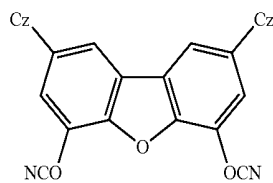


456

-continued

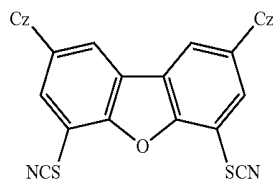
Compound 707

5



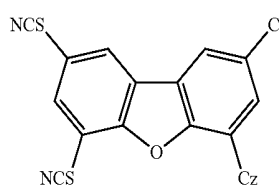
Compound 708

10



Compound 709

15

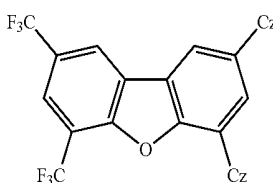


Compound 710

20

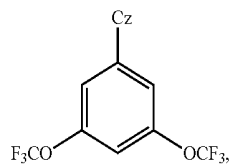
Compound 711

25



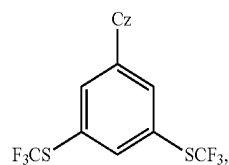
Compound 712

35



Compound 713

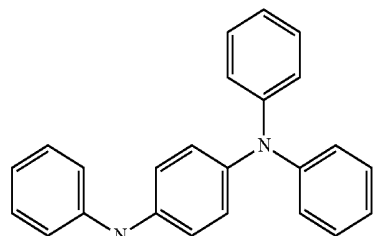
40



Compound 714

45

50

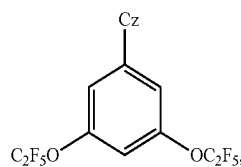


Compound 715

55

Compound 716

65



Compound 717

Compound 718

Compound 719

Compound 720

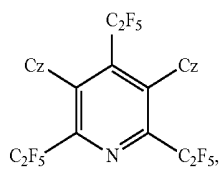
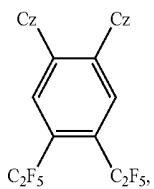
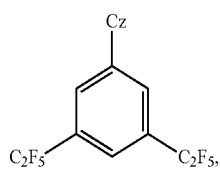
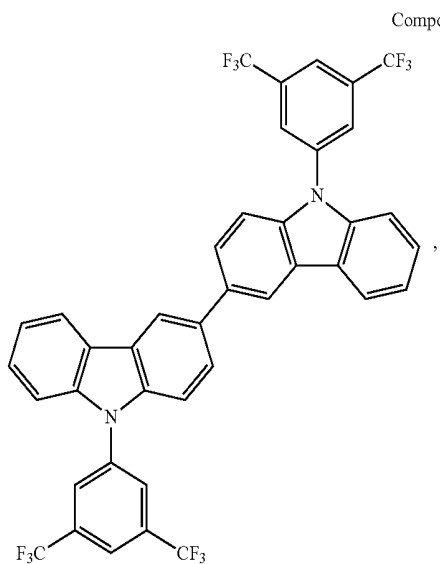
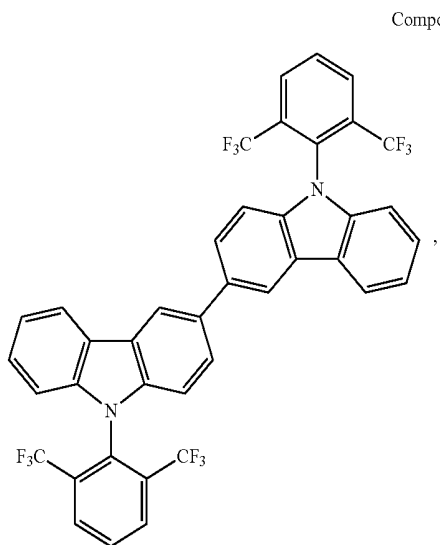
Compound 721

Compound 722

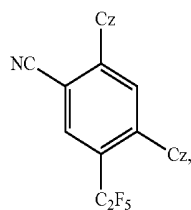
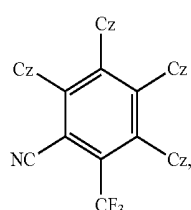
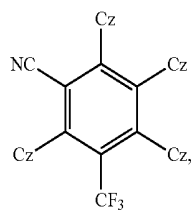
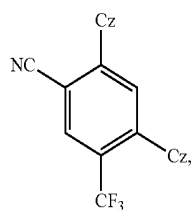
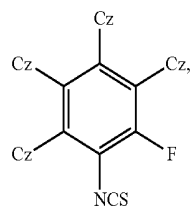
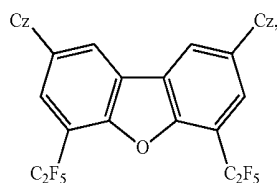
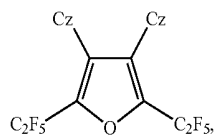
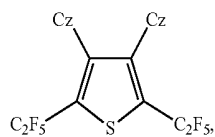
Compound 723

Compound 724

**457**  
-continued

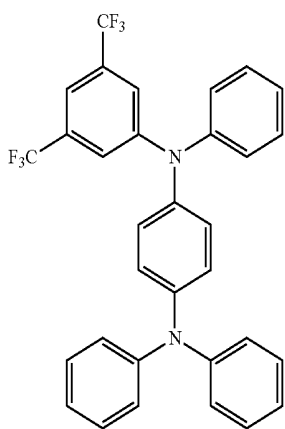
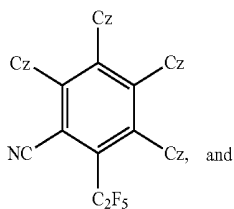
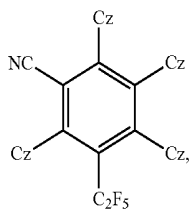


**458**  
-continued

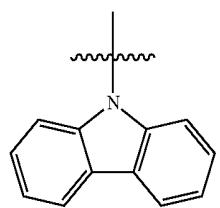


459

-continued

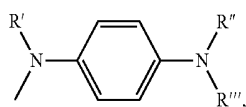


wherein Cz is



22. The first device of claim 14, wherein the compound comprises two structures according to Formula 2 bonded together.

23. A first device of claim 14, wherein at least one R group comprises the structure of Formula 3:



wherein R', R'', and R''' are independently aryl or heteroaryl.

24. The first device of claim 14, wherein the first device emits a luminescent radiation at room temperature when a voltage is applied across the organic light emitting device, and wherein the luminescent radiation comprises a delayed fluorescence process.

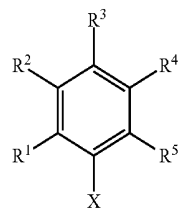
460

25. A formulation comprising a compound comprising a structure according to Formula 1:

Compound 741

5

Formula 1



Compound 742

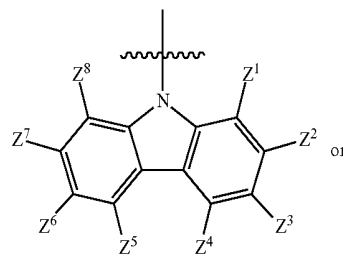
10

wherein R<sup>5</sup> is

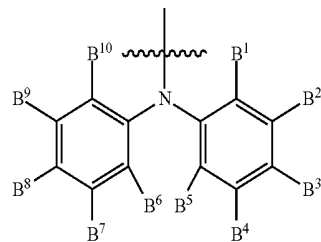
15

Compound 743

20



25



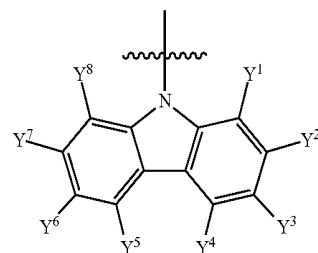
30

35

and

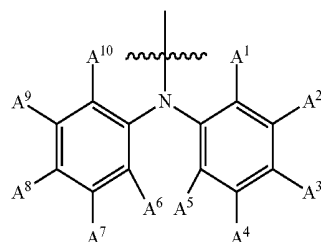
wherein (a) at least one of R<sup>1</sup>-R<sup>4</sup> is

40



45

50 or (b) R<sup>1</sup> is



55

60

wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, A<sup>1</sup>, A<sup>2</sup>, A<sup>3</sup>, A<sup>4</sup>, A<sup>5</sup>, A<sup>6</sup>, A<sup>7</sup>, A<sup>8</sup>, A<sup>9</sup>, A<sup>10</sup>, B<sup>1</sup>, B<sup>2</sup>, B<sup>3</sup>, B<sup>4</sup>, B<sup>5</sup>, B<sup>6</sup>, B<sup>7</sup>, B<sup>8</sup>, B<sup>9</sup>, B<sup>10</sup>, Y<sup>1</sup>, Y<sup>2</sup>, Y<sup>3</sup>, Y<sup>4</sup>, Y<sup>5</sup>, Y<sup>6</sup>, Y<sup>7</sup>, Y<sup>8</sup>, Z<sup>1</sup>, Z<sup>2</sup>, Z<sup>3</sup>, Z<sup>4</sup>, Z<sup>5</sup>, Z<sup>6</sup>, Z<sup>7</sup>, and Z<sup>8</sup>, are each independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, haloalkyl,

461

462

cycloalkyl, heteroalkyl, arylalkyl, alkoxy, thioalkoxy, aryoxy, thioaryloxy, amino, acylamino, diarylamino, carbazolyl, silyl, halosilyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfonyl, sulfinyl, sulfonyl, phosphino,  $-\text{C}_m\text{F}_{2m+1}$ ,  $-\text{Si}_m\text{F}_{2m+1}$ ,  $-\text{NCO}$ ,  $-\text{NCS}$ ,  $-\text{OCN}$ ,  $-\text{SCN}$ ,  $-\text{OC}_m\text{F}_{2m+1}$ ,  $-\text{SC}_m\text{F}_{2m+1}$ , and combinations thereof; 5  
 wherein  $m \geq 1$ ;  
 wherein adjacent A, B, Y, and Z groups are, optionally, 10  
 joined to form a fused ring structure; and  
 wherein X comprises an acceptor group selected from the group consisting of  $-\text{C}_m\text{F}_{2m+1}$ ,  $-\text{Si}_m\text{F}_{2m+1}$ ,  $-\text{NCO}$ ,  $-\text{NCS}$ ,  $-\text{OCN}$ ,  $-\text{SCN}$ ,  $-\text{OC}_m\text{F}_{2m+1}$ , and  $-\text{SC}_m\text{F}_{2m+1}$ . 15

\* \* \* \* \*

