



US010026907B2

(12) United States Patent
Kato et al.**(10) Patent No.: US 10,026,907 B2****(45) Date of Patent: *Jul. 17, 2018****(54) MATERIAL FOR ORGANIC ELECTROLUMINESCENCE DEVICE AND ORGANIC ELECTROLUMINESCENCE DEVICE USING THE SAME****(71) Applicant: IDEMITSU KOSAN CO., LTD.,**
Chiyoda-ku (JP)**(72) Inventors: Tomoki Kato,** Sodegaura (JP); **Masaki Numata,** Sodegaura (JP); **Kazuki Nishimura,** Sodegaura (JP); **Toshihiro Iwakuma,** Sodegaura (JP); **Chishio Hosokawa,** Sodegaura (JP)**(73) Assignee: IDEMITSU KOSAN CO., LTD.,**
Chiyoda-ku (JP)**(*) Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: 15/785,749**(22) Filed: Oct. 17, 2017****(65) Prior Publication Data**

US 2018/0040835 A1 Feb. 8, 2018

Related U.S. Application Data**(63)** Continuation of application No. 15/379,130, filed on Dec. 14, 2016, now Pat. No. 9,847,493, which is a continuation of application No. 14/987,249, filed on Jan. 4, 2016, now Pat. No. 9,660,203, which is a continuation of application No. 14/634,069, filed on Feb. 27, 2015, which is a continuation of application No. 13/173,486, filed on Jun. 30, 2011, now Pat. No. 9,056,870, which is a continuation of application No. 12/253,586, filed on Oct. 17, 2008, now Pat. No. 8,049,411.**(30) Foreign Application Priority Data**

Jun. 5, 2008 (JP) 2008-148514

(51) Int. Cl.**H01L 51/00** (2006.01)
C07D 495/04 (2006.01)
C07D 307/91 (2006.01)
C07D 493/04 (2006.01)
C07D 487/04 (2006.01)
C09K 11/06 (2006.01)
C09K 11/02 (2006.01)
H01L 51/50 (2006.01)**(52) U.S. Cl.**CPC **H01L 51/0073** (2013.01); **C07D 307/91** (2013.01); **C07D 487/04** (2013.01); **C07D 493/04** (2013.01); **C07D 495/04** (2013.01); **C09K 11/025** (2013.01); **C09K 11/06** (2013.01); **H01L 51/0055** (2013.01); **H01L 51/0067** (2013.01); **H01L 51/0072** (2013.01);**H01L 51/0074** (2013.01); **H01L 51/0085**(2013.01); **C09K 2211/1007** (2013.01); **C09K****2211/1029** (2013.01); **C09K 2211/185**(2013.01); **H01L 51/5016** (2013.01)**(58) Field of Classification Search**

None

See application file for complete search history.

(56)**References Cited**

U.S. PATENT DOCUMENTS

5,843,607 A 12/1998 Hu et al.
5,942,340 A 8/1999 Hu et al.
5,952,115 A 9/1999 Hu et al.
6,479,172 B2 11/2002 Hu et al.
6,562,485 B2 5/2003 Hu et al.
8,138,355 B2 3/2012 Watanabe
8,372,529 B2 2/2013 Kato et al.
8,748,010 B2 6/2014 Heil et al.
9,056,870 B2 * 6/2015 Kato C07D 487/04
9,660,203 B2 * 5/2017 Kato H01L 51/0073
9,847,493 B2 * 12/2017 Kato H01L 51/0073
2005/0040757 A1 2/2005 Chen et al.
2005/0112406 A1 5/2005 Han et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 906 947 A1 4/1999
EP 0909787 4/1999

(Continued)

OTHER PUBLICATIONS

Non-Final Office Action dated Nov. 17, 2016 issued in U.S. Appl. No. 14/987,249.

Japanese Office Action issued in connection with corresponding Japanese Patent Application No. 2015-025867, filed Feb. 12, 2015. Observation of a third party against EP-A-2301926 issued Apr. 14, 2016 in connection with European Patent Application No. 09758282.9, filed Jun. 1, 2009.

K-T. Wong, et al. "Synthesis and Structures of Novel Heteroarene-Fused Coplanar π -Conjugated Chromophores", Organic Letters 2006 8(22), pp. 5033-5036.

Petition for Inter Partes review of U.S. Pat. No. 9,056,870 filed on Nov. 2, 2016.

Petition for Inter Partes Review of U.S. Pat. No. 9,056,870 filed Nov. 4, 2015.

Excerpts from Prosecution File History of the '870 patent.

Declaration of Benjamin J. Schwartz, Ph.D.

(Continued)

Primary Examiner — J. Yang

(74) Attorney, Agent, or Firm — Oblon, McClelland, Maier & Neustadt, L.L.P.**(57)****ABSTRACT**

Provided are an organic electroluminescence device, which shows high luminous efficiency, is free of any pixel defect, and has a long lifetime, and a material for an organic electroluminescence device for realizing the device. The material for an organic electroluminescence device is a compound having a n-conjugated heteroacene skeleton crosslinked with a carbon atom, nitrogen atom, oxygen atom, or sulfur atom. The organic electroluminescence device has one or more organic thin film layers including a light emitting layer between a cathode and an anode, and at least one layer of the organic thin film layers contains the material for an organic electroluminescence device.

18 Claims, No Drawings

(56)

References Cited

U.S. PATENT DOCUMENTS

2005/0127823	A1	6/2005	Iwakuma et al.
2006/0051612	A1	3/2006	Ikeda et al.
2006/0214155	A1	9/2006	Ong et al.
2007/0112172	A1	5/2007	Li et al.
2007/0120466	A1	5/2007	Arakane et al.
2007/0237982	A1	10/2007	Inoue et al.
2007/0252139	A1	11/2007	McKiernan et al.
2008/0145708	A1	6/2008	Heil et al.
2008/0193797	A1	8/2008	Heil
2008/0220285	A1	9/2008	Vestweber et al.
2008/0284322	A1	11/2008	Hosokawa et al.
2009/0066225	A1	3/2009	Kimura et al.
2009/0096356	A1	4/2009	Murase et al.
2009/0184313	A1	7/2009	Buesing et al.
2009/0253883	A1	10/2009	McKiernan et al.
2009/0261717	A1	10/2009	Buesing et al.
2009/0295276	A1	12/2009	Asari et al.
2009/0302742	A1	12/2009	Komori et al.
2009/0302743	A1	12/2009	Kato et al.
2010/0148161	A1	6/2010	Kai et al.
2010/0148162	A1	6/2010	Komori et al.
2010/0187520	A1	7/2010	Sugimoto et al.
2010/0187977	A1	7/2010	Kai et al.
2011/0037027	A1	2/2011	Stoessel et al.
2011/0062429	A1	3/2011	Kai et al.
2011/0065895	A1	3/2011	Miura et al.
2012/0104943	A1	5/2012	Kato et al.
2012/0112629	A1	5/2012	Kato et al.
2013/0020563	A1	1/2013	Kato et al.
2013/0153874	A1	6/2013	Kato et al.

FOREIGN PATENT DOCUMENTS

EP	1 672 713	A1	6/2006
EP	1 860 097	A1	11/2007
EP	1 956 022	A1	8/2008
EP	1 956 666	A1	8/2008
EP	1 962 354		8/2008
EP	2 080 762	A1	7/2009
EP	2 166 011	A1	3/2010
EP	2 169 029	A1	3/2010
EP	2 172 534	A1	4/2010
EP	2 251 342	A1	11/2010
EP	2 284 920	A1	2/2011
EP	2 298 774	A1	3/2011
EP	2 301 921	A1	3/2011
JP	11-167215	A	6/1999
JP	11-176578	A	7/1999
JP	2004071500		3/2004
JP	2004-253298	A	9/2004
JP	2005-289914	A	10/2005
JP	2006-193729	A	7/2006
JP	2006-199679	A	8/2006
JP	2006-339577	A	12/2006
JP	2007-88222	A	4/2007
JP	2008-509266	A	3/2008
JP	2008-81494	A	4/2008
JP	2008-148514		6/2008
KR	10-2011-0058246		6/2011
KR	10-2011-0066766		6/2011
WO	WO 2005/023894	A2	3/2005
WO	WO 2005/023894	A3	3/2005
WO	2006/001333		1/2006
WO	WO 2006/015862	A1	2/2006
WO	WO 2006/100896	A1	9/2006
WO	WO 2006/108497	A1	10/2006
WO	2006/122630		11/2006
WO	WO 2006/122630		11/2006
WO	WO 2007/018007	A1	2/2007
WO	2007/022845		3/2007
WO	2007/029798		3/2007
WO	2007/063796		6/2007
WO	2007/069569		6/2007
WO	WO 2007/063754	A1	6/2007
WO	WO 2007/063796	A1	6/2007

WO	WO 2007/140847	A1	12/2007
WO	WO 2008/006449	A1	1/2008
WO	WO 2008/009343	A1	1/2008
WO	WO 2008/056746	A1	5/2008
WO	WO 2008/132103	A1	11/2008
WO	WO 2008/146839	A1	12/2008
WO	WO 2008/149691	A1	12/2008
WO	WO 2009/016964	A1	2/2009
WO	WO 2009/044615	A1	4/2009
WO	WO 2009/124627	A1	10/2009
WO	WO 2009/136595	A1	11/2009
WO	2010/107244		9/2010
WO	WO 2010/131855		11/2010

OTHER PUBLICATIONS

Curriculum Vitae of Benjamin J. Schwartz, Ph.D.

U.S. Appl. No. 12/253,586 ("The '586 parent application").

Transmittal Letter to U.S. Designated/Elected Office Concerning Submission Under 35 U.S.C. 371 for International Application PCT/EP2006/007386.

Kawaguchi et al., "Synthesis, Structures, and Properties of Asymmetrical Heteroacenes Containing Both Pyrrole and Furan Rings," Organic Letters 2008 vol. 10, No. 6, pp. 1199-1202 (Online published Feb. 16, 2008) ("Kawaguchi").

Transmittal Letter to U.S. Designated/Elected Office Concerning Submission Under 35 U.S.C. 371 for International Application PCT/JP2007/071728.

Transmittal Letter to U.S. Designated/Elected Office Concerning Submission Under 35 U.S.C. 371 for International Application PCT/EP2006/003670.

English Translation of PCT/EP2006/007386.

Machine English translation of Matsuura et al. (JP 2004-071500 A). Feb. 2, 2017.

International Search Report and Written Opinion dated Sep. 1, 2009 in corresponding International Application No. PCT/JP2009/059980 filed on Jun. 1, 2009.

Chuanjun Xia et al., "Ladder-Type Oligo(p-phenylene)s Tethered to a Poly(alkylene) Main Chain: The Orthogonal Approach to Functional Light-Emitting Polymers", Macromolecules, vol. 34, No. 20, 2001, pp. 6922-6928.

Josemon Jacob et al., "Ladder-Type Pentaphenylenes and Their Polymers: Efficient Blue-Light Emitters and Electron-Accepting Materials via a Common Intermediate", J. Am. Chem. Soc., vol. 126, No. 22, 2004, pp. 6987-6995.

Josemon Jacob et al., "A Fully Aryl-Substituted Poly(ladder-type pentaphenylene): A Remarkably Stable Blue-Light-Emitting Polymer", Macromolecules, vol. 38, No. 24, 2005, pp. 9933-9938.

Herbert Wiesenhöfer et al., "Molecular Origin of the Temperature-Dependent Energy Migration in a Rigid-Rod Ladder-Phenylene Molecular Host", Advanced Materials, vol. 18, 2006, pp. 310-314.

Ashok K. Mishra et al., "Blue-Emitting Carbon-and Nitrogen-Bridged Poly(ladder-type tetraphenylene)s", Chem. Mater., vol. 18, No. 12, 2006, pp. 2879-2885.

Frédéric Laquai et al., "Photophysical Properties of a Series of Poly(ladder-type phenylene)s", Advanced Functional Materials, vol. 17, 2007, pp. 3231-3240.

Henning Sirringhaus et al., "Dibenzothienobisbenzothiophene—A Novel Fused-Ring Oligomer with High Field-Effect Mobility", J. Mater. Chem., vol. 9, 1999, pp. 2095-2101.

Martin Sonntag et al., "Synthesis and Characterization of Novel Conjugated Bisindenocarbazoles", Tetrahedron, vol. 62, 2006, pp. 8103-8108.

Martin Sonntag et al., "Novel Bisindenocarbazole Derivative Exhibiting a Nematic Mesophase", Tetrahedron Letters, vol. 47, 2006, pp. 8313-8317.

Toby D. M. Bell et al., "Charge Transfer Enhanced Annihilation Leading to Deterministic Single Photon Emission in Rigid Perylene End-Capped Polyphenylenes", Chem. Commun., No. 39, 2005, pp. 4973-4975.

Ming Zhang et al., "Conjugated Alternating Copolymers Containing Both Donor and Acceptor Moieties in the Main Chain", Chem. Commun., No. 17, 2007, pp. 1704-1706.

(56)

References Cited

OTHER PUBLICATIONS

- Martin Sonntag et al., "Synthesis of a Novel Liquid Crystalline Bisindenocarbazole Derivative", *Liquid Crystals*, vol. 34, No. 1, Jan. 2007, pp. 49-57.
- Eduard Fron et al., "Singlet-Singlet Annihilation Leading to a Charge-Transfer Intermediate in Chromophore-End-Capped Pentaphenylenes", *Chem. Phys. Chem.*, vol. 8, 2007, 1386-1393.
- M. Angeles Izquierdo et al., "Switching of the Fluorescence Emission of Single Molecules Between the Locally Excited and Charge Transfer States", *Chemical Physics Letters*, vol. 401, 2005, pp. 503-508.
- Wen-Ya Lee et al., "Synthesis of New Fluorene-Indolocarbazole Alternating Copolymers for Light-Emitting Diodes and Field Effect Transistors", *Polymer Journal*, vol. 40, No. 3, 2008, pp. 249-255.
- John P. Amara et al., "Conjugated Polymers with Geminal Trifluoromethyl Substituents Derived from Hexafluoroacetone", *Macromolecules*, vol. 39, 2006, pp. 5753-5759.
- Nan-Xing Hu et al., "5,11-Dihydro-5,11-di-1-naphthylindolo[3,2-b]carbazole: Atropisomerism in a Novel Hole-Transport Molecule for Organic Light-Emitting Diodes", *J. Am. Chem. Soc.*, vol. 121, No. 21, 1999, pp. 5097-5098.
- Extended European Search Report dated Dec. 6, 2011, in Patent Application No. 09758282.9.
- Yuncheol Na, et al., "Formation of Pyro-products by the Pyrolysis of Monobromophenols", *Bulletin Korean Chemical Society*, vol. 24, No. 9, XP 2664291, 2003, pp. 1276-1280.
- Holger Erdtman, et al., "Studies on Humic Acids", *Acta Chemica Scandinavica*, vol. 13, No. 4, XP 2664292, 1959, pp. 653-658.
- Masaki Shimizu, et al., "Palladium-Catalyzed Annulation of vic-Bis(pinacolatoboryl)alkenes and -phenanthrenes with 2,2'-Dibromobiaryls: Facile Synthesis of Functionalized Phenanthrenes and Dibenzofluorenes", *Angewandte Chemie, International Edition*, vol. 47, No. 42, XP 2664293, 2008, pp. 8096-8099.
- Teruhisa Tsuchimoto, et al., "Indium-Catalyzed Annulation of 2-Aryl- and 2-Heteroarylindoles with Propargyl Ethers: Concise Synthesis and Photophysical Properties of Diverse Aryl- and Heteroaryl-Annulated[*a*]carbazoles", *Journal of American Chemical Society*, vol. 130, XP 2664294, 2008, pp. 15823-15835.
- Korean Office Action dated May 12, 2014, in Korea Patent Application No. 10-2010-7027215.
- Teruhisa Tsuchimoto, et al., "Easy Access to Aryl-and Heteroaryl-Annulated[*a*]carbazoles by the Indium-Catalyzed Reaction of 2-Arylindoles with Propargyl Ethers", *Angew. Chem Int. Ed.* 2005, vol. 44, (Jan. 21, 2005), pp. 1336-1340.
- Office Action dated Jul. 15, 2014 in Japanese Patent Application No. 2013-178412.
- Li et al., "Novel Starburst Molecule as a Hole Injecting and Transporting Material for Organic Light-Emitting Devices" *Chem. of Materials* 17, 615-619 (2005).
- Taft et al., "A Survey of Hammett Substituent Constants and Resonance and Field Parameters," 91 *Chem. Rev.* 165-195 (1991).
- Guisado et al., "The Facile Preparation of Primary and Secondary Amines via an Improved Fukuyama-Mitsunobu Procedure. Application to the Synthesis of a Lung-Targeted Gene Delivery Agent" 3 *Organic and Biomolecular Chem.*, 3 1049-1057 (2005).
- Curriculum Vitae of John E. Anthony, Ph.D.
- Patent Owner Preliminary Response submitted in IPR 2016-00148.
- PTAB Decision to Institute Trial submitted in IPR2016-00148.
- Patent Owner Response submitted in IPR2016-00148.
- Petitioner's Reply submitted in IPR2016-00148.
- Petition for Inter Partes review (IPR2017-00197) of U.S. Pat. No. 9,056,870 filed on Nov. 2, 2016.
- Deposition of John Anthony, Ph. D. Alexandria, VA (Sep. 29, 2016), including Errata Sheet.
- Anthony, Functionalized Acenes and Heteroacenes for Organic Electronics, *Chem. Rev.* 2006, 108,p. 5028.
- Declaration of Benjamin J. Schwartz Ph. D. in Support of Petitioner's Reply.
- Moorthy et al., *Steric Inhibition of π -Stacking: 1,3,6,8-Tetraarylpyrenes as Efficient Blue Emitters in Organic Light Emitting Diodes (OLEDs)*, 9 *Organic Letters* (25) 5215-5218 (2007).
- Park et al., *High mobility solution processed 6,13-bis(triisopropylsilyl)ethynyl pentacene organic thin film transistors*, 91 *Applied Physics Letters*, 063514-01-03 (2007).
- Wolak et al., *Photophysical Properties of Dioxolane-Substituted Pentacene Derivatives Dispersed in Tris(quinolin-8-olato)aluminum(III)*, 110 *J. Phys. Chem. B.*, 7928-37 (2006).
- Shih et al., *A Novel Fluorene-Triphenylamine Hybrid That is a Highly Efficient Host Material for Blue-, Green-, and Red-Light-Emitting Electrophosphorescent Devices*, 17 *Advanced Functional Materials*, 3514-3520 (2007).
- Deposition of Benjamin J. Schwartz, Ph. D. Los Angeles, CA (Jun. 28, 2016), including Errata Sheet.
- Declaration of John E. Anthony, Ph.D.
- Garnier et al., "Molecular Engineering of Organic Semiconductors: Design of Self-Assembly Properties in Conjugated Thiophene Oligomers" 115 *J. Am. Chem. Soc'y.*, 8716-8721 (1993).
- Wang et al., "Graphene-Assisted Solution Growth of Vertically Oriented Organic Semiconducting Single Crystals" 9 *ACS Nano* 9486-9496 (2015).
- Murphy et al., "Organic Semiconducting Oligomers for Use in Thin Film Transistors" 107 *Chem. Rev.*, 1066-1096 (2007).
- Vehoff et al., "Charge Transport in Organic Crystals: Role of Disorder and Topological Connectivity" 132 *J. Am. Chem. Soc'y.*, 11702-11708 (2010).
- Meng et al., "High Field-Effect Mobility Oligofluorene Derivatives with High Environmental Stability" 123 *J. Am. Chem. Soc'y.*, 9214-9215 (2001).
- May et al., "Design rules for charge-transport efficient host materials for phosphorescent organic light-emitting diodes" 134 *J. Am. Chem. Soc'y.* 13818-13822 (2012).
- Li et al., "Maximizing Alq₃ OLED Internal and External Efficiencies: Charge Balanced Device Structure and Color Conversion Outcoupling Lenses" 2 *J. Display Tech.*, 143-152 (2006).
- Yang et al., "Porous Shape Persistent Fluorescent Polymer Films: An Approach to TNT Sensory Materials" 120 *J. Am. Chem. Soc'y.*, 5321-5322 (1998).
- Landis et al., "Silylethynylated Anthracene Derivatives for Use in Organic Light-Emitting Diodes" 44 *Japanese J. of Applied Physics*, 3921-3922 (2005).
- Picciolo et al., "RGB Emission Using a Dimesitylboryl-bithiophene as a Universal Host and Pentacene Derivatives as the Red Emitters" *Proceedings of the SPIE—The Int'l Soc'y for Optical Engineering*, 4464 (2002).
- Wolak et al., "High Performance Organic Light-Emitting Diodes Based on Dioxolane-Substituted Pentacene Derivatives" 16 *Advanced Functional Materials*, 1943-1947 (2006).
- Sapochak et al., "Inductive Effects of Diphenylphosphoryl Moieties on Carbazole Host Materials: Design Rules for Blue Electrophosphorescent Organic Light-Emitting Devices" *J. of Physical Chem. C* 112, 7989-7996 (2008).
- David St. C. Black et al.; "Modified Vilsmeier Reactions of Activated Benzofurans with Indolines: Synthesis of Benzofuran-fused Benzocarbazoles"; *Tetrahedron Letters* 40, pp. 4251-4254, 1999.
- Oct. 13, 2014 letter from Mr. Hyejin Kang.
- Oct. 22, 2014 letter from Mr. Hyejin Kang.
- Japanese Office Action dated Apr. 23, 2013 in connection with Japanese Patent Application No. 2010-515858.

* cited by examiner

MATERIAL FOR ORGANIC ELECTROLUMINESCENCE DEVICE AND ORGANIC ELECTROLUMINESCENCE DEVICE USING THE SAME

TECHNICAL FIELD

The present invention relates to a material for an organic electroluminescence device and an organic electroluminescence device using the material, in particular, an organic electroluminescence device, which shows high luminous efficiency, is free of any pixel defect, and has a long lifetime, and a material for an organic electroluminescence device for realizing the device.

BACKGROUND ART

An organic electroluminescence device (hereinafter, "electroluminescence" may be abbreviated as "EL") is a spontaneous light emitting device which utilizes the principle that a fluorescent substance emits light by energy of recombination of holes injected from an anode and electrons injected from a cathode when an electric field is applied. Since an organic EL device of the laminate type driven under a low electric voltage was reported, many studies have been conducted on organic EL devices using organic materials as the constituent materials. The devices of the laminate type use tris(8-quinolinolato) aluminum for a light emitting layer and a triphenyldiamine derivative for a hole transporting layer. Advantages of the laminate structure are that the efficiency of hole injection into the light emitting layer can be increased, that the efficiency of forming exciton which are formed by blocking and recombining electrons injected from the cathode can be increased, and that exciton formed within the light emitting layer can be enclosed. As described above, for the structure of the organic EL device, a two-layered structure having a hole transporting (injecting) layer and an electron transporting light emitting layer and a three-layered structure having a hole transporting (injecting) layer, a light emitting layer, and an electron transporting (injecting) layer are well known. To increase the efficiency of recombination of injected holes and electrons in the devices of the laminate type, the structure of the device and the process for forming the device have been studied.

As the light emitting material of the organic EL device, chelate complexes such as tris(8-quinolinolato) aluminum complexes, coumarine derivatives, tetraphenylbutadiene derivatives, distyrylarylene derivatives, and oxadiazole derivatives are known. It is reported that light in the visible region ranging from blue light to red light can be obtained by using these light emitting materials, and development of a device exhibiting color images is expected.

In addition, it has been recently proposed that a phosphorescent material as well as a fluorescent material be utilized in the light emitting layer of an organic EL device. High luminous efficiency is achieved by utilizing the singlet and triplet states of an excited state of an organic phosphorescent material in the light emitting layer of an organic EL device. Upon recombination of an electron and a hole in an organic EL device, singlet excitons and triplet excitons may be produced at a ratio of 1:3 owing to a difference in spin multiplicity between the singlet and triplet excitons, so the use of a phosphorescent material may achieve luminous efficiency three to four times as high as that of a device using fluorescence alone.

Patent Documents 1 to 7 are exemplary inventions each describing such materials for an organic EL device.

Patent Document 1 describes a compound using, as a mother skeleton, a structure obtained by crosslinking a terphenylene skeleton with, for example, a carbon atom, nitrogen atom, or oxygen atom. The document, which mainly discloses data indicative of the potential of the compound to serve as a hole transporting material, describes that the compound is used as a host material for a phosphorescent material in a light emitting layer. However, the description is limited to a red phosphorescent device, and the luminous efficiency of the device is not high enough for the device to be put into practical use.

Patent Document 2 describes an indolocarbazole compound having a substituent on a nitrogen atom or on an aromatic ring. The document recommends that the compound be used as a hole transporting material, and describes that a thermally and morphologically stable, thin hole transporting layer can be prepared from the compound. However, the document does not describe data indicative of the usefulness of the compound as a host material or electron transporting material to be used together with a phosphorescent material.

Patent Document 3 describes indolocarbazole compounds each having a substituent on a nitrogen atom or on an aromatic ring. The document discloses data on a green light emitting device using any one of those compounds as a host material for a phosphorescent material in its light emitting layer. However, a high voltage must be applied to the device to drive the device, and the device shows low luminous efficiency, so the device cannot be sufficiently put into practical use.

Patent Document 4 describes indolocarbazole compounds each having a substituent. The document describes that each of the compounds functions as a host material for a phosphorescent material in a light emitting layer. However, each of those compounds is characterized in that the compound has a dimer or trimer structure through a linking group, and each of the compounds tends to have a large molecular weight. The document discloses data on a green phosphorescent device using any one of those compounds, but all the compounds used each have a large molecular weight of 800 or more. The efficiency with which a material having a large molecular weight is deposited in a vacuum is poor, and the material may decompose owing to heating for a long time period, so the material may be insufficient in terms of practical use.

Patent Documents 5 and 6 describe indenofluorene compounds each having a substituent on an aromatic ring, and describe that each of the compounds functions as a fluorescent material in a light emitting layer. However, none of the documents describes data indicative of the usefulness of each of the compounds as a host material or electron transporting material to be used together with a phosphorescent material.

Patent Document 7 describes compounds each using, as a mother skeleton, a structure obtained by crosslinking a terphenylene skeleton with a sulfur atom, boron atom, or phosphorus atom. The document describes that each of those compounds has excellent oxidation resistance, and allows the formation of an organic semiconductor active layer by an application method. However, the document does not describe data indicative of the usefulness of each of the compounds as a host material or electron transporting material to be used together with a fluorescent material or phosphorescent material.

Patent Document 1: WO 2006/122630

Patent Document 2: EP 0909787

Patent Document 3: WO 2007/063796

Patent Document 4: WO 2007/063754
 Patent Document 5: US 2002/0132134
 Patent Document 6: US 2003/0044646
 Patent Document 7: JP 2008-81494

DISCLOSURE OF THE INVENTION

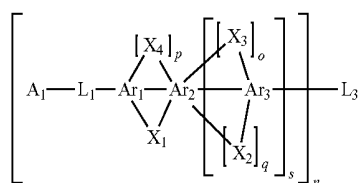
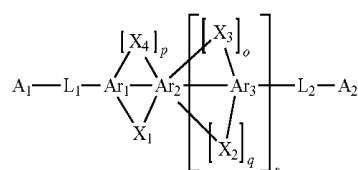
Problems to be Solved by the Invention

The present invention has been made with a view to solving the above problems, and an object of the present invention is to provide an organic EL device which shows high luminous efficiency, is free of any pixel defect, and has a long lifetime, and a material for an organic EL device for realizing the device.

Means for Solving the Problems

The inventors of the present invention have made extensive studies with a view to achieving the above object. As a result, the inventors have found that the above object can be achieved by using a compound having a π -conjugated heteroacene skeleton crosslinked with a carbon atom, nitrogen atom, oxygen atom, or sulfur atom as a material for an organic EL device. Thus, the inventors have completed the present invention.

That is, the present invention provides a material for an organic EL device represented by the following formulae (1) or (2).



[In the formulae (1) and (2), Ar₁, Ar₂, and Ar₃ each independently represent a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, Ar₁, Ar₂, and Ar₃ each may have one substituent Y or multiple substituents Ys, in the case of multiple substituents Ys, the substituent Ys may be different from each other, Y represents an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁, Ar₂, or Ar₃ through a carbon-carbon bond.

In the formulae (1) and (2), X₁, X₂, X₃, and X₄ each independently represent O, S, N—R₁ or CR₂R₃ (N atom of N—R, or C atom of CR₂R₃ binds to Ar₁, Ar₂, or Ar₃).

In the formulae (1) and (2), R₁, R₂, and R₃ each independently represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, when both X₁ and X₂ represent N—R₁, o and p each represent 0, and q represents 1, or when both X₁ and X₃ represent N—R₁, p and q each represent 0, and o represents 1, at least one R₁ represents a substituted or unsubstituted, monovalent fused aromatic heterocyclic group having a ring formed of 8 to 24 atoms.

In the formulae (1) and (2), o, p, and q each represent 0 or 1 and s represents 1, 2, or 3. n represents 2, 3, or 4, and the material represented by the formula (2) includes a dimer using L₃ as a linking group for n=2, a trimer using L₃ as a linking group for n=3, or a tetramer using L₃ as a linking group for n=4.

In the formulae (1) and (2), L₁ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁ through a carbon-carbon bond.

In the formula (1), L₂ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₃ through a carbon-carbon bond, provided that, when both X₁ and X₂ represent CR₂R₃, o and p each represent 0, q represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X₁ and X₃ represent CR₂R₃, p and q each represent 0, o represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L₁ and L₂ are simultaneously linked at para positions with respect to Ar₂ is excluded.

In the formula (2), when n represents 2, L₃ represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₃ through a carbon-carbon bond, when n represents 3, L₃ represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted,

5

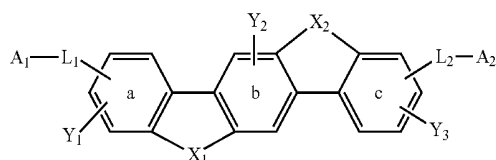
trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₃ through a carbon-carbon bond, or when n represents 4, L₃ represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₃ through a carbon-carbon bond, provided that, when both X₁ and X₂ represent CR₂R₃, o and p each represent 0, q represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X₁ and X₃ represent CR₂R₃, p and q each represent 0, o represents 1, and both L₁ and L₃ represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L₁ and L₃ are simultaneously linked at para positions with respect to Ar₂ is excluded.

In the formulae (1) and (2), A₁ represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L₁ through a carbon-carbon bond, provided that, when L₁ represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A₁ represents a hydrogen atom is excluded.

In the formula (1), A₂ represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L₂ through a carbon-carbon bond, provided that, when L₂ represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A₂ represents a hydrogen atom is excluded, and, when X₁ and X₂ each represent O, S, or CR₂R₃, o and p each represent 0, q represents 1, and both L₁ and L₂ represent single bonds, or when both X₁ and X₃ each represent O, S, or CR₂R₃, p and q each represent 0, o represents 1, and both L₁ and L₂ represent single bonds, a case where A₁ and A₂ simultaneously represent hydrogen atoms is excluded;

In the formulae (1) and (2), A₁, A₂, L₁, L₂, and L₃ are each free of any carbonyl group.

A case where the formula (1) has a structure represented by the following general formula (3) is excluded,

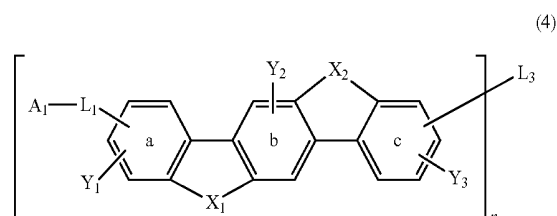


6

provided that, X₁, X₂, A₁, A₂, L₁, and L₂ in the formula (3) has the same meaning X₁, X₂, A₁, A₂, L₁, and L₂ in the formula (1), respectively.

In the formula (3), Y₁, Y₂, and Y₃ each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y₁ and Y₃ is 0, 1, 2, or 3, and the number of Y₂ is 0, 1, or 2.

A case where the formula (2) has a structure represented by the following general formula (4) is excluded,



provided that, X₁, X₂, A₁, L₁, L₃, and n in the formula (4) has the same meaning X₁, X₂, A₁, L₁, L₃, and n in the formula (2), respectively.

In the formula (4), Y₁, Y₂, and Y₃ each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y₁ and Y₃ is 0, 1, 2, or 3, and the number of Y₂ is 0, 1, or 2.]

In addition, the present invention provides an organic EL device having one or more organic thin film layers including a light emitting layer between a cathode and an anode in which at least one layer of the organic thin film layers contains a material for an organic EL device as a compound having a n-conjugated heteroacene skeleton crosslinked with a carbon atom, nitrogen atom, oxygen atom, or sulfur atom. A material for an organic EL device represented by the above formula (1) or (2) is preferably used as the material for an organic EL device of the present invention.

Further, the material for an organic EL device is effective also as a material for an organic electron device such as an organic solar cell, organic semiconductor laser, a sensor using organic matter, or an organic TFT.

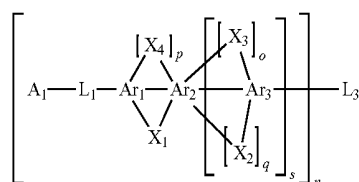
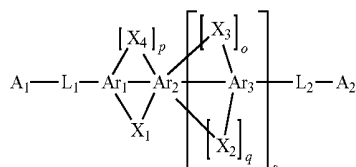
Effects of the Invention

According to the present invention, there can be provided an organic EL device which shows high luminous efficiency,

is free of any pixel defect, and has a long lifetime, and a material for an organic EL device for realizing the device.

BEST MODE FOR CARRYING OUT THE INVENTION

A material for an organic EL device of the present invention is represented by the following general formula (1) or (2).

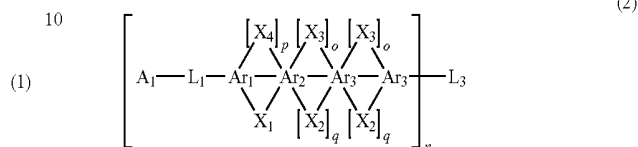
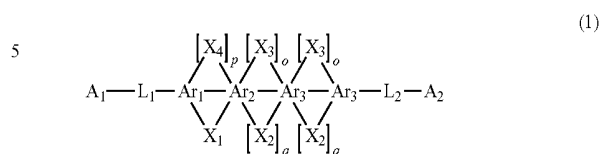


[In the formulae (1) and (2), Ar₁, Ar₂, and Ar₃ each independently represent a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, Ar₁, Ar₂, and Ar₃ each may have one substituent Y or multiple substituents Ys, in the case of multiple substituents Ys, the substituent Ys may be different from each other, Y represents an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁, Ar₂, or Ar₃ through a carbon-carbon bond. In the formulae (1) and (2), X₁, X₂, X₃, and X₄ each independently represent O, S, N—R₁, or CR₂R₃.

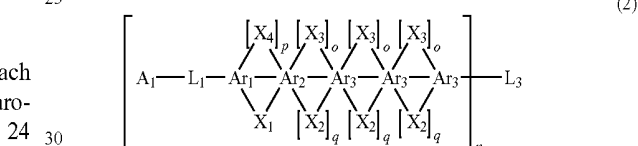
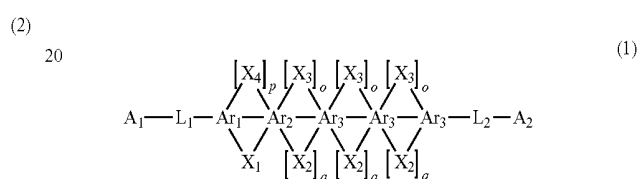
In the formulae (1) and (2), R₁, R₂, and R₃ each independently represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, when both X₁ and X₂ represent N—R₁, o and p each represent 0, and q represents 1, or when both X₁ and X₃ represent N—R₁, p and q each represent 0, and o represents 1, at least one of R₁ represents a substituted or unsubstituted, monovalent fused aromatic heterocyclic group having a ring formed of 8 to 24 atoms.

In the formulae (1) and (2), o, p, and q each represent 0 or 1, s represents 1, 2, or 3, when s represents 2 or 3, and the general formulae (1) and (2) are each represented as the following.

When s represents 2



When s represents 3



n represents 2, 3, or 4, and the material represented by the formula (2) includes a dimer using L₃ as a linking group for n=2, a trimer using L₃ as a linking group for n=3, or a tetramer using L₃ as a linking group for n=4.

In the formulae (1) and (2), L₁ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁ through a carbon-carbon bond.

In the formula (1), L₂ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₃ through a carbon-carbon bond, provided that, when both X₁ and X₂ represent CR₂R₃, o and p each represent 0, q represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X₁ and X₃ represent CR₂R₃, p and q each represent 0, o represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L₁ and L₂ are simultaneously linked at para positions with respect to Ar₂ is excluded.

In the formula (2), when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, 5 divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_3 through a carbon-carbon bond, when n represents 3, L_3 10 represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, 15 trivalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_3 through a carbon-carbon bond, or when n represents 4, L_3 represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_3 through a carbon-carbon bond, provided that, when both X_1 and X_2 represent CR_2R_3 , o and p each represent 0, q represents 1, and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, 20 trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X_1 and X_3 represent CR_2R_3 , p and q each represent 0, o represents 1, and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_3 are simultaneously linked at para positions with respect to Ar_2 is excluded.

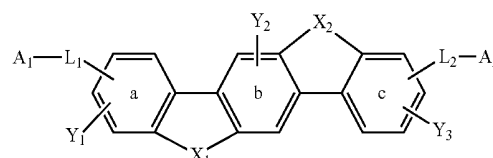
In the formulae (1) and (2), A_1 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_1 through a carbon-carbon bond, provided that, when L_1 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_1 represents a hydrogen atom is excluded.

In the formula (1), A_2 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_2 through a carbon-carbon bond, provided that, when L_2 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_2 represents a hydrogen atom is excluded, and, when X_1 and X_2 each represent O, S, or CR_2R_3 , o and p each represent 0, q represents 1, and both L_1 and L_2 represent single bonds, or when both X_1 and X_3 each represent O, S, or CR_2R_3 , p and q each represent 0, o represents 1, and both L_1 and L_2 represent single bonds, a case where A_1 and A_2 simultaneously represent hydrogen atoms is excluded.

In the formulae (1) and (2), A_1 , A_2 , L_1 , L_2 , and L_3 are each free of any carbonyl group.

A case where the formula (1) has a structure represented by the following general formula (3) is excluded,

(3)

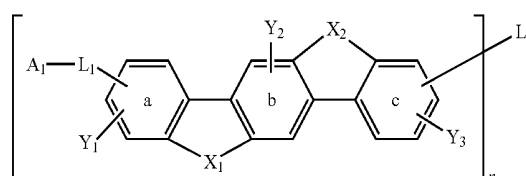


provided that, X_1 , X_2 , A_1 , A_2 , L_1 , and L_2 in the formula (3) has the same meaning X_1 , X_2 , A_1 , A_2 , L_1 , and L_2 in the formula (1), respectively.

In the formula (3), Y_1 , Y_2 , and Y_3 each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y_1 and Y_3 is 0, 1, 2, or 3, and the number of Y_2 is 0, 1, or 2.

A case where the formula (2) has a structure represented by the following general formula (4) is excluded,

(4)

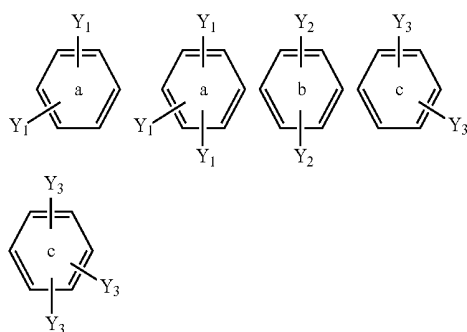


provided that, X_1 , X_2 , A_1 , L_1 , L_3 , and n in the formula (4) has the same meaning X_1 , X_2 , A_1 , L_1 , L_3 , and n in the formula (2), respectively.

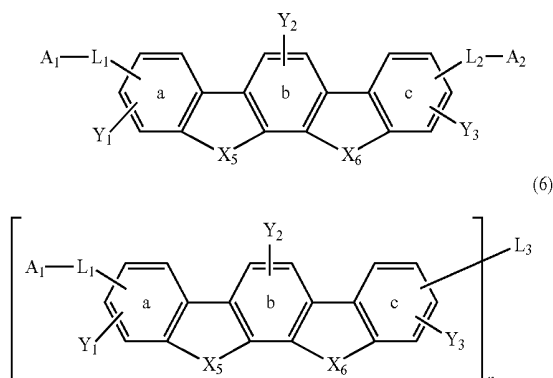
In the formula (4), Y_1 , Y_2 , and Y_3 each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y_1 and Y_3 is 0, 1, 2, or 3, and the number of Y_2 is 0, 1, or 2.

When the benzene ring a is substituted by multiple Y_1 s, the benzene ring b is substituted by multiple Y_2 s, or the benzene ring c is substituted by multiple Y_3 s in the formulae (3) and (4), each of the rings is represented as shown below.

11



The material for an organic EL device represented by the general formula (1) is preferably a material for an organic EL device represented by any one of the following general formulae (5), (7) to (9), (13), (15), and (17), and the material for an organic EL device represented by the general formula (2) is preferably a material for an organic EL device represented by any one of the following general formulae (6), (10) to (12), (14), (16), and (18).



[In the formulae (5) and (6), X_5 and X_6 each independently represent O, S, N— R_1 , or CR_2R_3 .

In the formulae (5) and (6), R_1 , R_2 , and R_3 each independently represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, when both X_5 and X_6 represent N— R_1 , at least one R_1 represents a substituted or unsubstituted, monovalent fused aromatic heterocyclic group having a ring formed of 8 to 24 atoms.

In the formula (6), n represents 2, 3, or 4, and the material represented by the formula (6) includes a dimer using L_3 as a linking group for $n=2$, a trimer using L_3 as a linking group for $n=3$, or a tetramer using L_3 as a linking group for $n=4$.

In the formulae (5) and (6), L_1 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, mon-

12

ovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a through a carbon-carbon bond.

In the formula (5), L_2 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, provided that, when both X_5 and X_6 represent CR_2R_3 and both L_1 and L_2 represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_2 are simultaneously linked at para positions with respect to a benzene ring b is excluded.

In the formulae (6), when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring c through a carbon-carbon bond, when n represents 3, L_3 represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has 3 to 24 atoms and which is linked with a benzene ring c through a carbon-carbon bond, or when n represents 4, L_3 represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, provided that, when both X_5 and X_6 represent CR_2R_3 and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_3 are simultaneously linked at para positions with respect to the benzene ring b is excluded.

In the formulae (5) and (6), A_1 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_1 through a carbon-carbon bond, provided that, when L_1 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_1 represents a hydrogen atom is excluded.

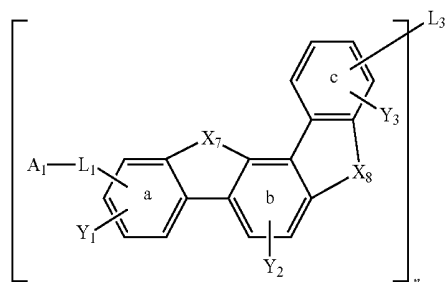
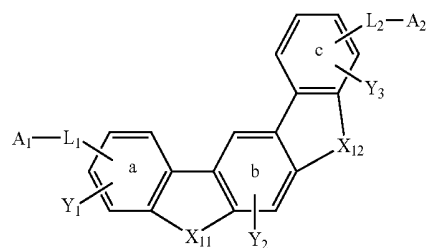
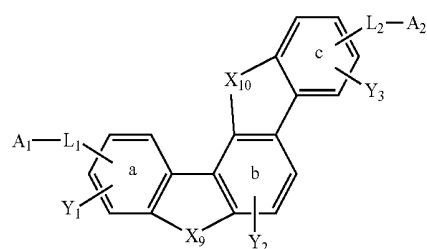
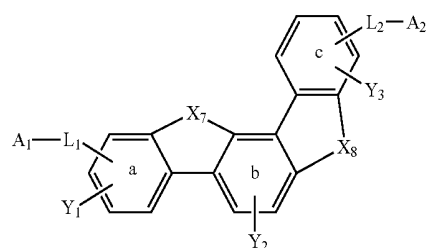
In the formula (5), A_2 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20

13

carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_2 through a carbon-carbon bond, provided that, when L_2 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_2 represents a hydrogen atom is excluded, and, when X_5 and X_6 each represent O, S, or CR_2R_3 and both L_1 and L_2 represent single bonds, a case where A_1 and A_2 simultaneously represent hydrogen atoms is excluded.

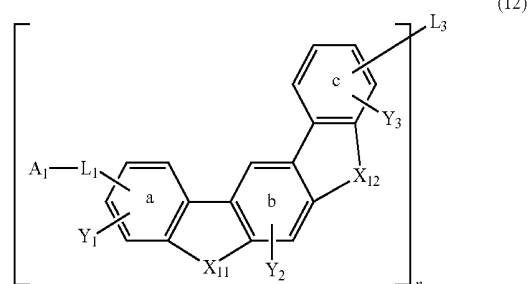
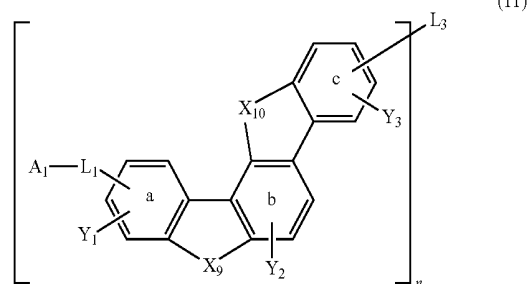
In the formulae (5) and (6), Y_1 , Y_2 , and Y_3 each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y_1 and Y_3 is 0, 1, 2, or 3, and the number of Y_2 is 0, 1, or 2.

In the formulae (5) and (6), A_1 , A_2 , L_1 , L_2 , and L_3 are each free of any carbonyl group.]



14

-continued



[In the formulae (7) to (12), X_7 , X_8 , X_9 , X_{10} , X_{11} , and X_{12} each independently represent O, S, $N-R_1$, or CR_2R_3 .

In the formulae (7) to (12), R_1 , R_2 , and R_3 each independently represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, when both X_7 and X_8 , both X_9 and X_{10} , and both X_{11} and X_{12} represent $N-R_1$, at least one R_1 represents a substituted or unsubstituted, monovalent fused aromatic heterocyclic group having a ring formed of 8 to 24 atoms.

In the formulae (10) to (12), n represents 2, 3, or 4, and the material represented by any one of the formulae (10) to (12) includes a dimer using L_3 as a linking group for $n=2$, a trimer using L_3 as a linking group for $n=3$, or a tetramer using L_3 as a linking group for $n=4$.

In the formulae (7) to (12), L_1 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a through a carbon-carbon bond.

In the formulae (7) to (9), L_2 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring c through a carbon-carbon bond, provided that,

15

when both X_7 and X_8 , both X_9 and X_{10} , or both X_{11} and X_{12} , represent CR_2R_3 and both L_1 and L_2 represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_2 are simultaneously linked at para positions with respect to a benzene ring b is excluded.

In the formulae (10) to (12), when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, when n represents 3, L_3 represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, or when n represents 4, L_3 represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, provided that, when both X_7 , and X_8 , both X_9 and X_{10} , or both X_{11} and X_{12} , represent CR_2R_3 and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_3 are simultaneously linked at para positions with respect to the benzene ring b is excluded.

In the formulae (7) to (12), A_1 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_1 through a carbon-carbon bond, provided that, when L_1 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_1 represents a hydrogen atom is excluded.

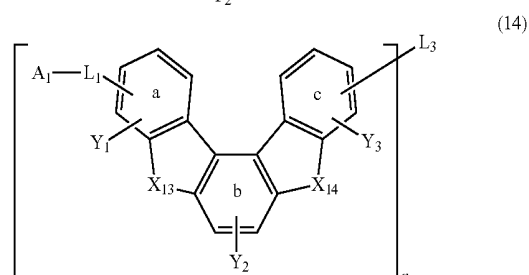
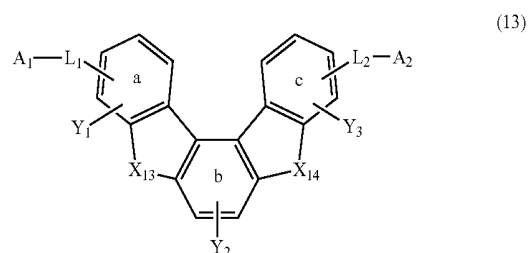
In the formulae (7) to (9), A_2 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_2 through a carbon-carbon bond, provided that, when L_2 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_2 represents a hydrogen atom is excluded, and, when both X_7 and X_8 , both X_9 and X_{10} , or both X_{11} and X_{12} , represent O, S, or CR_2R_3 and both L_1 and L_2 represent single bonds, a case where A_1 and A_2 simultaneously represent hydrogen atoms is excluded.

In the formulae (7) to (12), Y_1 , Y_2 , and Y_3 each represent an alkyl group having 1 to 20 carbon atoms, a substituted or

16

unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y_1 and Y_3 is 0, 1, 2, or 3, and the number of Y_2 is 0, 1, or 2.

In the formulae (7) to (12), A_1 , A_2 , L_1 , L_2 , and L_3 are each free of any carbonyl group.]



[In the formulae (13) and (14), X_{13} and X_{14} each independently represent O, S, N— R_1 , or CR_2R_3 .

In the formulae (13) and (14), R_1 , R_2 , and R_3 each independently represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, provided that, when both X_{13} and X_{14} represent N— R_1 , at least one R_1 represents a substituted or unsubstituted, monovalent fused aromatic heterocyclic group having a ring formed of 8 to 24 atoms.

In the formula (14), n represents 2, 3, or 4, and the material represented by the formula (14) includes a dimer using L_3 as a linking group for $n=2$, a trimer using L_3 as a linking group for $n=3$, or a tetramer using L_3 as a linking group for $n=4$.

In the formulae (13) and (14), L_1 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a through a carbon-carbon bond.

17

In the formula (13), L_2 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring c through a carbon-carbon bond, provided that, when both X_{13} and X_{14} represent CR_2R_3 and both L_1 and L_2 represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_2 are simultaneously linked at para positions with respect to a benzene ring b is excluded.

In the formula (14), when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, when represents 3, L_3 represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, or when n represents 4, L_3 represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, provided that, when both X_{13} and X_{14} represent CR_2R_3 and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L_1 and L_3 are simultaneously linked at para positions with respect to the benzene ring b is excluded.

In the formulae (13) and (14), A_1 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_1 through a carbon-carbon bond, provided that, when L_1 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_1 represents a hydrogen atom is excluded.

In the formula (13), A_2 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed

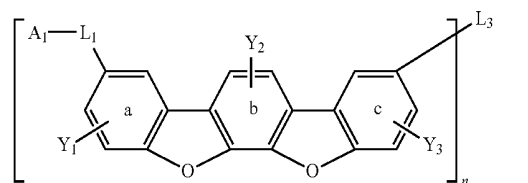
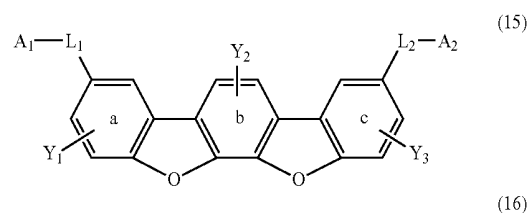
18

of 3 to 24 atoms and which is linked with L_2 through a carbon-carbon bond, provided that, when L_2 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_2 represents a hydrogen atom is excluded, and, when X_{13} and X_{14} each represent O, S, or CR_2R_3 , and both L_1 and L_2 represent single bonds, a case where A_1 and A_2 simultaneously represent hydrogen atoms is excluded.

In the formulae (13) and (14), Y_1 , Y_2 , and Y_3 each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y_1 and Y_3 is 0, 1, 2, or 3, and the number of Y_2 is 0, 1, or 2.

In the formulae (13) and (14), A_1 , A_2 , L_1 , L_2 , and L_3 are each free of any carbonyl group.]

The compounds represented by the general formulae (5) and (6) are each preferably a benzofurano dibenzofuran derivative represented by one of the following general formulae (15) and (16).



[In the formula (16), n represents 2, 3, or 4, and the material represented by the formula (16) includes a dimer using L_3 as a linking group for $n=2$, a trimer using L_3 as a linking group for $n=3$, or a tetramer using L_3 as a linking group for $n=4$.

In the formulae (15) and (16), L_1 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a through a carbon-carbon bond.

In the formula (15), L_2 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon

19

atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring c through a carbon-carbon bond.

In the formula (16), when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, when n represents 3, L_3 represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, or when n represents 4, L_3 represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond.

In the formulae (15) and (16), A_1 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_1 through a carbon-carbon bond, provided that, when L_1 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_1 represents a hydrogen atom is excluded.

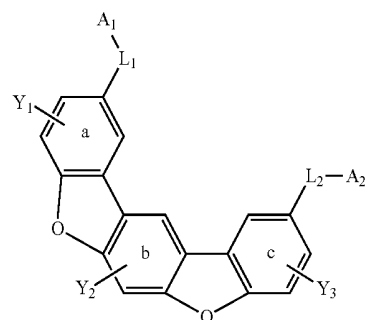
In the formula (15), A_2 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_2 through a carbon-carbon bond, provided that, when L_2 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_2 represents a hydrogen atom is excluded, and, when both L_1 and L_2 represent single bonds, a case where A_1 and A_2 simultaneously represent hydrogen atoms is excluded.

In the formulae (15) and (16), Y_1 , Y_2 , and Y_3 each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y_1 and Y_3 is 0, 1, 2, or 3, and the number of Y_2 is 0, 1, or 2.

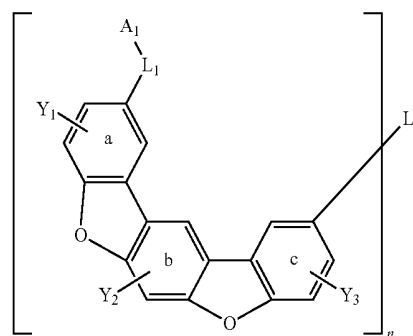
20

In the formulae (15) and (16), A_1 , A_2 , L_1 , L_2 , and L_3 are each free of any carbonyl group.]

The compounds represented by the general formulae (9) and (12) are each preferably a benzofurano dibenzofuran derivative represented by one of the following general formulae (17) and (18).



(17)



(18)

[In the formula (18), n represents 2, 3, or 4, and the material represented by the formula (18) includes a dimer using L_3 as a linking group for $n=2$, a trimer using L_3 as a linking group for $n=3$, or a tetramer using L_3 as a linking group for $n=4$.

In the formulae (17) and (18), L_1 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a through a carbon-carbon bond.

In the formula (17), L_2 represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a through a carbon-carbon bond.

In the formula (18), when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted,

divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, when n represents 3, L₃ represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond, or when n represents 4, L₃ represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring c through a carbon-carbon bond.

In the formulae (17) and (18), A₁ represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L₁ through a carbon-carbon bond, provided that, when L₁ represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A₁ represents a hydrogen atom is excluded.

In the formula (17), A₂ represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or an aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L₂ through a carbon-carbon bond, provided that, when L₂ represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A₂ represents a hydrogen atom is excluded, and, when both L₁ and L₂ represent single bonds, a case where A₁ and A₂ simultaneously represent hydrogen atoms is excluded.

In the formulae (17) and (18), Y₁, Y₂, and Y₃ each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with the benzene ring a, b, or c through a carbon-carbon bond, the number of each of Y₁ and Y₃ is 0, 1, 2, or 3, and the number of Y₂ is 0, 1, or 2.

In the formulae (17) and (18), A₁, A₂, L₁, L₂, and L₃ are each free of any carbonyl group.]

In the general formulae (1) to (18), specific examples of each group are described below.

Examples of the substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms represented by Ar₁ to Ar₃, Y, Y₁ to Y₃, R₁ to R₃, L₁ to L₃, and A₁ and A₂ include residues having corresponding valencies such as substituted or unsubstituted benzene,

naphthalene, biphenyl, terphenyl, fluorene, phenanthrene, triphenylene, perylene, chrysene, fluoranthene, benzo[fluorene], benzotriphenylene, benzochrysene, and anthracene. Preferred are benzene, naphthalene, biphenyl, terphenyl, fluorene, and phenanthrene.

Examples of the substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms represented by Ar₁ to Ar₃, Y, Y₁ to Y₃, R₁ to R₃, L₁ to L₃, and A₁ and A₂ include residues having corresponding valencies such as pyridine, pyridazine, pyrimidine, pyrazine, 1,3,5-triazine, carbazole, dibenzofuran, dibenzothiophene, phenoxazine, phenothiazine, and dihydroacridine. Preferred are pyridine, pyridazine, pyrimidine, pyrazine, carbazole, dibenzofuran, dibenzothiophene, phenoxazine, and dihydroacridine. In addition, examples of at least one substituted or unsubstituted, monovalent fused aromatic heterocyclic group having a ring formed of 8 to 24 atoms represented by R₁ include aromatic heterocyclic groups each having a fused structure in examples of the aromatic heterocyclic groups.

Examples of the alkyl group, alkylene group, and trivalent or tetravalent alkane, each of which has 1 to 20 carbon atoms represented by Y, Y₁ to Y₃, L₁ to L₃, and R₁ to R₃ include a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, a t-butyl group, an isobutyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, an n-nonyl group, an n-decyl group, an n-undecyl group, an n-dodecyl group, an n-tridecyl group, an n-tetradecyl group, an n-pentadecyl group, an n-hexadecyl group, an n-heptadecyl group, an n-octadecyl group, a neopentyl group, a 1-methylpentyl group, a 2-methylpentyl group, a 1-pentylhexyl group, a 1-butylpentyl group, a 1-heptyloctyl group, and a 3-methylpentyl group or groups obtained by allowing those groups to have two to four valencies. Preferred are a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, an n-nonyl group, an n-decyl group, an n-undecyl group, an n-dodecyl group, an n-tridecyl group, an n-tetradecyl group, an n-pentadecyl group, an n-hexadecyl group, an n-heptadecyl group, an n-octadecyl group, a neopentyl group, a 1-methylpentyl group, a 1-pentyl hexyl group, a 1-butylpentyl group, and a 1-heptyloctyl group.

Examples of the substituted or unsubstituted cycloalkyl group, cycloalkylene group, and trivalent or tetravalent cycloalkane, each of which has a ring formed of 3 to 20 carbon atoms, represented by Y, Y₁ to Y₃, L₁ to L₃, R₁ to R₃, and A₁ and A₂ include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and groups obtained by allowing those group to have two to four valencies. Preferred are a cyclobutyl group, a cyclopentyl group, and a cyclohexyl group.

Examples of the alkoxy group having 1 to 20 carbon atoms and represented by Y, Y₁ to Y₃ include a methoxy group, an ethoxy group, a methoxy group, an i-propoxy group, an n-propoxy group, an n-butoxy group, an s-butoxy group, and a t-butoxy group. Preferred are a methoxy group, an ethoxy group, a methoxy group, an i-propoxy group, and an n-propoxy group.

Examples of the silyl group having 1 to 20 carbon atoms represented by Y, Y₁ to Y₃, L₁ to L₃, R₁ to R₃, and A₁ and A₂ include a trimethyl silyl group, a triethyl silyl group, a tributyl silyl group, a trioctyl silyl group, a triisobutyl silyl group, a dimethylethyl silyl group, a dimethylisopropyl silyl group, a dimethylpropyl silyl group, a dimethylbutyl silyl group, a dimethyltertiary butyl silyl group, a diethylisopropyl silyl group, a phenyldimethyl silyl group, a diphenylm-

ethyl silyl group, a diphenyl tertiary butyl group, a triphenyl silyl group, and groups obtained by allowing those groups to have two or three valencies. Preferred are a trimethyl silyl group, a triethyl silyl group, and a tributyl silyl group.

Examples of the aralkyl group having 7 to 24 carbon atoms represented by Y, Y₁ to Y₃, and R₁ to R₃ include a benzyl group, a phenethyl group, and a phenylpropyl group.

Examples of the substituent that can be substituted for the each group in the general formulae (1) to (18) include alkyl groups each having 1 to 10 carbon atoms (such as a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, a iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, and a 1,2,3-trinitropropyl group), cycloalkyl groups each having a ring formed of 3 to 40 carbon atoms (such as a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, a 4-methylcyclohexyl group, a 1-adamantyl group, a 2-adamantyl group, a 1-norbornyl group, and a 2-norbornyl group), alkoxy groups each having 1 to 6 carbon atoms (such as an ethoxy group, a methoxy group, an i-propoxy group, an

n-propoxy group, an s-butoxy group, a t-butoxy group, a pentoxy group, and a hexyloxy group), cycloalkoxy groups each having a ring formed of 3 to 10 carbon atoms (such as a cyclopentoxy group and a cyclohexyloxy group), aromatic hydrocarbon groups each having a ring formed of 6 to 40 carbon atoms, aromatic heterocyclic groups having a ring formed of 3 to 40 atoms, amino groups substituted with aromatic hydrocarbon groups having a ring formed of 6 to 40 carbon atoms, ester groups having aromatic hydrocarbon groups having a ring formed of 6 to 40 carbon atoms, an ester group, cyano group, nitro group, and halogen atom, each of which has an alkyl group having 1 to 6 carbon atoms.

Of those, alkyl groups each having 1 to 6 carbon atoms, a phenyl group, a pyridyl group, a carbazolyl group, and a dibenzofuranyl group are preferred and the number of substituents is preferably 1 or 2.

In the material for an organic EL device represented by the general formula (2), (6), (10) to (12), (14), (16), or (18), n preferably represents 2.

In the general formula (5), (7) to (9), (13), (15), or (17), the total number of the substituents represented by Y₁, Y₂, and Y₃ is preferably 3 or less, and the total number of the substituents represented by Y₁, Y₂, and Y₃ in the structure of []_n in the general formula (6), (10) to (12), (14), (16) or (18) is preferably 3 or less.

In the general formula (1) or (2), X₁ and X₂, or X₃ and X₄ are each represented by N—R₁. N—R₁ of X₁ and N—R₁ of X₂, or N—R₁ of X₃ and N—R₁ of X₄ may be preferably different from each other.

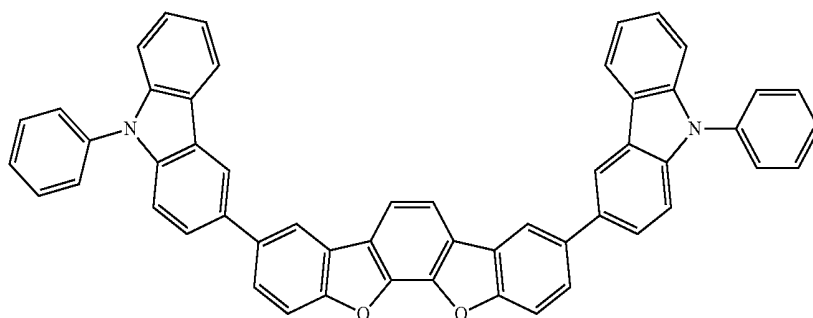
In the general formula (5) or (6), X₅ and X₆ are each represented by N—R₁. N—R₁ of X₅ and N—R₁ of X₆ may be preferably different from each other.

In the general formulae (7) to (12), X₇ and X₈, X₉ and X₁₀, or X₁₁ and X₁₂, are each represented by N—R₁. N—R₁ of X₇ and N—R₁ of X₈, N—R₁ of X₉ and N—R₁ of X₁₀, or N—R₁ of X₁₁ and N—R₁ of X₁₂, may be preferably different from each other.

In the general formula (13) or (14), X₁₃ and X₁₄ are each represented by N—R₁. N—R₁ of X₁₃ and N—R₁ of X₁₄ may be preferably different from each other.

In the general formulae (1), (2), (5) to (14), both X₁ and X₂, both X₃ and X₄, both X₅ and X₆, both X₇ and X₈, both X₉ and X₁₀, both X₁₁ and X₁₂, both X₁₃ and X₁₄, and both X₁₅ and X₁₆ preferably represent oxygen atoms.

Specific examples of the material for an organic EL device represented by any one of the general formulae (1), (2), (5) to (18) of the present invention are shown below. However, the present invention is not limited to these exemplified compounds.



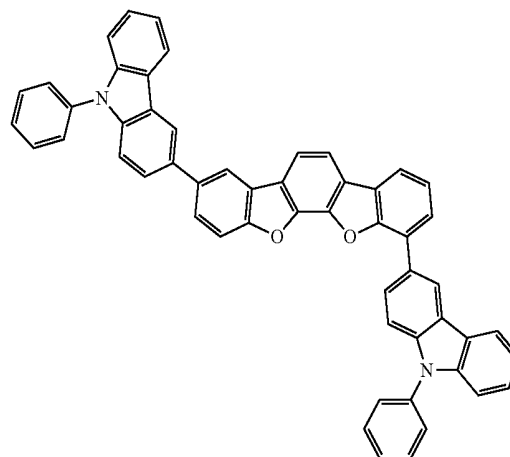
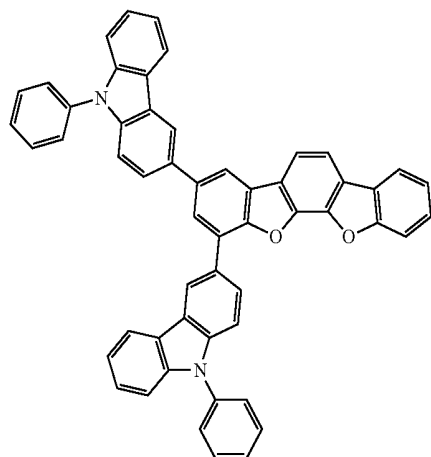
25

26

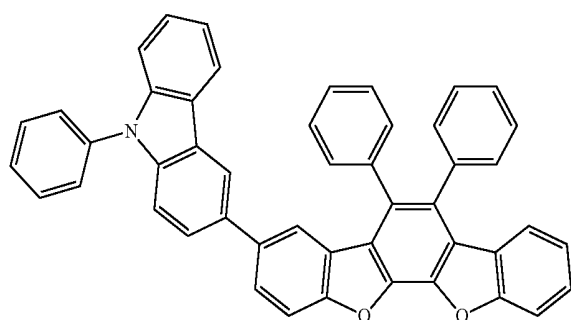
-continued

No. 2

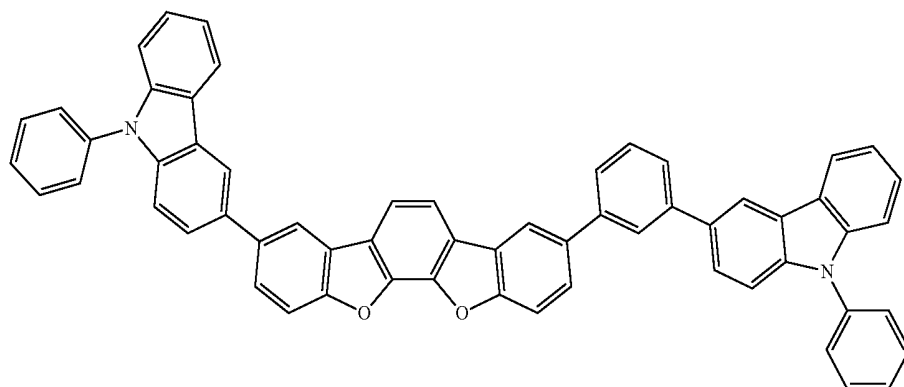
No. 3



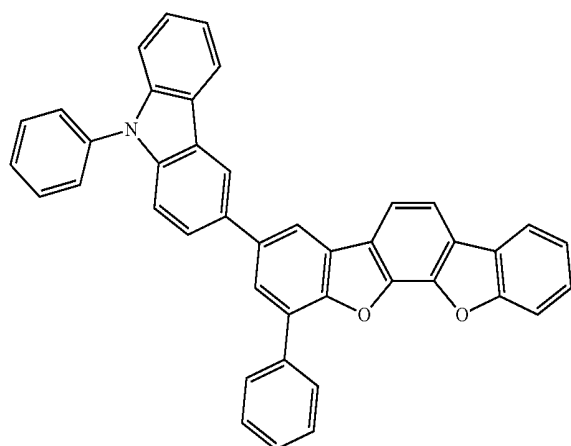
No. 4



No. 5



No. 6

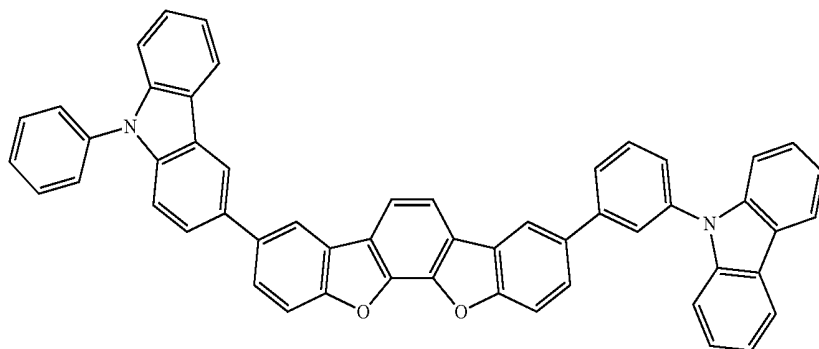


27

28

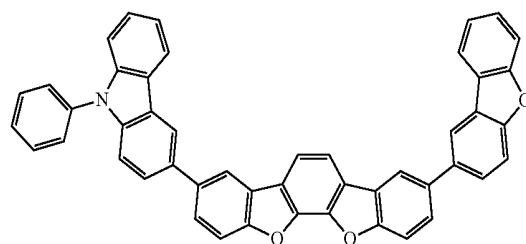
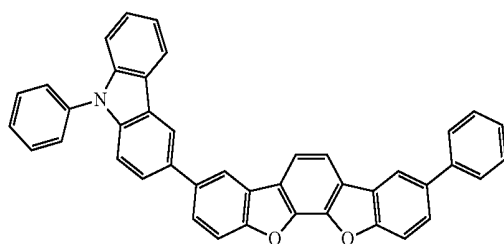
-continued

No. 7

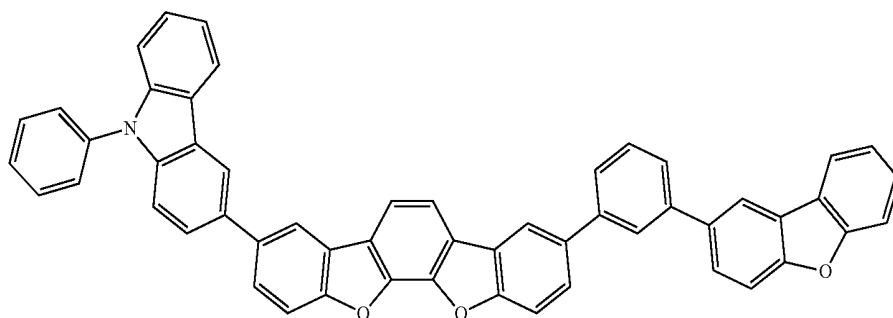


No. 8

No. 9

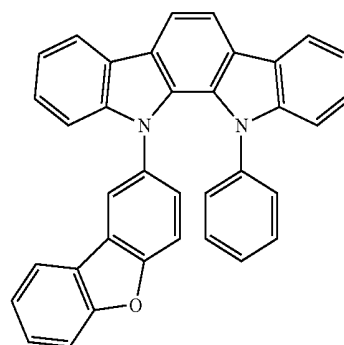
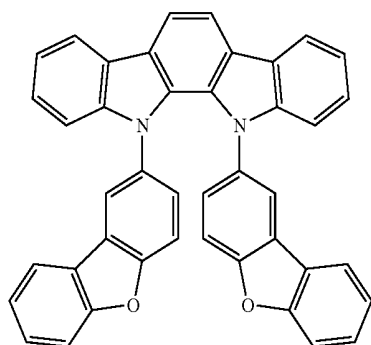


No. 10



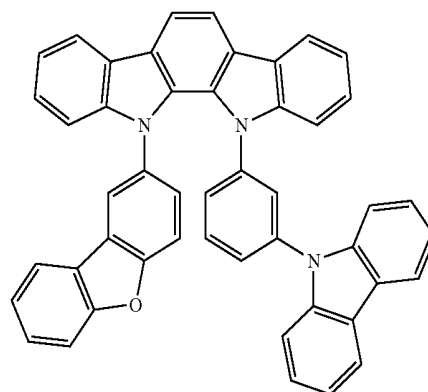
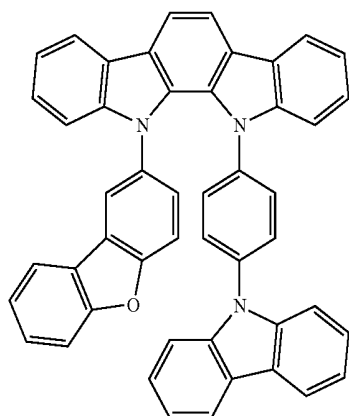
No. 11

No. 12



No. 13

No. 14

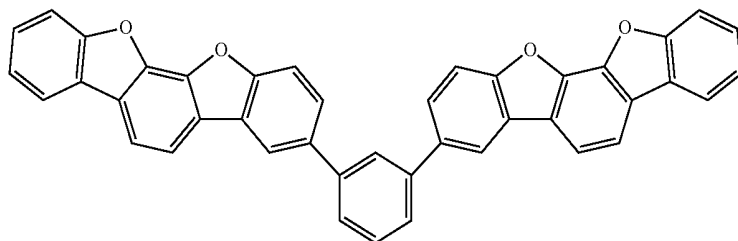


29

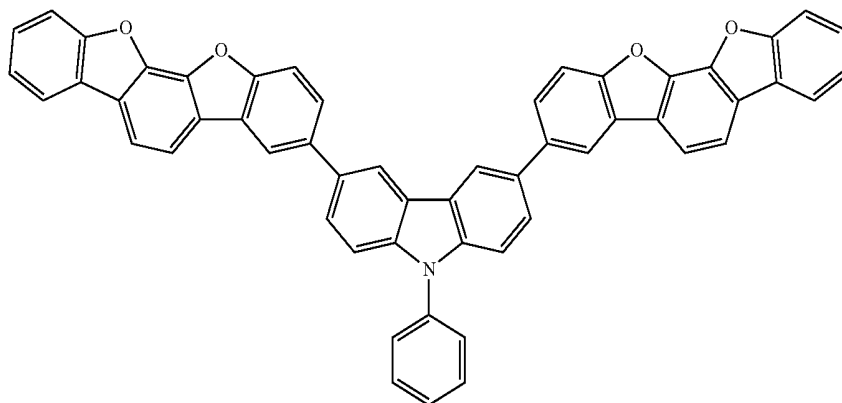
30

-continued

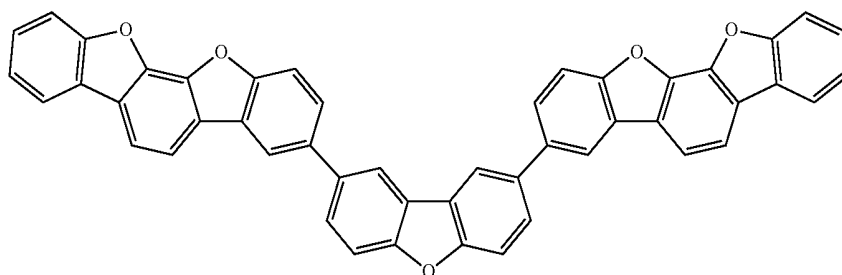
No. 15



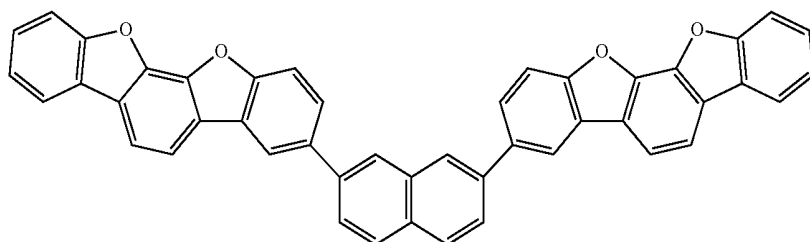
No. 16



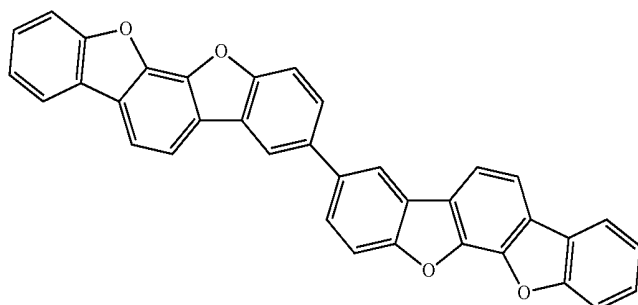
No. 17



No. 18



No. 19

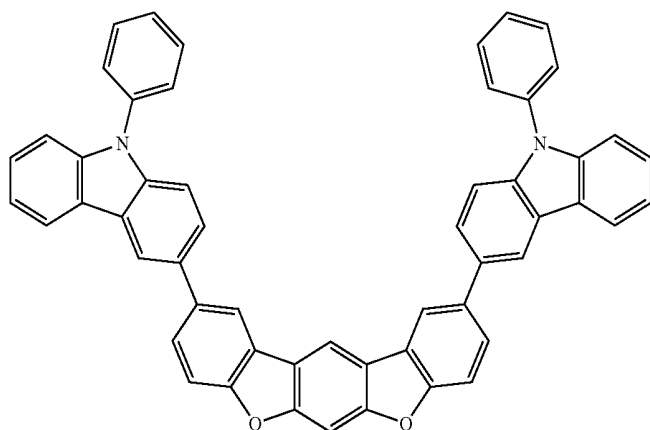


31

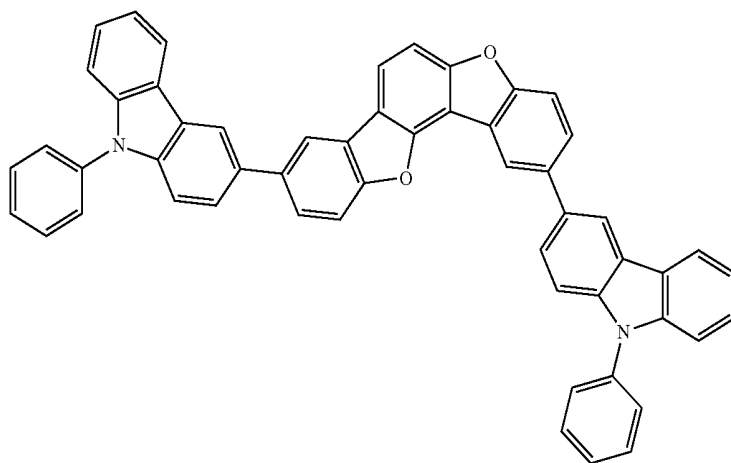
32

-continued

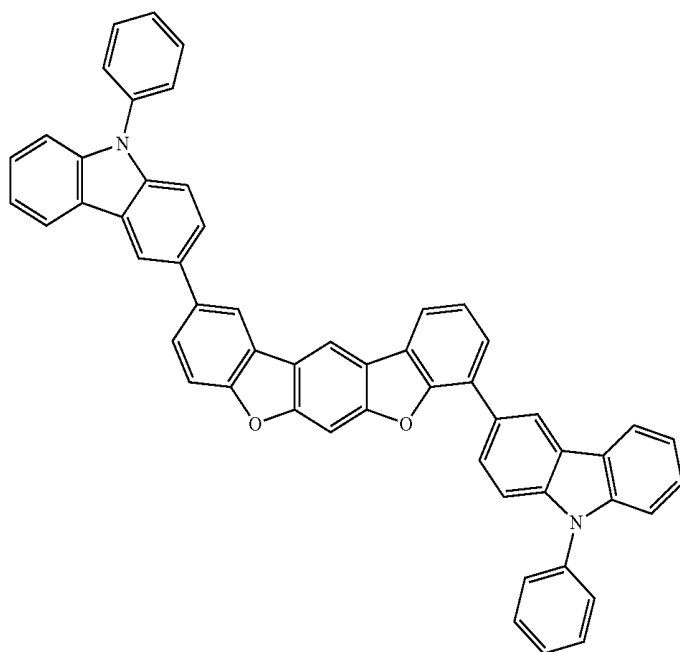
No. 20



No. 21



No. 22

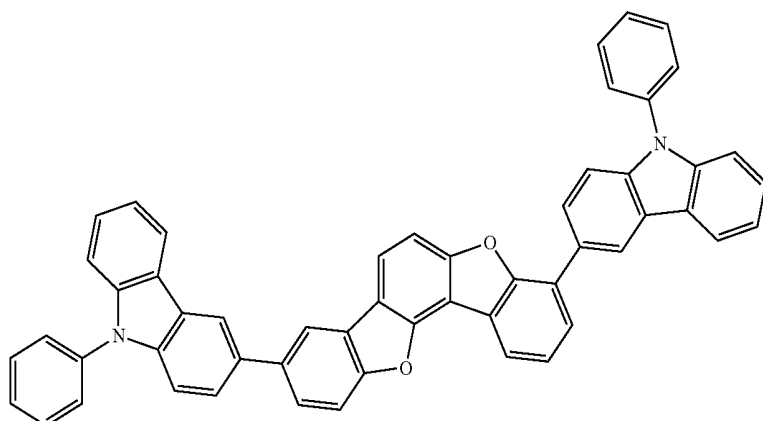


33

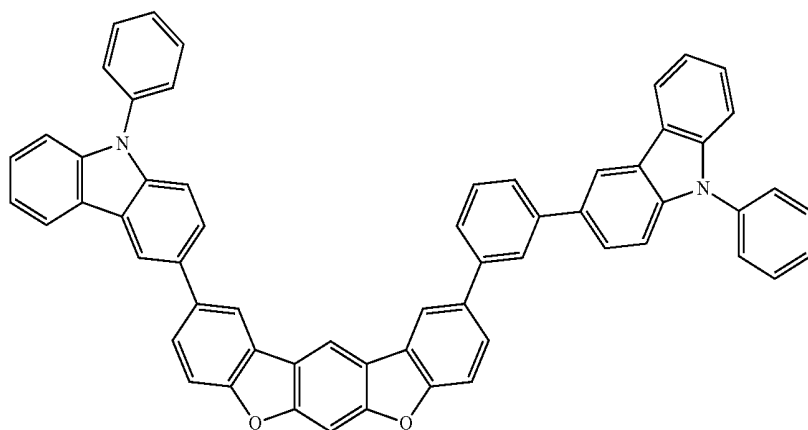
34

-continued

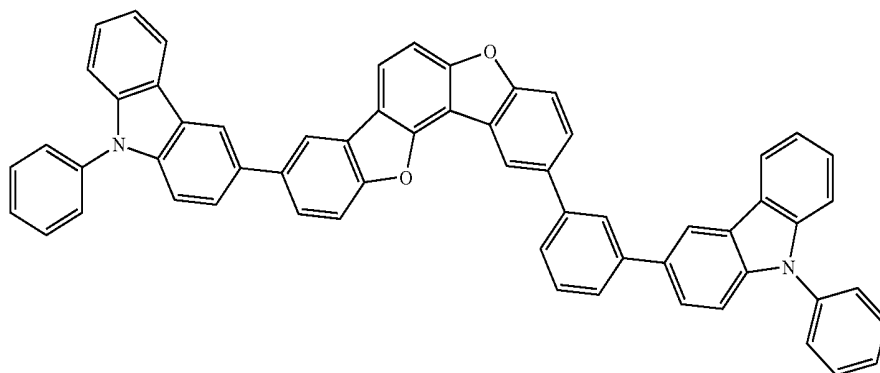
No. 23



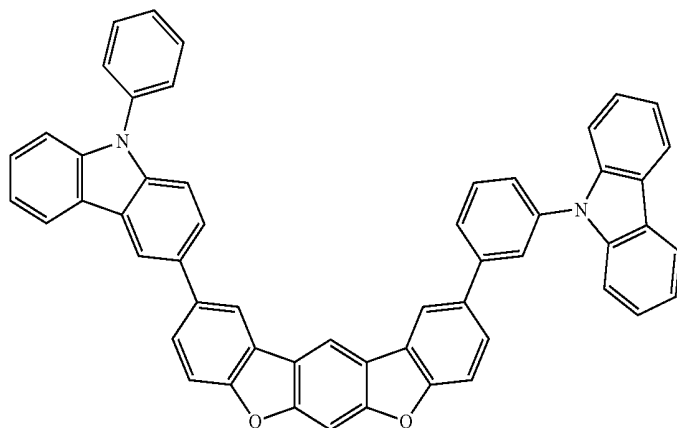
No. 24



No. 25



No. 26

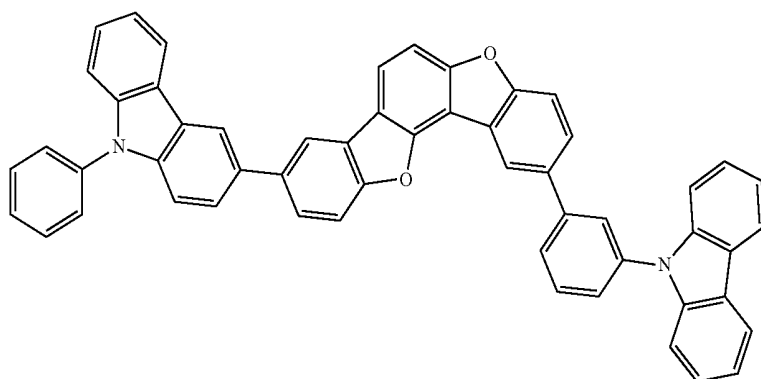


35

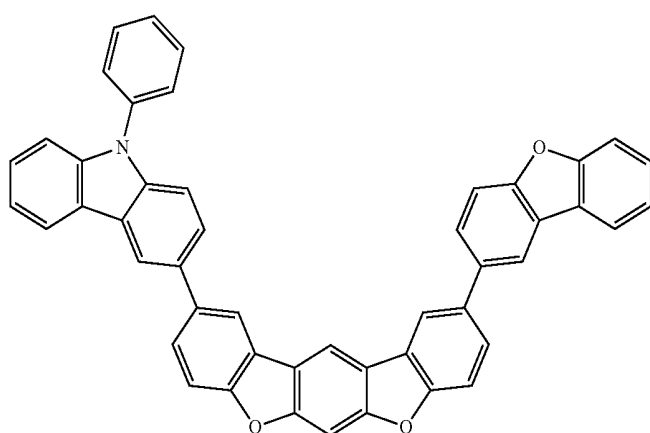
36

-continued

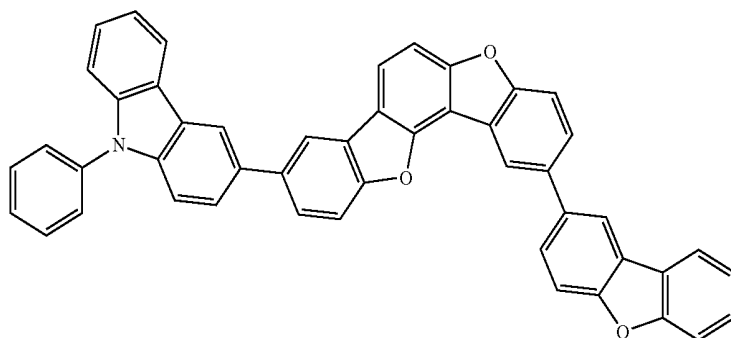
No. 27



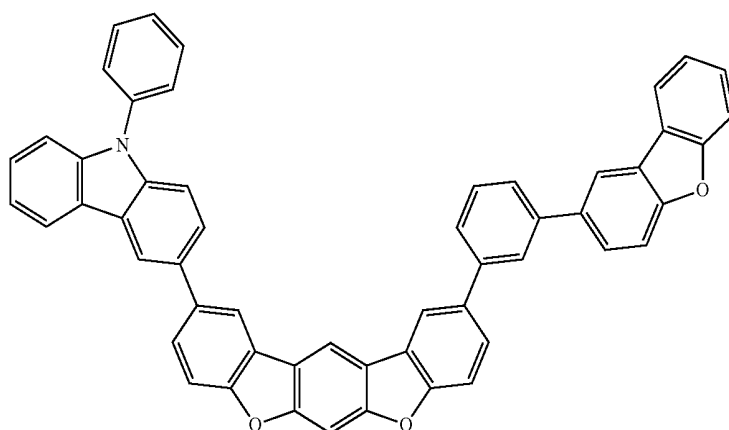
No. 28



No. 29



No. 30

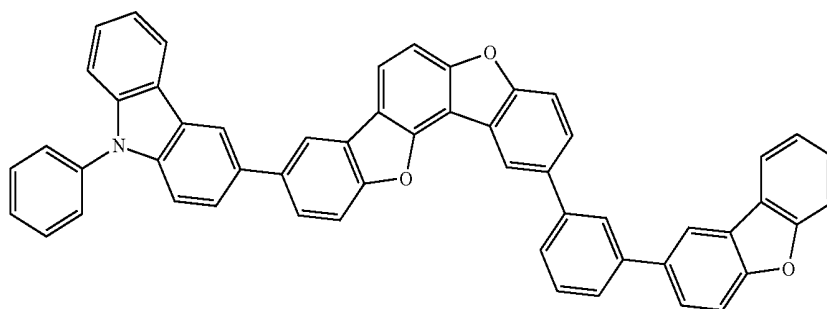


37

38

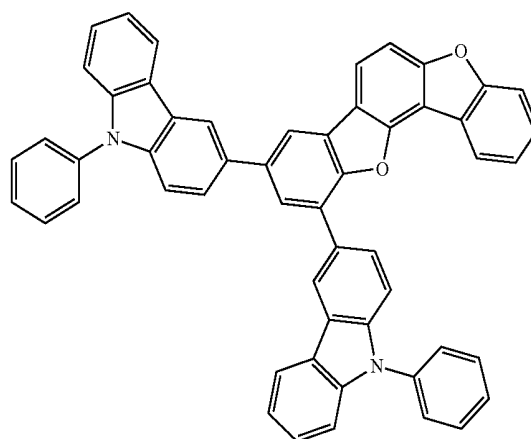
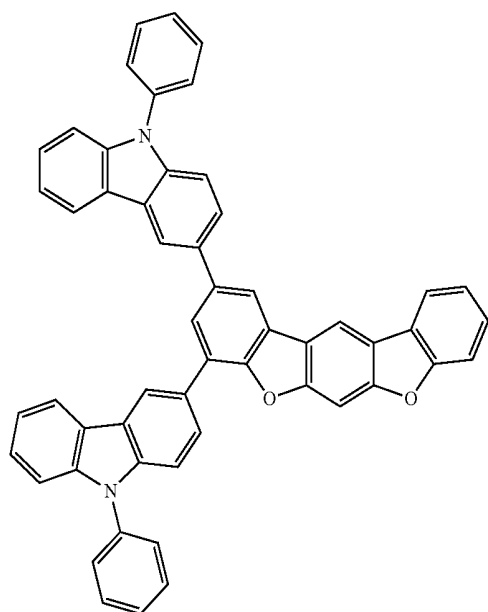
-continued

No. 31



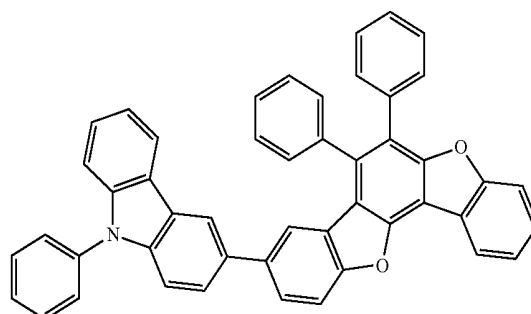
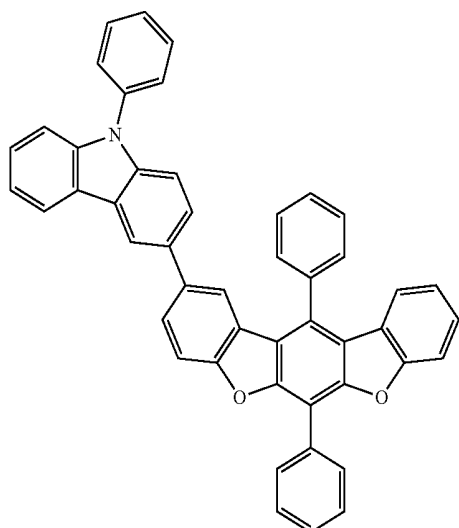
No. 32

No. 33



No. 34

No. 35



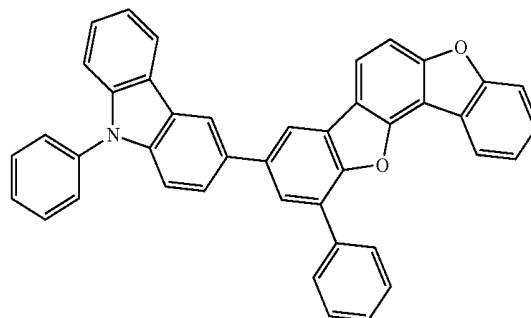
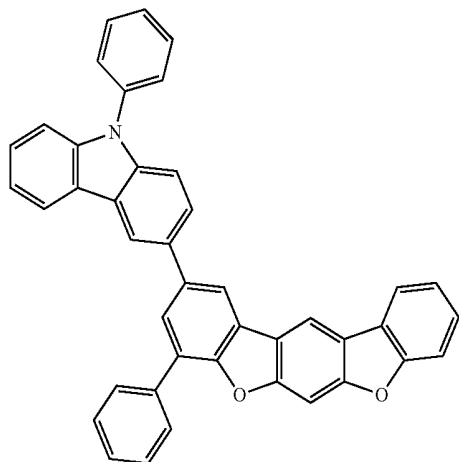
39

40

-continued

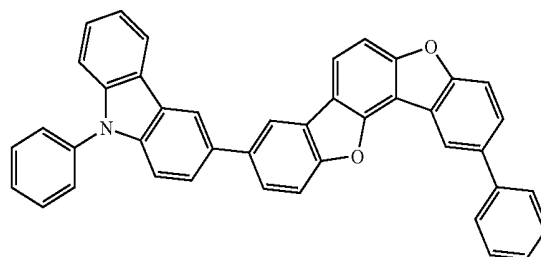
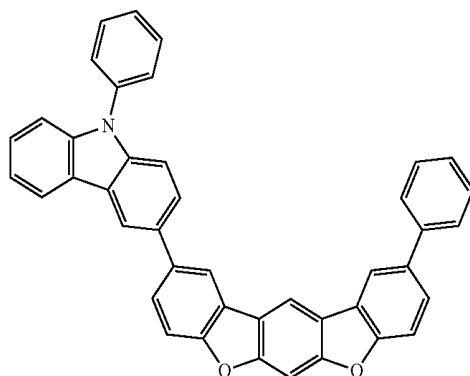
No. 36

No. 37



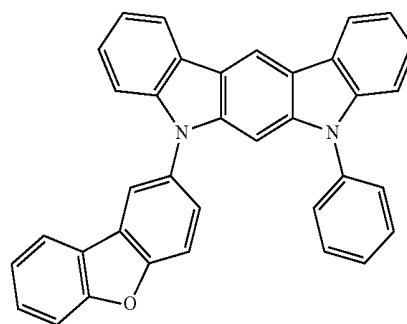
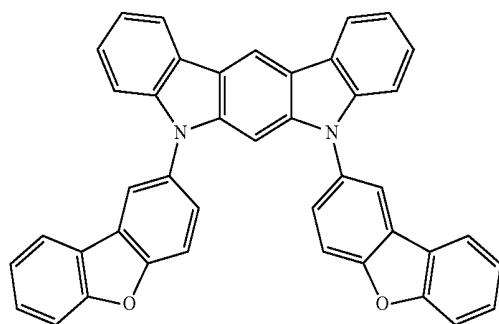
No. 38

No. 39



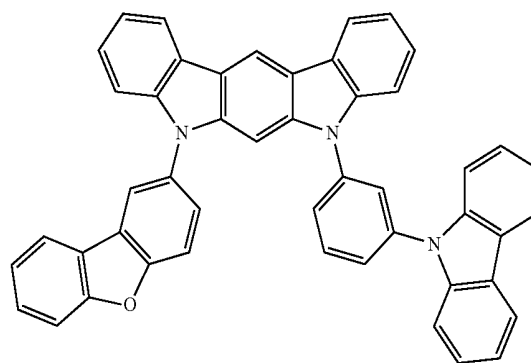
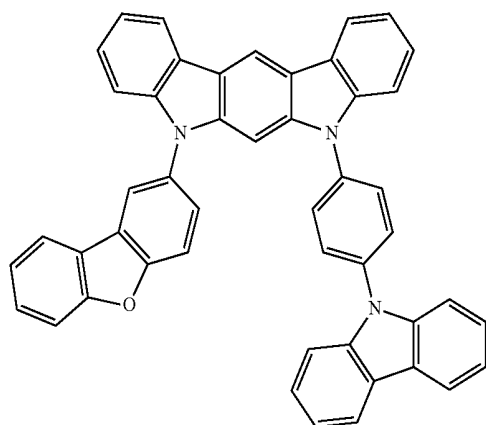
No. 40

No. 41

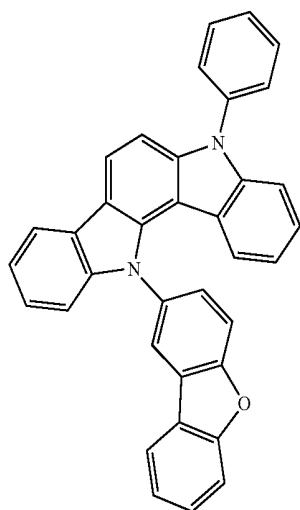


No. 42

No. 43



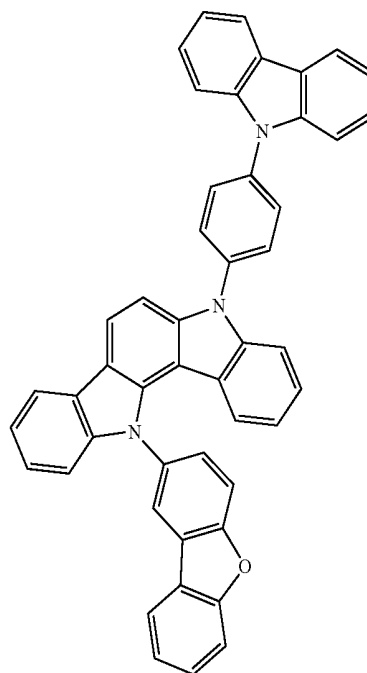
41



-continued

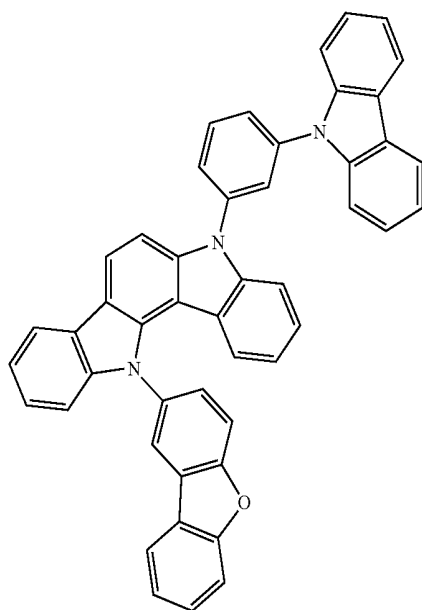
No. 44

42

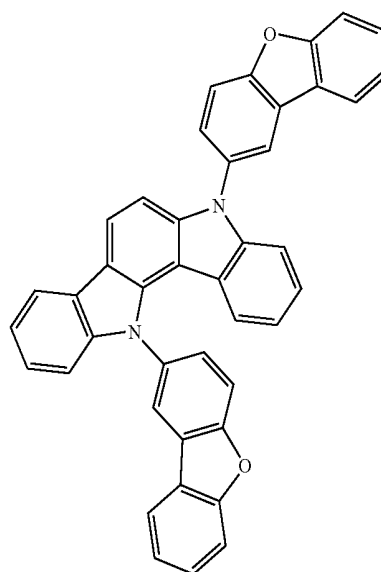


No. 45

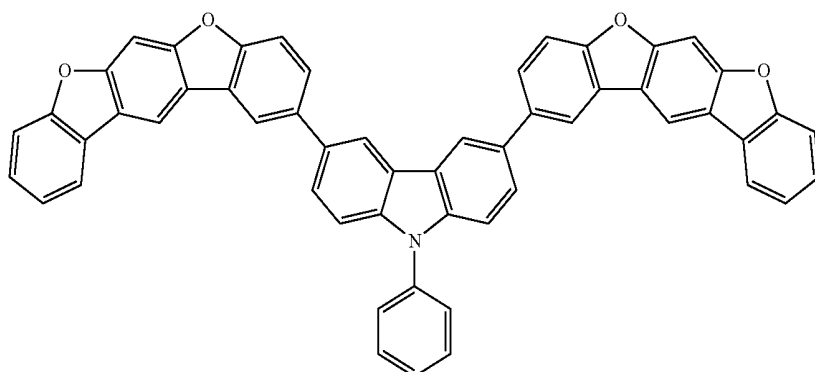
No. 46




No. 47

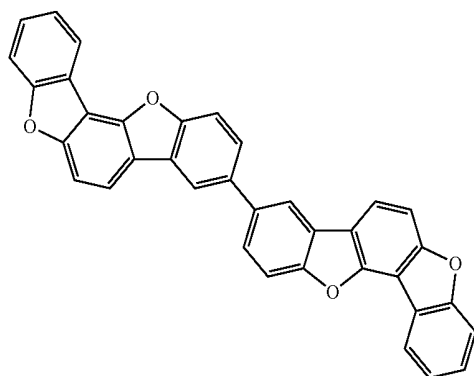


No. 48



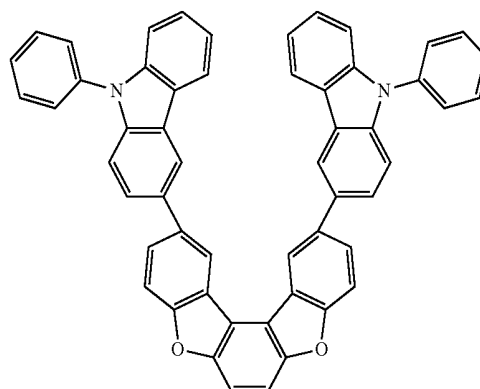
c1ccc(cc1)N2C(=O)c3cc(ccc3C2=O)C4=CC=C(C=C4)C5=CC=C(C=C5)C6=CC=C(C=C6)C7=CC=C(C=C7)C8=CC=C(C=C8)C9=CC=C(C=C9)C10=CC=C(C=C10)C11=CC=C(C=C11)C12=CC=C(C=C12)C13=CC=C(C=C13)C14=CC=C(C=C14)C15=CC=C(C=C15)C16=CC=C(C=C16)C17=CC=C(C=C17)C18=CC=C(C=C18)C19=CC=C(C=C19)C20=CC=C(C=C20)C21=CC=C(C=C21)C22=CC=C(C=C22)C23=CC=C(C=C23)C24=CC=C(C=C24)C25=CC=C(C=C25)C26=CC=C(C=C26)C27=CC=C(C=C27)C28=CC=C(C=C28)C29=CC=C(C=C29)C30=CC=C(C=C30)C31=CC=C(C=C31)C32=CC=C(C=C32)C33=CC=C(C=C33)C34=CC=C(C=C34)C35=CC=C(C=C35)C36=CC=C(C=C36)C37=CC=C(C=C37)C38=CC=C(C=C38)C39=CC=C(C=C39)C40=CC=C(C=C40)C41=CC=C(C=C41)C42=CC=C(C=C42)C43=CC=C(C=C43)C44=CC=C(C=C44)C45=CC=C(C=C45)C46=CC=C(C=C46)C47=CC=C(C=C47)C48=CC=C(C=C48)C49=CC=C(C=C49)C50=CC=C(C=C50)C51=CC=C(C=C51)C52=CC=C(C=C52)C53=CC=C(C=C53)C54=CC=C(C=C54)C55=CC=C(C=C55)C56=CC=C(C=C56)C57=CC=C(C=C57)C58=CC=C(C=C58)C59=CC=C(C=C59)C60=CC=C(C=C60)C61=CC=C(C=C61)C62=CC=C(C=C62)C63=CC=C(C=C63)C64=CC=C(C=C64)C65=CC=C(C=C65)C66=CC=C(C=C66)C67=CC=C(C=C67)C68=CC=C(C=C68)C69=CC=C(C=C69)C70=CC=C(C=C70)C71=CC=C(C=C71)C72=CC=C(C=C72)C73=CC=C(C=C73)C74=CC=C(C=C74)C75=CC=C(C=C75)C76=CC=C(C=C76)C77=CC=C(C=C77)C78=CC=C(C=C78)C79=CC=C(C=C79)C80=CC=C(C=C80)C81=CC=C(C=C81)C82=CC=C(C=C82)C83=CC=C(C=C83)C84=CC=C(C=C84)C85=CC=C(C=C85)C86=CC=C(C=C86)C87=CC=C(C=C87)C88=CC=C(C=C88)C89=CC=C(C=C89)C90=CC=C(C=C90)C91=CC=C(C=C91)C92=CC=C(C=C92)C93=CC=C(C=C93)C94=CC=C(C=C94)C95=CC=C(C=C95)C96=CC=C(C=C96)C97=CC=C(C=C97)C98=CC=C(C=C98)C99=CC=C(C=C99)C100=CC=C(C=C100)C101=CC=C(C=C101)C102=CC=C(C=C102)C103=CC=C(C=C103)C104=CC=C(C=C104)C105=CC=C(C=C105)C106=CC=C(C=C106)C107=CC=C(C=C107)C108=CC=C(C=C108)C109=CC=C(C=C109)C110=CC=C(C=C110)C111=CC=C(C=C111)C112=CC=C(C=C112)C113=CC=C(C=C113)C114=CC=C(C=C114)C115=CC=C(C=C115)C116=CC=C(C=C116)C117=CC=C(C=C117)C118=CC=C(C=C118)C119=CC=C(C=C119)C120=CC=C(C=C120)C121=CC=C(C=C121)C122=CC=C(C=C122)C123=CC=C(C=C123)C124=CC=C(C=C124)C125=CC=C(C=C125)C126=CC=C(C=C126)C127=CC=C(C=C127)C128=CC=C(C=C128)C129=CC=C(C=C129)C130=CC=C(C=C130)C131=CC=C(C=C131)C132=CC=C(C=C132)C133=CC=C(C=C133)C134=CC=C(C=C134)C135=CC=C(C=C135)C136=CC=C(C=C136)C137=CC=C(C=C137)C138=CC=C(C=C138)C139=CC=C(C=C139)C140=CC=C(C=C140)C141=CC=C(C=C141)C142=CC=C(C=C142)C143=CC=C(C=C143)C144=CC=C(C=C144)C145=CC=C(C=C145)C146=CC=C(C=C146)C147=CC=C(C=C147)C148=CC=C(C=C148)C149=CC=C(C=C149)C150=CC=C(C=C150)C151=CC=C(C=C151)C152=CC=C(C=C152)C153=CC=C(C=C153)C154=CC=C(C=C154)C155=CC=C(C=C155)C156=CC=C(C=C156)C157=CC=C(C=C157)C158=CC=C(C=C158)C159=CC=C(C=C159)C160=CC=C(C=C160)C161=CC=C(C=C161)C162=CC=C(C=C162)C163=CC=C(C=C163)C164=CC=C(C=C164)C165=CC=C(C=C165)C166=CC=C(C=C166)C167=CC=C(C=C167)C168=CC=C(C=C168)C169=CC=C(C=C169)C170=CC=C(C=C170)C171=CC=C(C=C171)C172=CC=C(C=C172)C173=CC=C(C=C173)C174=CC=C(C=C174)C175=CC=C(C=C175)C176=CC=C(C=C176)C177=CC=C(C=C177)C178=CC=C(C=C178)C179=CC=C(C=C179)C180=CC=C(C=C180)C181=CC=C(C=C181)C182=CC=C(C=C182)C183=CC=C(C=C183)C184=CC=C(C=C184)C185=CC=C(C=C185)C186=CC=C(C=C186)C187=CC=C(C=C187)C188=CC=C(C=C188)C189=CC=C(C=C189)C190=CC=C(C=C190)C191=CC=C(C=C191)C192=CC=C(C=C192)C193=CC=C(C=C193)C194=CC=C(C=C194)C195=CC=C(C=C195)C196=CC=C(C=C196)C197=CC=C(C=C197)C198=CC=C(C=C198)C199=CC=C(C=C199)C200=CC=C(C=C200)C201=CC=C(C=C201)C202=CC=C(C=C202)C203=CC=C(C=C203)C204=CC=C(C=C204)C205=CC=C(C=C205)C206=CC=C(C=C206)C207=CC=C(C=C207)C208=CC=C(C=C208)C209=CC=C(C=C209)C210=CC=C(C=C210)C211=CC=C(C=C211)C212=CC=C(C=C212)C213=CC=C(C=C213)C214=CC=C(C=C214)C215=CC=C(C=C215)C216=CC=C(C=C216)C217=CC=C(C=C217)C218=CC=C(C=C218)C219=CC=C(C=C219)C220=CC=C(C=C220)C221=CC=C(C=C221)C222=CC=C(C=C222)C223=CC=C(C=C223)C224=CC=C(C=C224)C225=CC=C(C=C225)C226=CC=C(C=C226)C227=CC=C(C=C227)C228=CC=C(C=C228)C229=CC=C(C=C229)C230=CC=C(C=C230)C231=CC=C(C=C231)C232=CC=C(C=C232)C233=CC=C(C=C233)C234=CC=C(C=C234)C235=CC=C(C=C235)C236=CC=C(C=C236)C237=CC=C(C=C237)C238=CC=C(C=C238)C239=CC=C(C=C239)C240=CC=C(C=C240)C241=CC=C(C=C241)C242=CC=C(C=C242)C243=CC=C(C=C243)C244=CC=C(C=C244)C245=CC=C(C=C245)C246=CC=C(C=C246)C247=CC=C(C=C247)C248=CC=C(C=C248)C249=CC=C(C=C249)C250=CC=C(C=C250)C251=CC=C(C=C251)C252=CC=C(C=C252)C253=CC=C(C=C253)C254=CC=C(C=C254)C255=CC=C(C=C255)C256=CC=C(C=C256)C257=CC=C(C=C257)C258=CC=C(C=C258)C259=CC=C(C=C259)C260=CC=C(C=C260)C261=CC=C(C=C261)C262=CC=C(C=C262)C263=CC=C(C=C263)C264=CC=C(C=C264)C265=CC=C(C=C265)C266=CC=C(C=C266)C267=CC=C(C=C267)C268=CC=C(C=C268)C269=CC=C(C=C269)C270=CC=C(C=C270)C271=CC=C(C=C271)C272=CC=C(C=C272)C273=CC=C(C=C273)C274=CC=C(C=C274)C275=CC=C(C=C275)C276=CC=C(C=C276)C277=CC=C(C=C277)C278=CC=C(C=C278)C279=CC=C(C=C279)C280=CC=C(C=C280)C281=CC=C(C=C281)C282=CC=C(C=C282)C283=CC=C(C=C283)C284=CC=C(C=C284)C285=CC=C(C=C285)C286=CC=C(C=C286)C287=CC=C(C=C287)C288=CC=C(C=C288)C289=CC=C(C=C289)C290=CC=C(C=C290)C291=CC=C(C=C291)C292=CC=C(C=C292)C293=CC=C(C=C293)C294=CC=C(C=C294)C295=CC=C(C=C295)C296=CC=C(C=C296)C297=CC=C(C=C297)C298=CC=C(C=C298)C299=CC=C(C=C299)C300=CC=C(C=C300)C301=CC=C(C=C301)C302=CC=C(C=C302)C303=CC=C(C=C303)C304=CC=C(C=C304)C305=CC=C(C=C305)C306=CC=C(C=C306)C307=CC=C(C=C307)C308=CC=C(C=C308)C309=CC=C(C=C309)C310=CC=C(C=C310)C311=CC=C(C=C311)C312=CC=C(C=C312)C313=CC=C(C=C313)C314=CC=C(C=C314)C315=CC=C(C=C315)C316=CC=C(C=C316)C317=CC=C(C=C317)C318=CC=C(C=C318)C319=CC=C(C=C319)C320=CC=C(C=C320)C321=CC=C(C=C321)C322=CC=C(C=C322)C323=CC=C(C=C323)C324=CC=C(C=C324)C325=CC=C(C=C325)C326=CC=C(C=C326)C327=CC=C(C=C327)C328=CC=C(C=C328)C329=CC=C(C=C329)C330=CC=C(C=C330)C331=CC=C(C=C331)C332=CC=C(C=C33

45

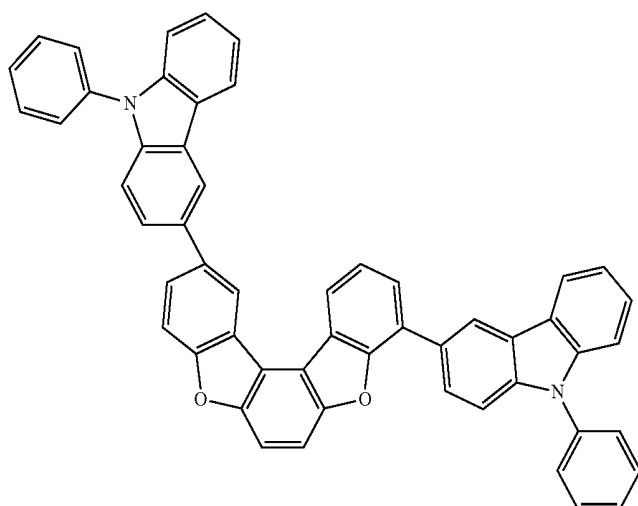


-continued
No. 55

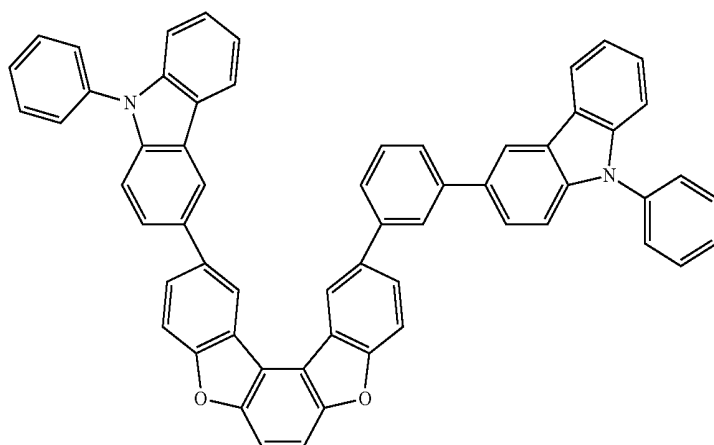
46



No. 56



No. 57



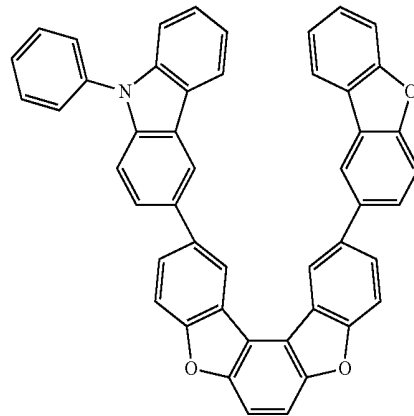
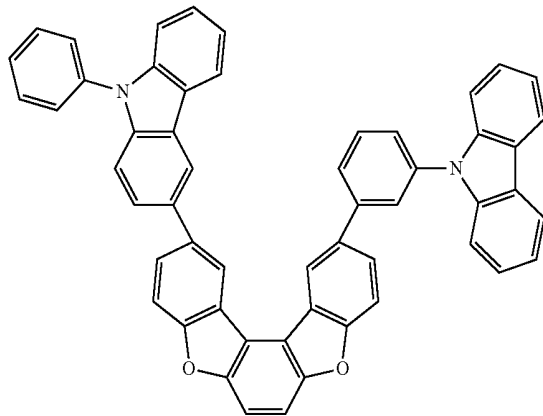
No. 58

47

48

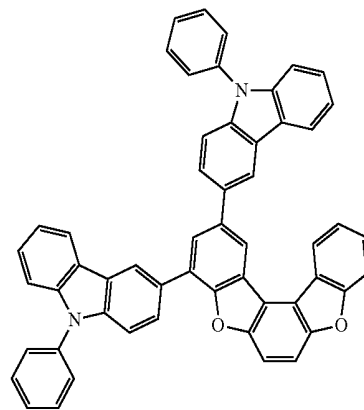
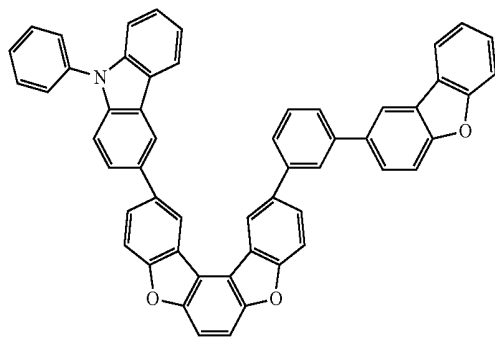
-continued
No. 59

No. 60



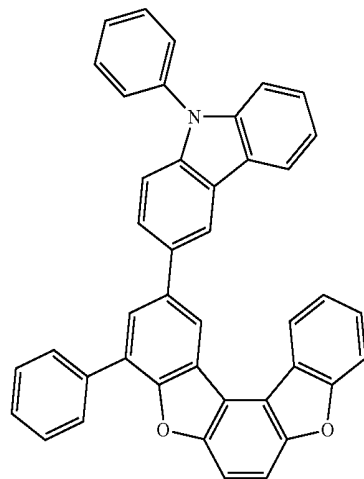
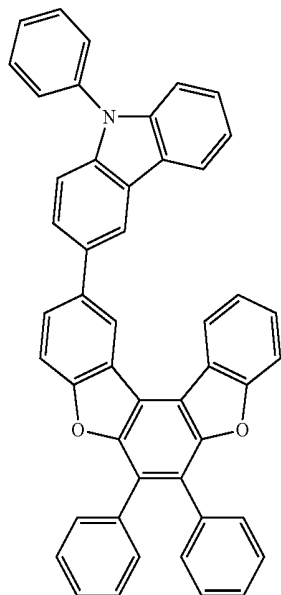
No. 61

No. 62



No. 63

No. 64



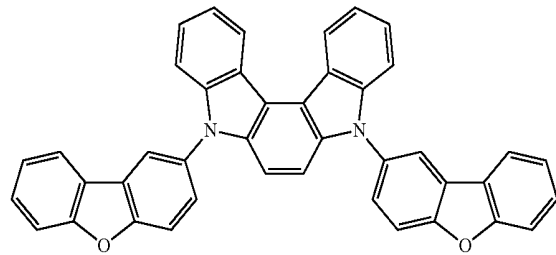
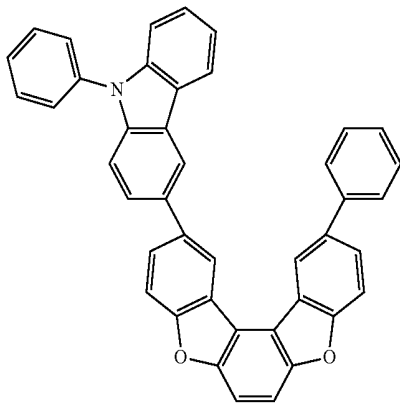
49

50

-continued

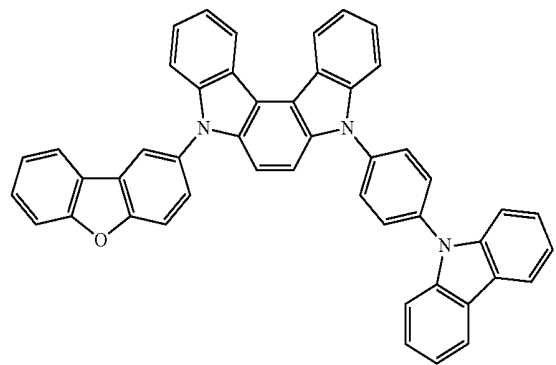
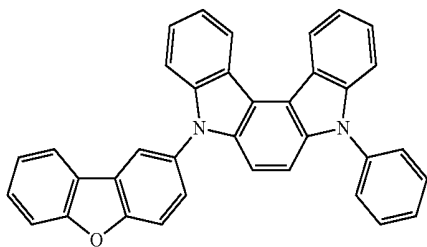
No. 65

No. 66



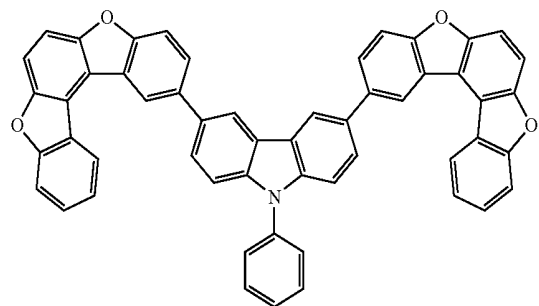
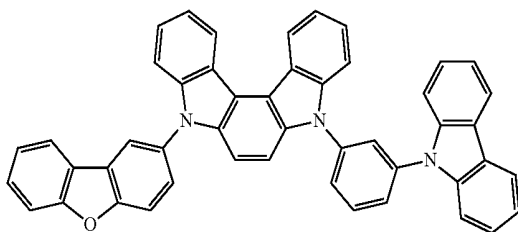
No. 67

No. 68



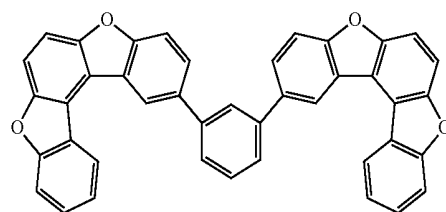
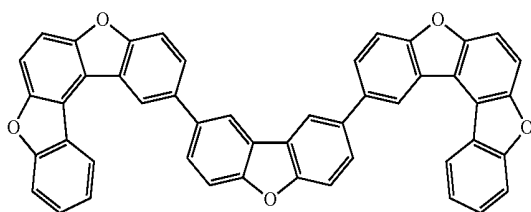
No. 69

No. 70



No. 71

No. 72



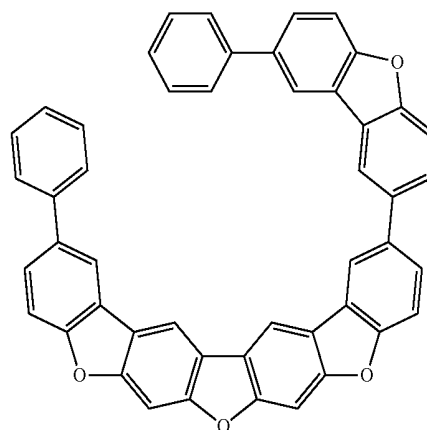
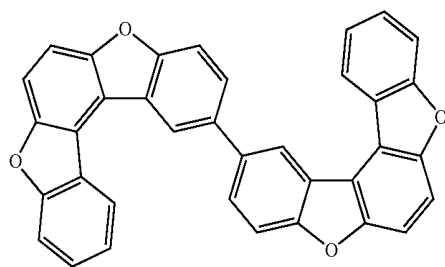
51

52

-continued

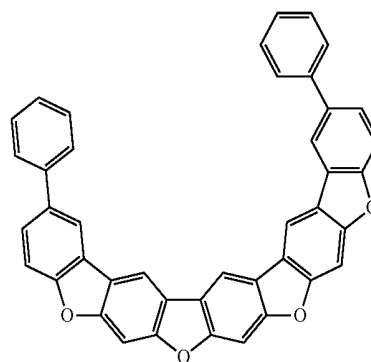
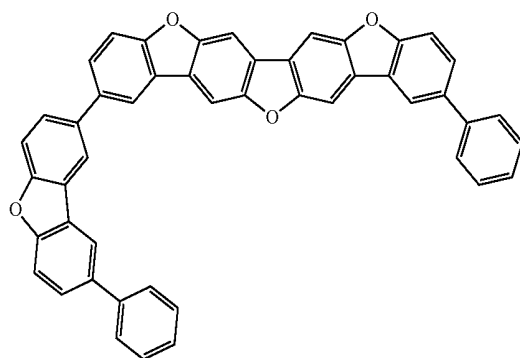
No. 73

No. 74

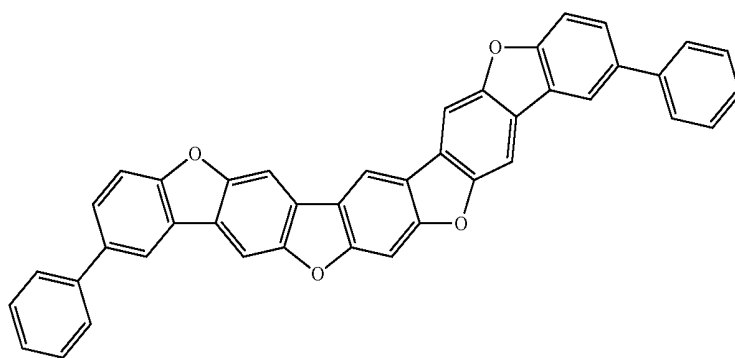


No. 75

No. 76

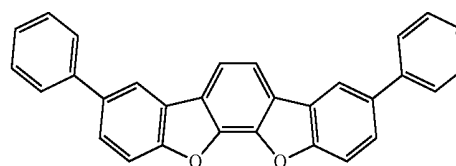
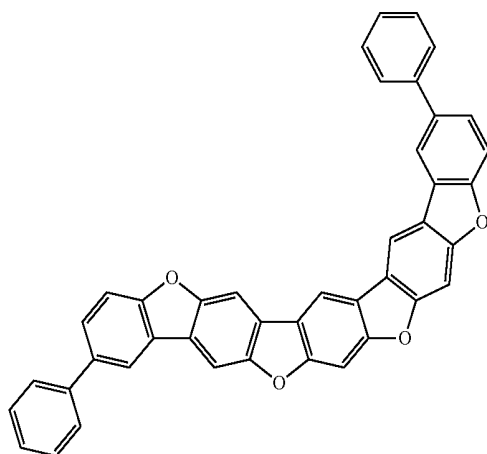


No. 77

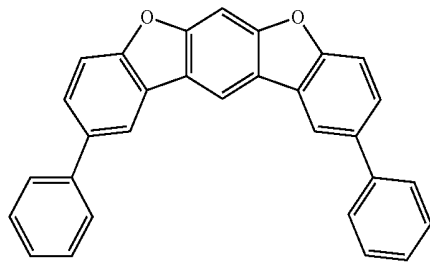


No. 78

No. 79



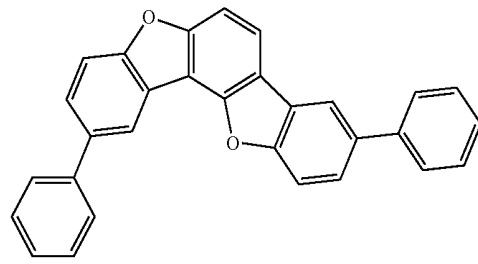
53



-continued

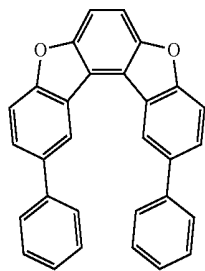
No. 80

54

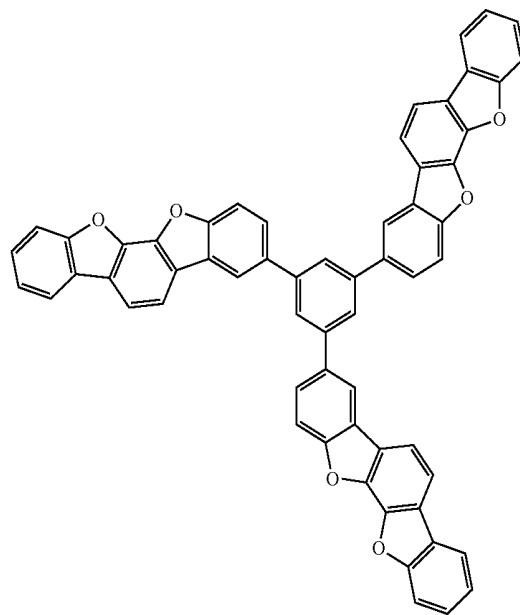


No. 81

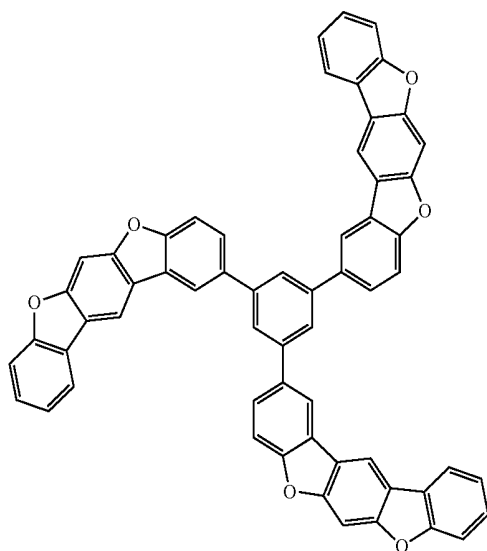
No. 82



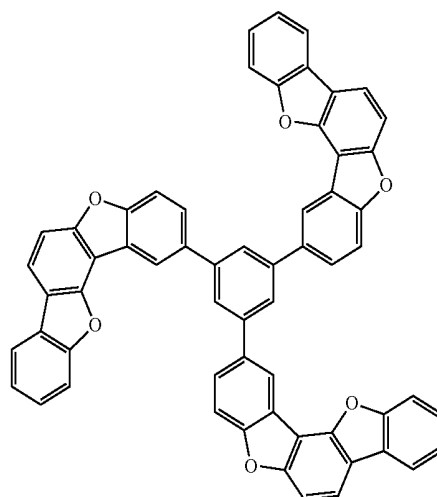
No. 83



No. 84



No. 85



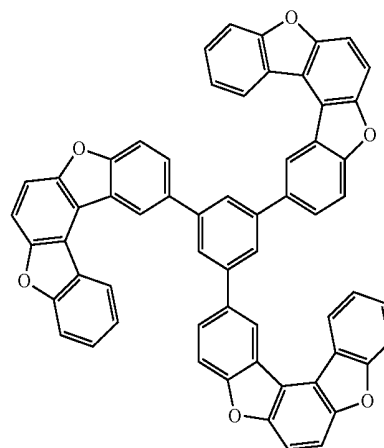
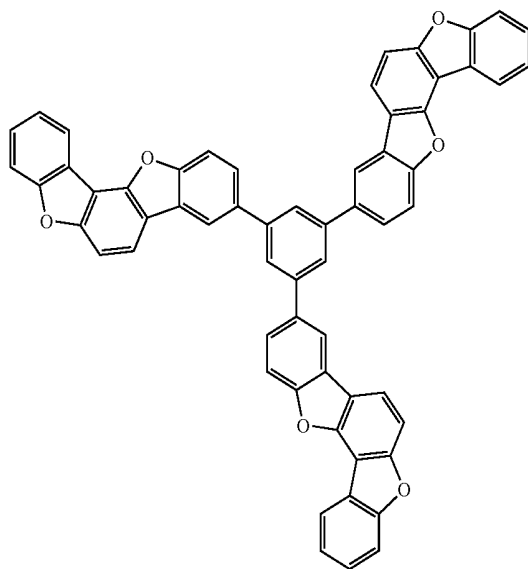
55

56

-continued

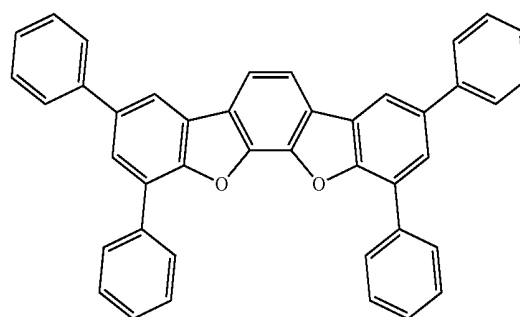
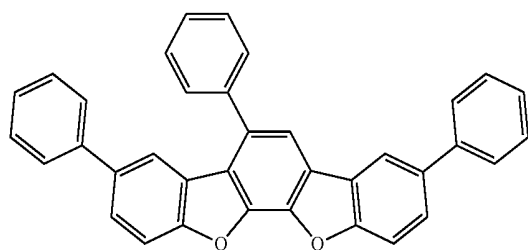
No. 86

No. 87

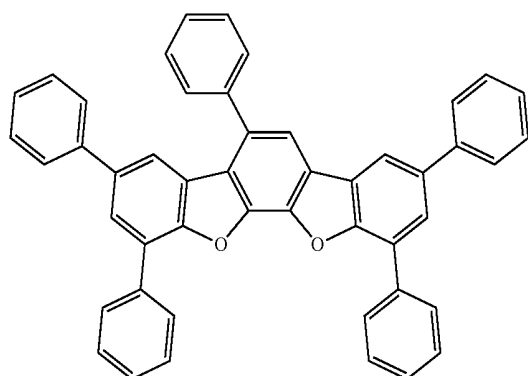


No. 88

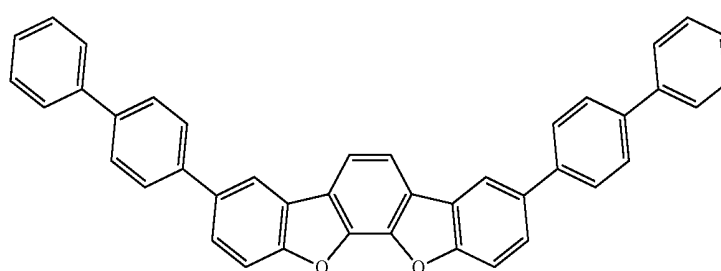
No. 89



No. 90



No. 91

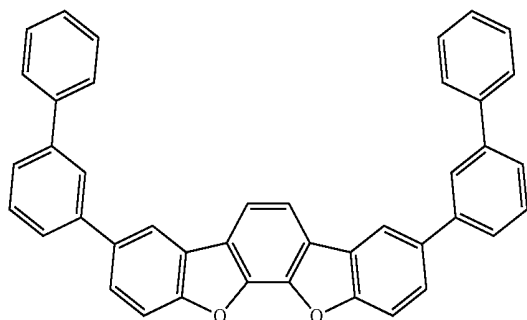


57

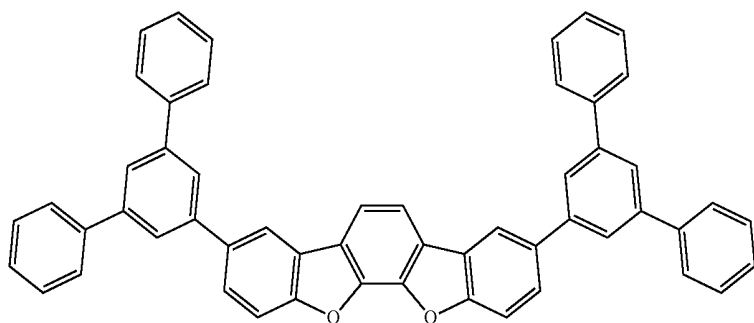
58

-continued

No. 92

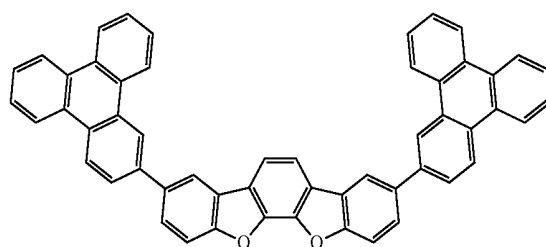
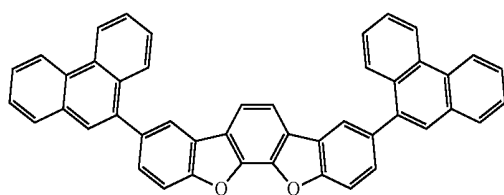


No. 93



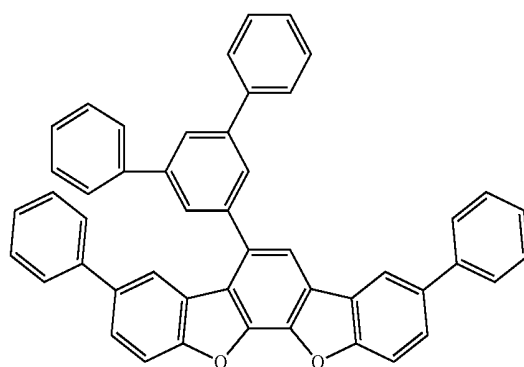
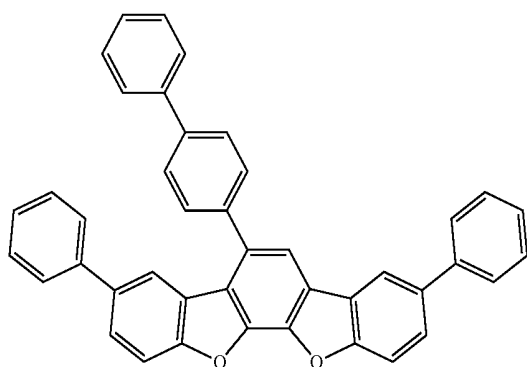
No. 94

No. 95



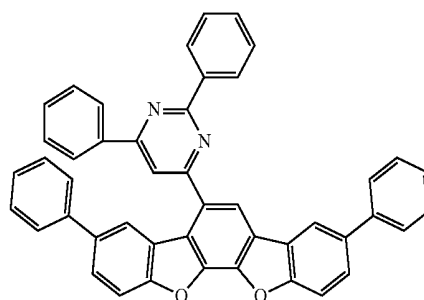
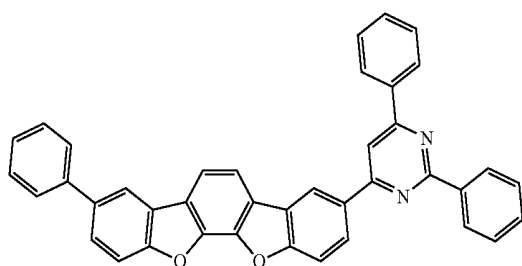
No. 96

No. 97



No. 98

No. 99

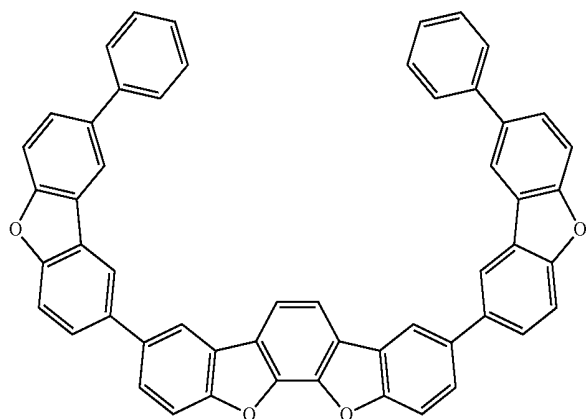


59

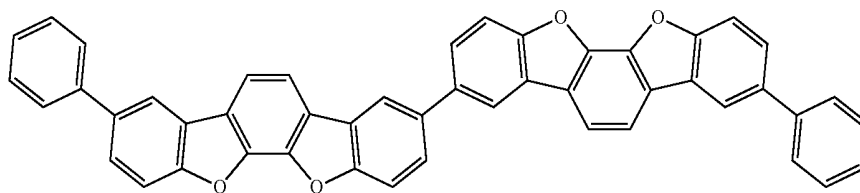
60

-continued

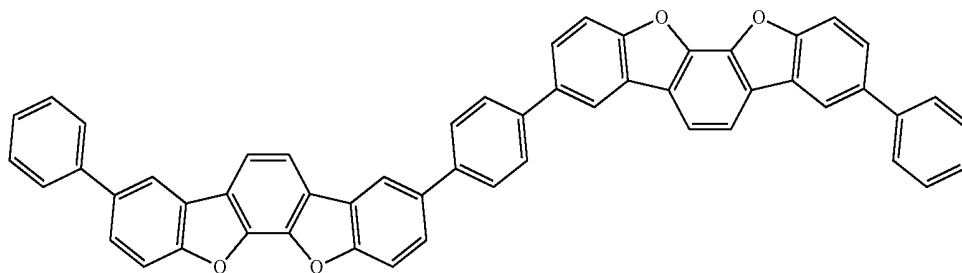
No. 100



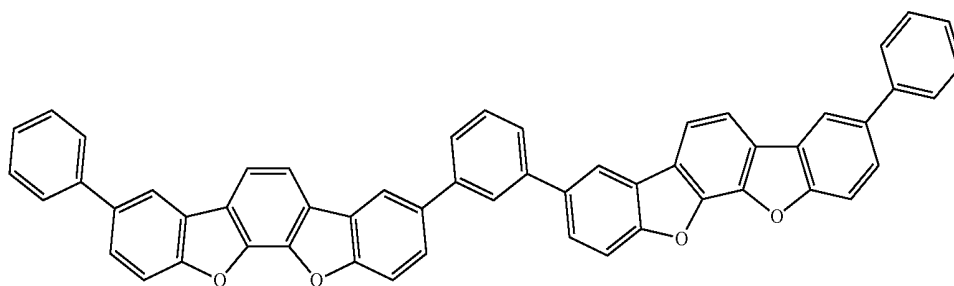
No. 101



No. 102

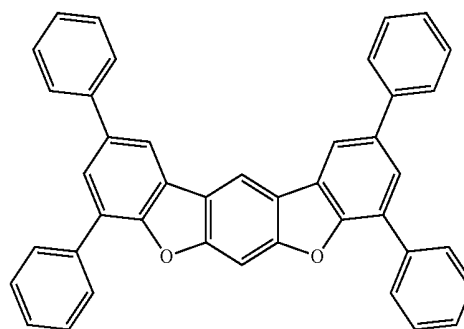
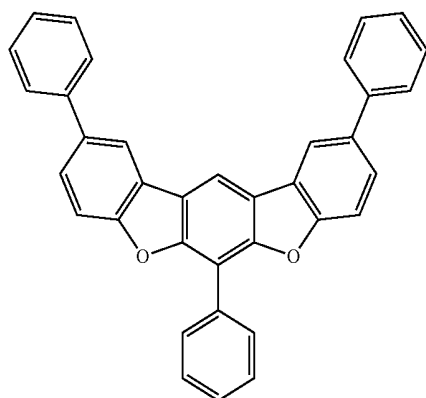


No. 103



No. 104

No. 105



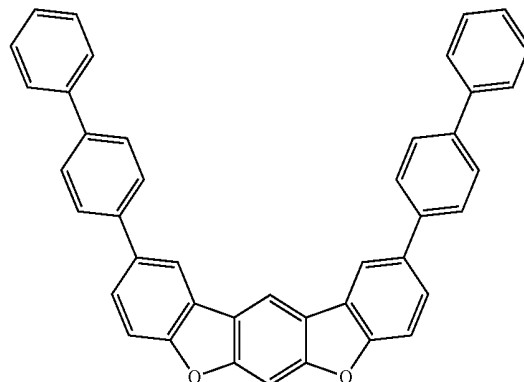
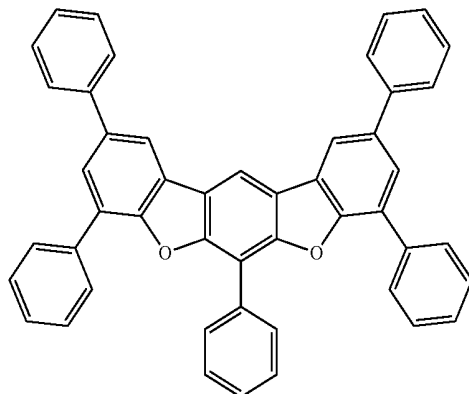
61

62

-continued

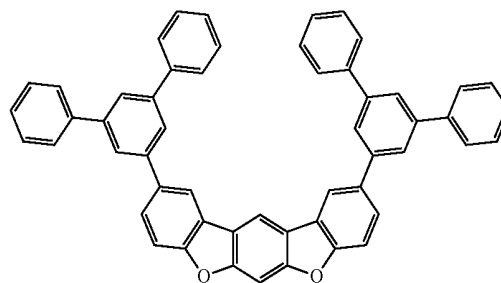
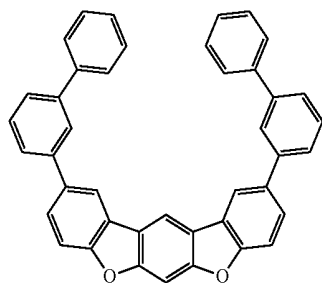
No. 106

No. 107



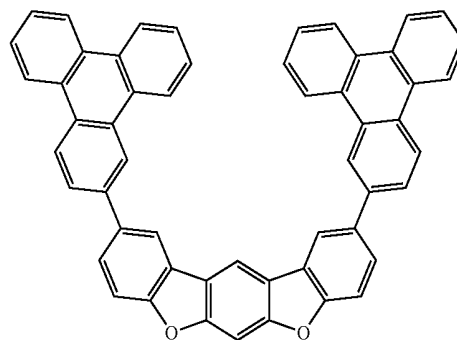
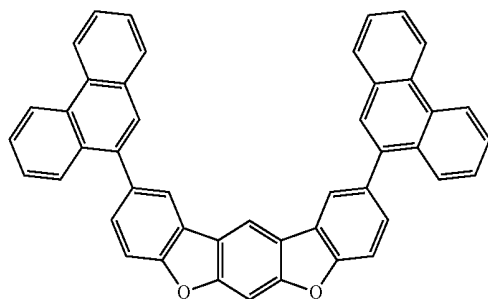
No. 108

No. 109



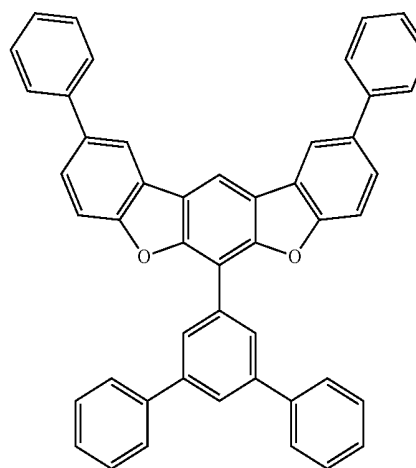
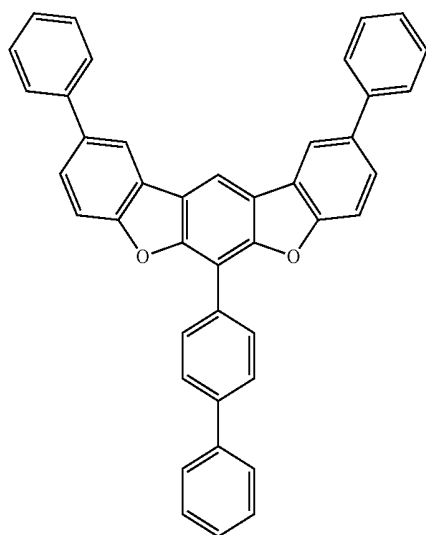
No. 110

No. 111



No. 112

No. 113



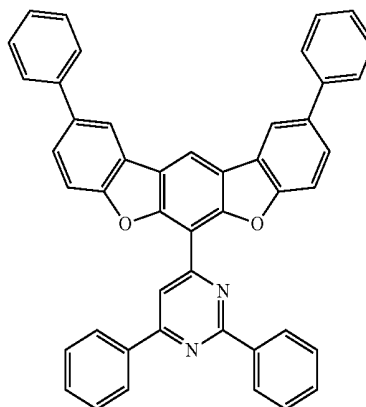
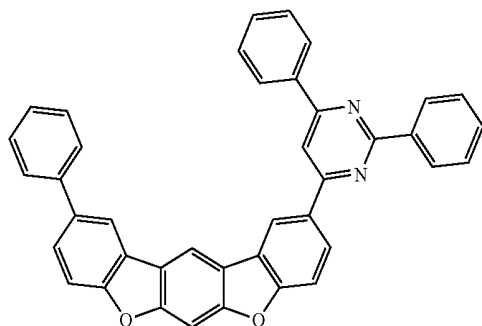
63

64

-continued

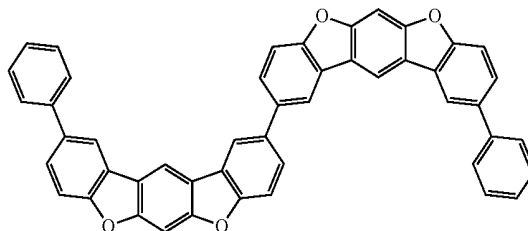
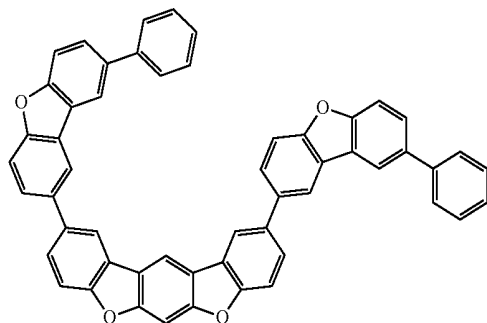
No. 114

No. 115

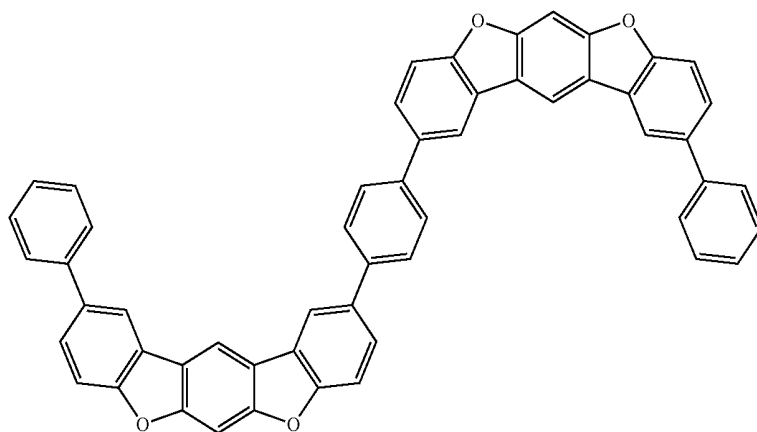


No. 116

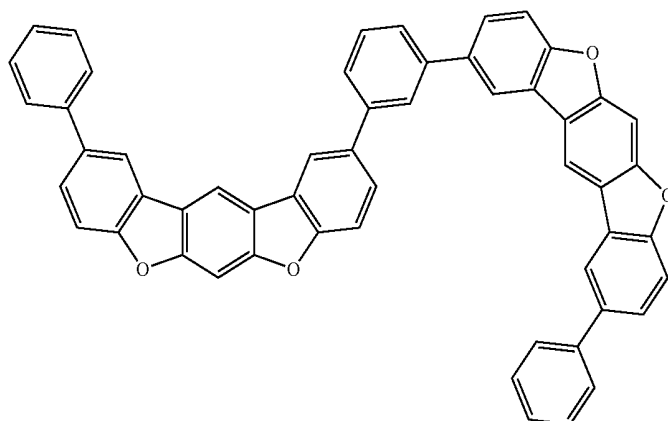
No. 117



No. 118



No. 119

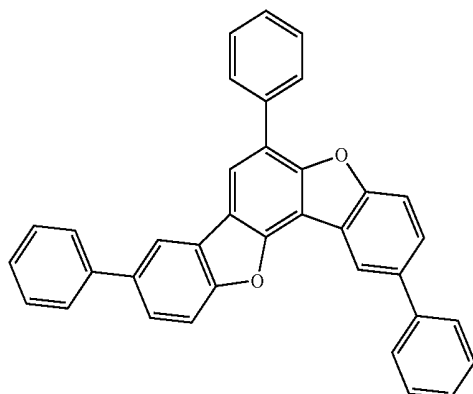


65

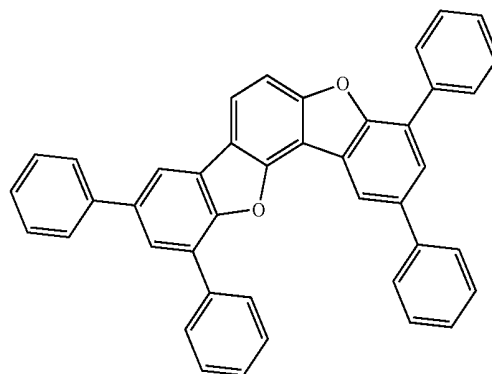
66

-continued
No. 120

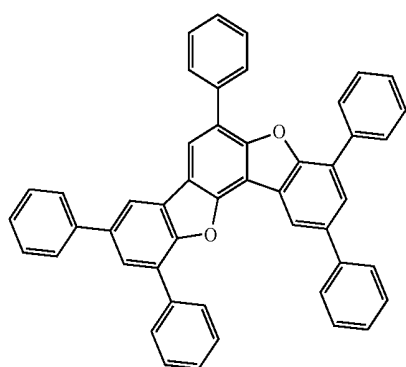
No. 121



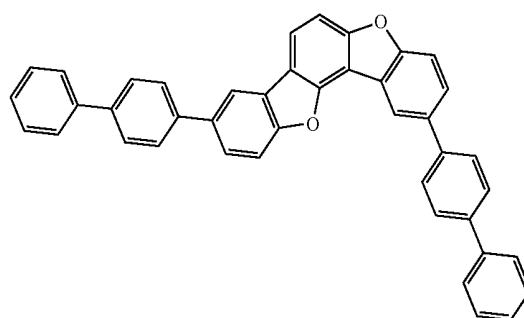
No. 122



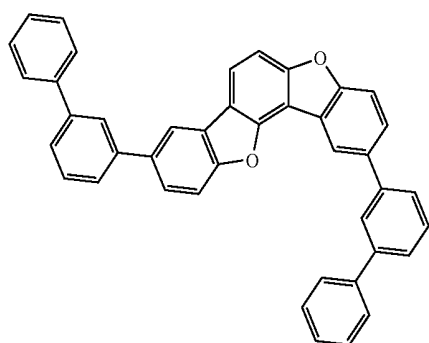
No. 123



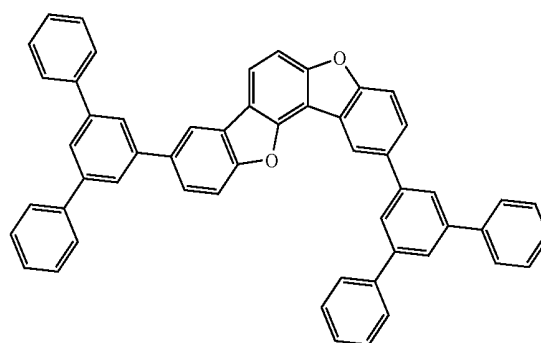
No. 124



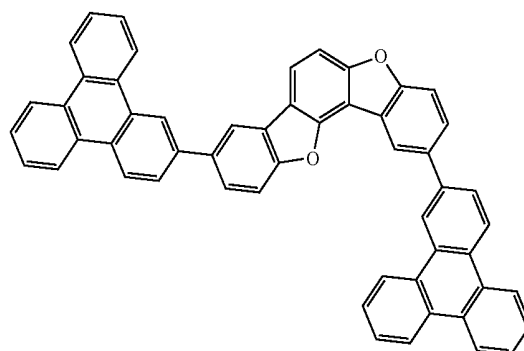
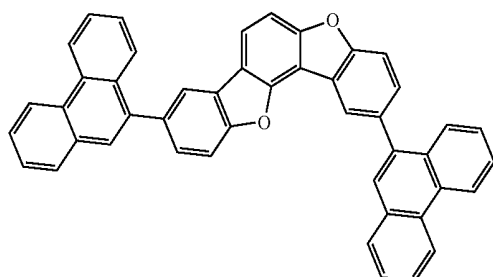
No. 125



No. 126

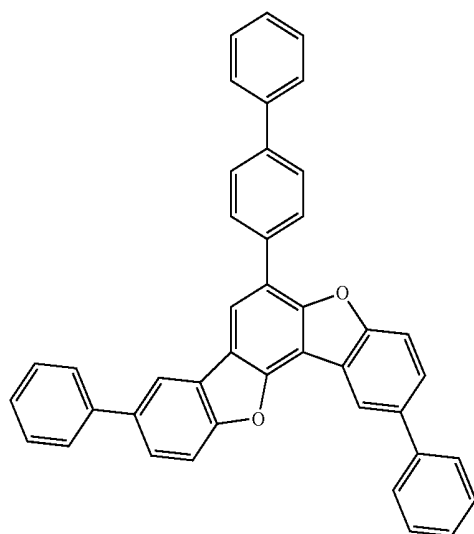


No. 127



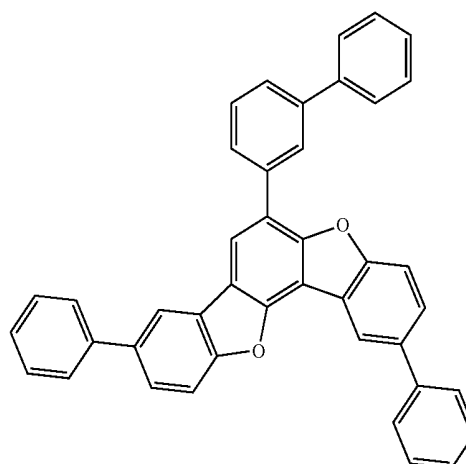
67

-continued
No. 128



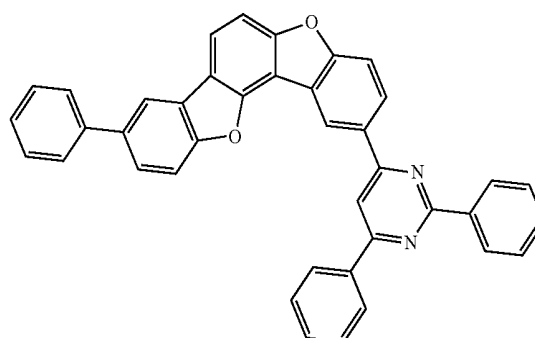
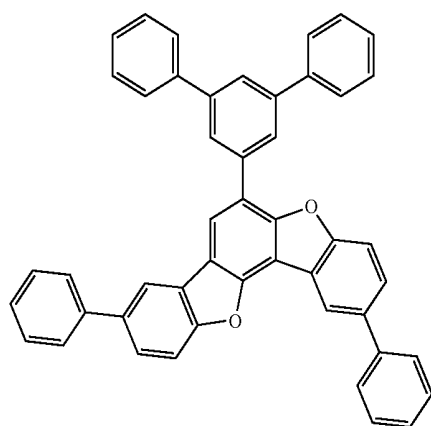
68

No. 129



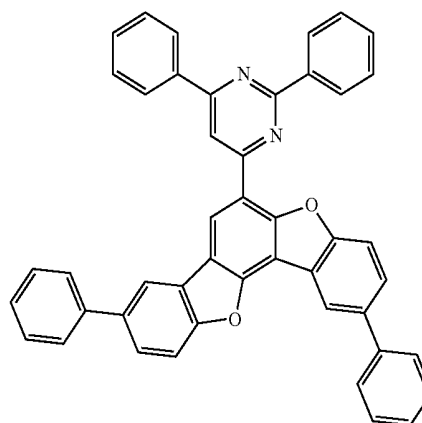
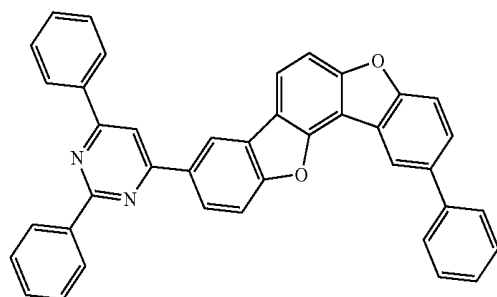
No. 130

No. 131



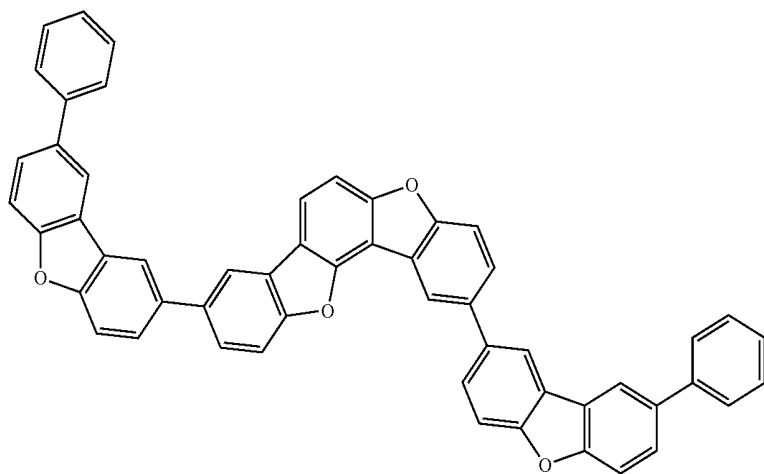
No. 132

No. 133

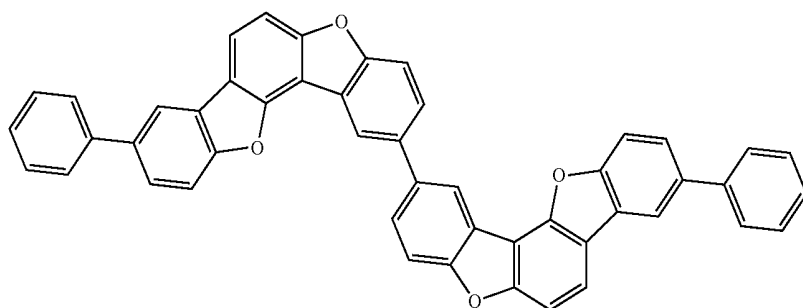


-continued

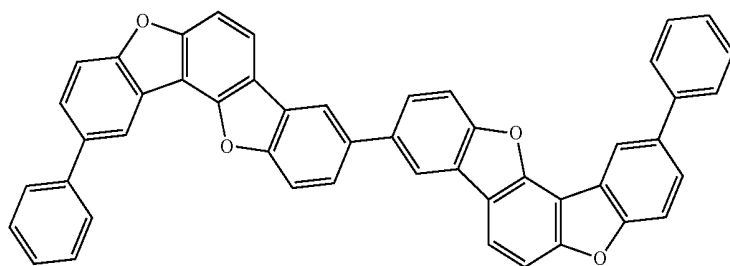
No. 134



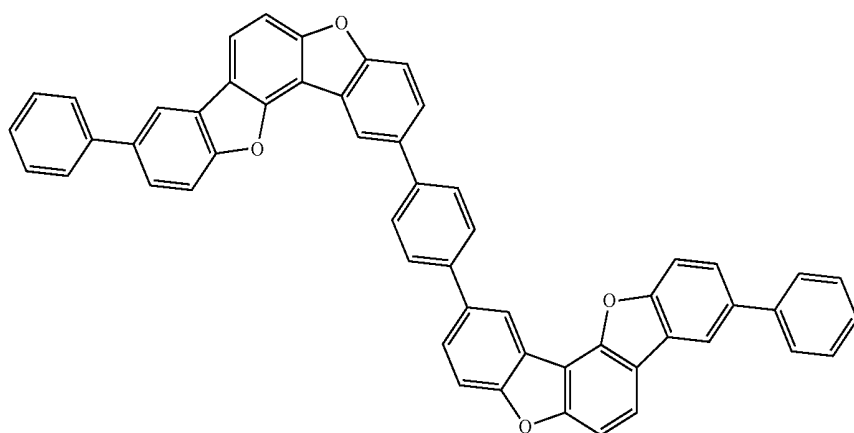
No. 135



No. 136



No. 137

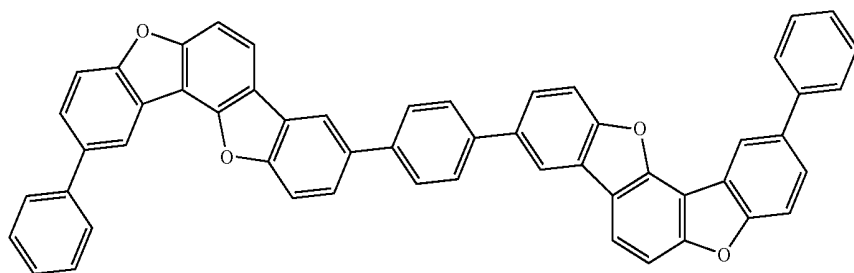


71

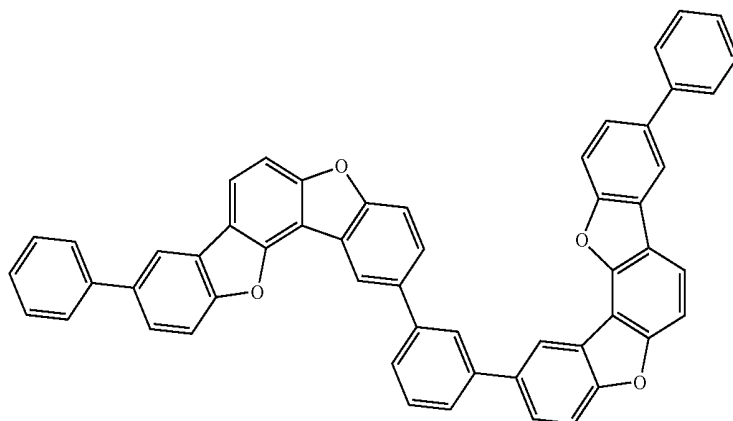
72

-continued

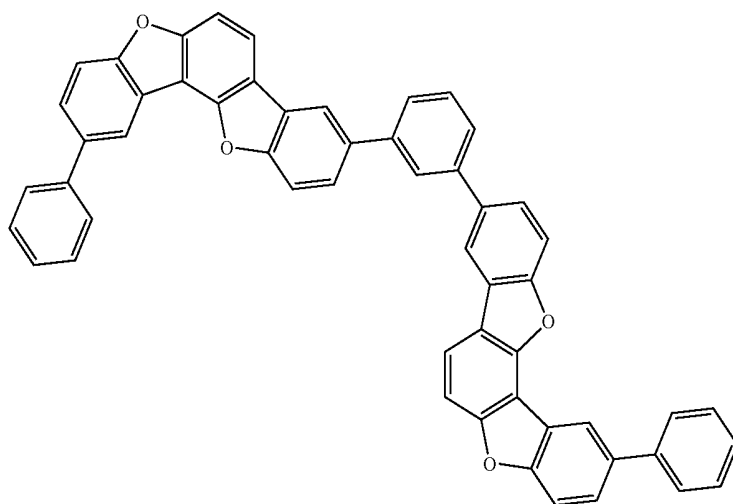
No. 138



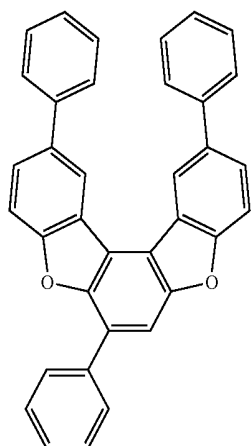
No. 139



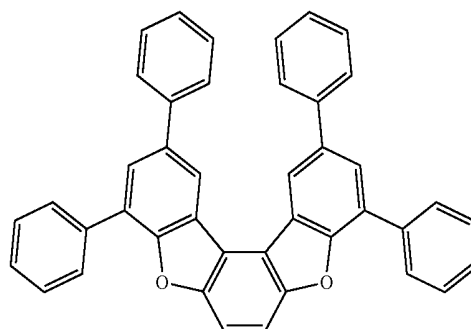
No. 140



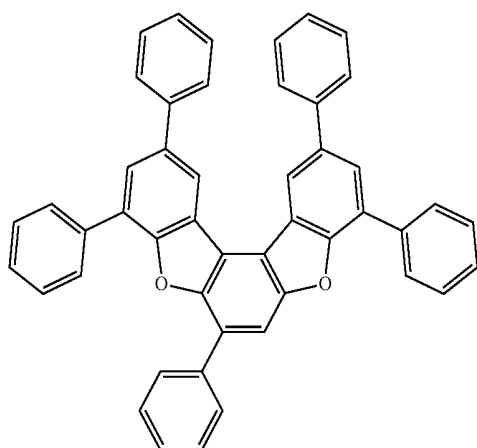
No. 141



No. 142

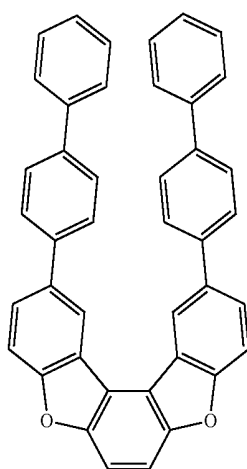


73



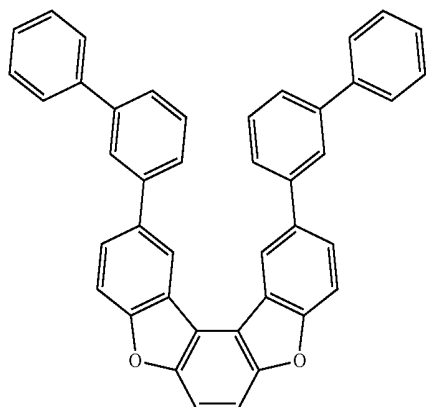
-continued
No. 143

74

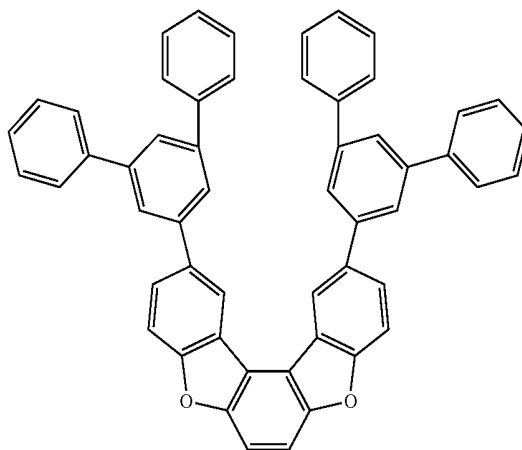


No. 144

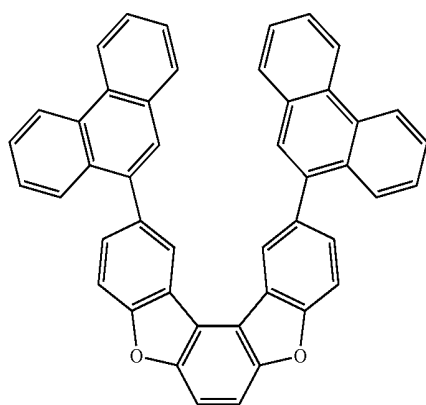
No. 145



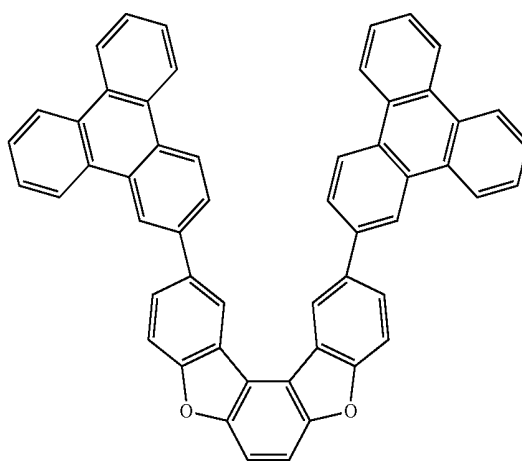
No. 146



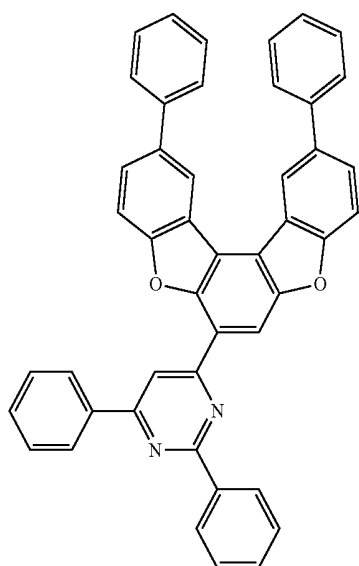
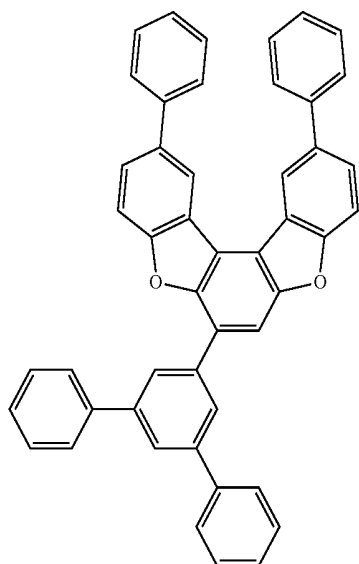
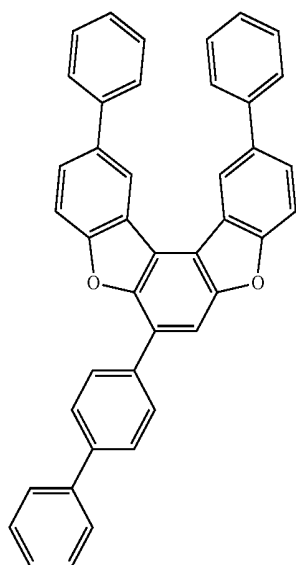
No. 147



No. 148



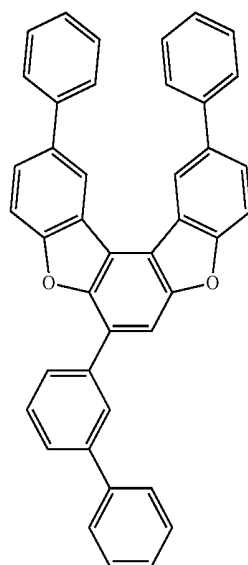
75



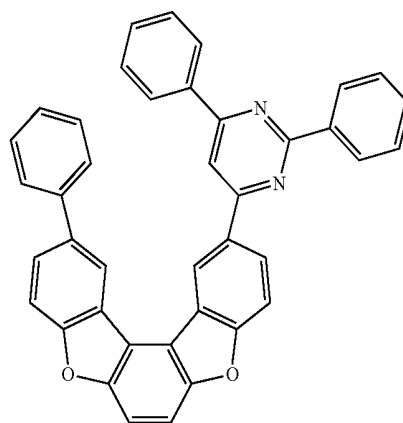
76

-continued

No. 149



No. 151



No. 150

No. 152

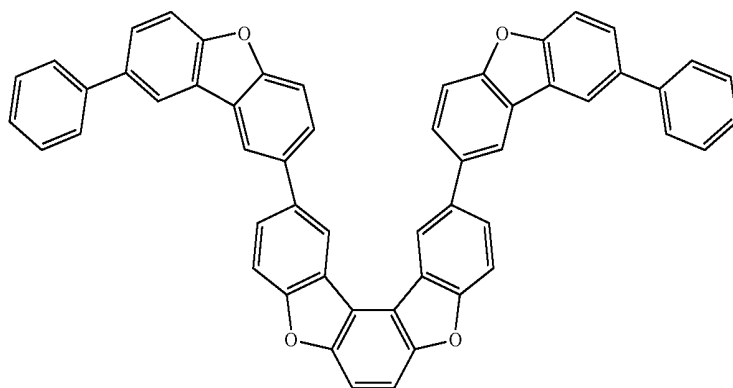
No. 153

77

78

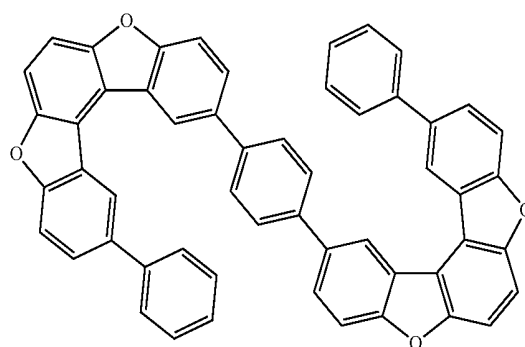
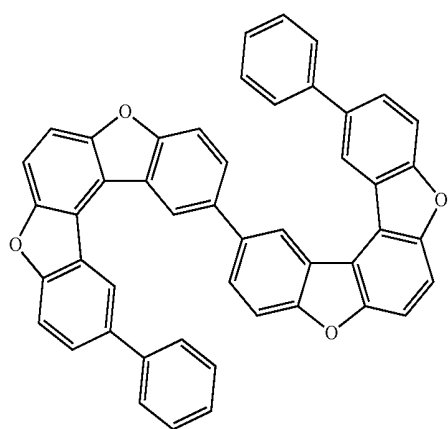
-continued

No. 154



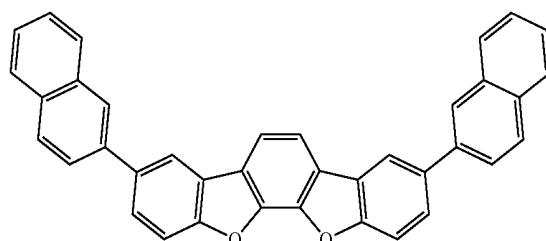
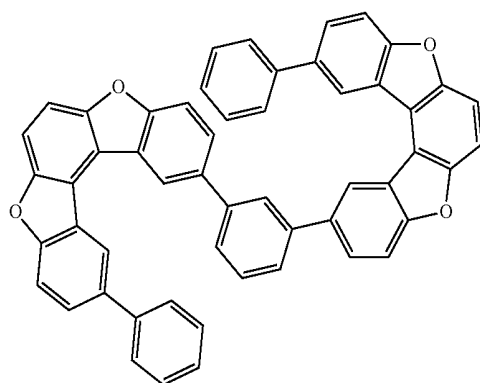
No. 155

No. 156



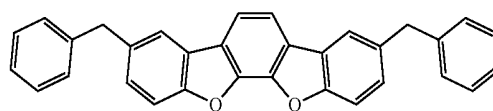
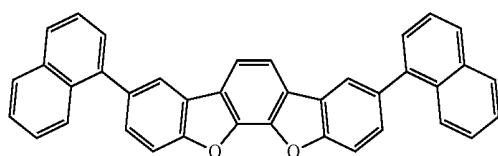
No. 157

No. 158

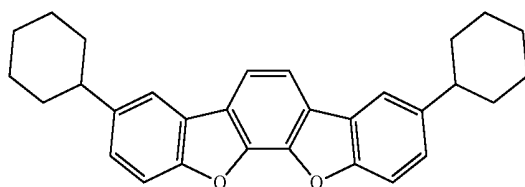


No. 159

No. 160



No. 161

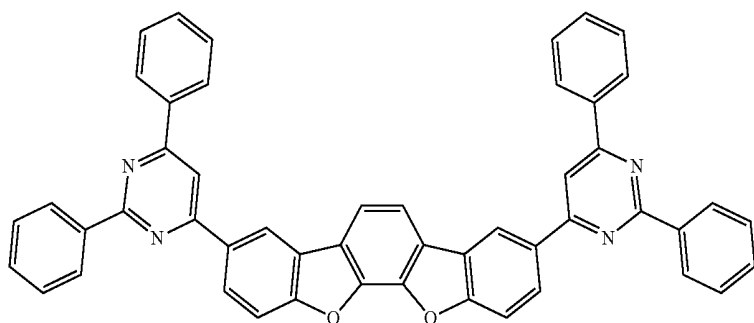


79

80

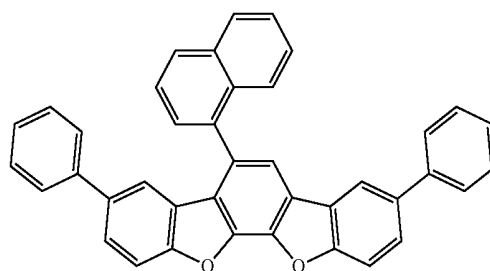
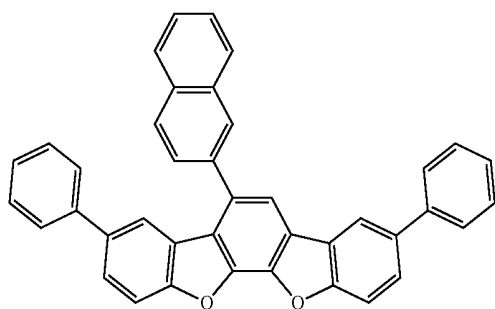
-continued

No. 162



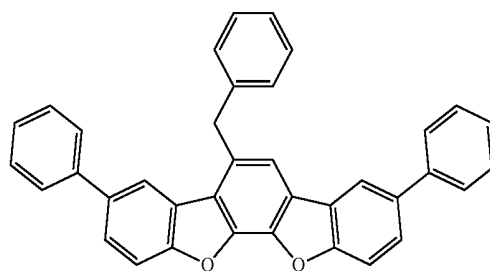
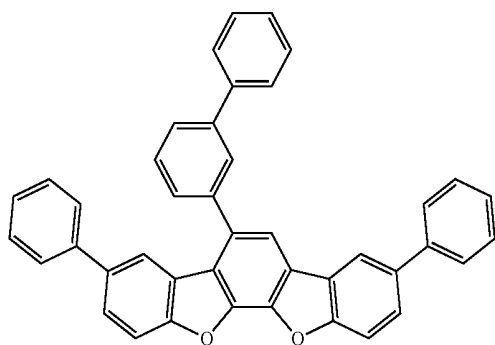
No. 163

No. 164



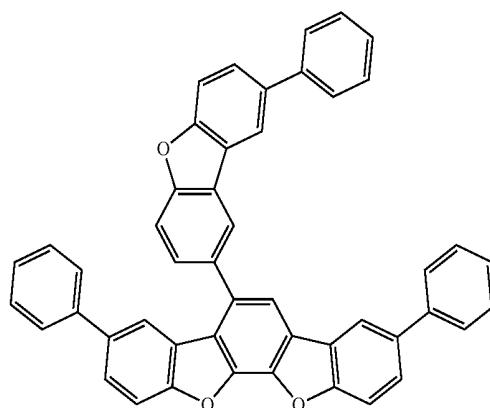
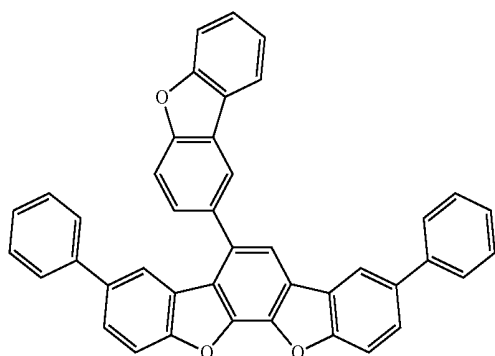
No. 165

No. 166



No. 167

No. 168



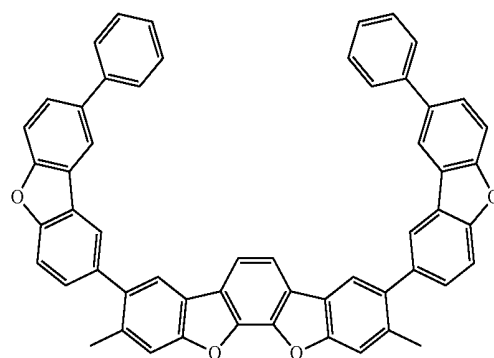
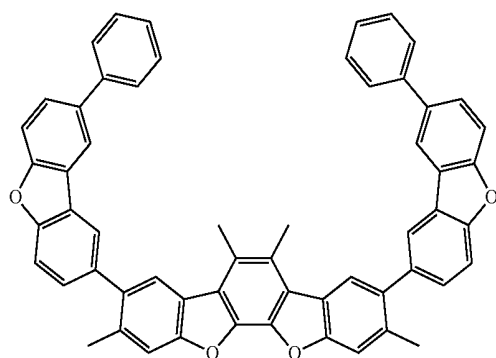
81

82

-continued

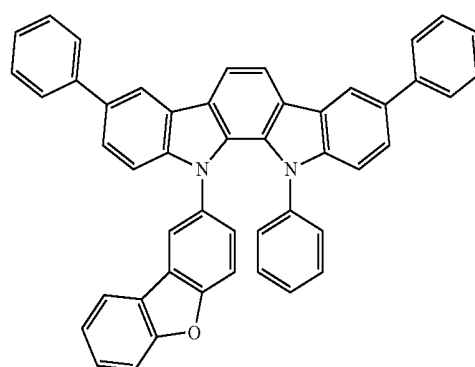
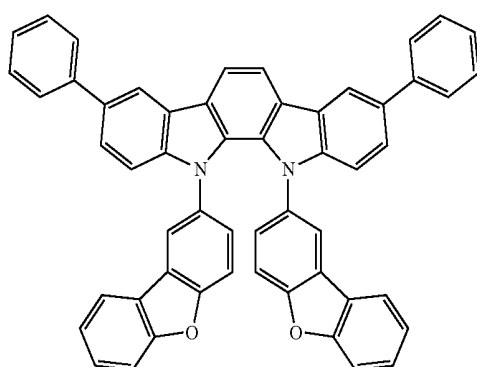
No. 169

No. 170



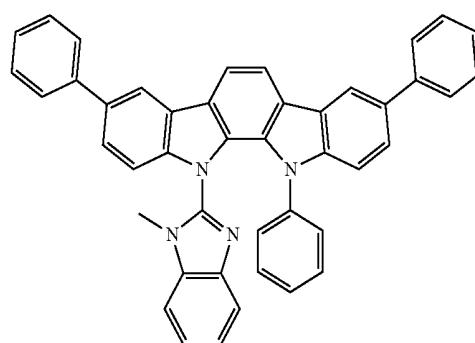
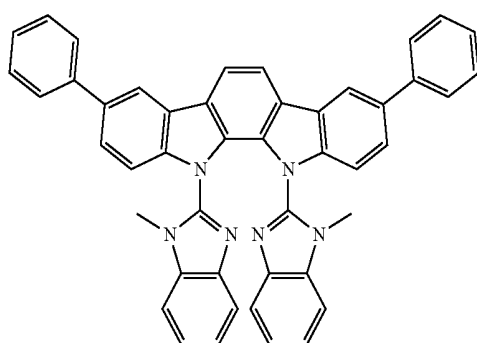
No. 171

No. 172



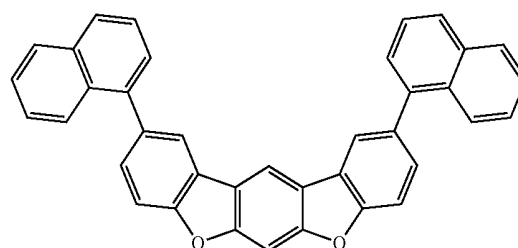
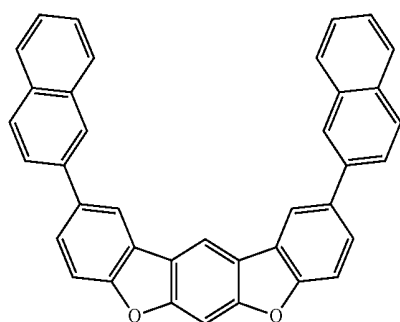
No. 173

No. 174



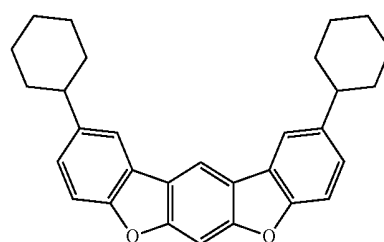
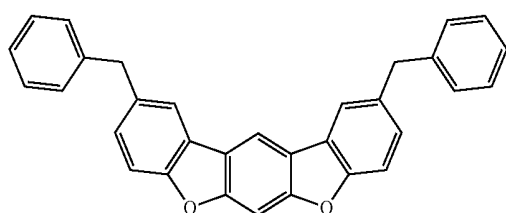
No. 175

No. 176

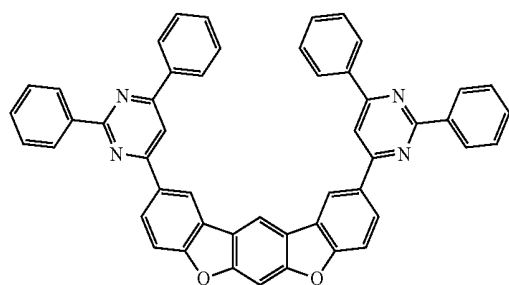


No. 177

No. 178

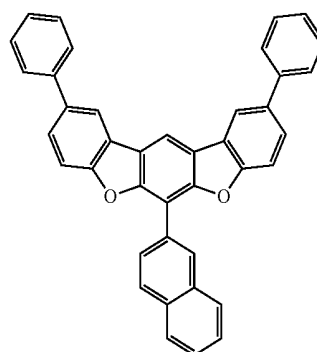


83



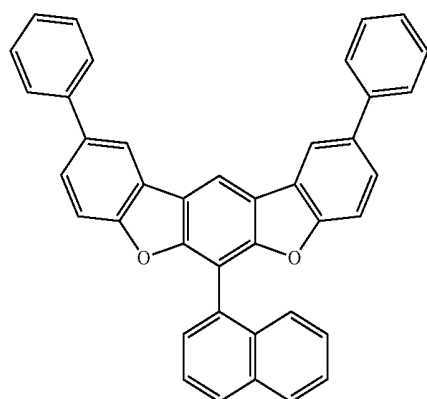
-continued
No. 179

84

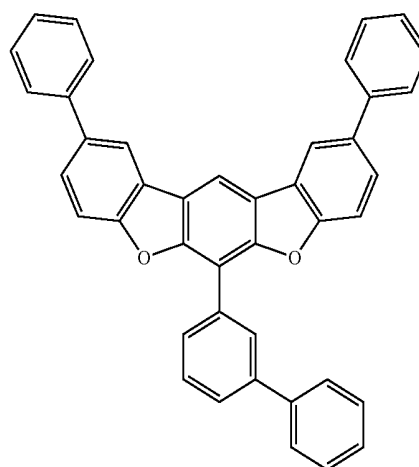


No. 180

No. 181

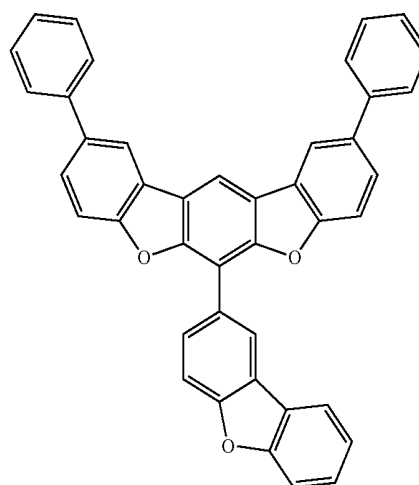
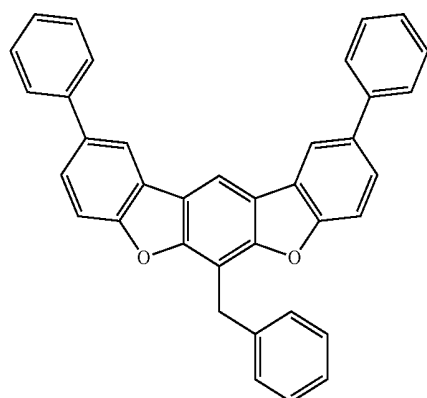


No. 182



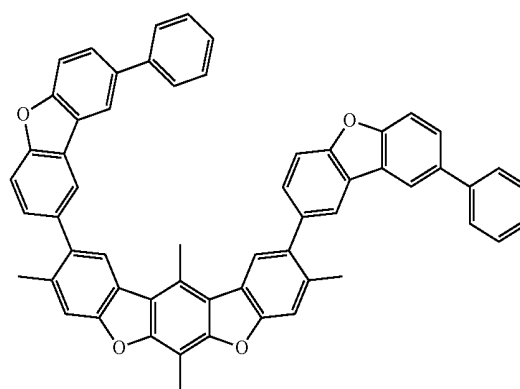
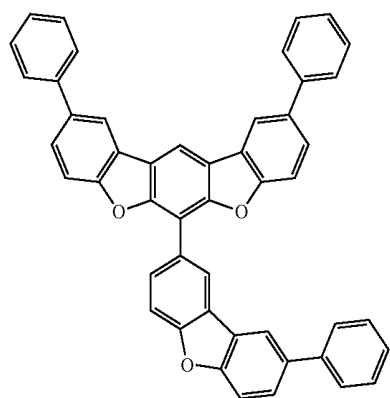
No. 183

No. 184



No. 185

No. 186



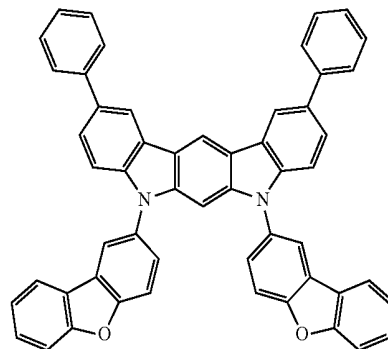
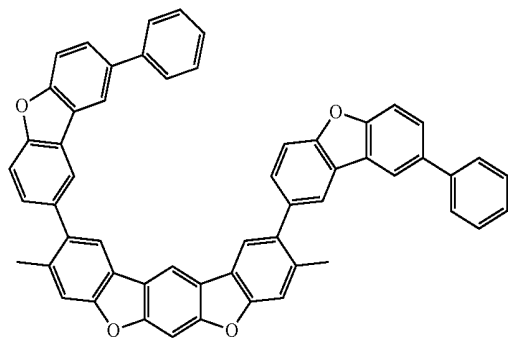
85

86

-continued

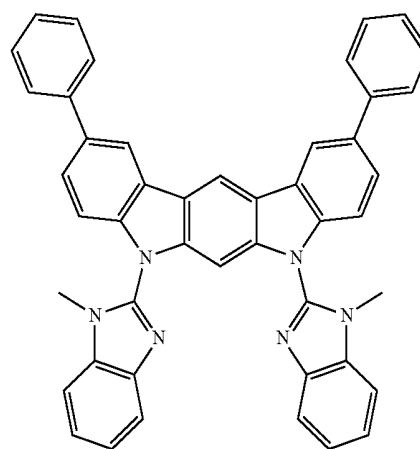
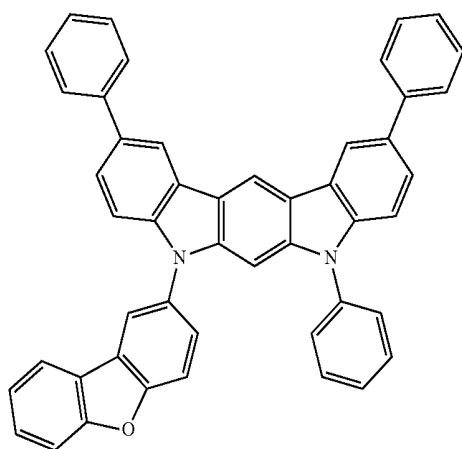
No. 187

No. 188



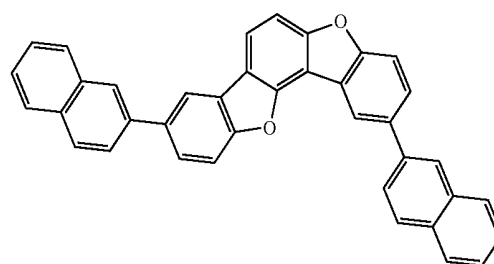
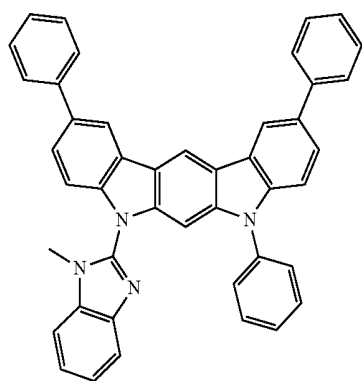
No. 189

No. 190



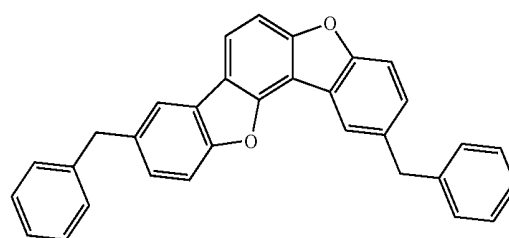
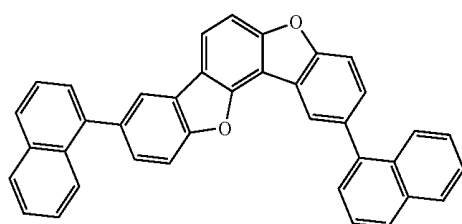
No. 191

No. 192

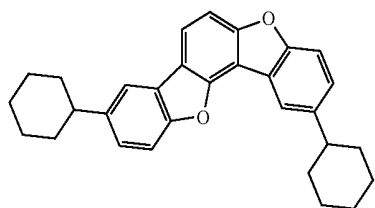


No. 193

No. 194



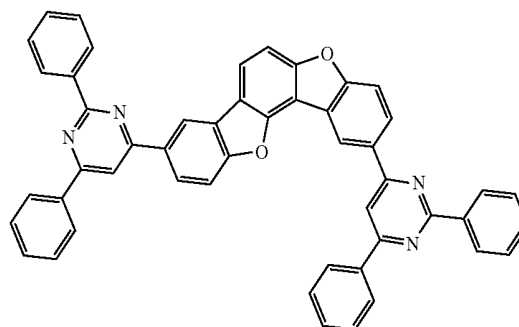
87



-continued

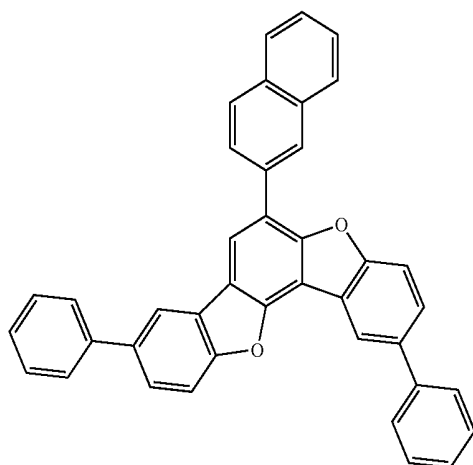
No. 195

88

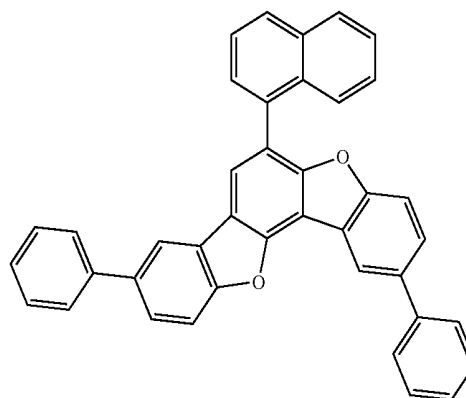


No. 196

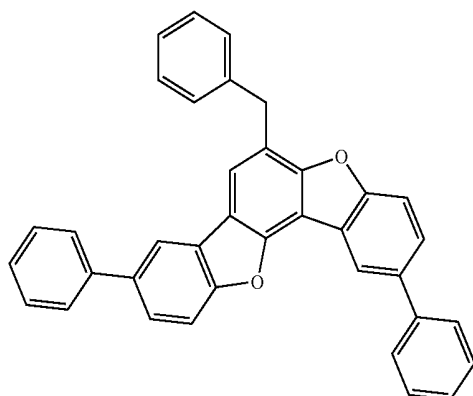
No. 197



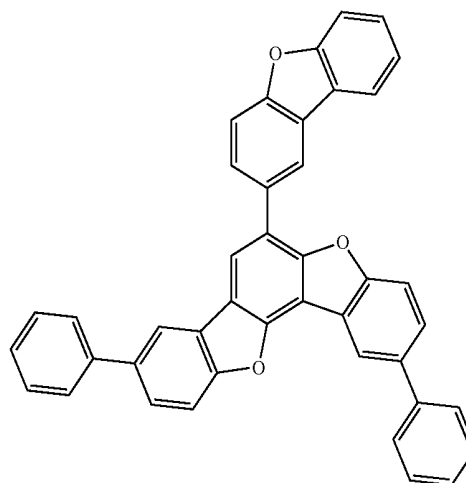
No. 198



No. 199



No. 200

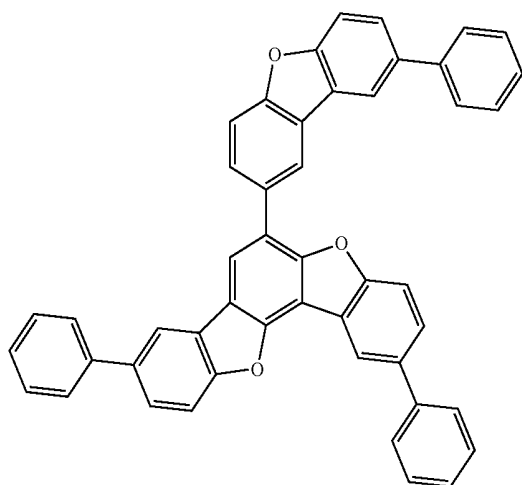


89

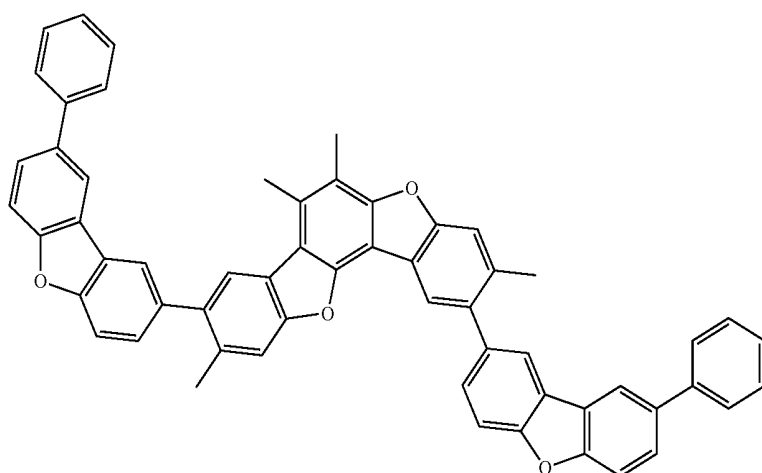
90

-continued

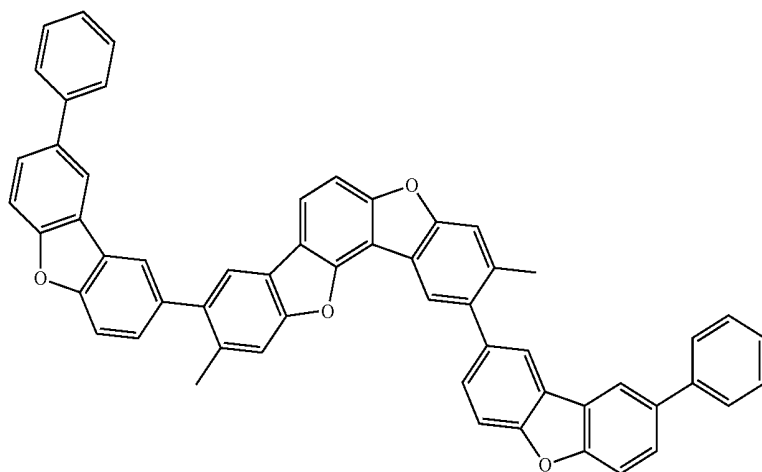
No. 201



No. 202



No. 203



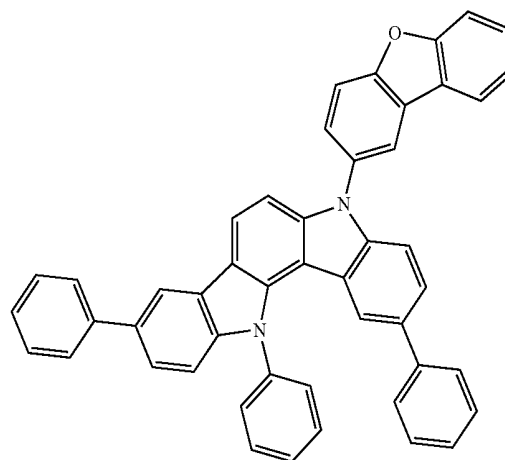
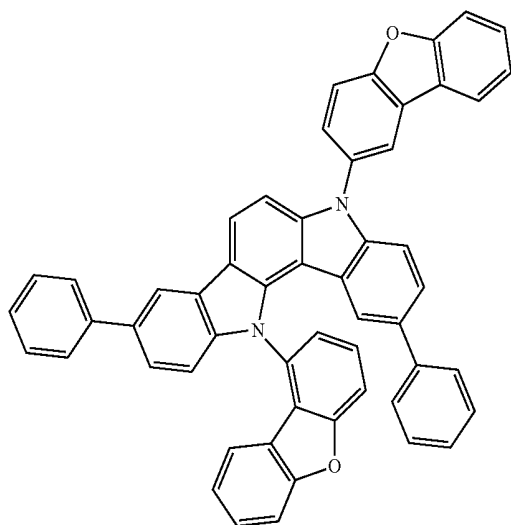
91

92

-continued

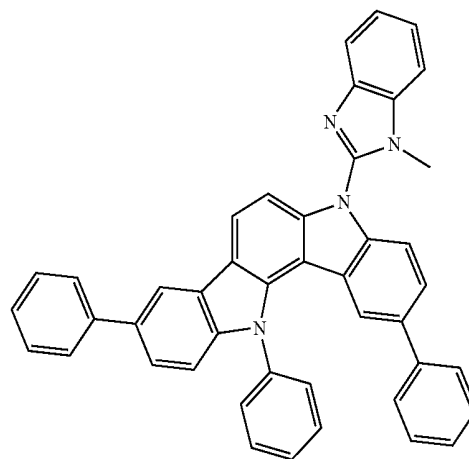
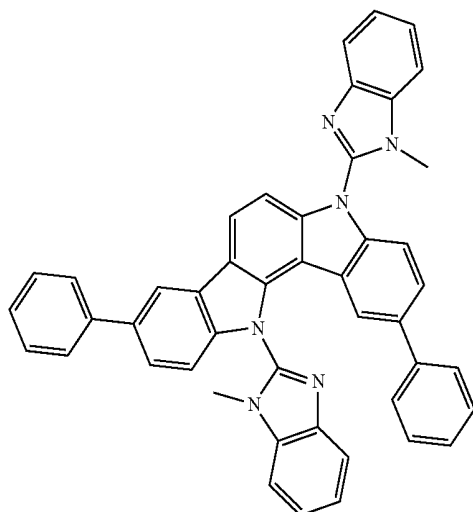
No. 204

No. 205



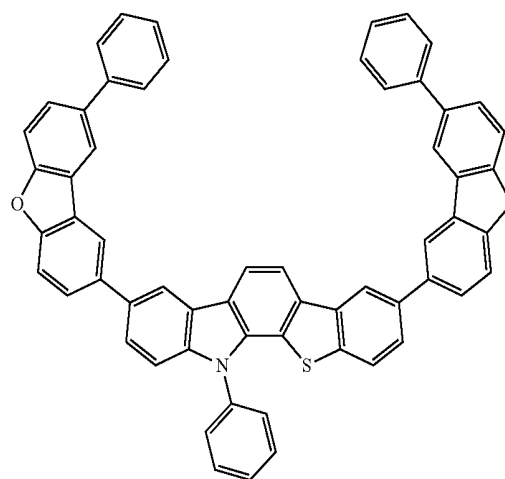
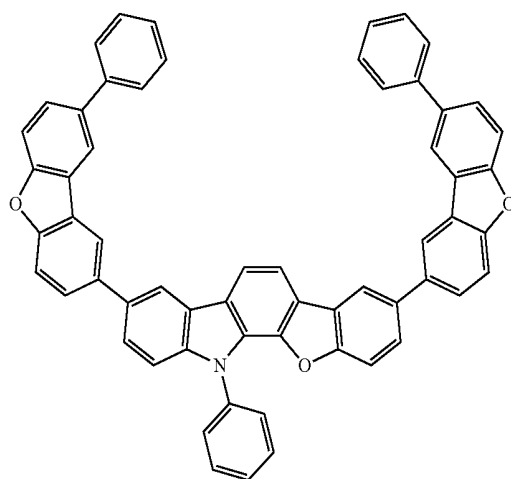
No. 206

No. 207



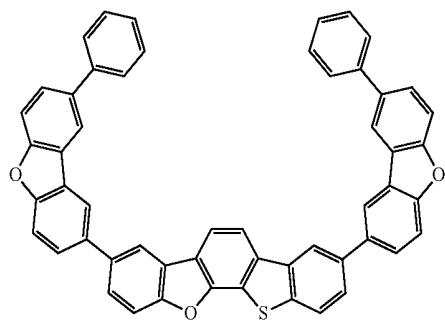
No. 208

No. 209



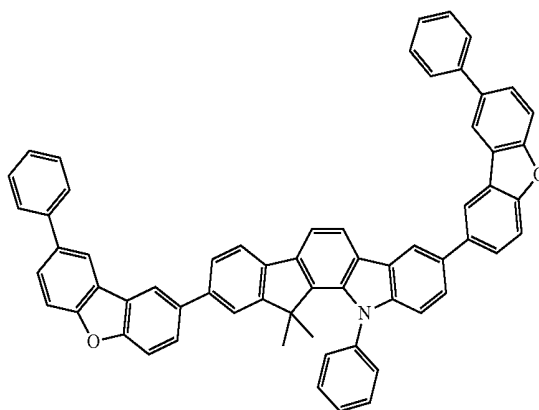
93

-continued
No. 210

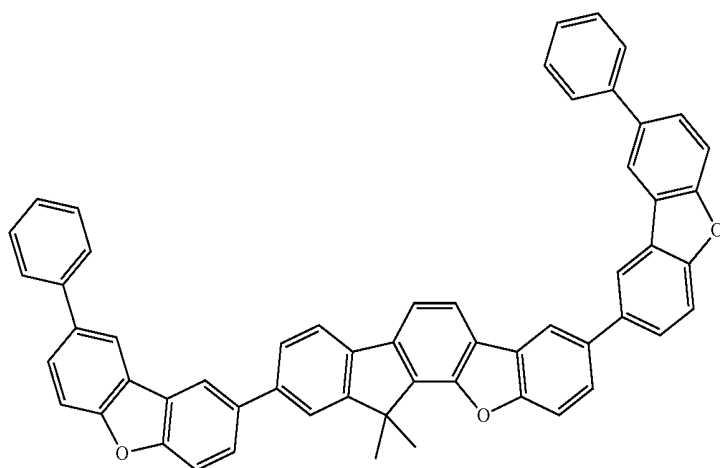


94

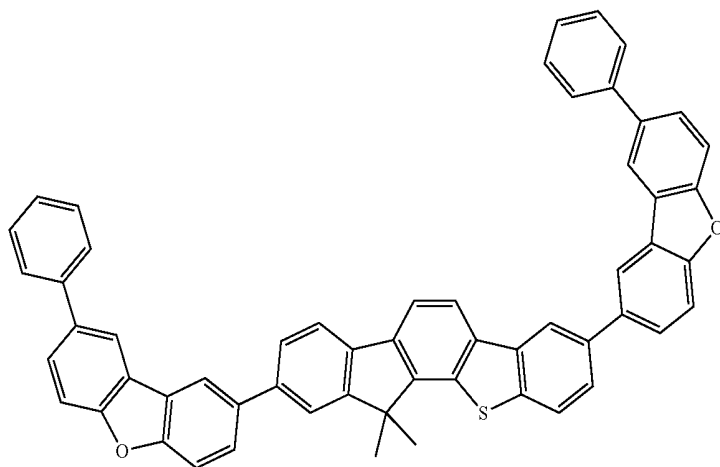
No. 211



No. 212



No. 213



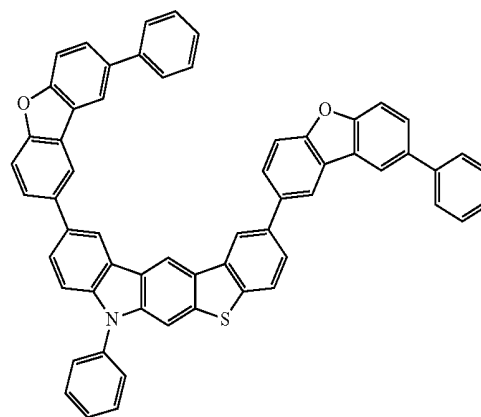
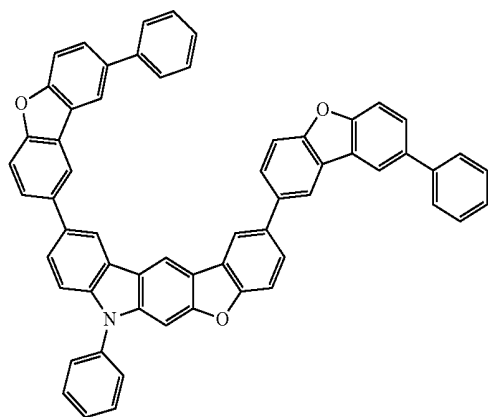
95

96

-continued

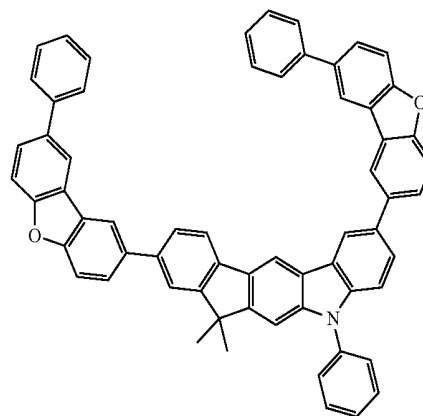
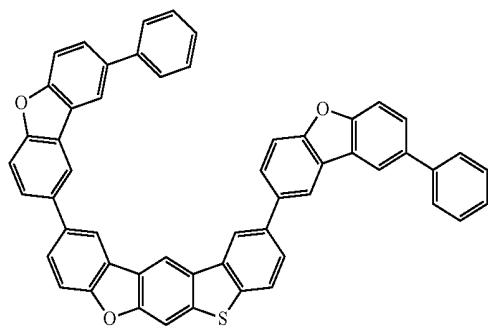
No. 214

No. 215



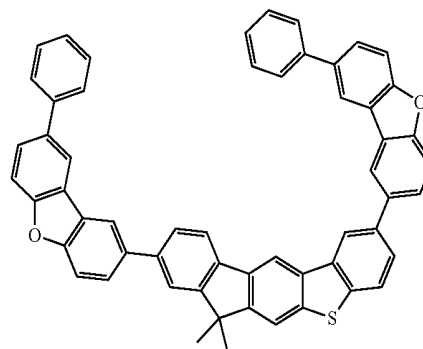
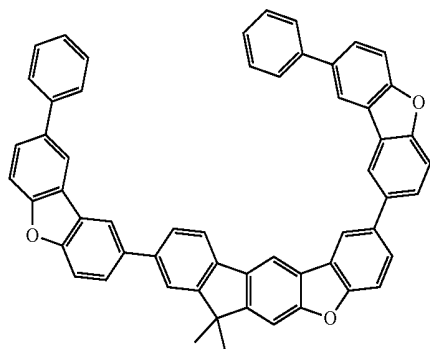
No. 216

No. 217

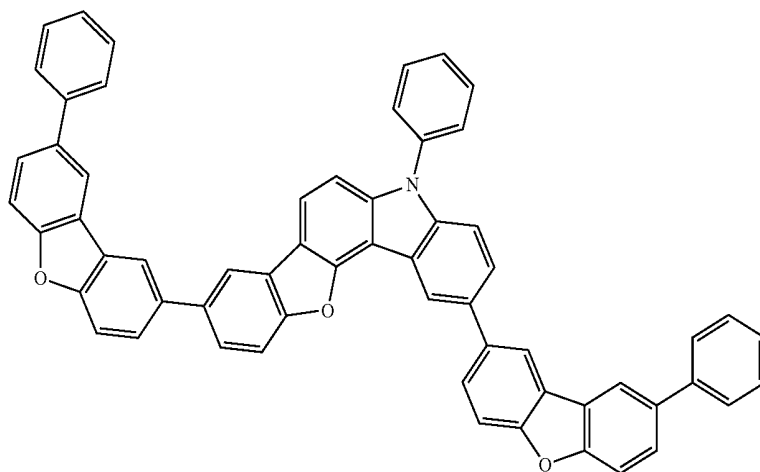


No. 218

No. 219

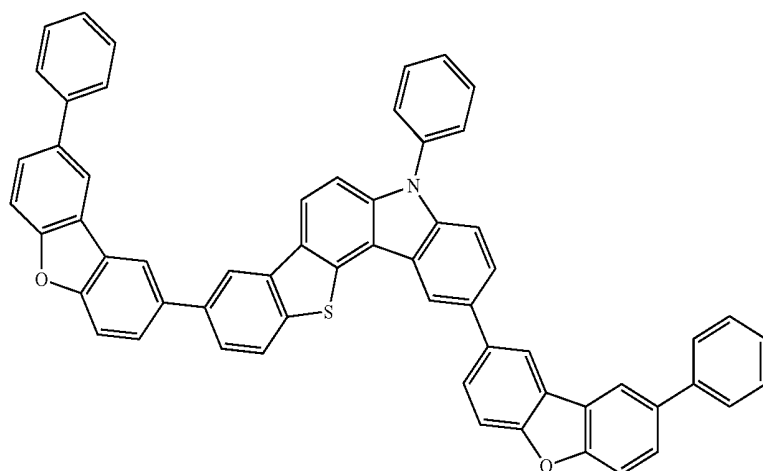


No. 220

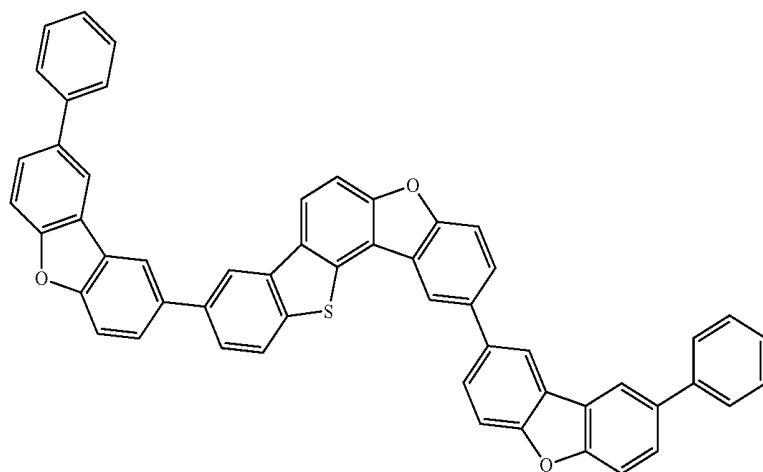


-continued

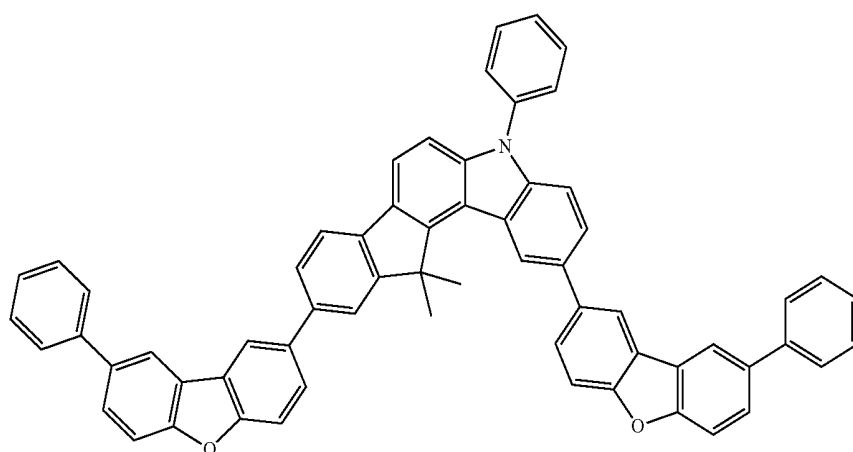
No. 221



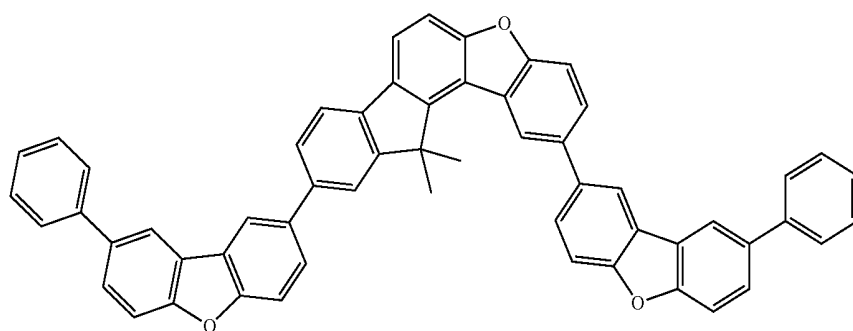
No. 222



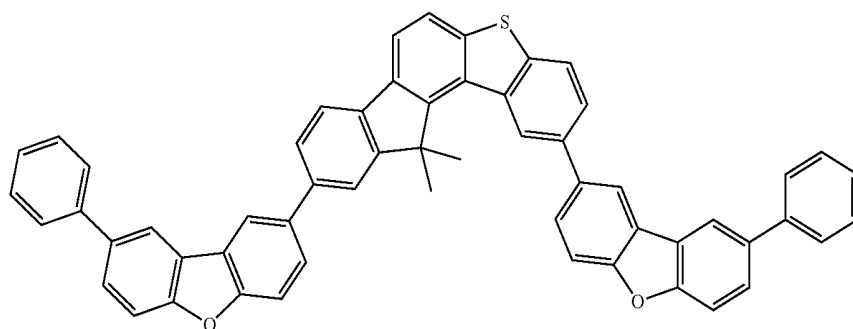
No. 223



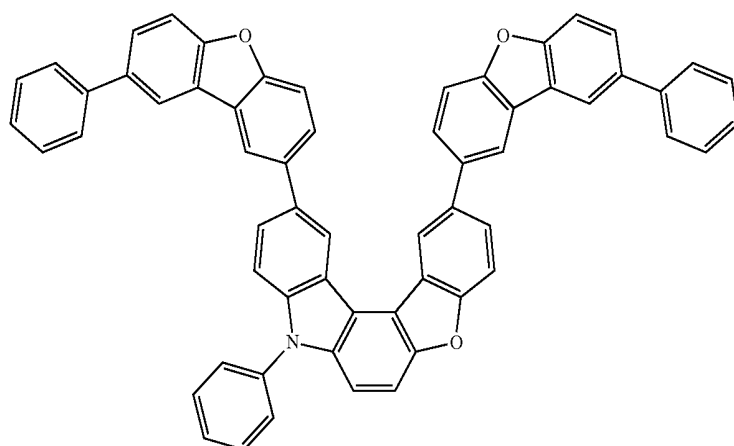
No. 224



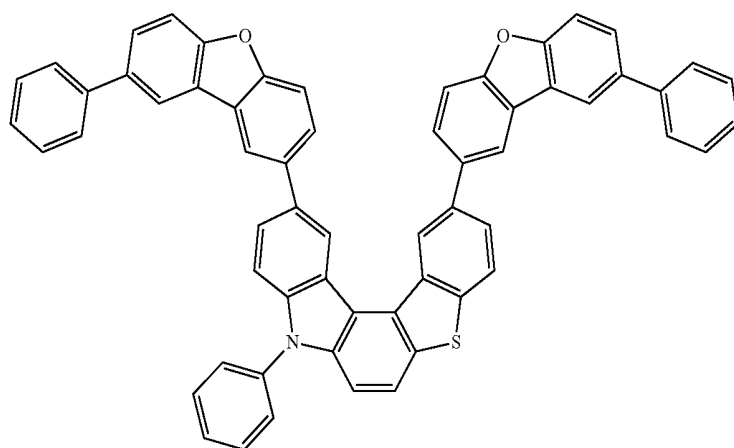
-continued



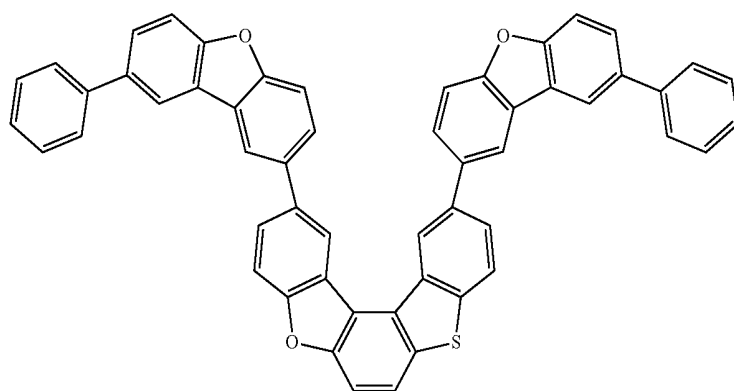
No. 225



No. 226



No. 227



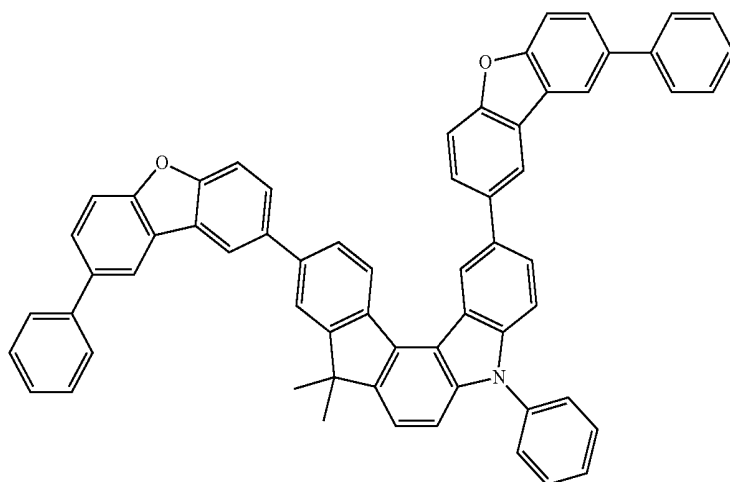
No. 228

101

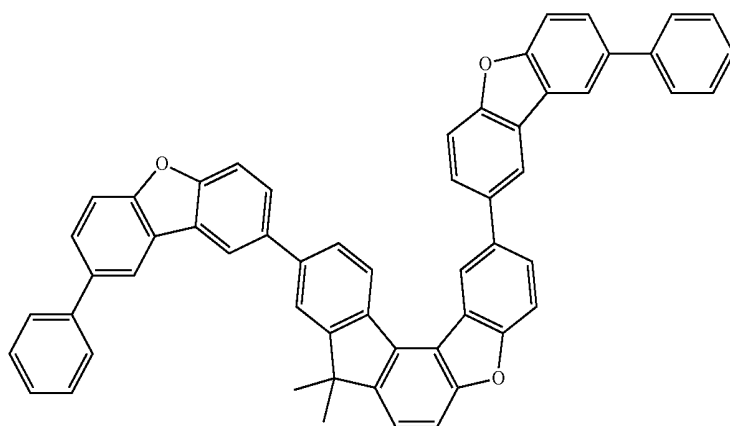
102

-continued

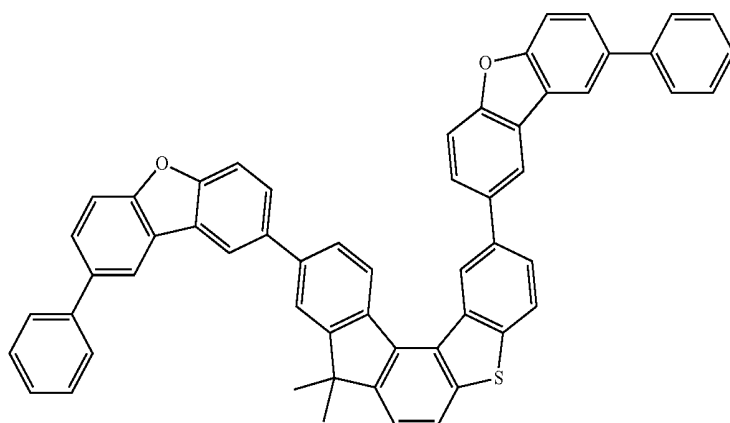
No. 229



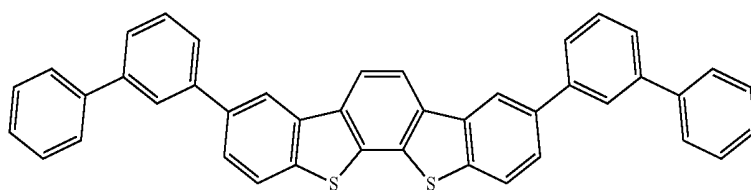
No. 230



No. 231



No. 232

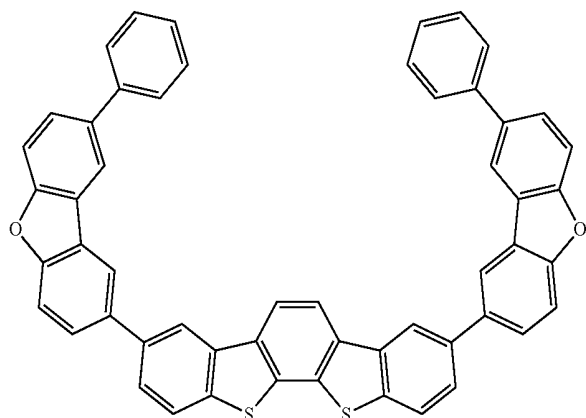


103

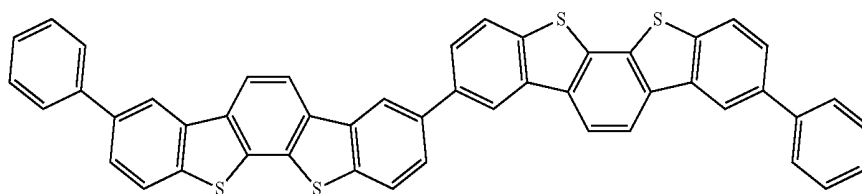
104

-continued

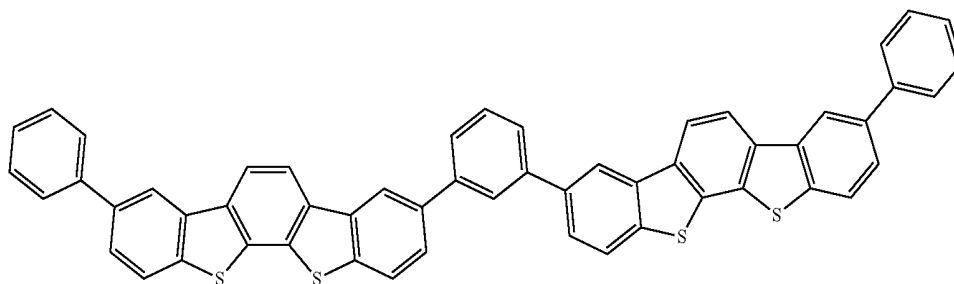
No. 233



No. 234

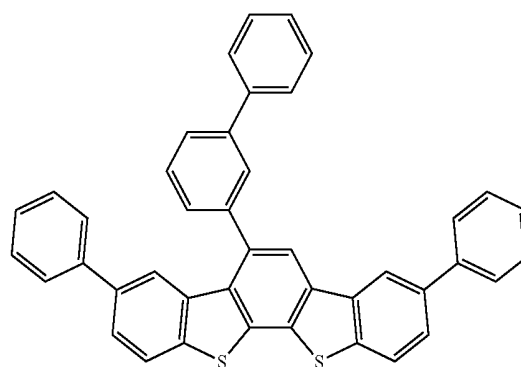
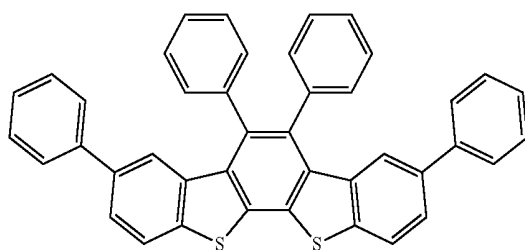


No. 235

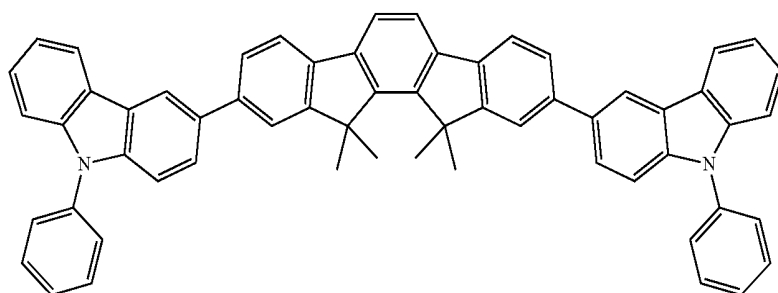


No. 236

No. 237



No. 238

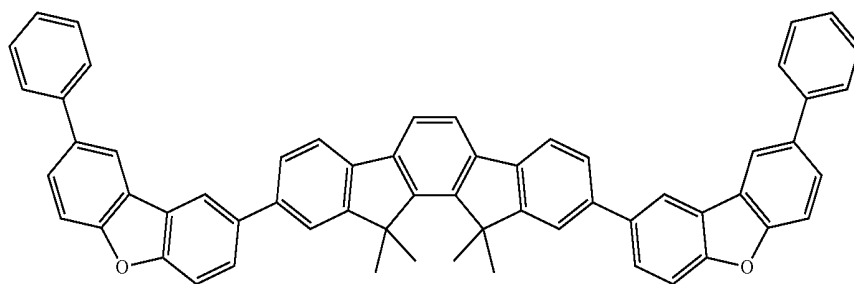


105

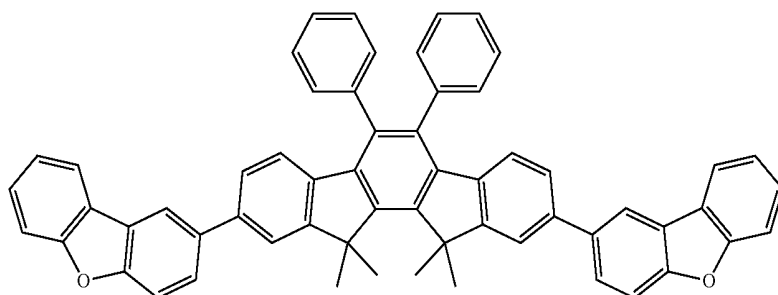
106

-continued

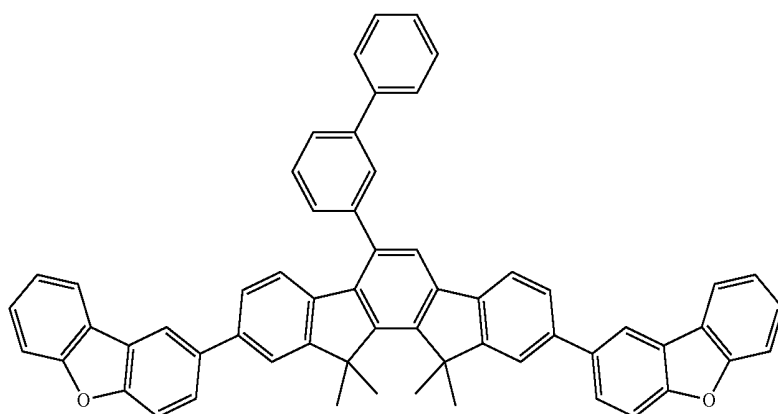
No. 239



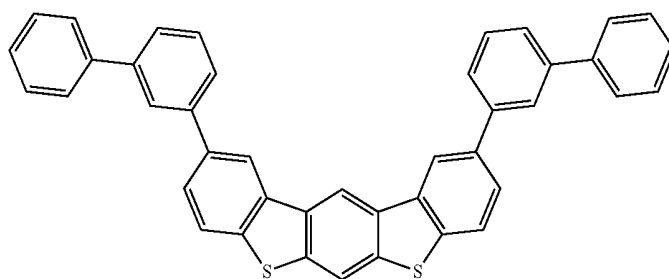
No. 240



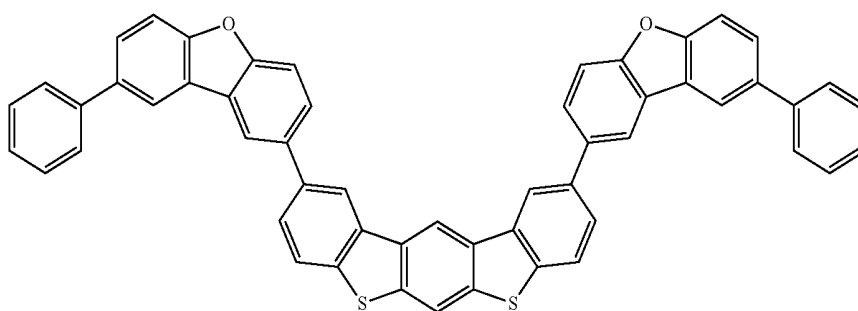
No. 241



No. 242



No. 243



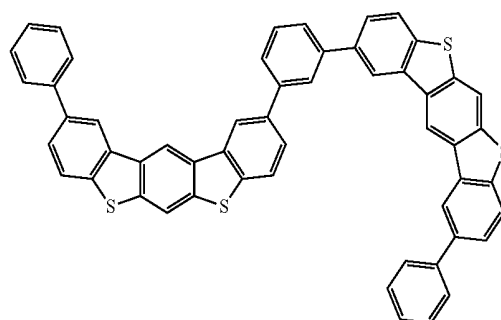
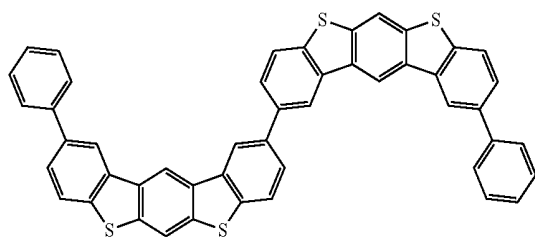
107

108

-continued

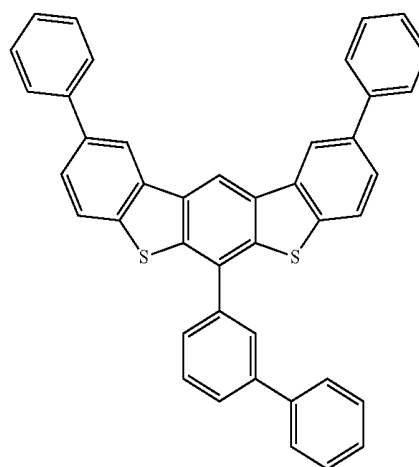
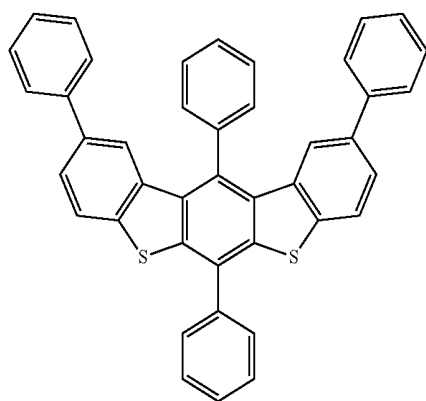
No. 244

No. 245

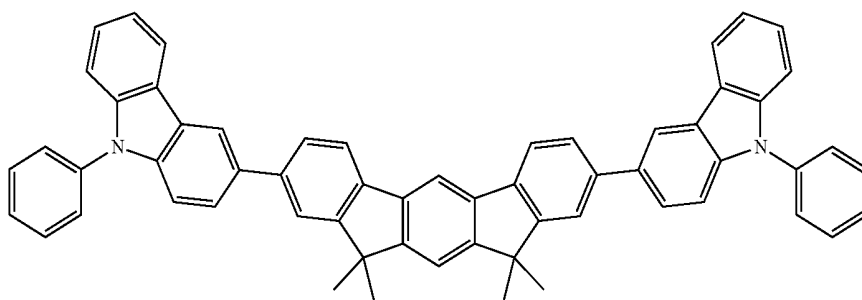


No. 246

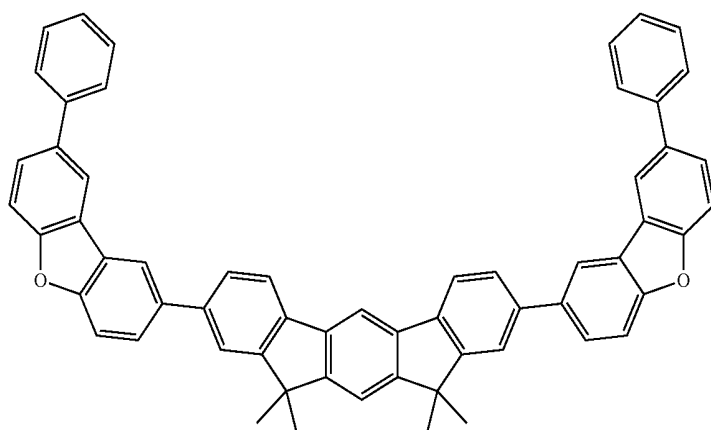
No. 247



No. 248



No. 249

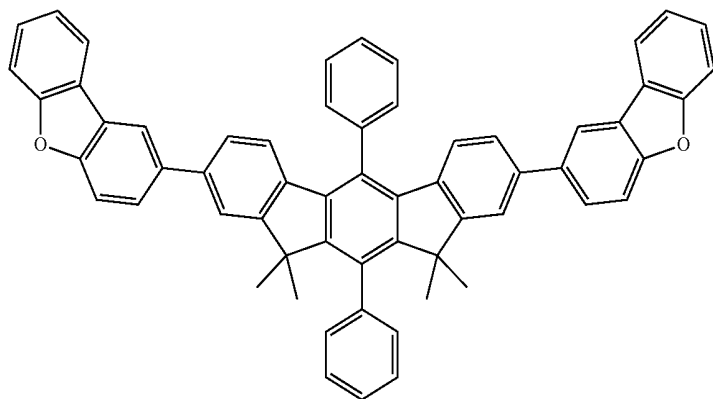


109

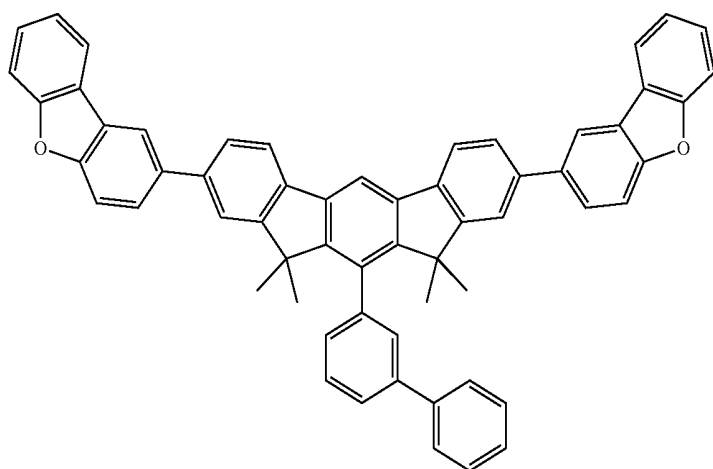
110

-continued

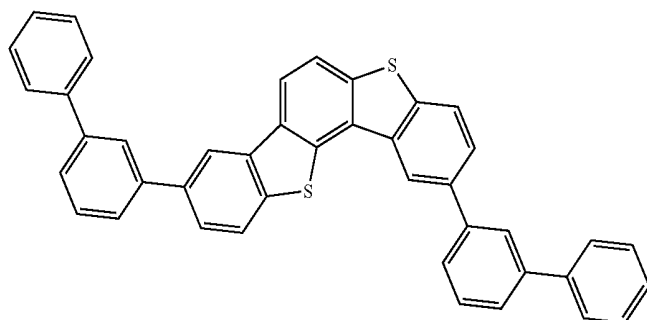
No. 250



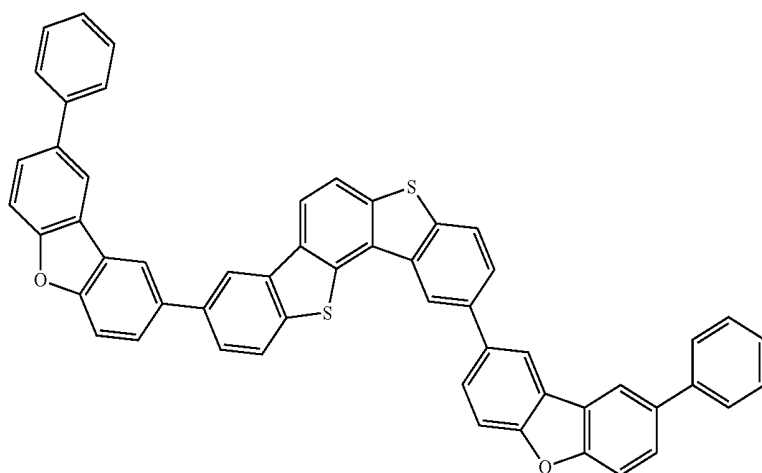
No. 251



No. 252



No. 253

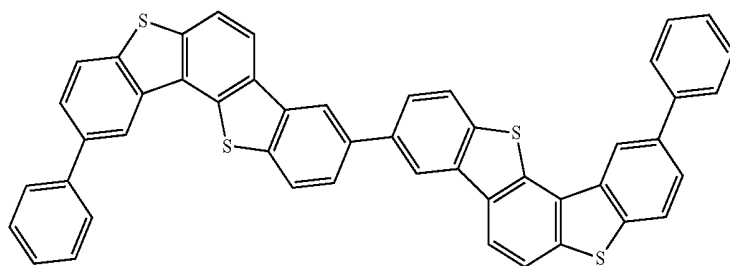


111

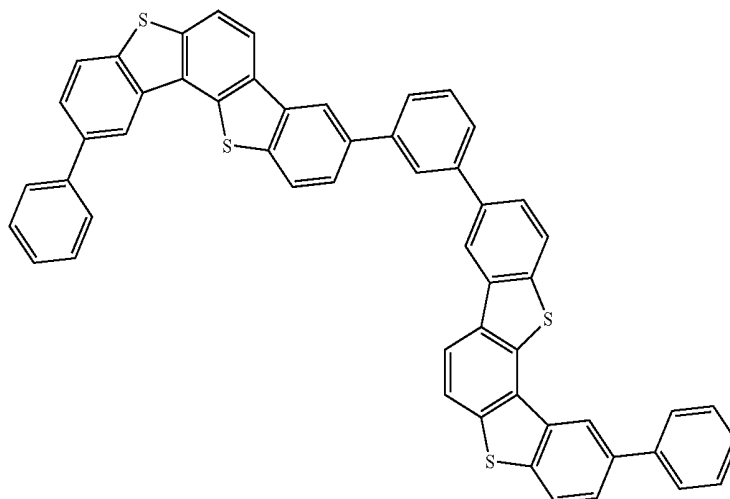
112

-continued

No. 254

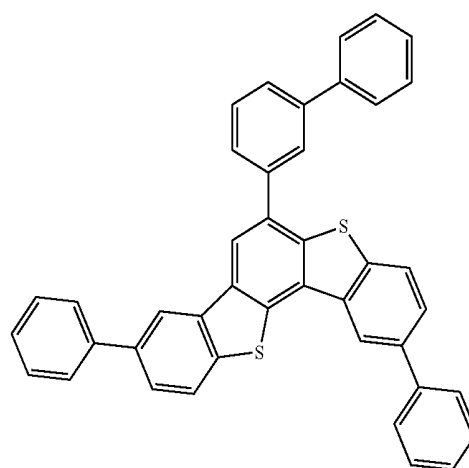
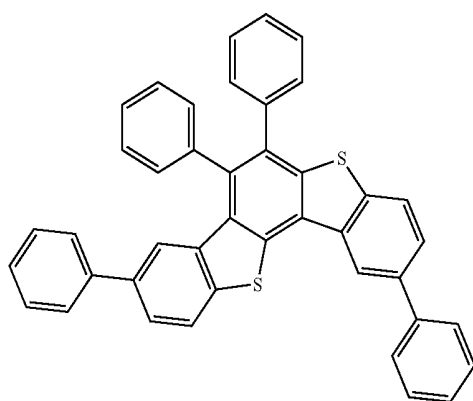


No. 255

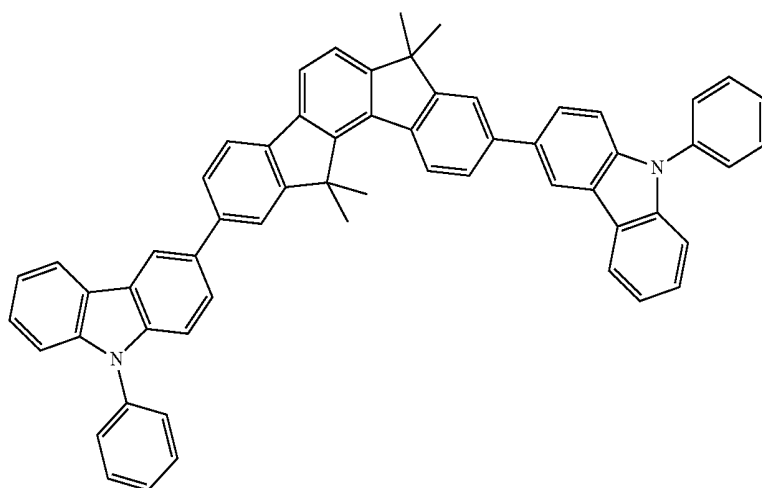


No. 256

No. 257



No. 258

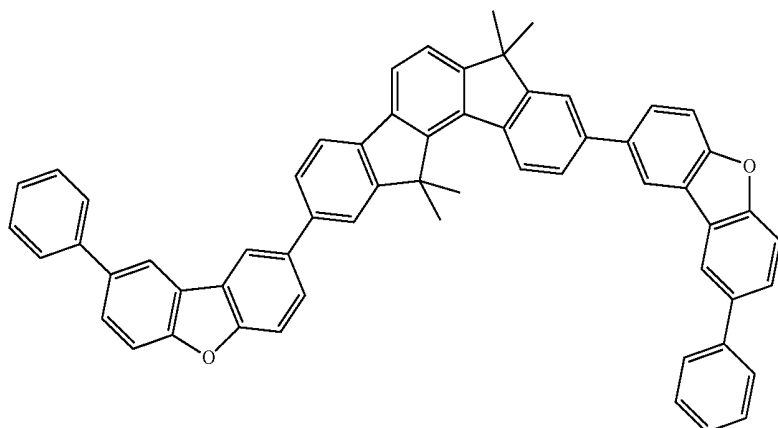


113

114

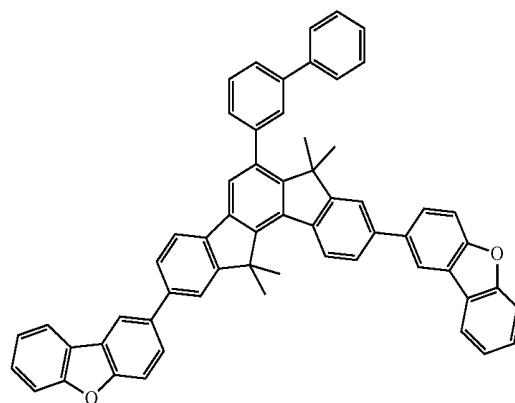
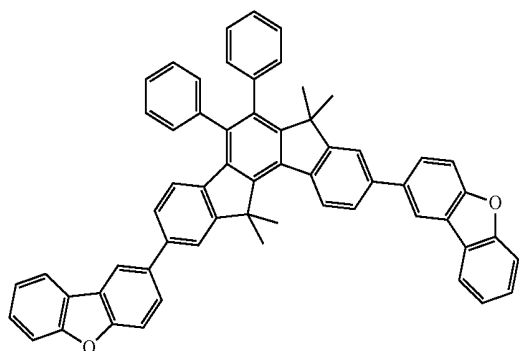
-continued

No. 259



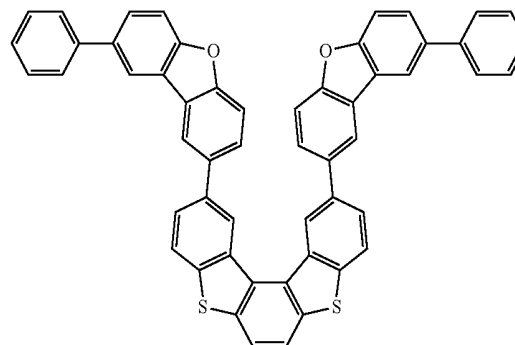
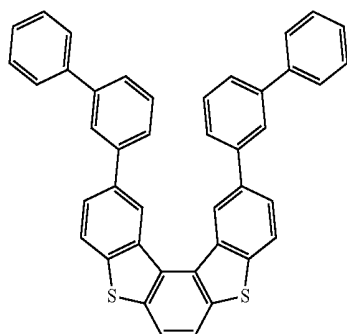
No. 260

No. 261



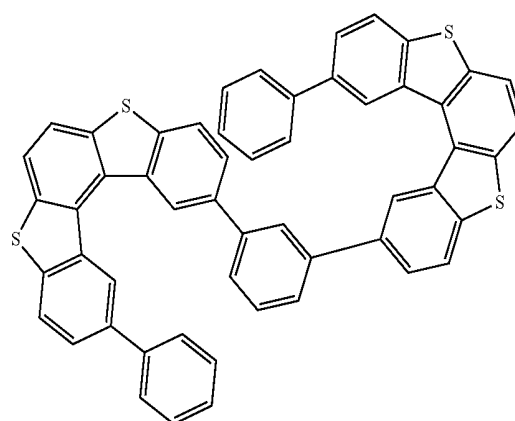
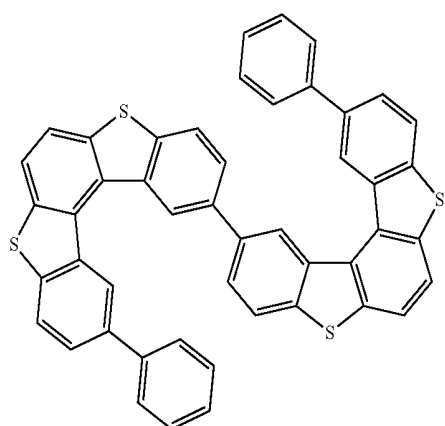
No. 262

No. 263

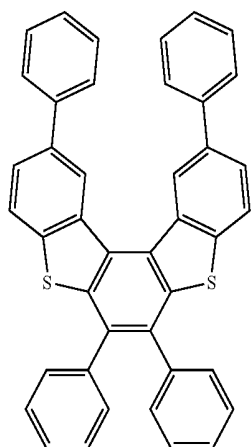


No. 264

No. 265

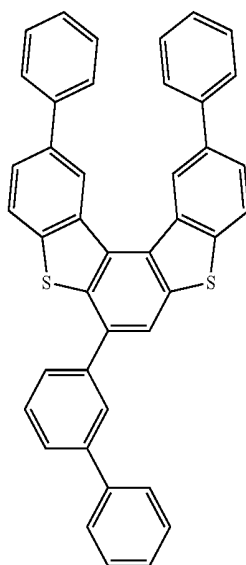


115

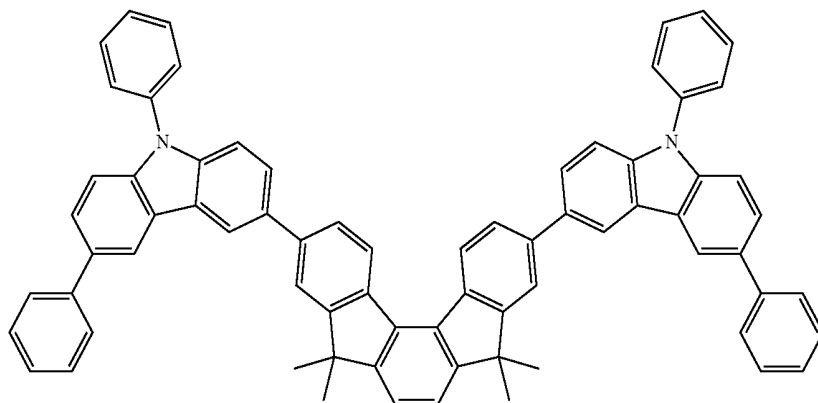


-continued
No. 266

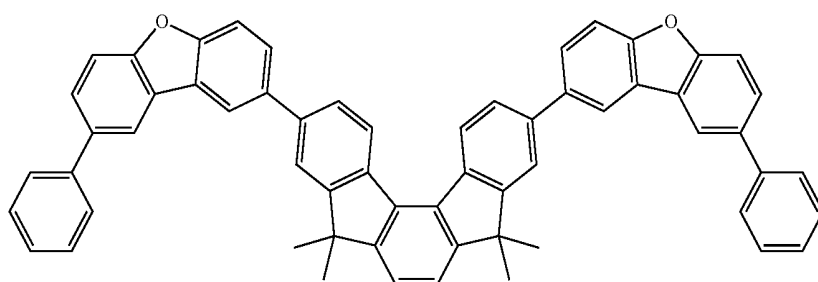
116



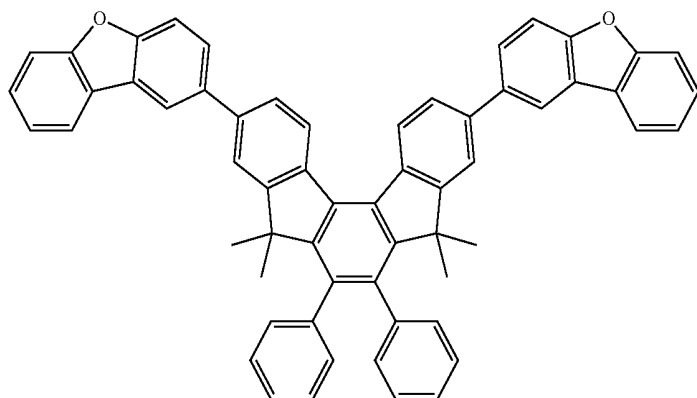
No. 267



No. 268



No. 269



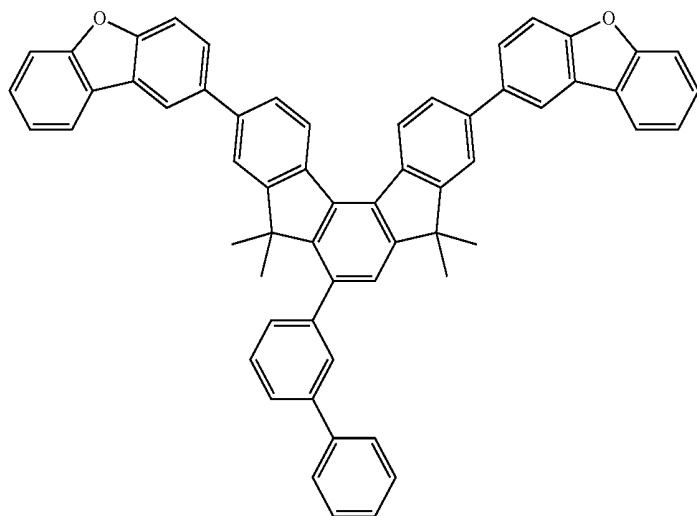
No. 270

117

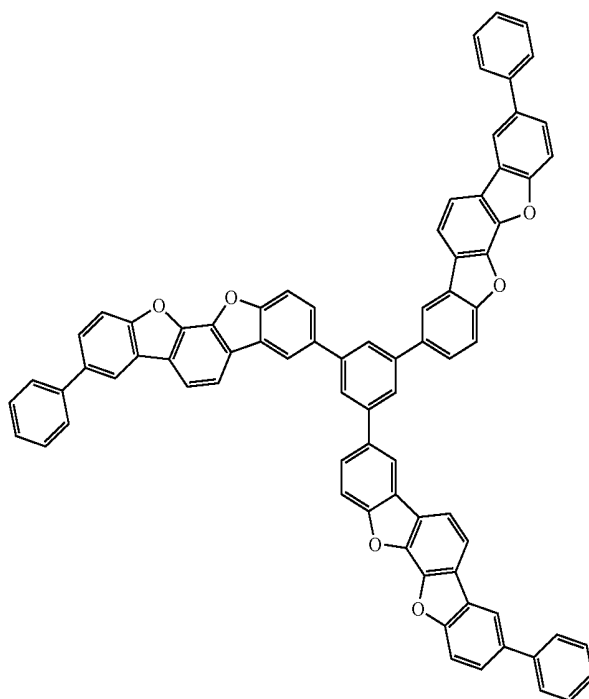
118

-continued

No. 271



No. 272

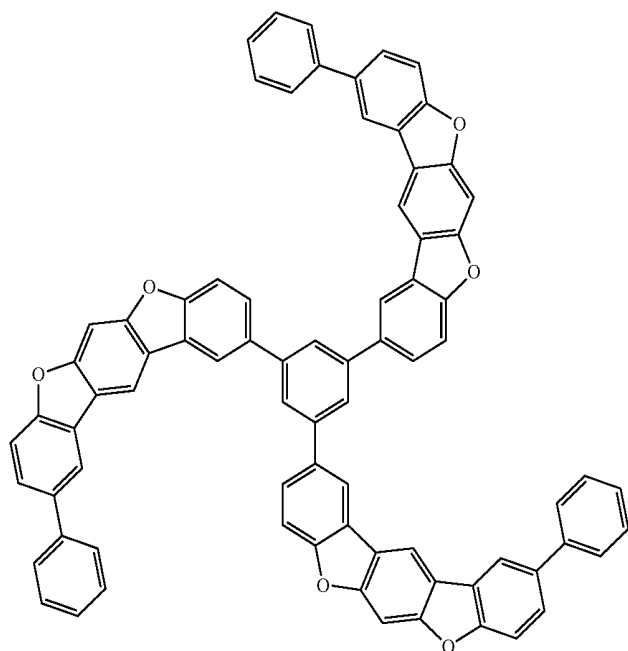


119

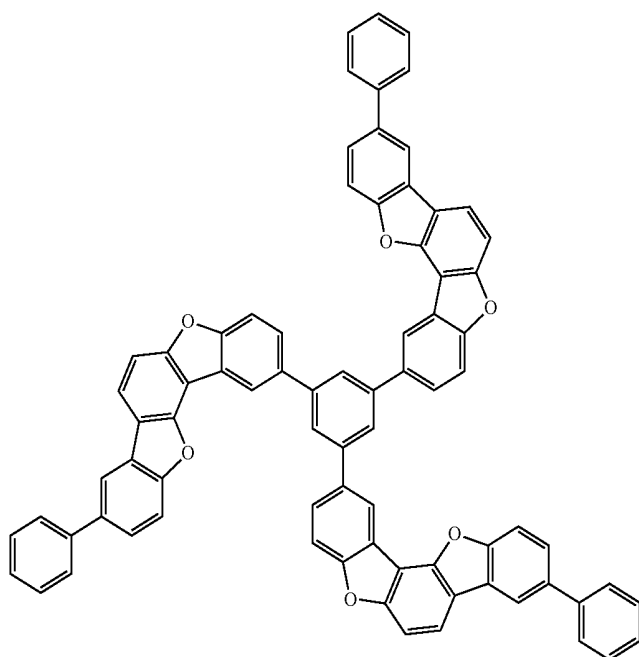
120

-continued

No. 273



No. 274

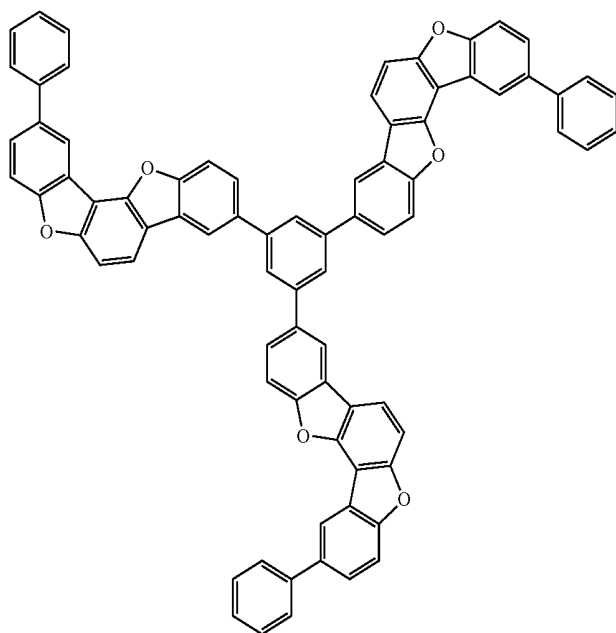


121

122

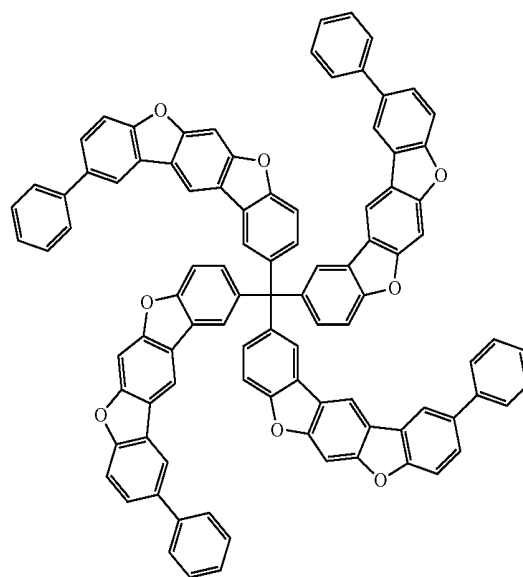
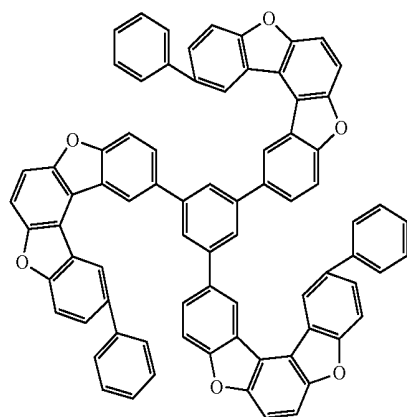
-continued

No. 275



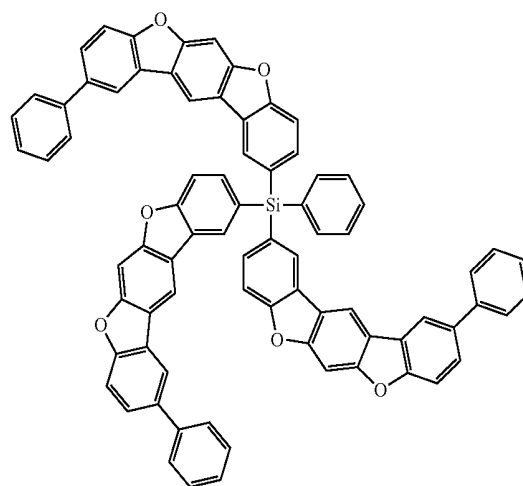
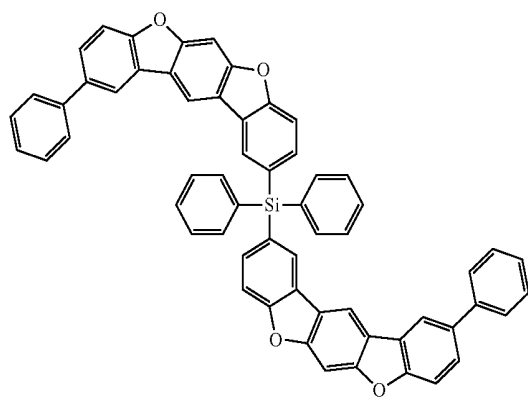
No. 276

No. 277



No. 278

No. 279

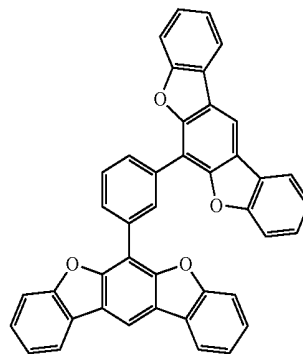
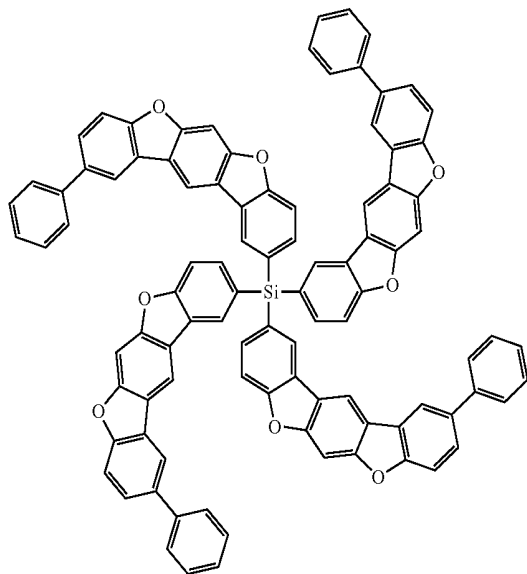


123

124

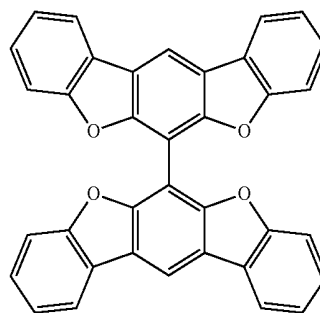
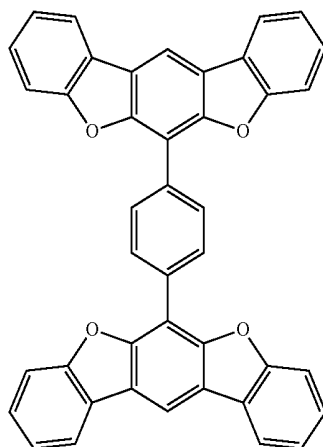
-continued
No. 280

No. 281



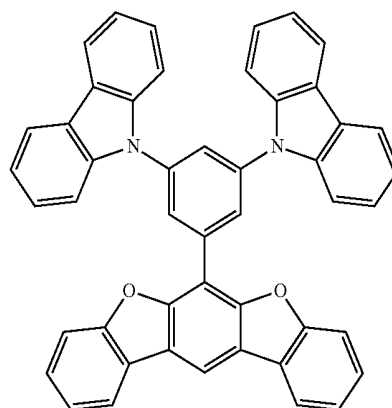
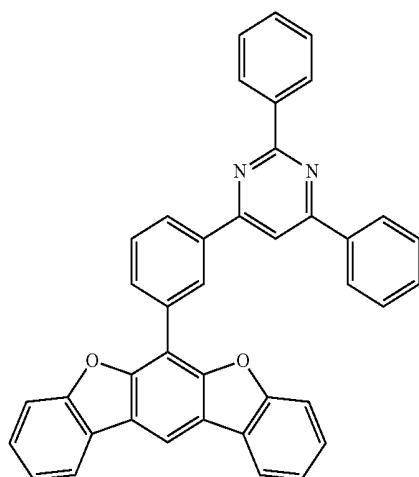
No. 282

No. 283

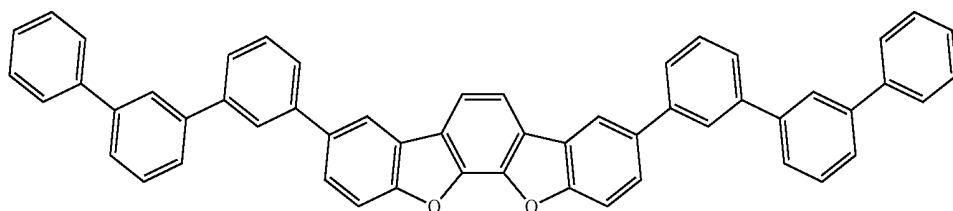


No. 284

No. 285



No. 286

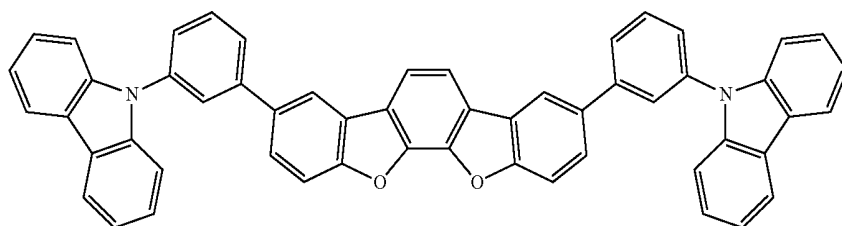


125

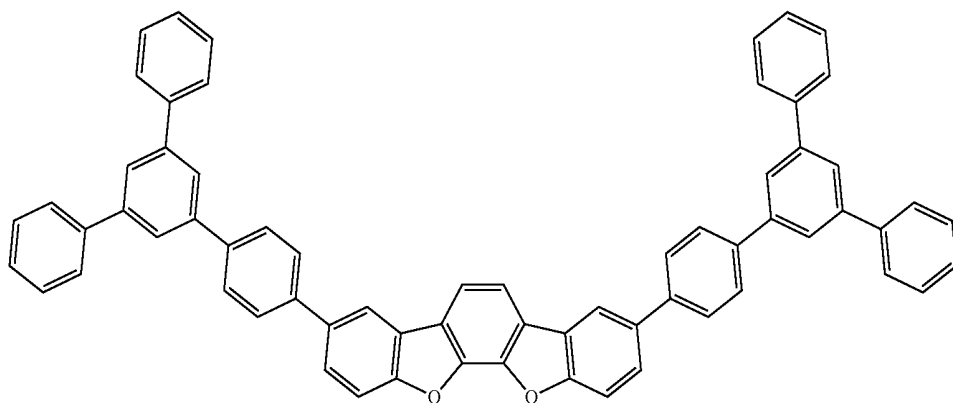
126

-continued

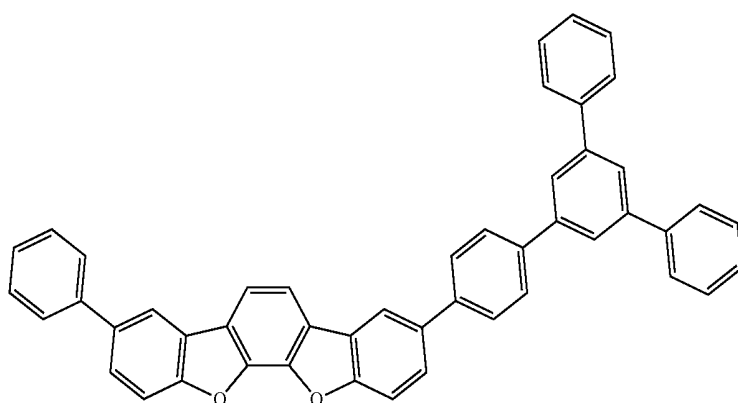
No. 287



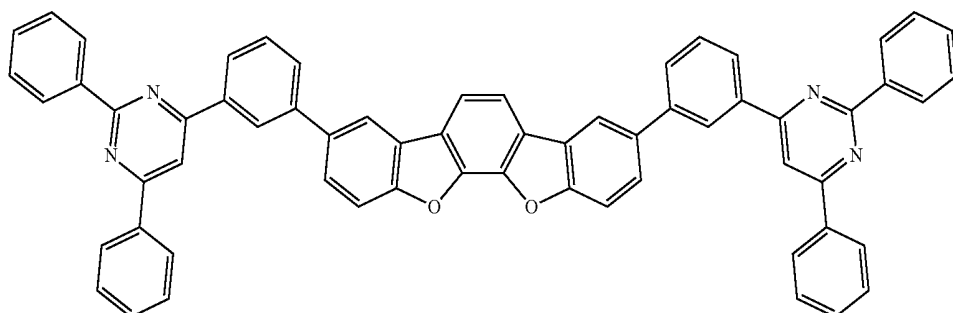
No. 288



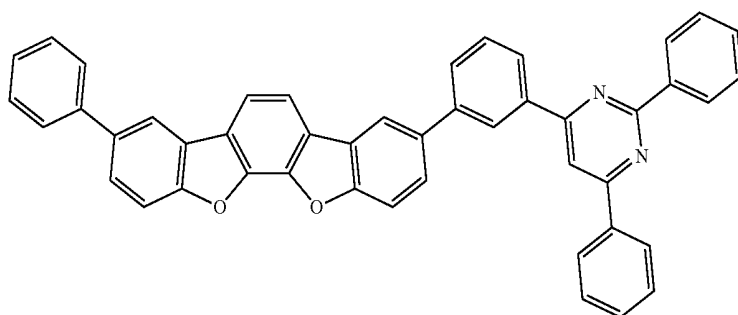
No. 289



No. 290



No. 291

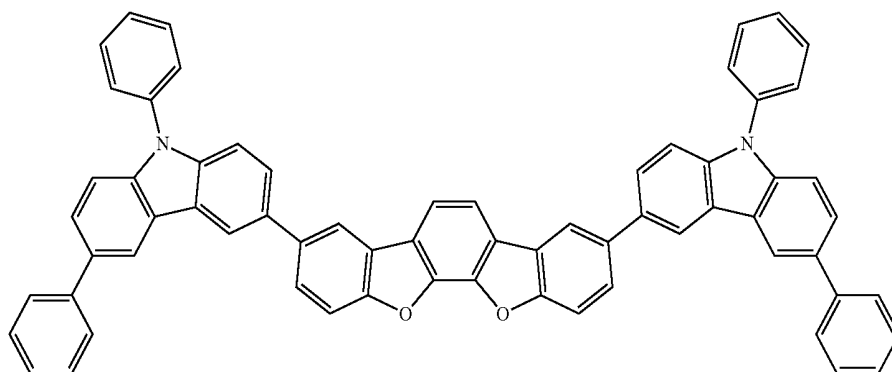


127

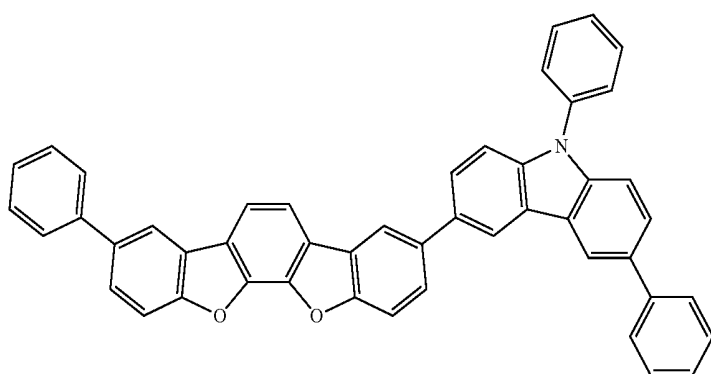
128

-continued

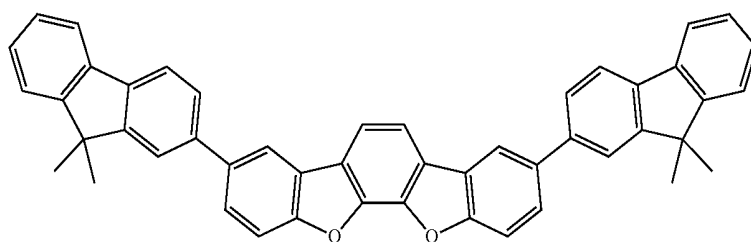
No. 292



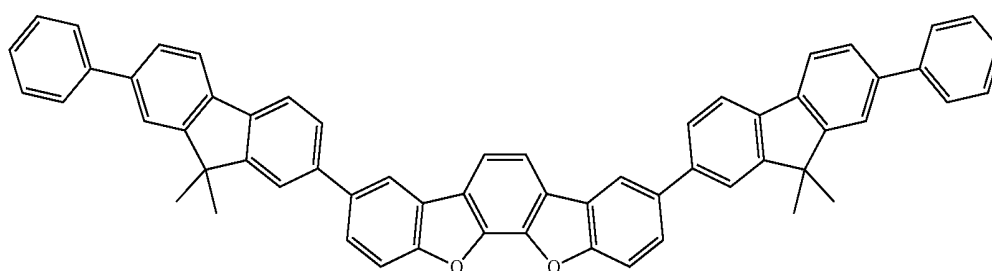
No. 293



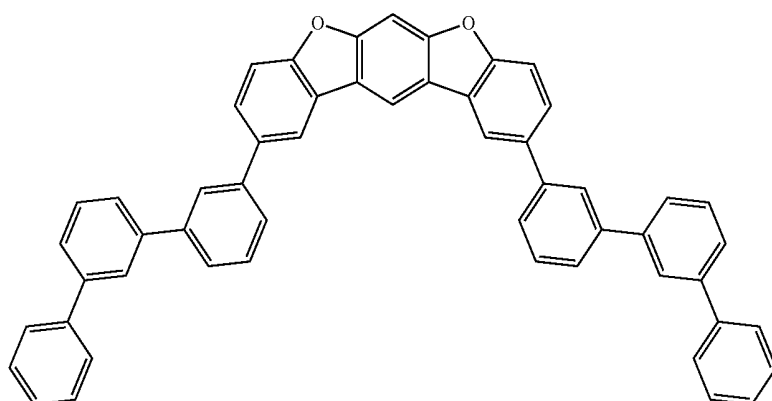
No. 294



No. 295



No. 296

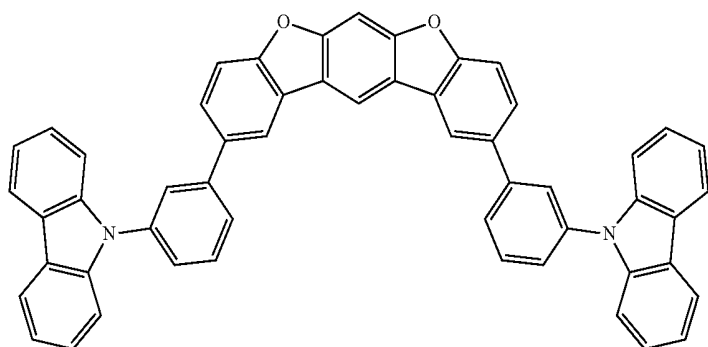


129

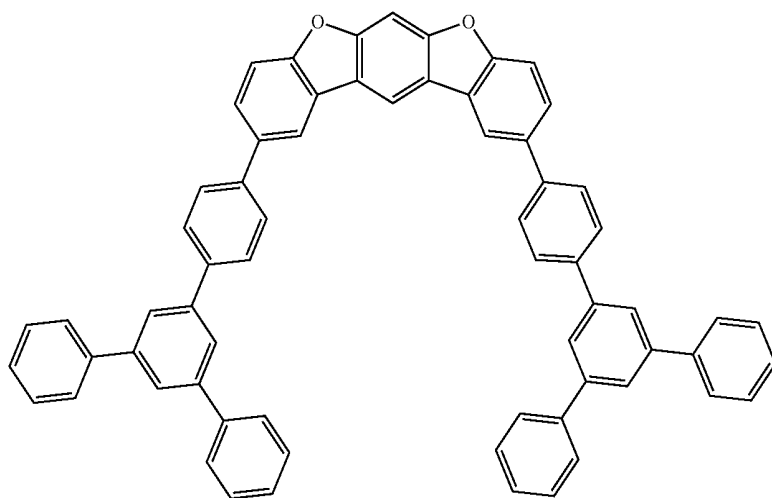
130

-continued

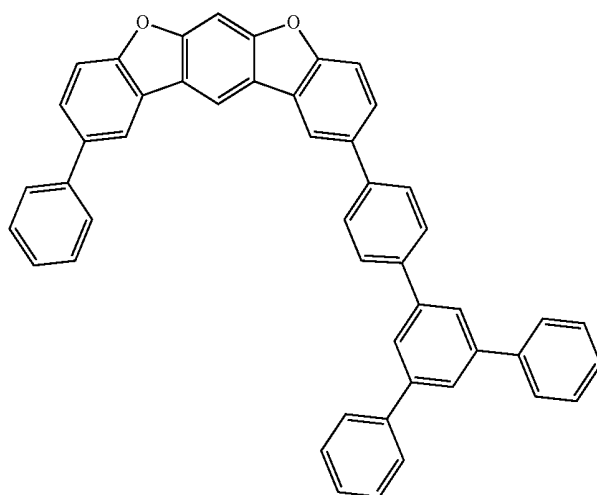
No. 297



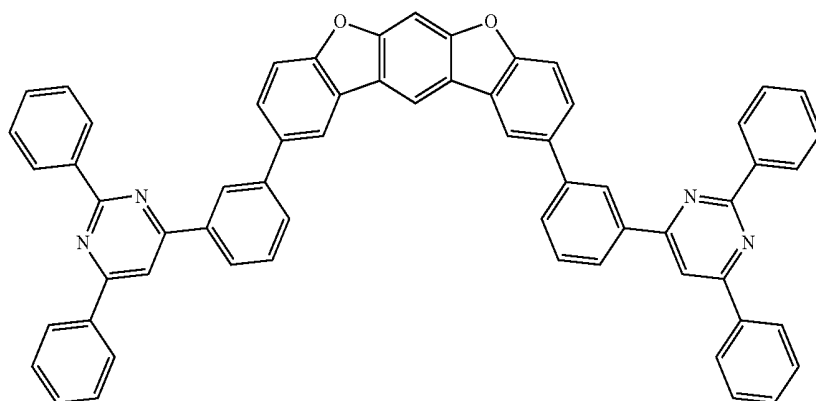
No. 298



No. 299



No. 300

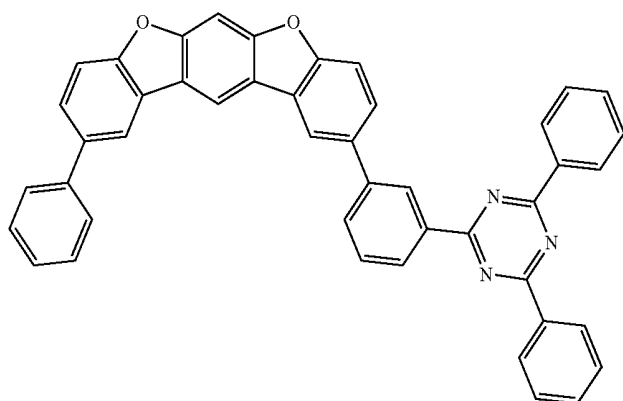


131

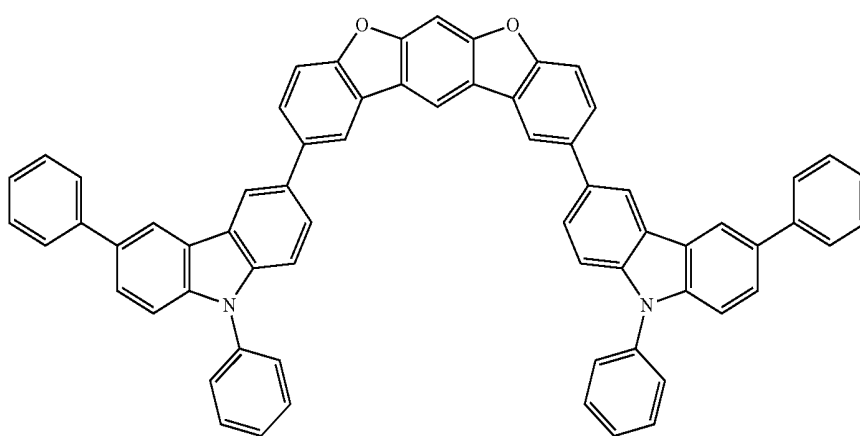
132

-continued

No. 301

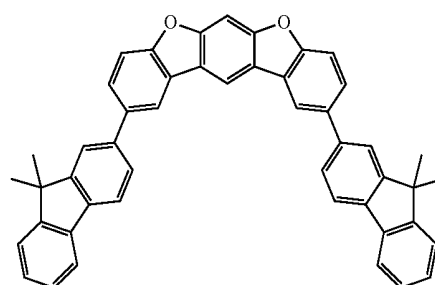
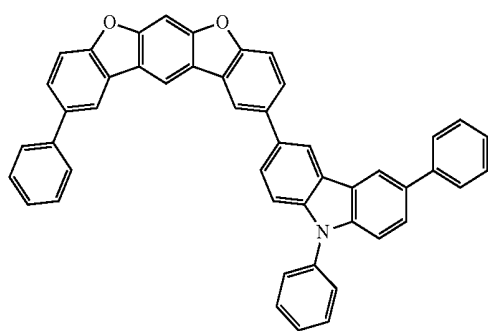


No. 302

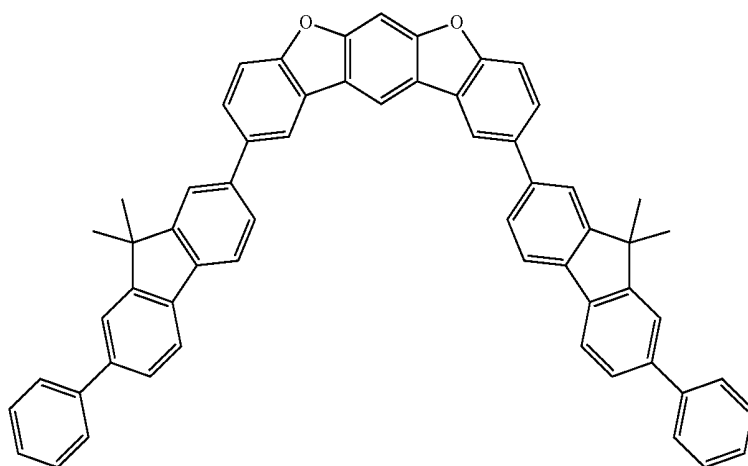


No. 303

No. 304



No. 305

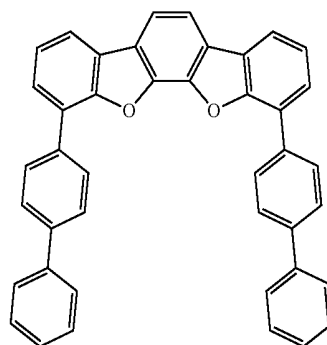
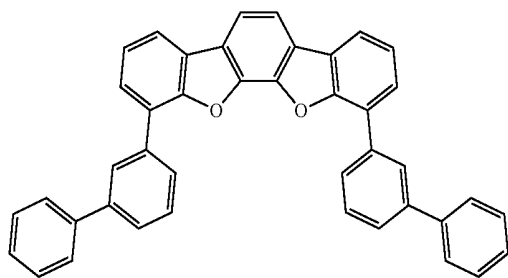


133

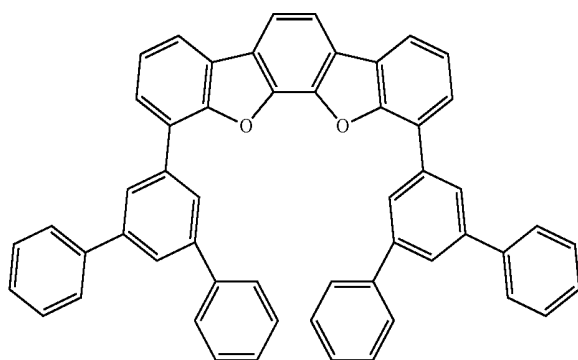
134

-continued
No. 306

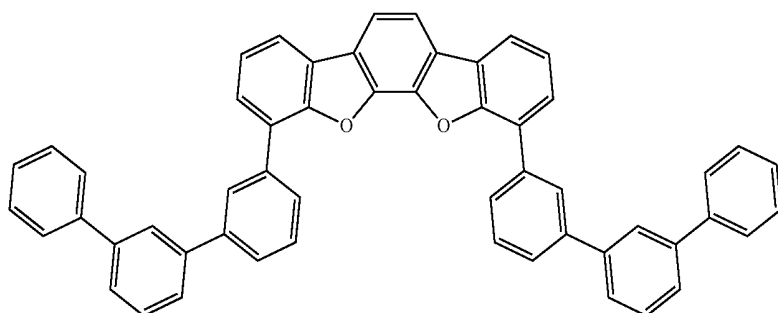
No. 307



No. 308

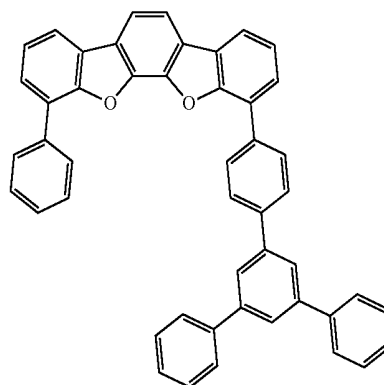
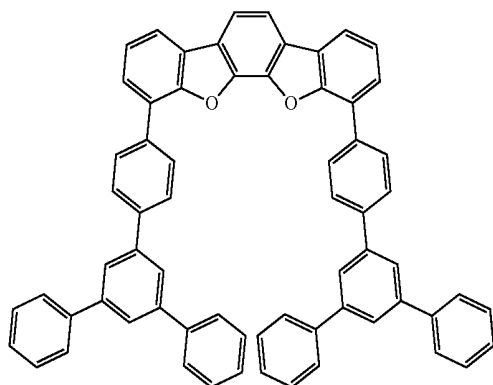


No. 309



No. 310

No. 311



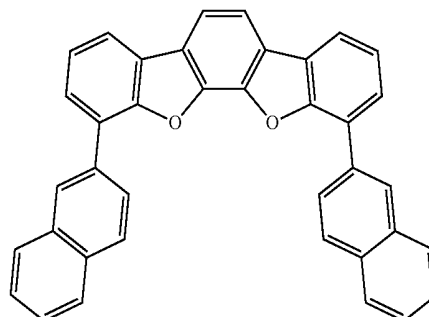
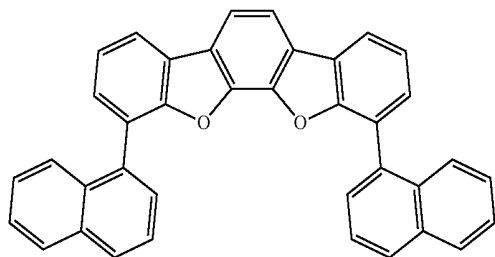
135

136

-continued

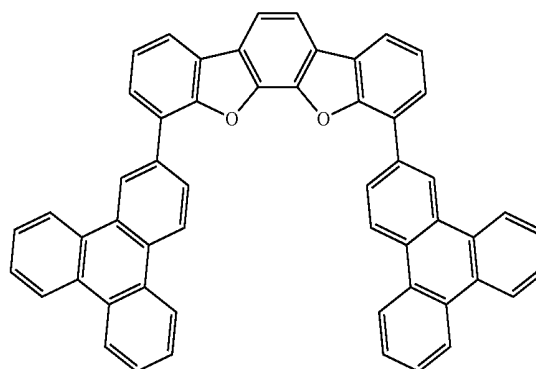
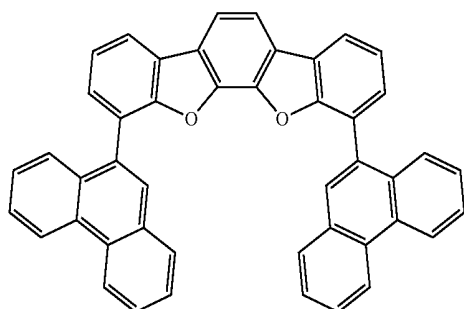
No. 312

No. 313



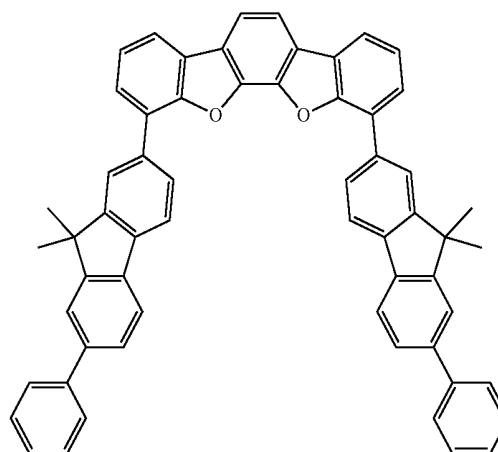
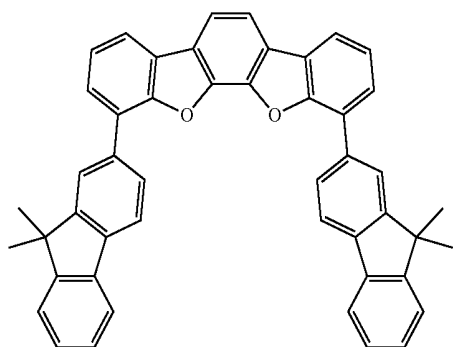
No. 314

No. 315



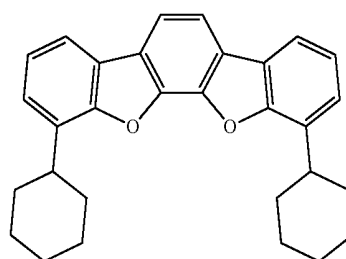
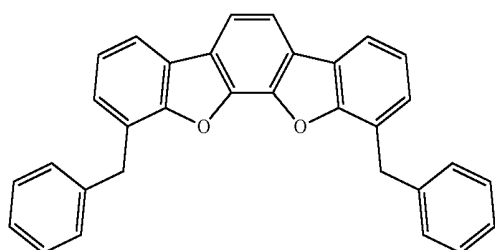
No. 316

No. 317



No. 318

No. 319

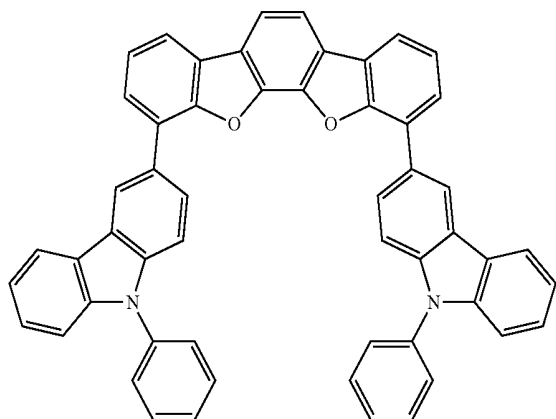


137

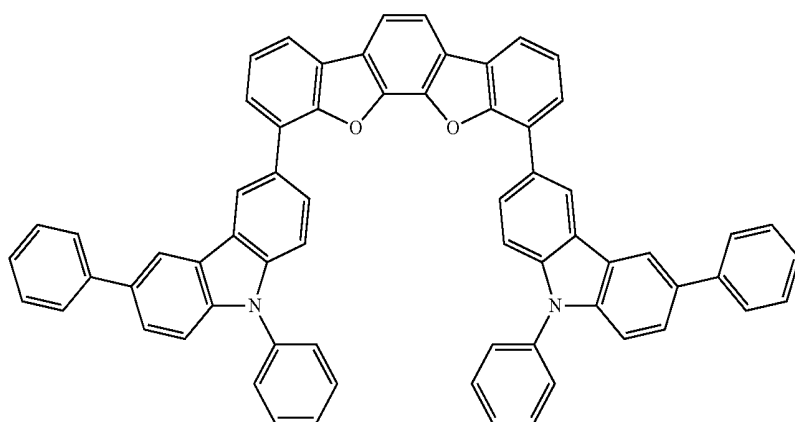
138

-continued

No. 320

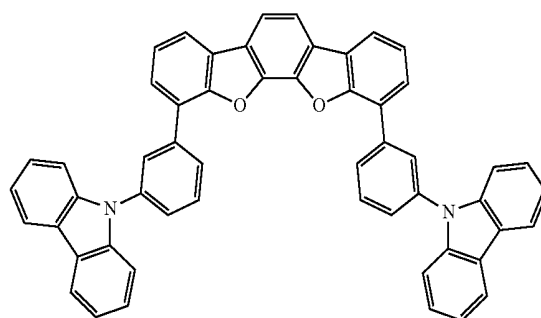
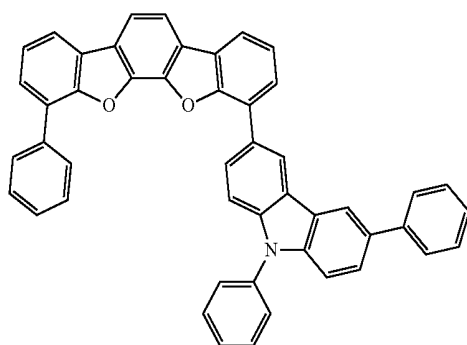


No. 321

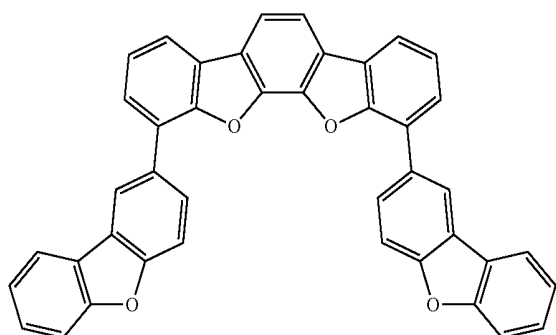


No. 322

No. 323



No. 324

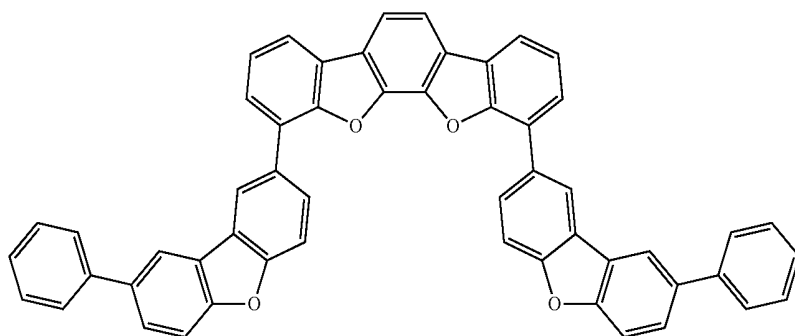


139

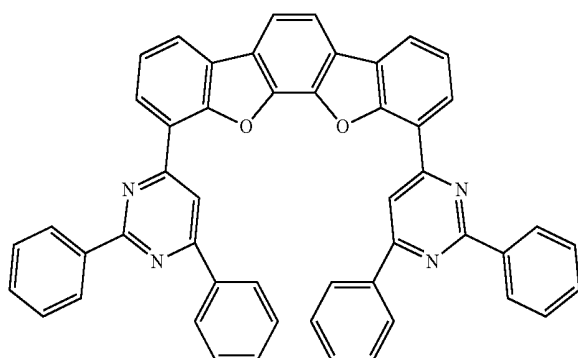
140

-continued

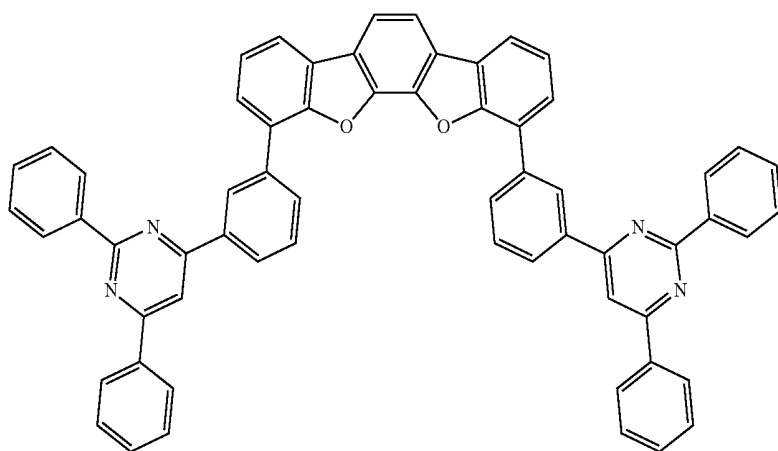
No. 325



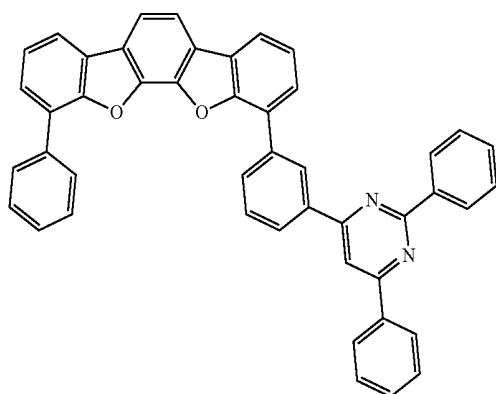
No. 326



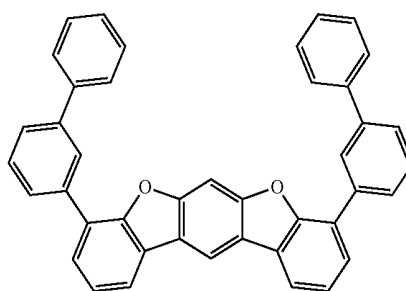
No. 327



No. 328



No. 329



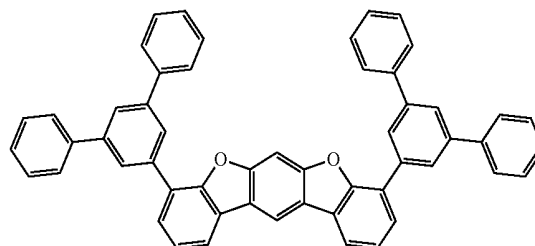
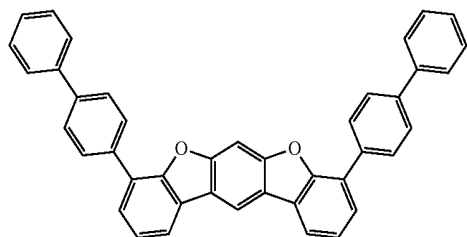
141

142

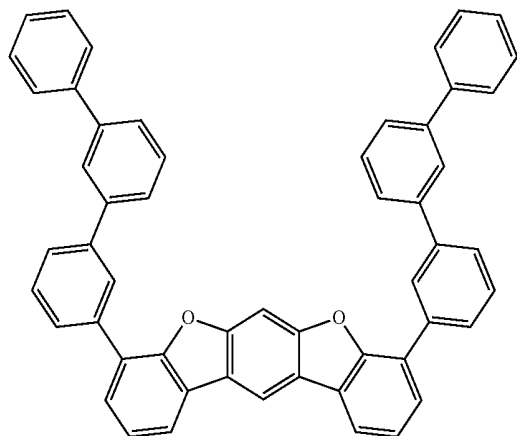
-continued

No. 330

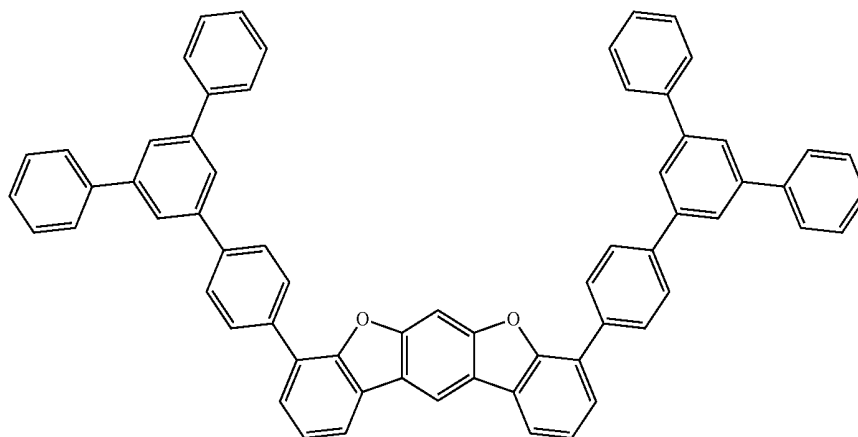
No. 331



No. 332

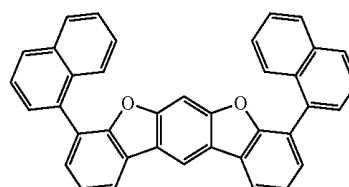
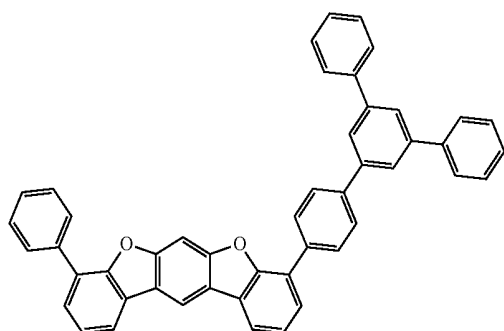


No. 333



No. 334

No. 335



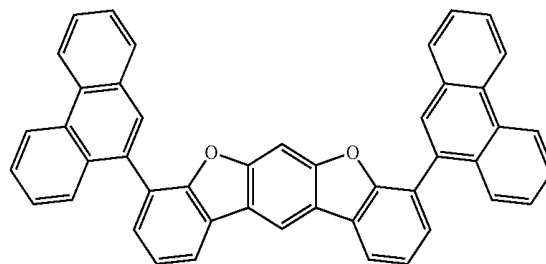
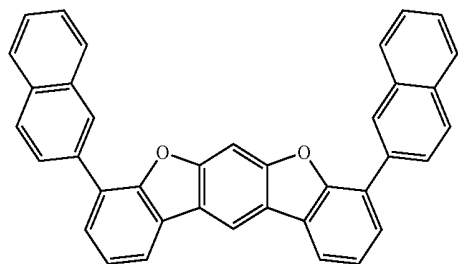
143

144

-continued

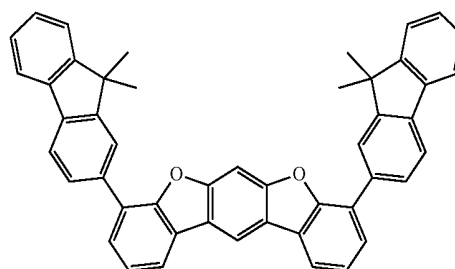
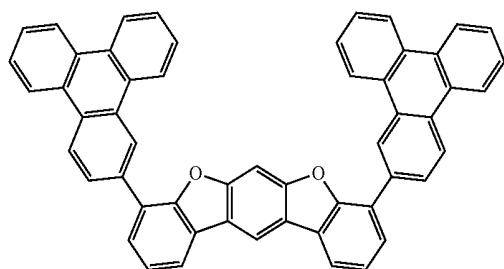
No. 336

No. 337



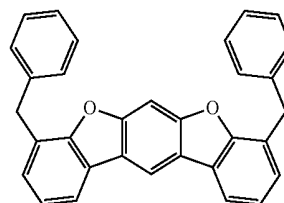
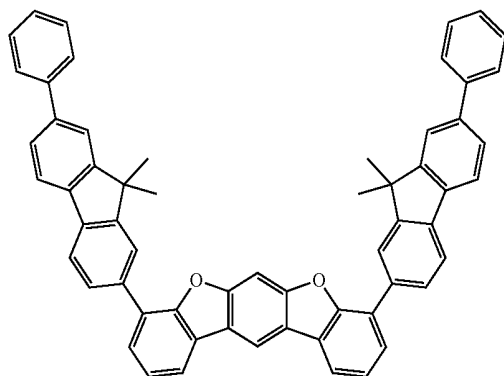
No. 338

No. 339



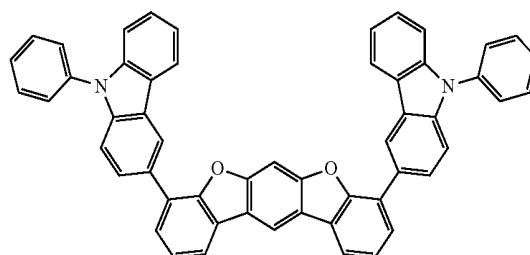
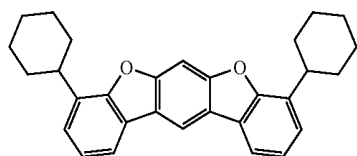
No. 340

No. 341

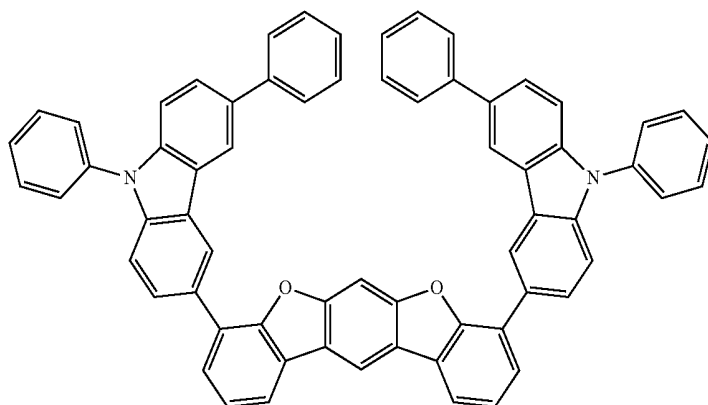


No. 342

No. 343



No. 344



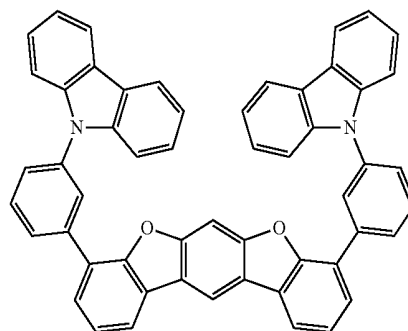
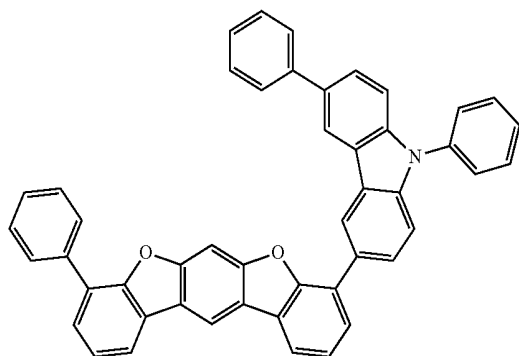
145

146

-continued

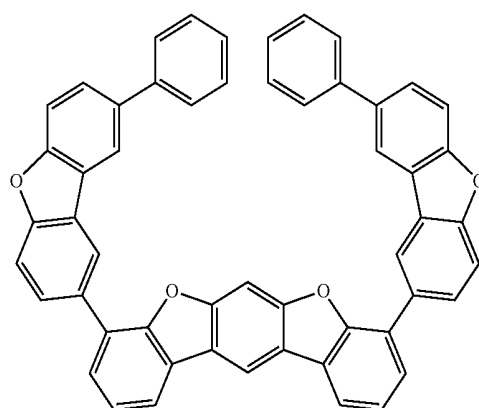
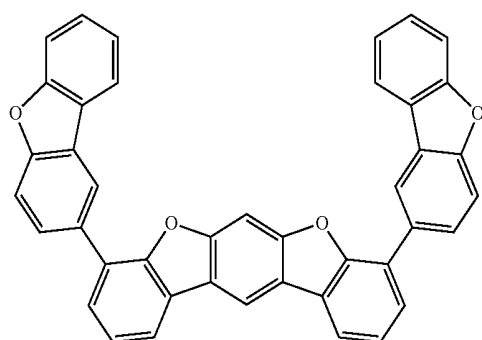
No. 345

No. 346

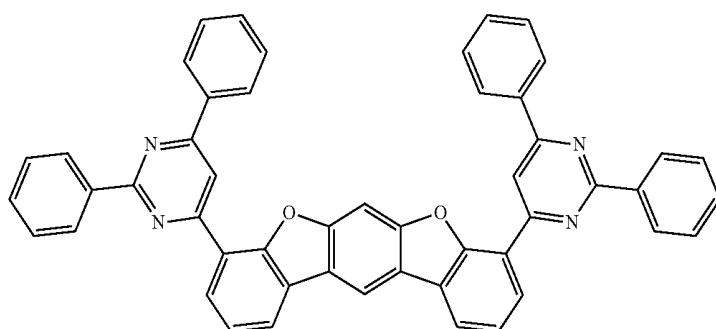


No. 347

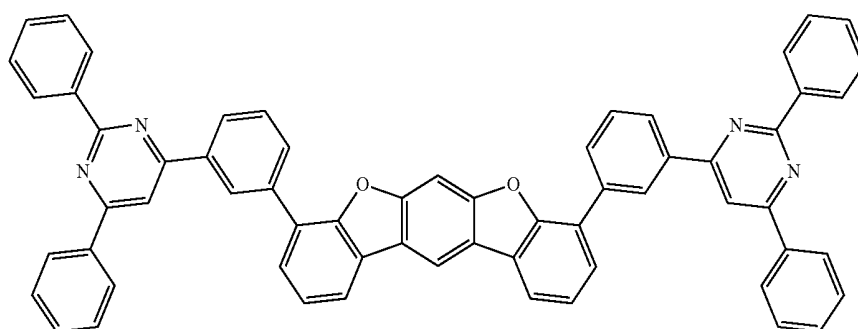
No. 348



No. 349



No. 350

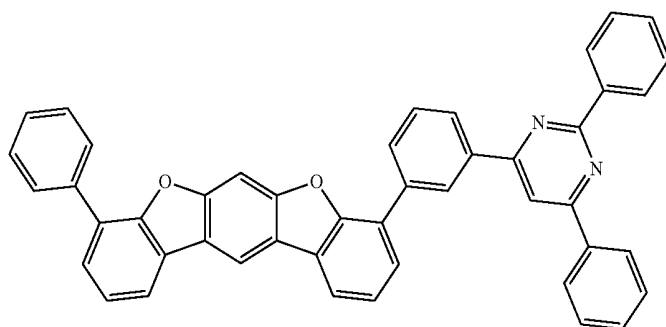


147

148

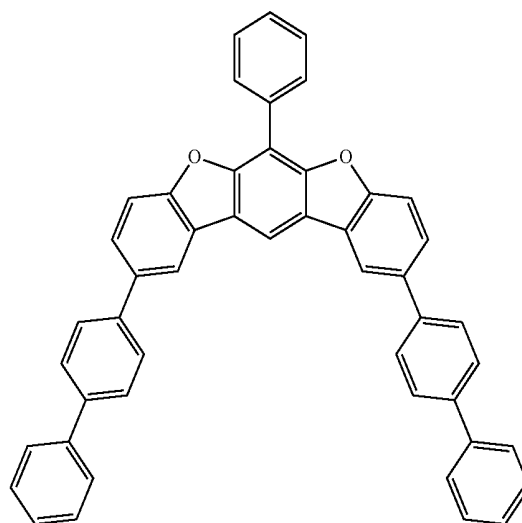
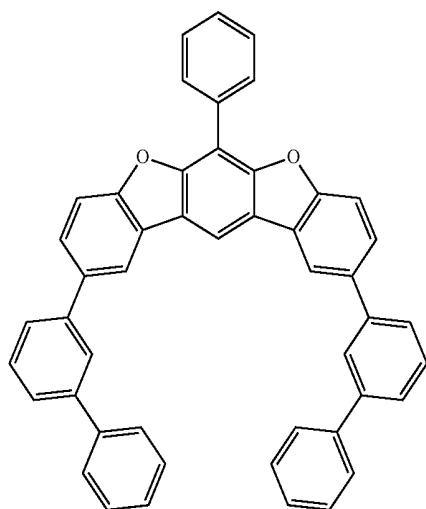
-continued

No. 351

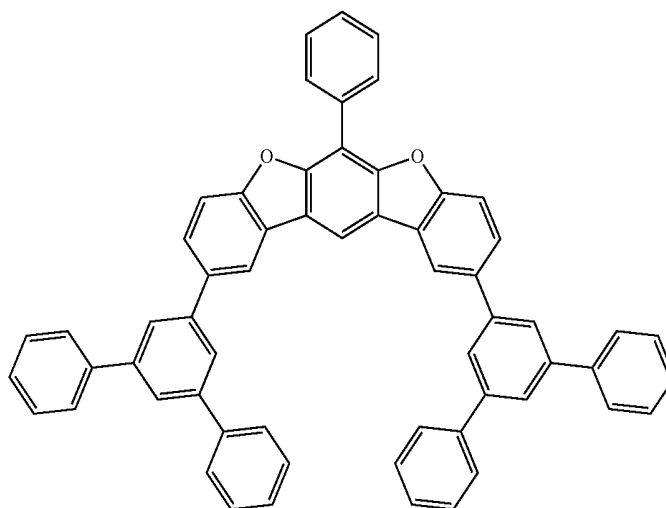


No. 352

No. 353



No. 354

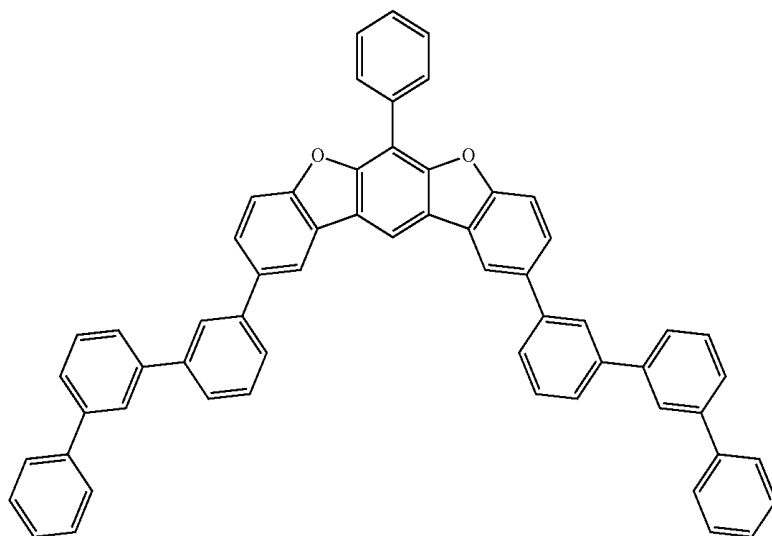


149

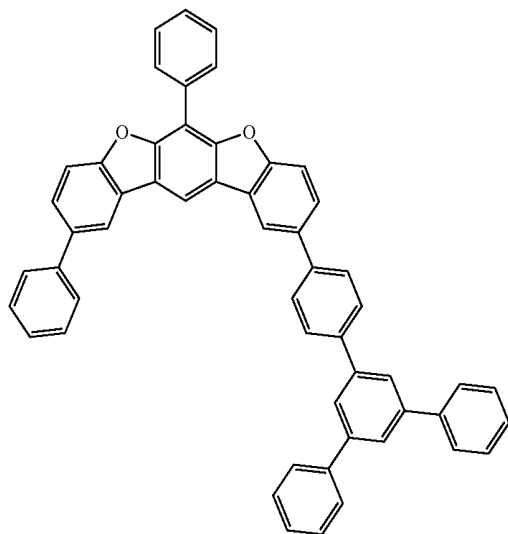
150

-continued

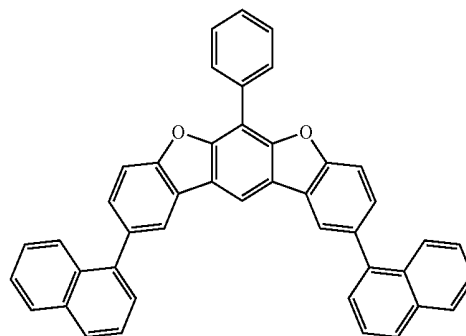
No. 355



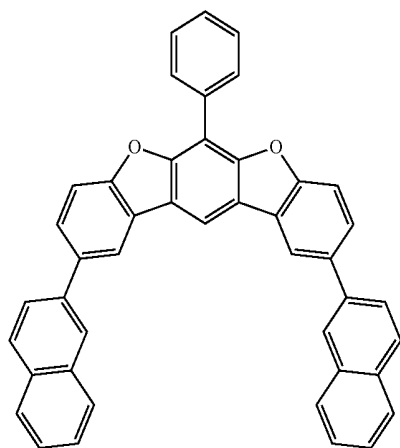
No. 356



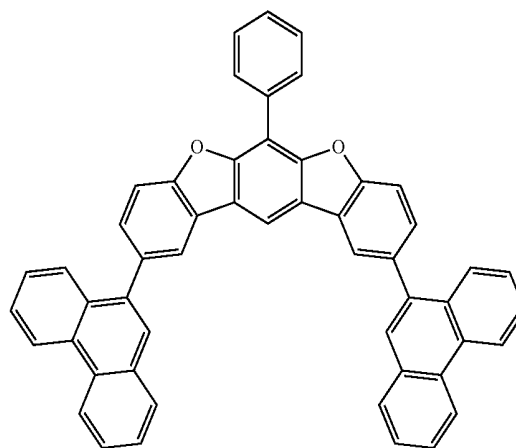
No. 357



No. 358



No. 359



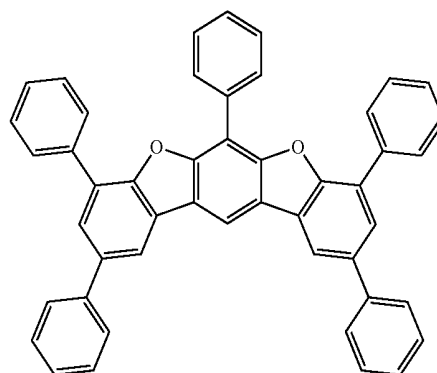
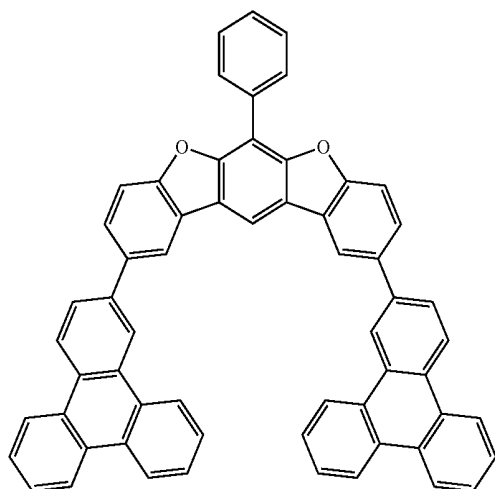
151

152

-continued

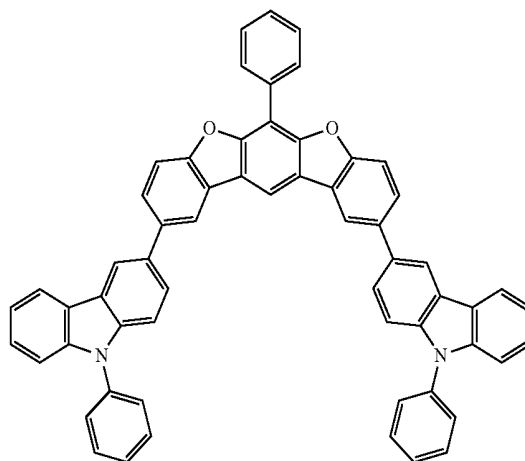
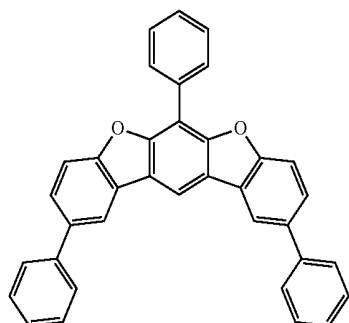
No. 360

No. 361



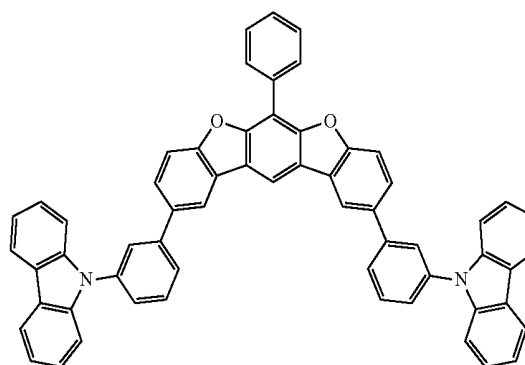
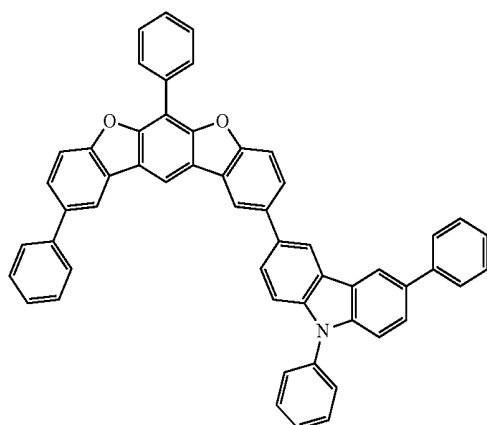
No. 362

No. 363



No. 364

No. 365

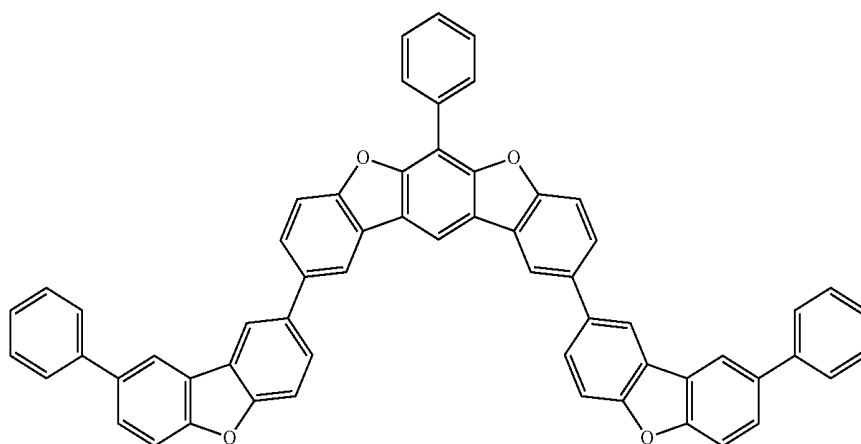


153

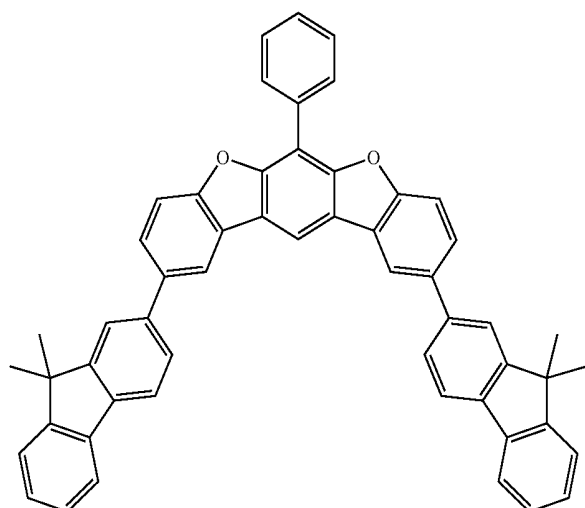
154

-continued

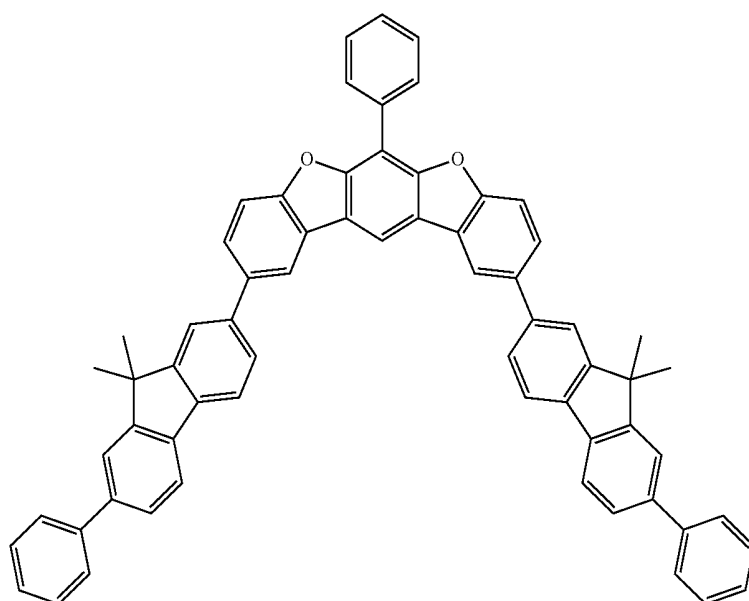
No. 366



No. 367



No. 368



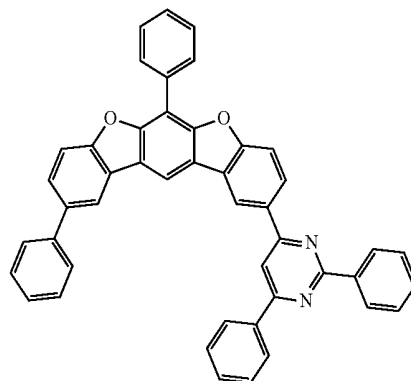
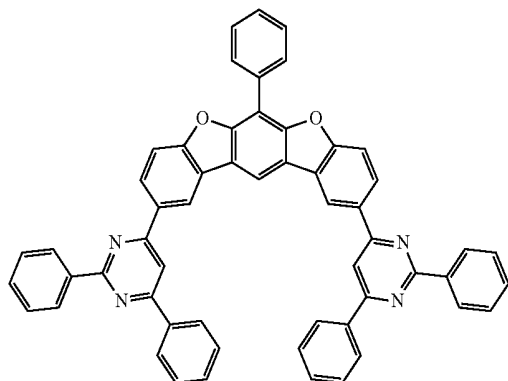
155

156

-continued

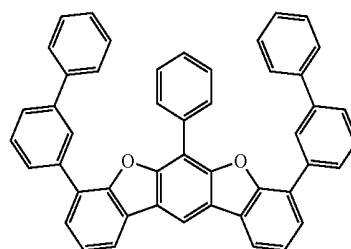
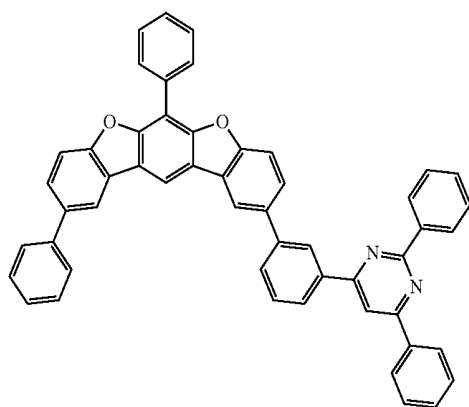
No. 369

No. 370

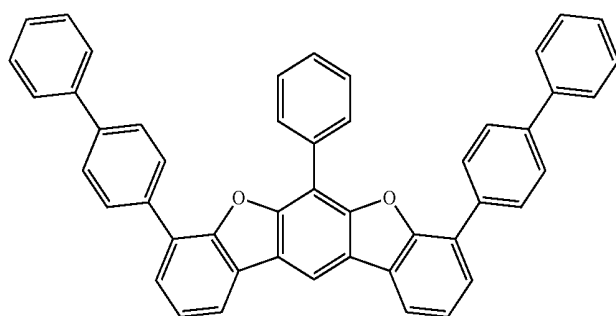


No. 371

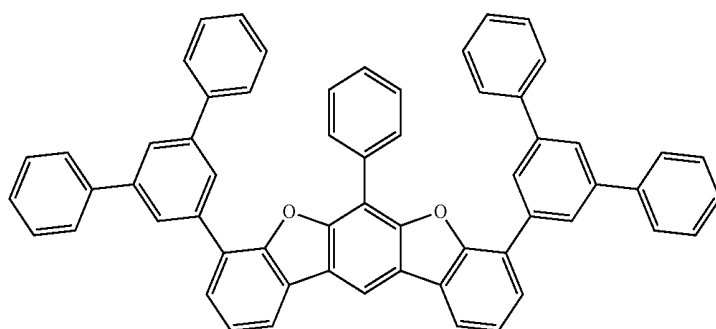
No. 372



No. 373



No. 374



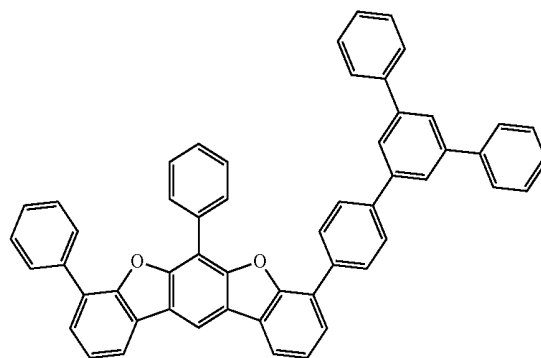
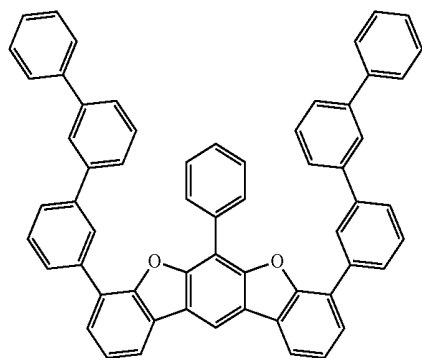
157

158

-continued

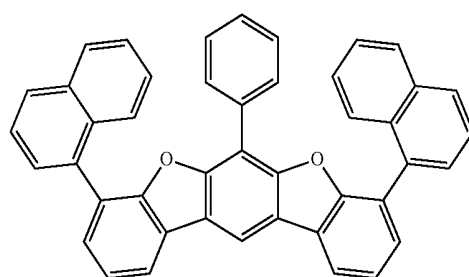
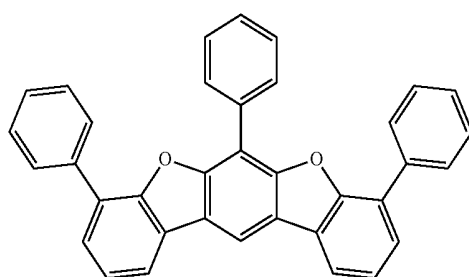
No. 375

No. 376



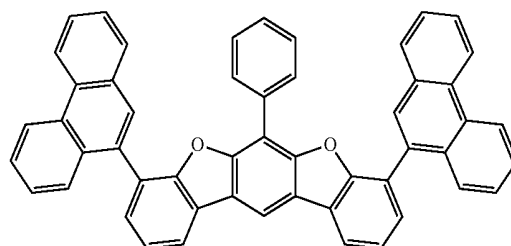
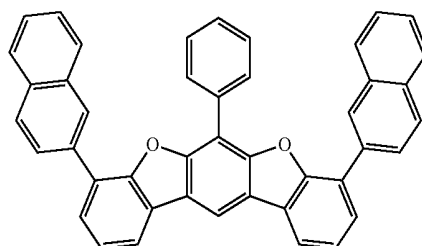
No. 377

No. 378



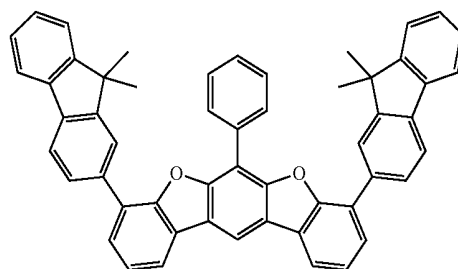
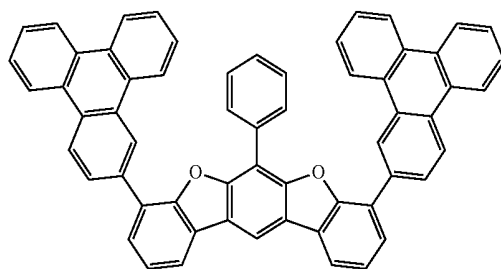
No. 379

No. 380



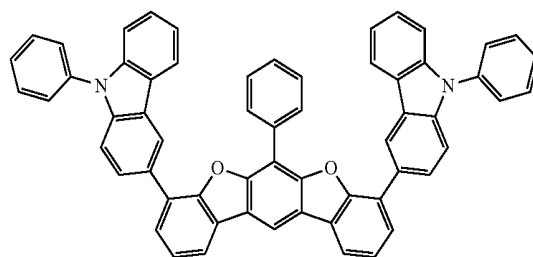
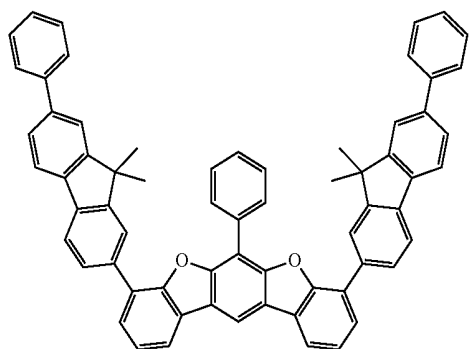
No. 381

No. 382



No. 383

No. 384

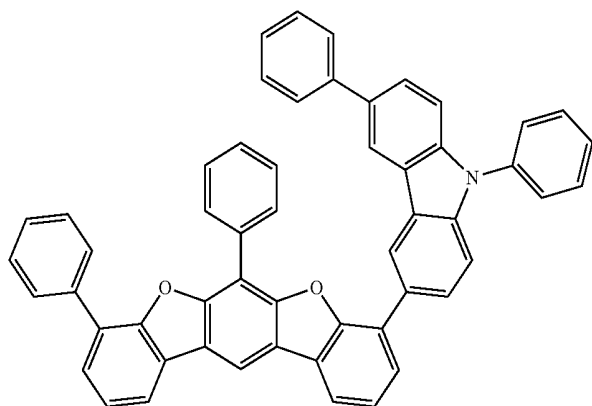


159

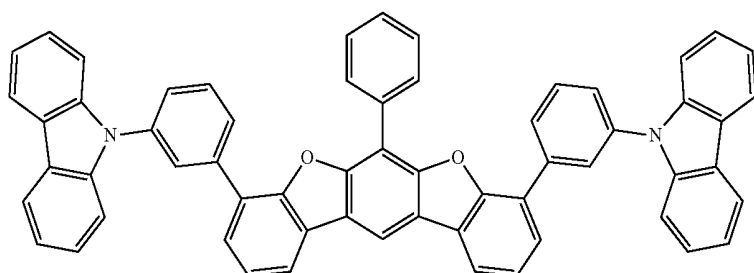
160

-continued

No. 385

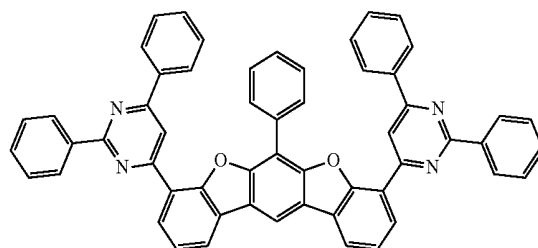
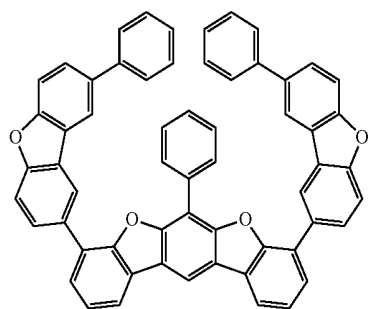


No. 386



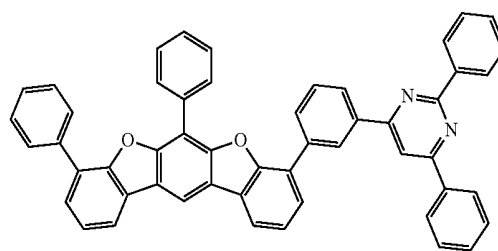
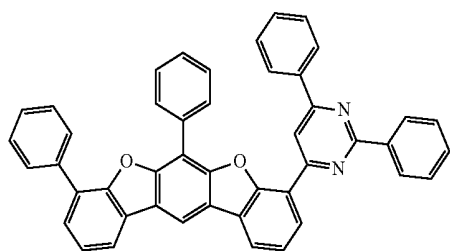
No. 387

No. 388

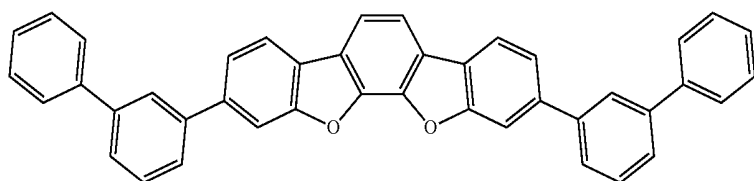


No. 389

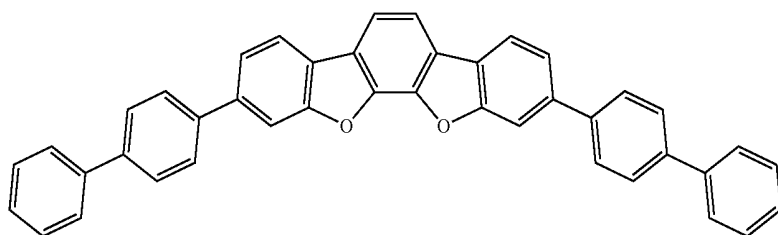
No. 390



No. 391



No. 392

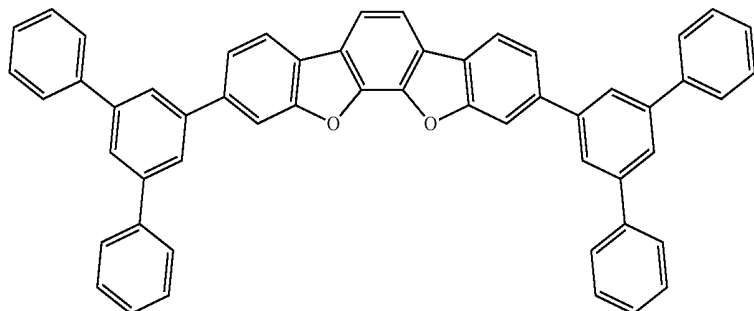


161

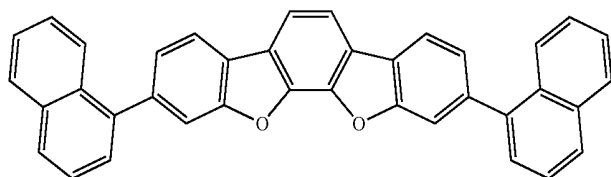
162

-continued

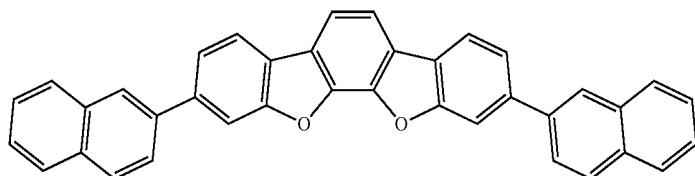
No. 393



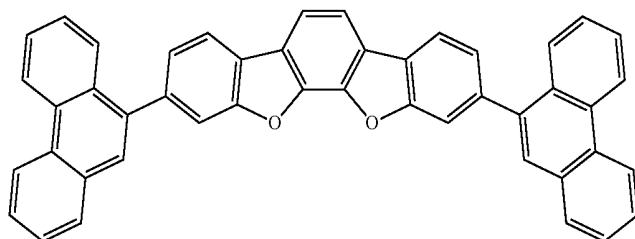
No. 394



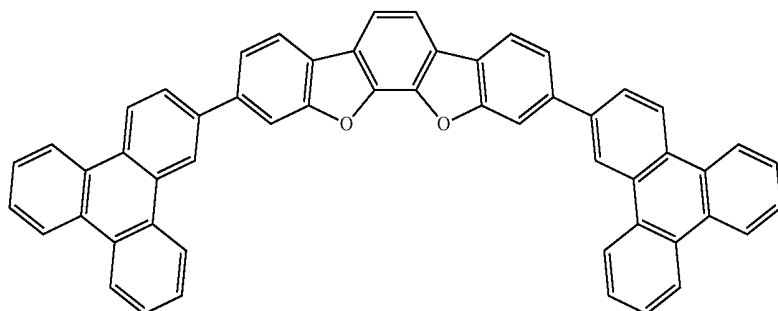
No. 395



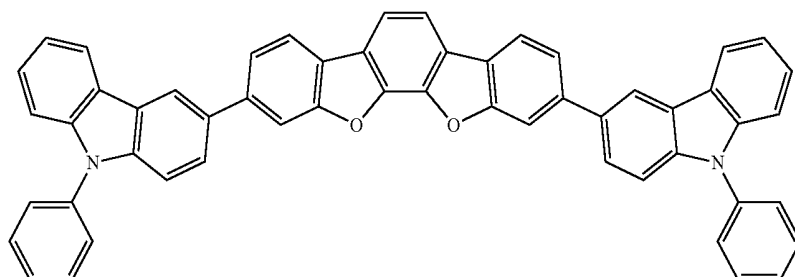
No. 396



No. 397



No. 398

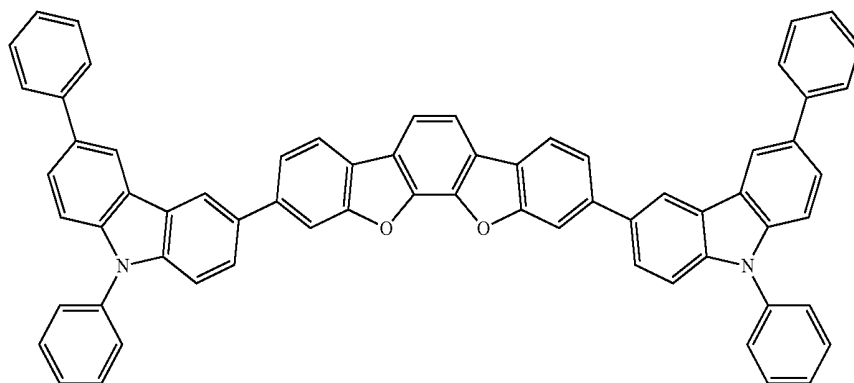


163

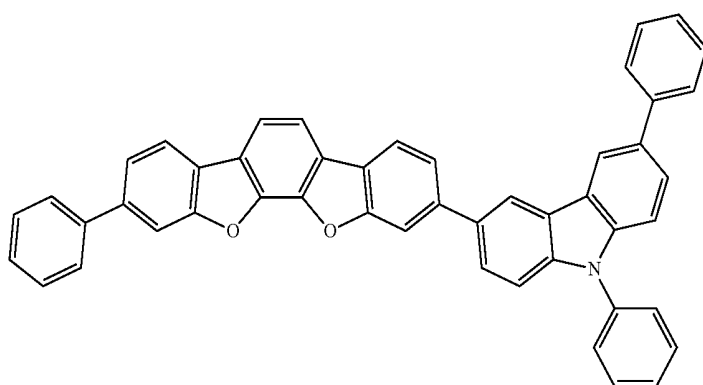
164

-continued

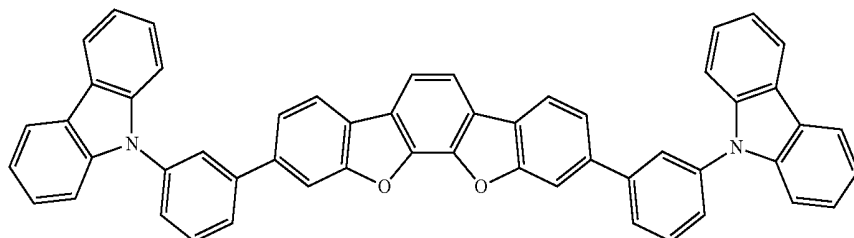
No. 399



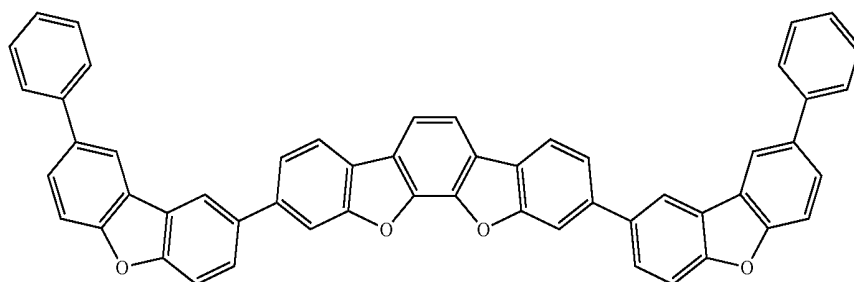
No. 400



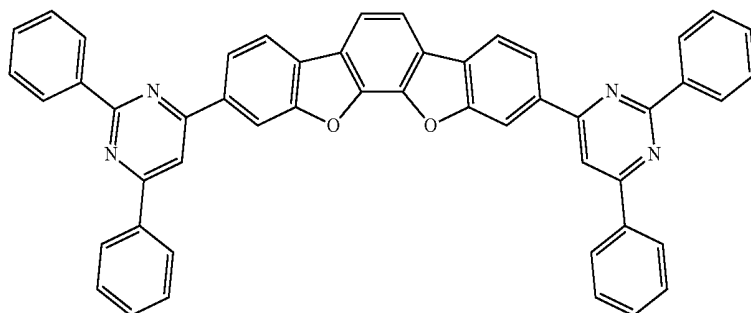
No. 401



No. 402



No. 403

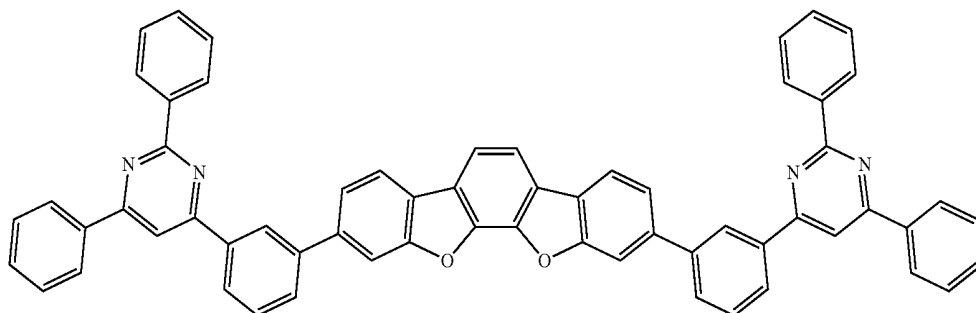


165

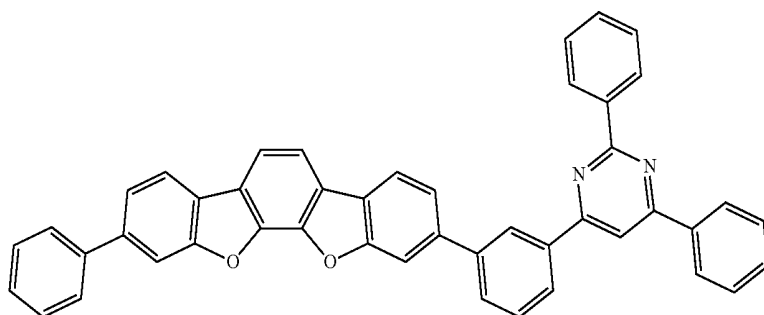
166

-continued

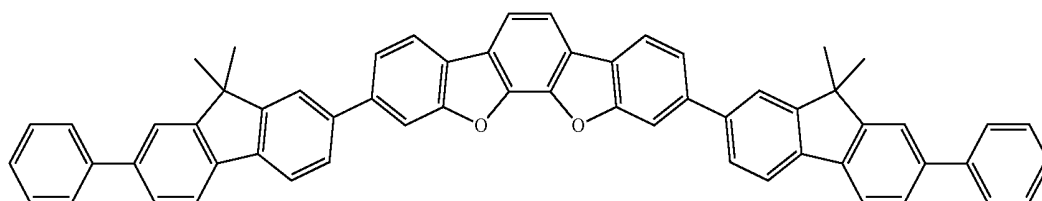
No. 404



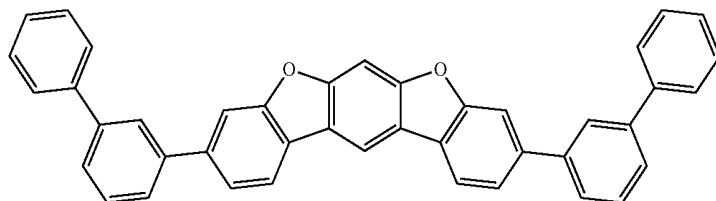
No. 405



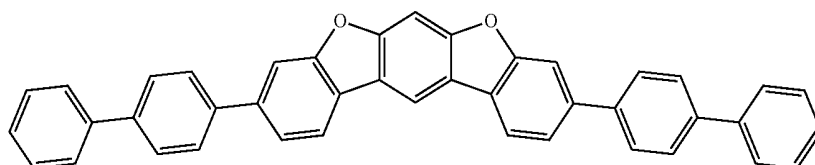
No. 406



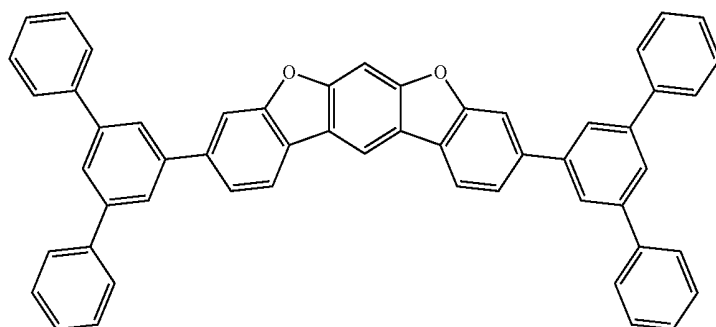
No. 407



No. 408



No. 409

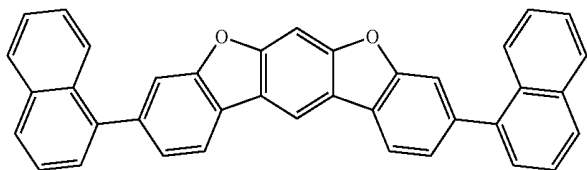


167

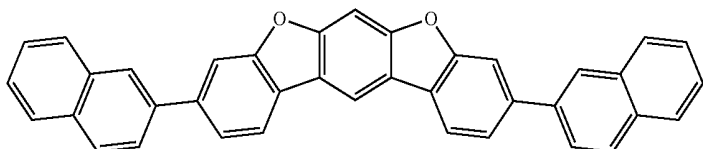
168

-continued

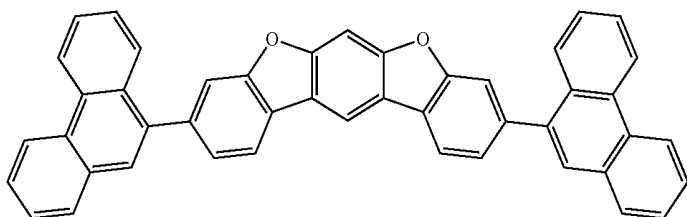
No. 410



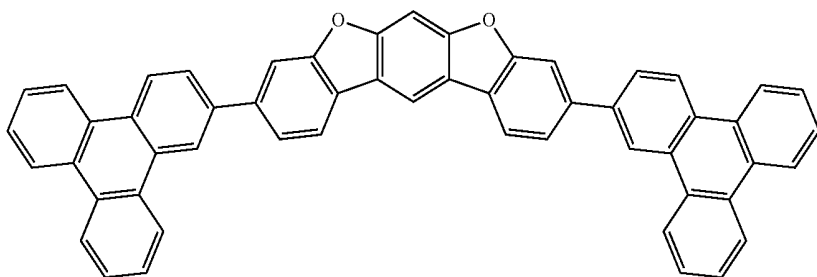
No. 411



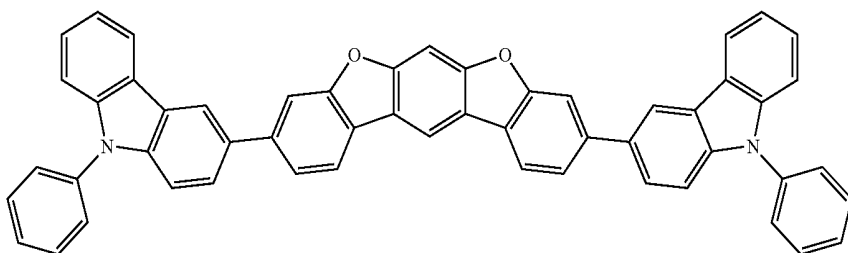
No. 412



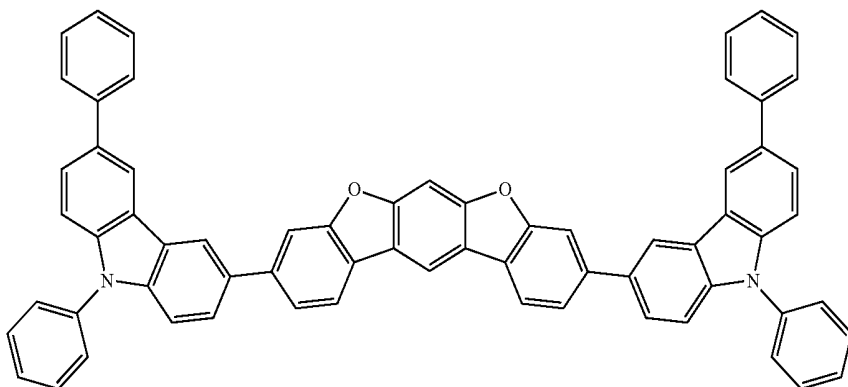
No. 413



No. 414

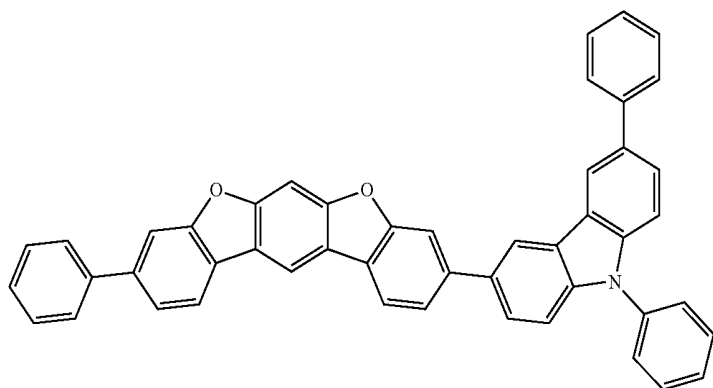


No. 415

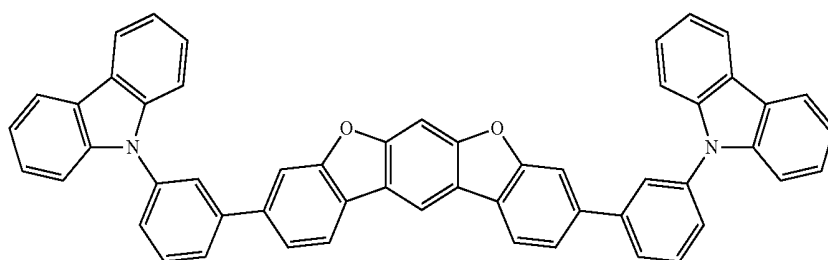


-continued

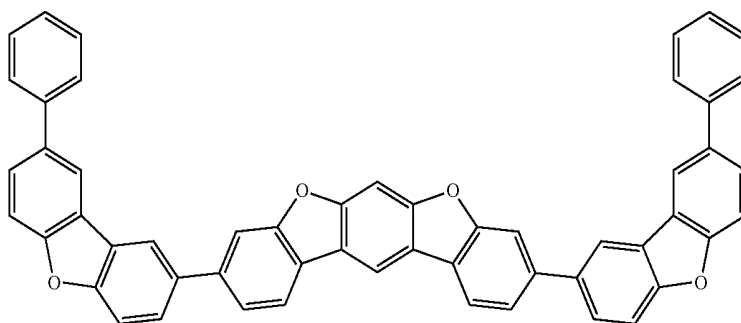
No. 416



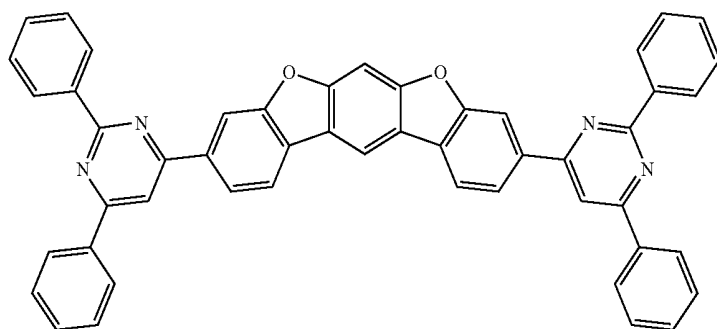
No. 417



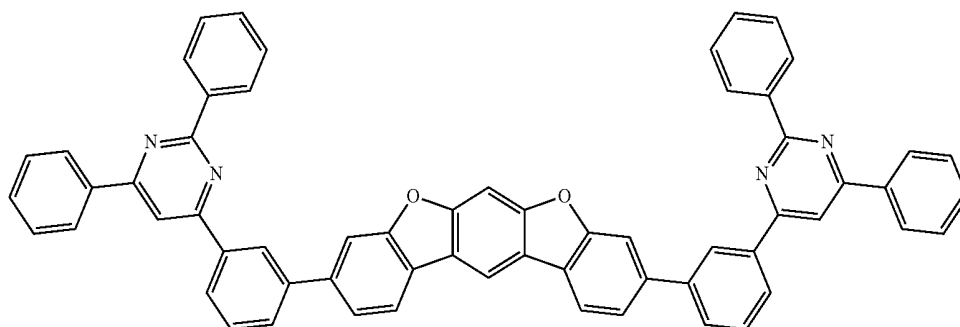
No. 418



No. 419



No. 420

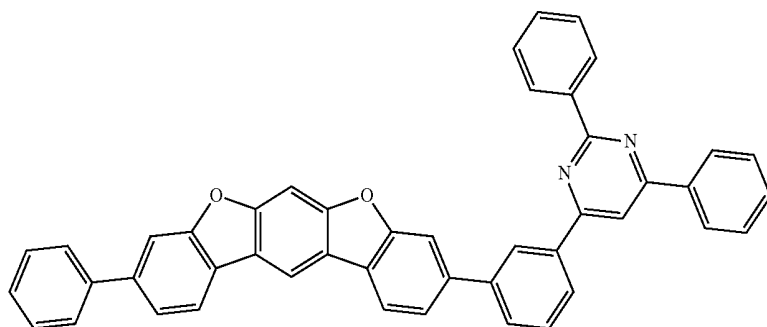


171

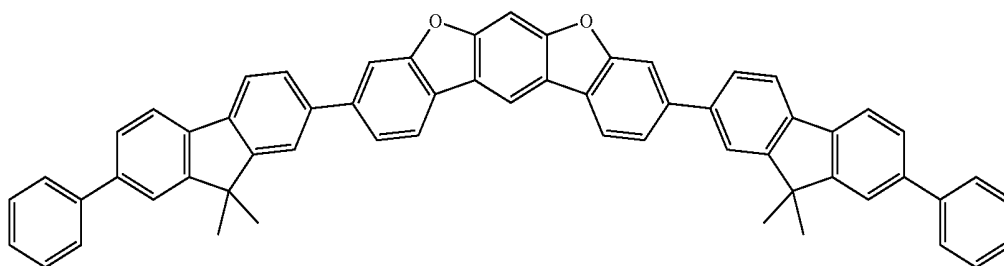
172

-continued

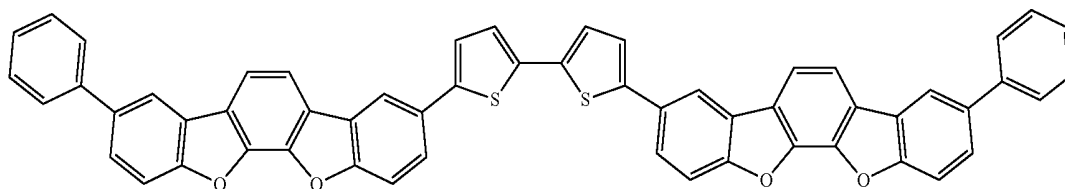
No. 421



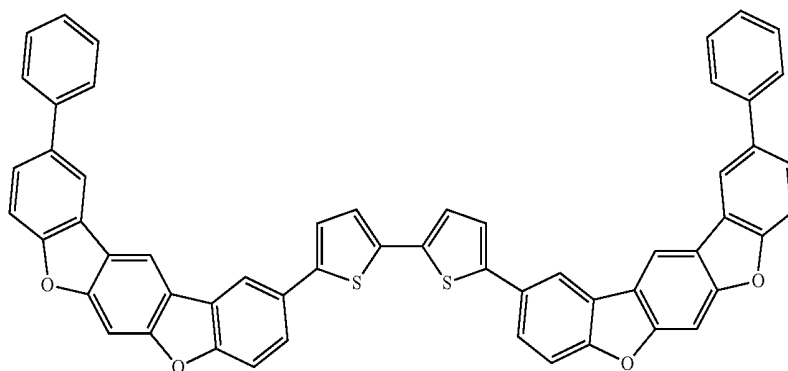
No. 422



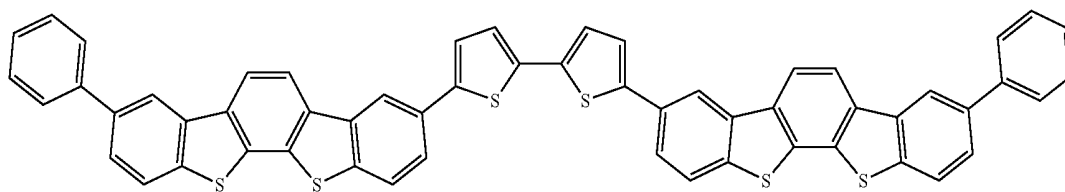
No. 423



No. 424



No. 425

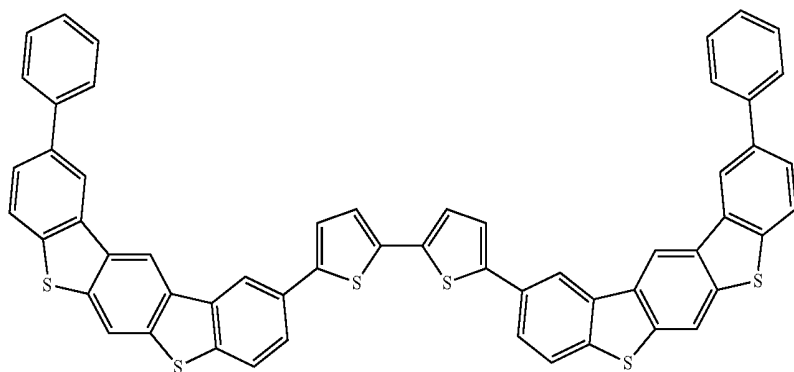


173

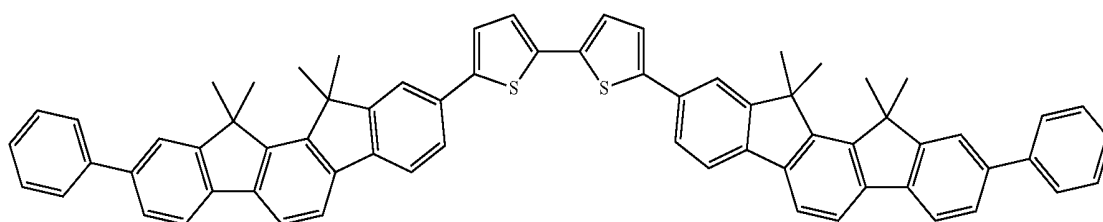
174

-continued

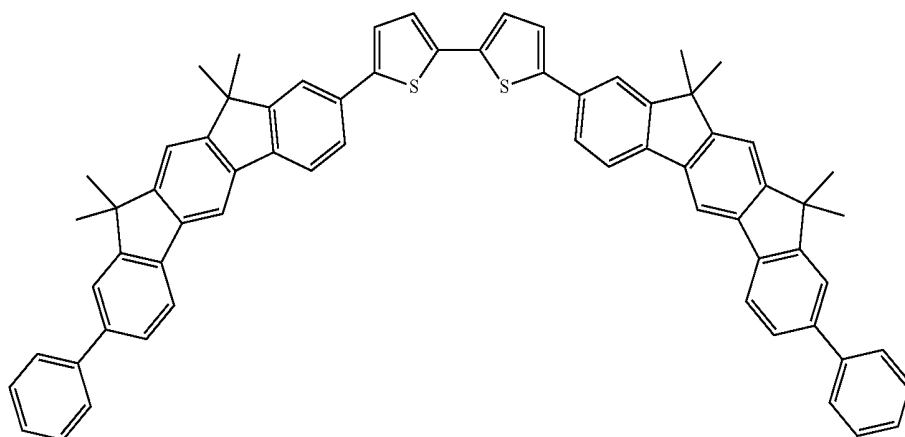
No. 426



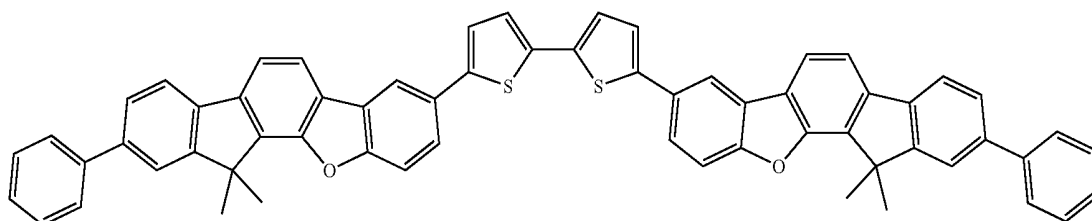
No. 427



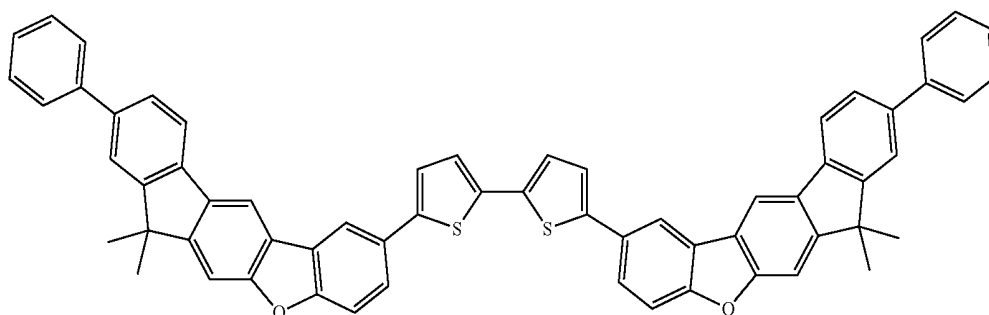
No. 428



No. 429



No. 430

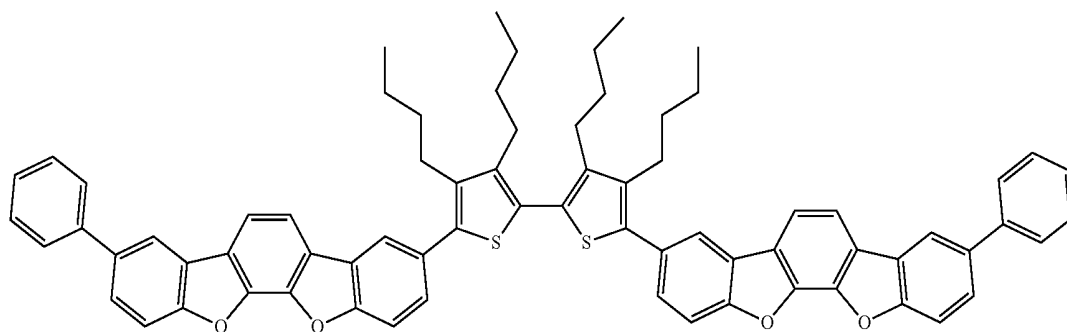


175

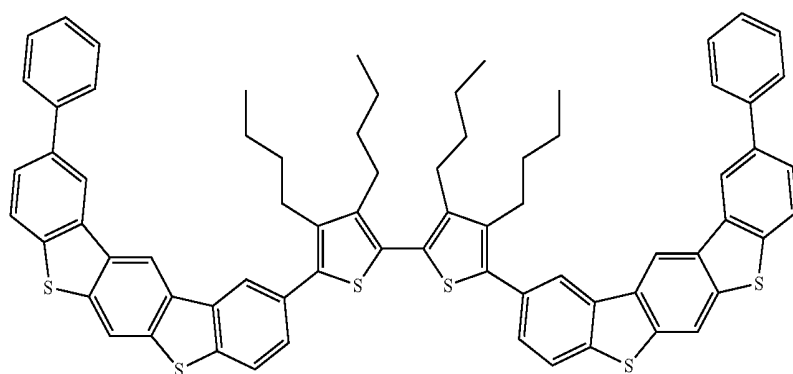
176

-continued

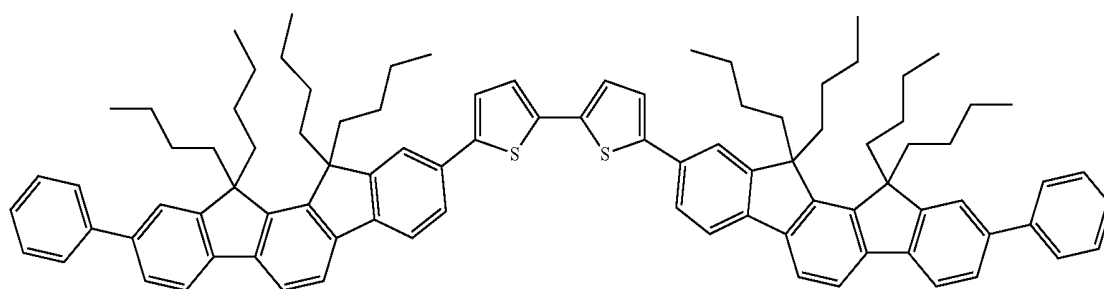
No. 431



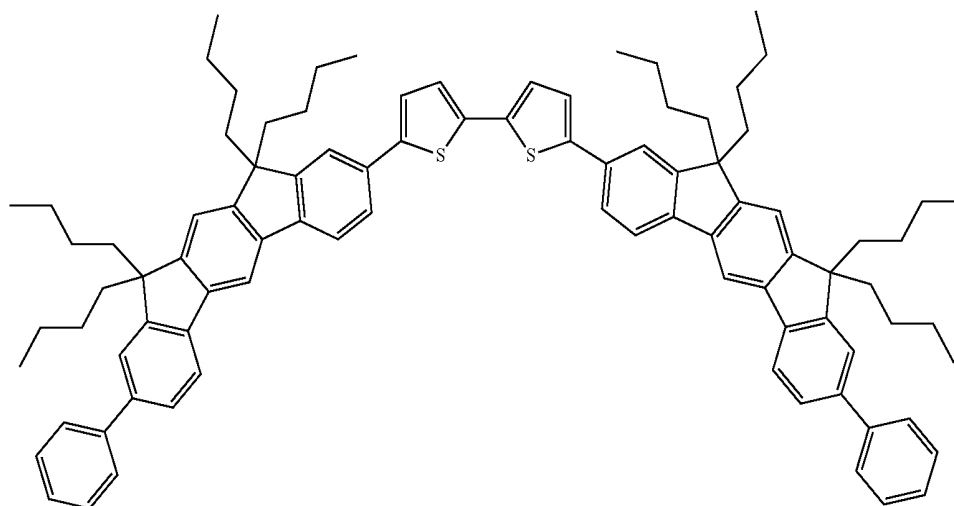
No. 432



No. 433



No. 434

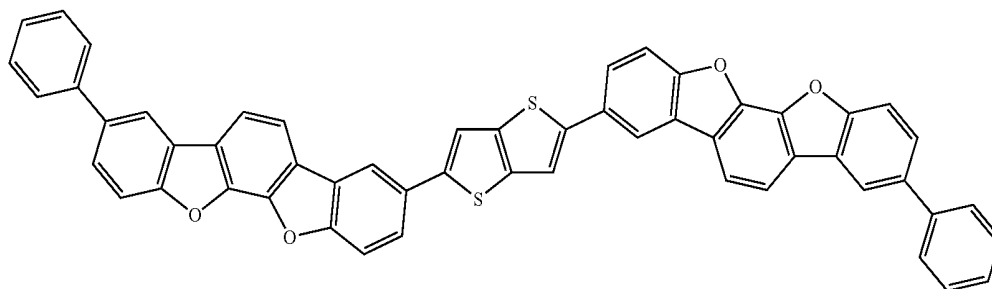


177

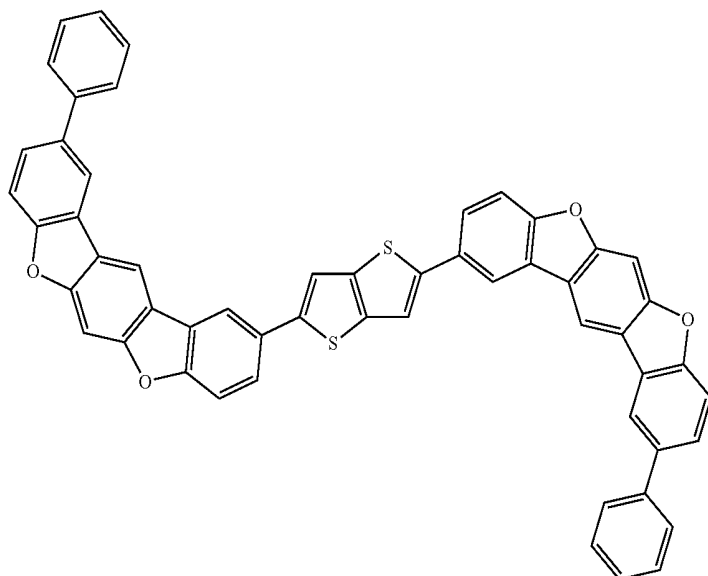
178

-continued

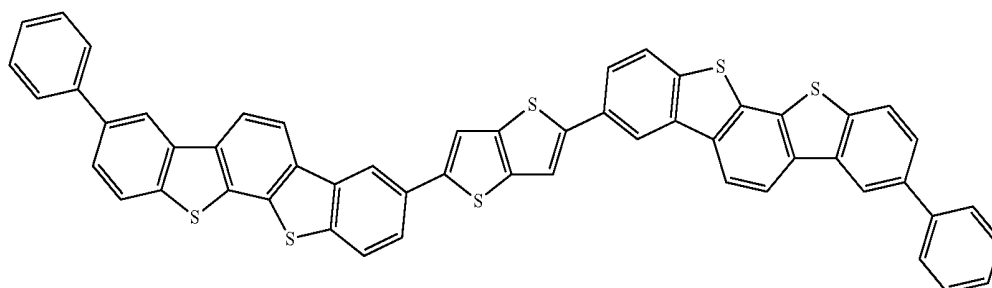
No. 435



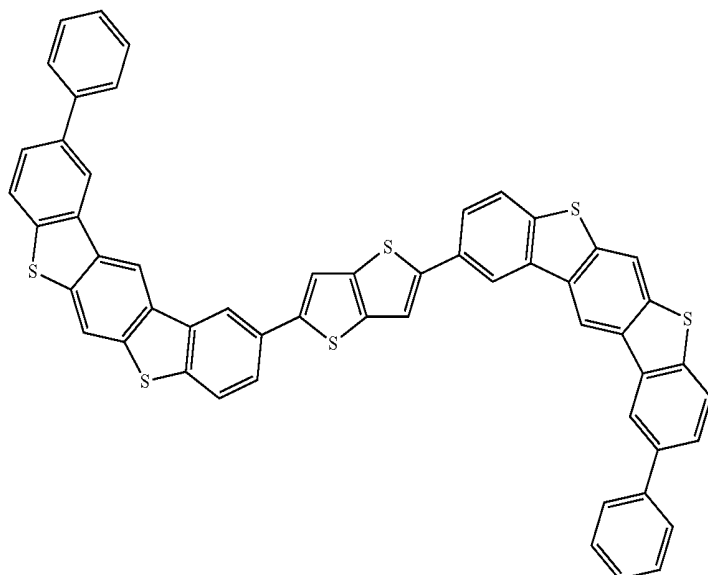
No. 436



No. 437



No. 438

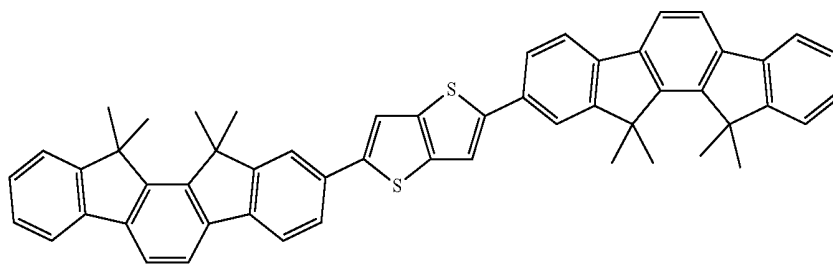


179

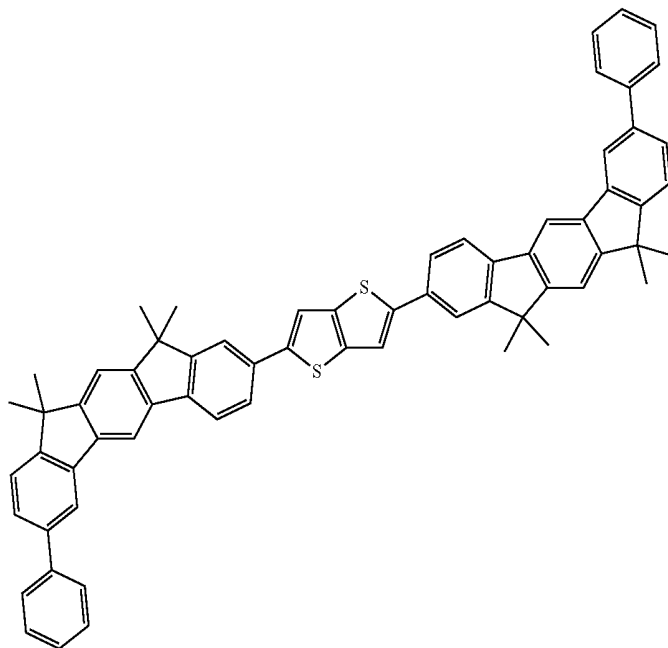
180

-continued

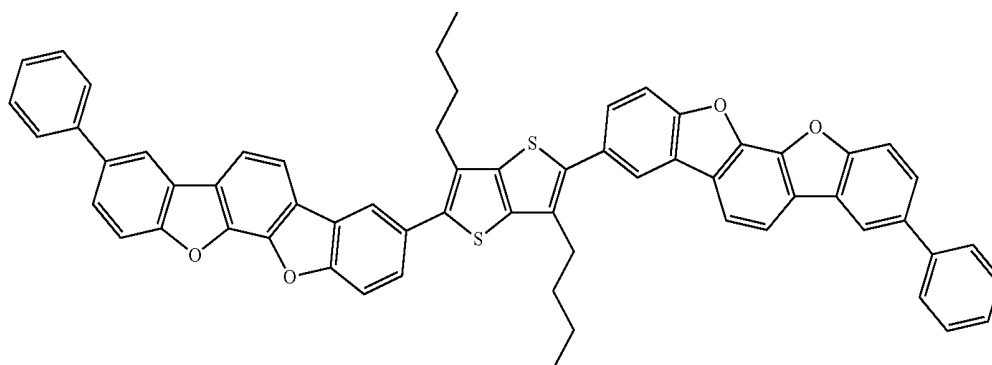
No. 439



No. 440



No. 441

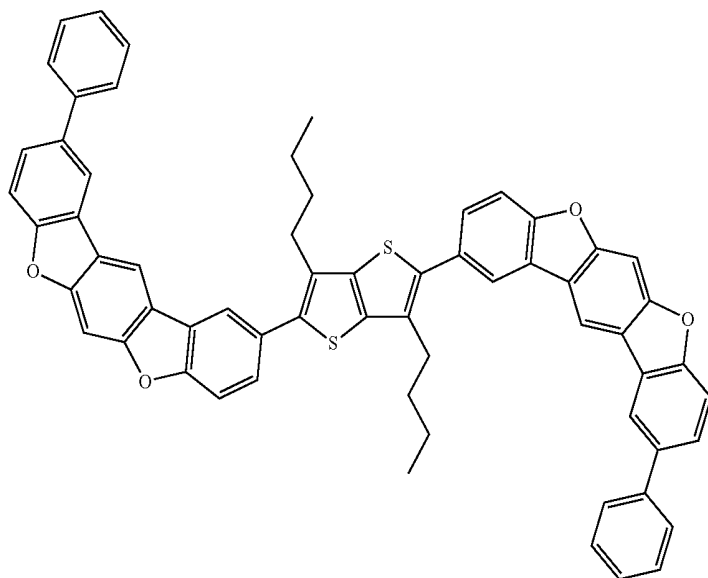


181

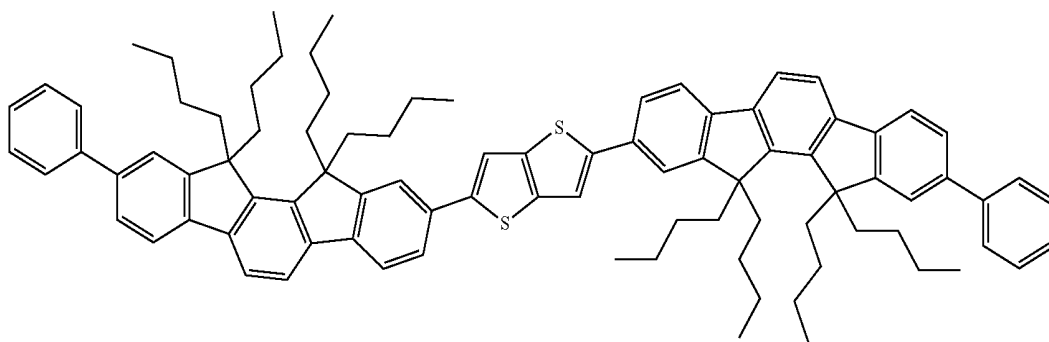
182

-continued

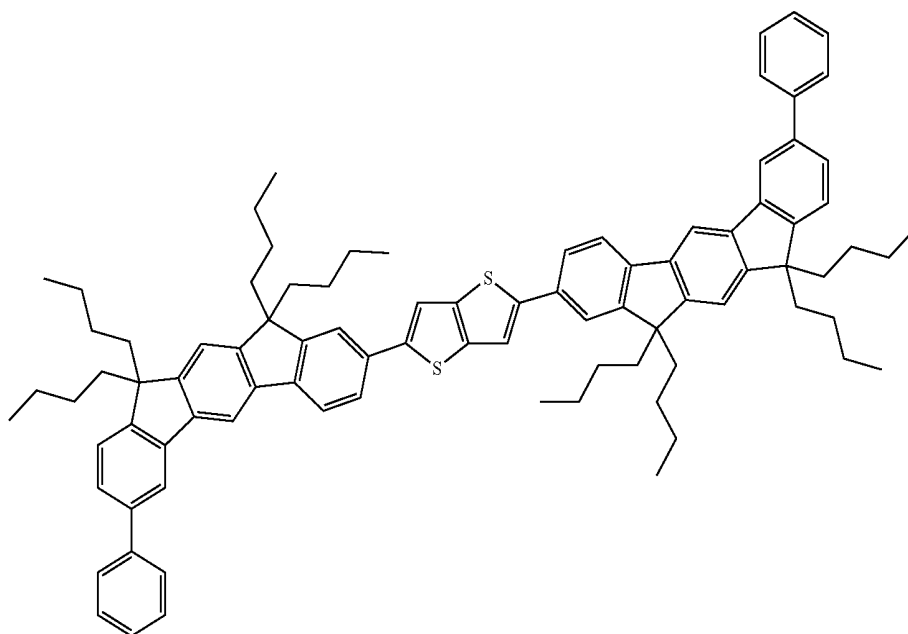
No. 442



No. 443



No. 444

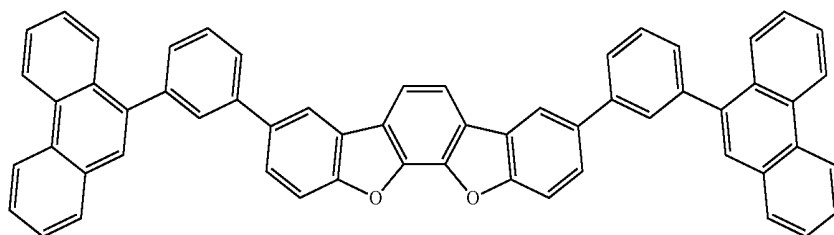


183

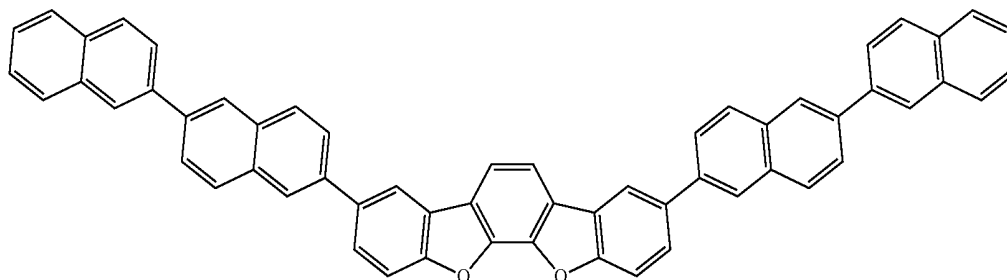
184

-continued

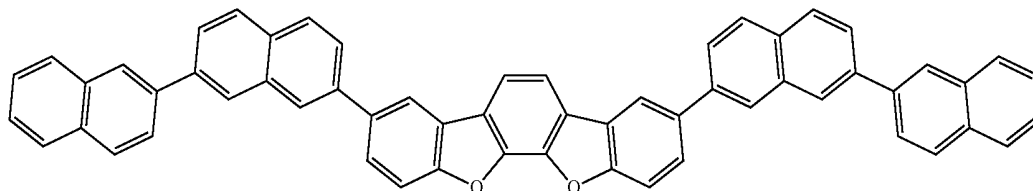
No. 445



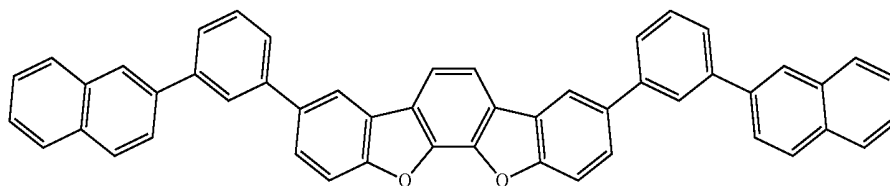
No. 446



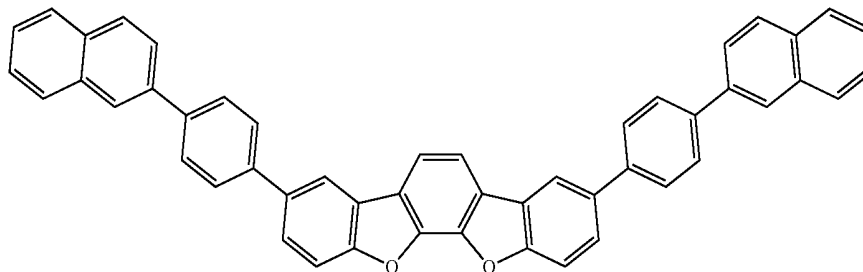
No. 447



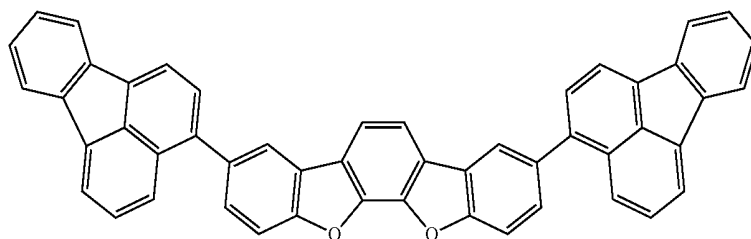
No. 448



No. 449

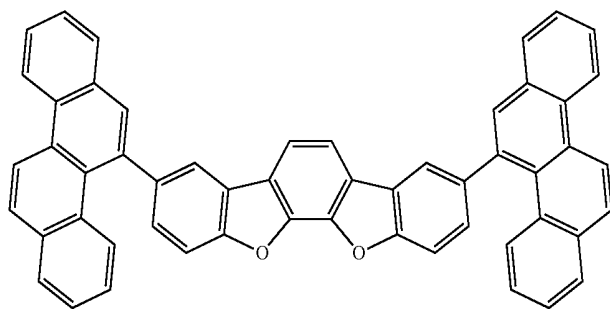


No. 450

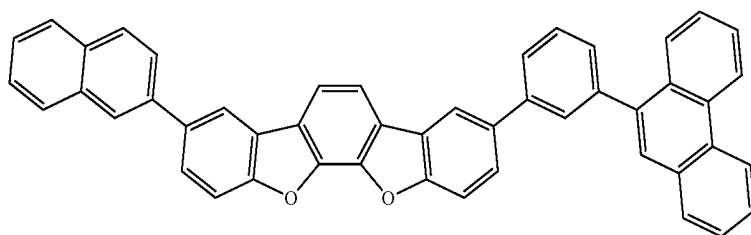


-continued

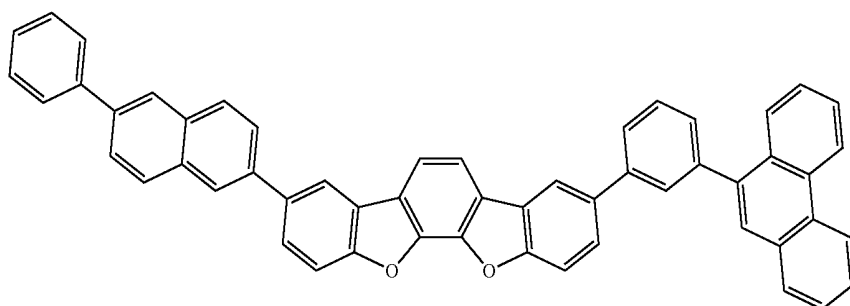
No. 451



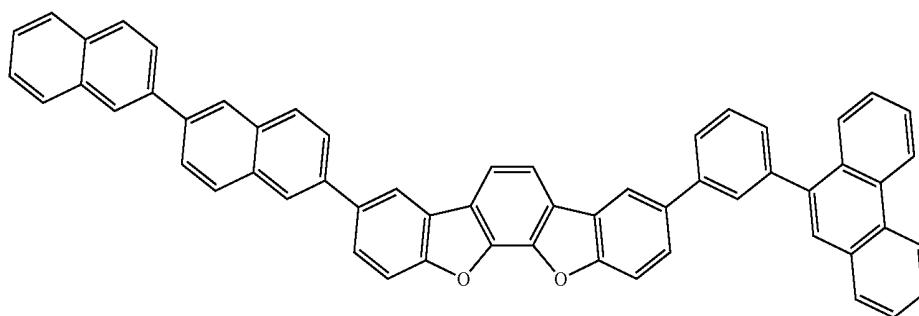
No. 452



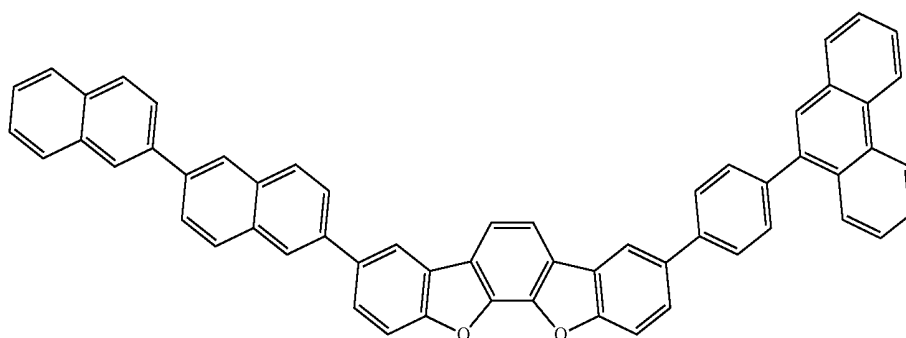
No. 453



No. 454



No. 455

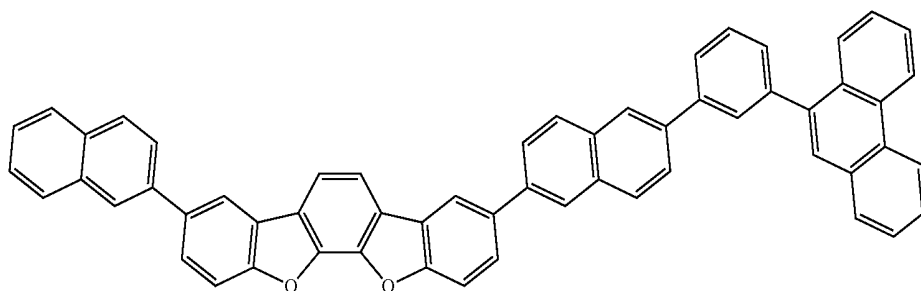


187

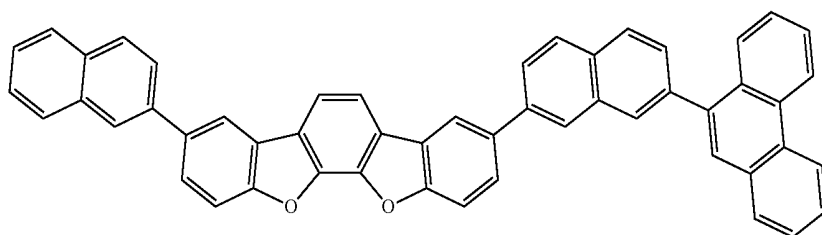
188

-continued

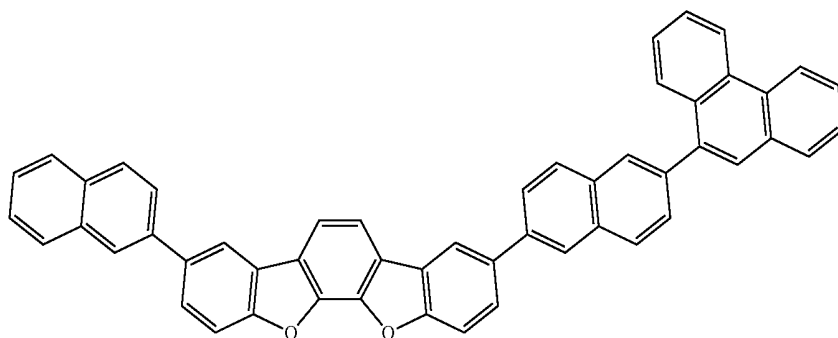
No. 456



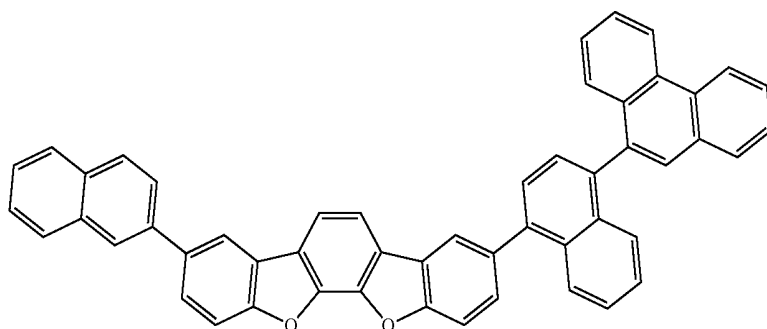
No. 457



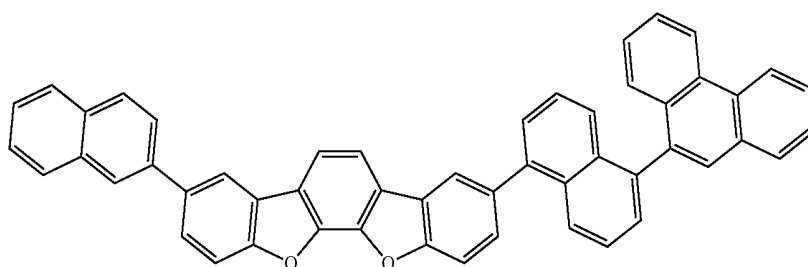
No. 458



No. 459



No. 460

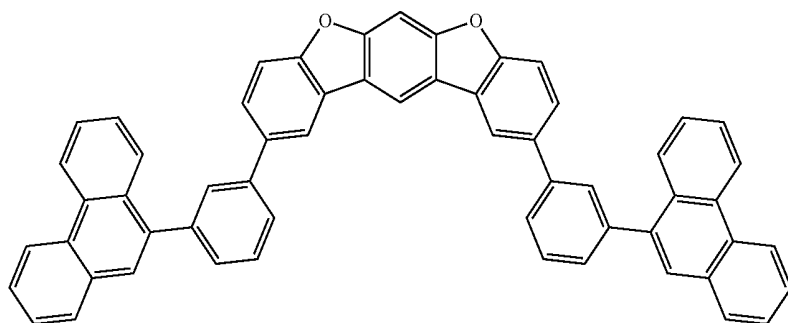


189

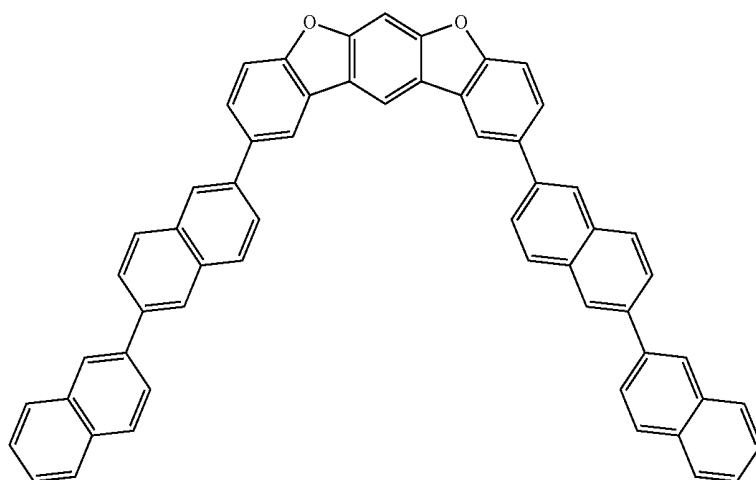
190

-continued

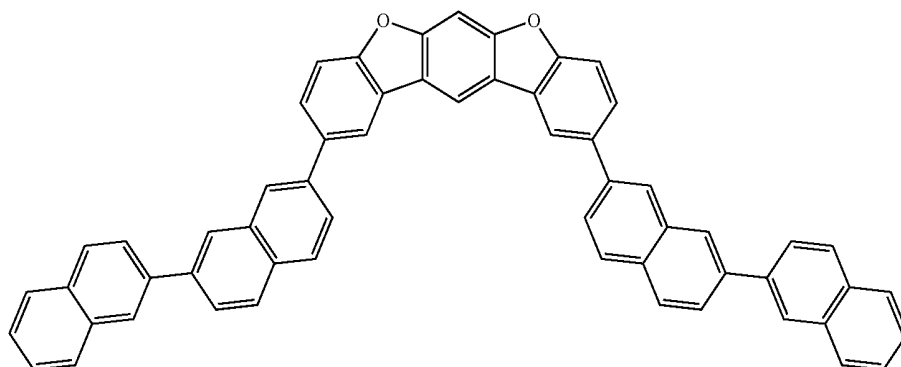
No. 461



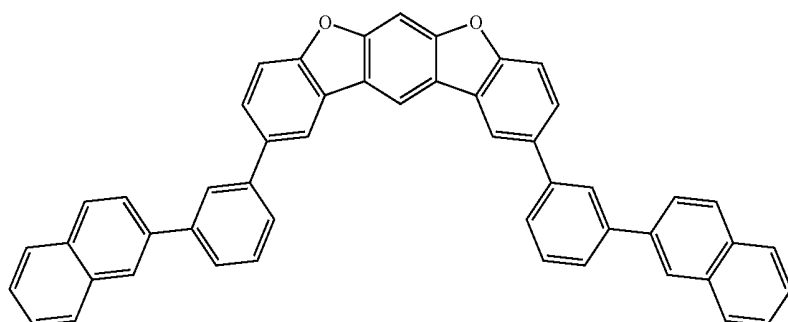
No. 462



No. 463



No. 464



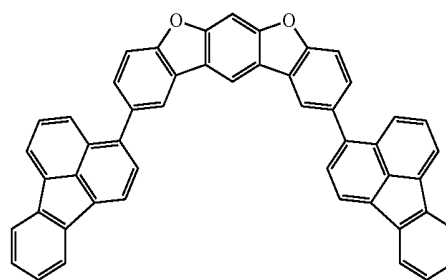
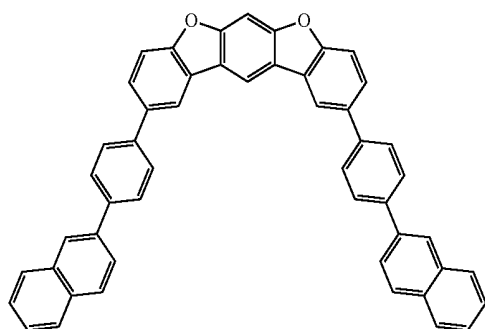
191

192

-continued

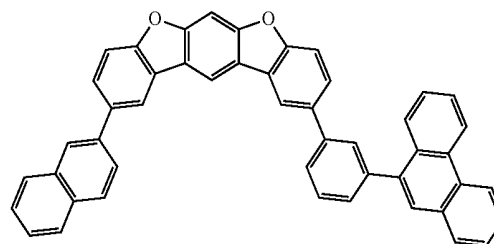
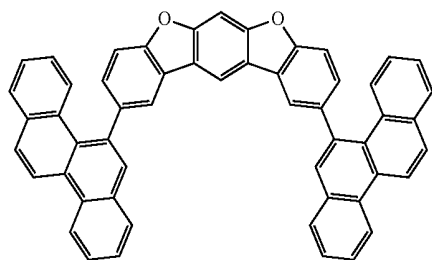
No. 465

No. 466

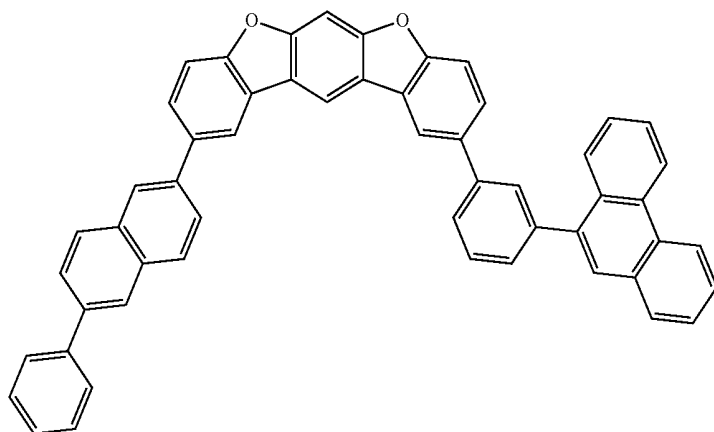


No. 467

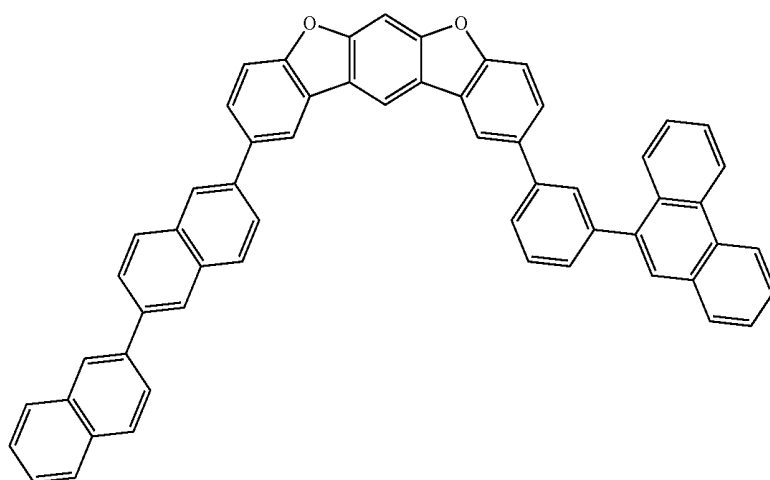
No. 468



No. 469



No. 470

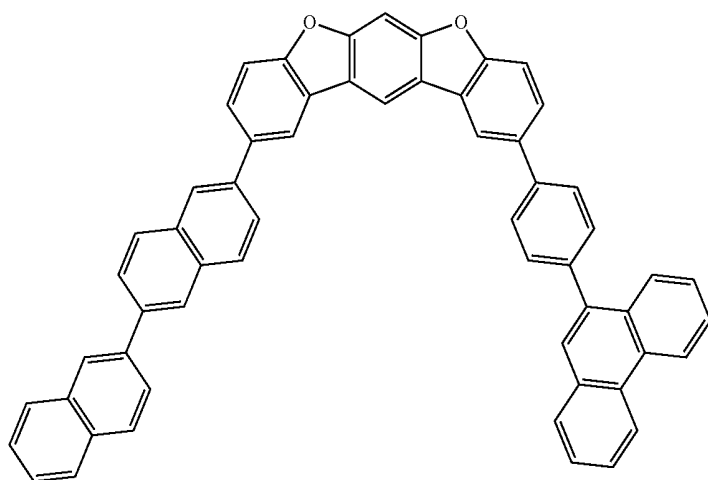


193

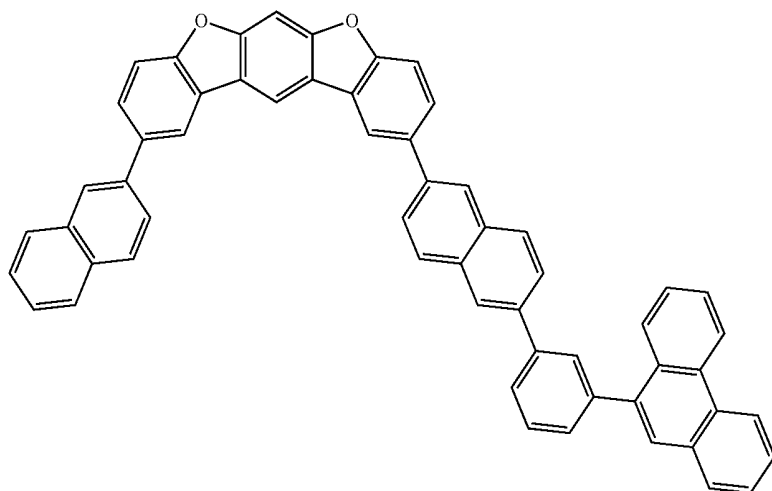
194

-continued

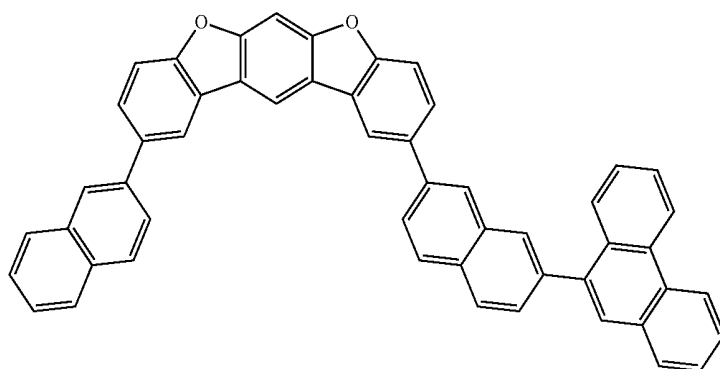
No. 471



No. 472

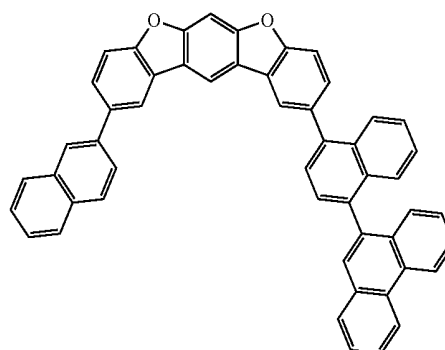
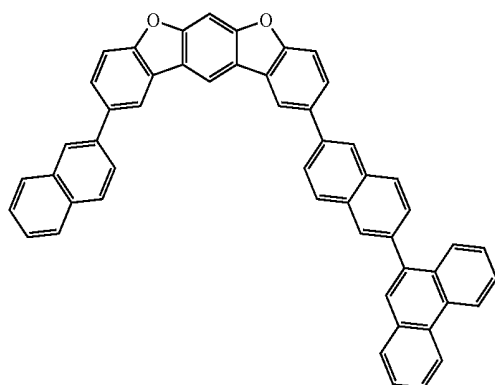


No. 473



No. 474

No. 475

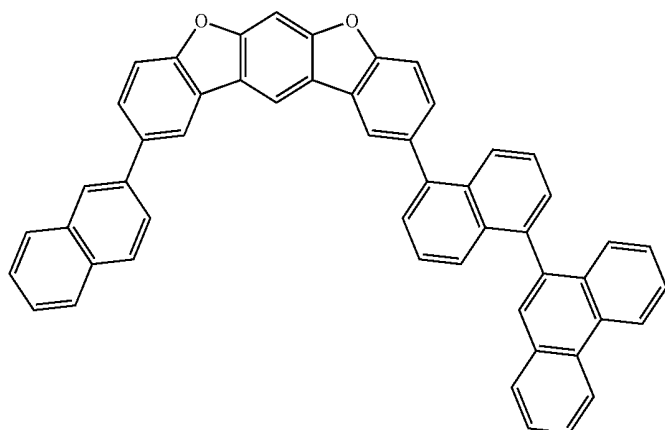


195

196

-continued

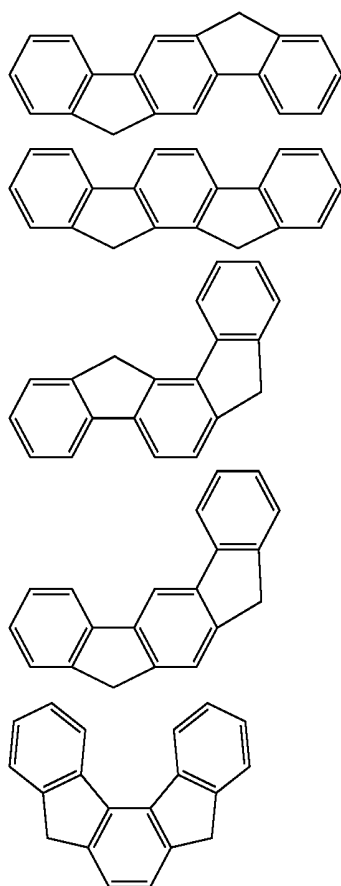
No. 476



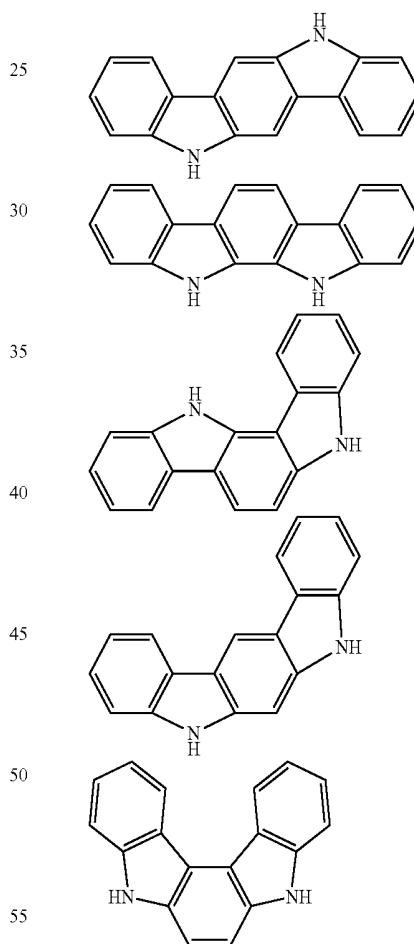
Next, an organic EL device of the present invention will be described.

The organic EL device of the present invention has one or more organic thin film layers including a light emitting layer between a cathode and an anode, and at least one layer of the organic thin film layers contains a material for an organic EL device serving as a compound having a π -conjugated heteroacene skeleton crosslinked with a carbon atom, nitrogen atom, oxygen atom, or sulfur atom. Specific examples of the π -conjugated heteroacene skeleton are shown below.

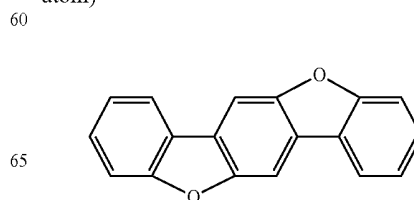
Indenofluorene (crosslinked with a carbon atom)



Indolocarbazole (crosslinked with a nitrogen atom)

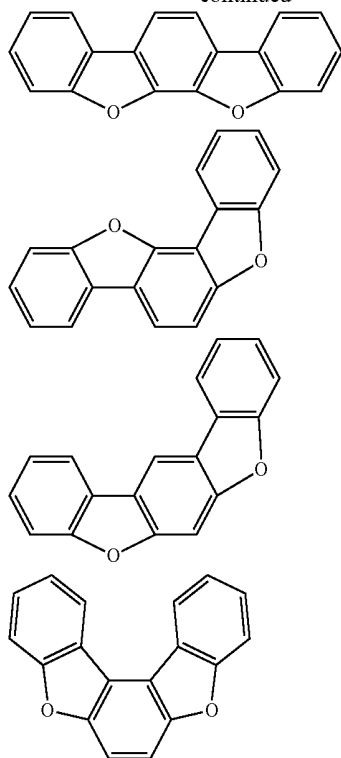


Benzofuranodibenzofuran (crosslinked with an oxygen atom)

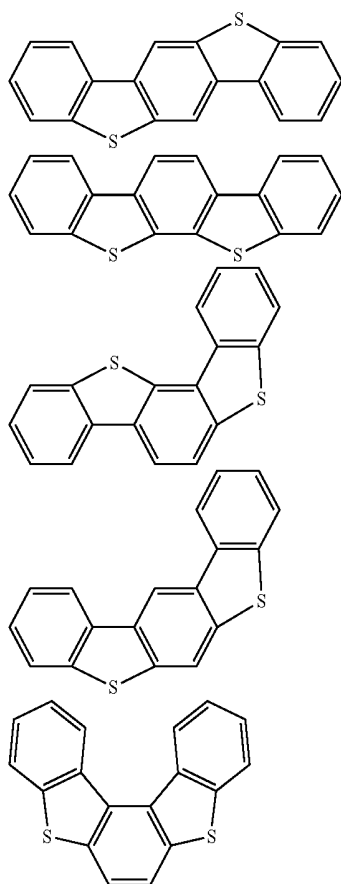


197

-continued

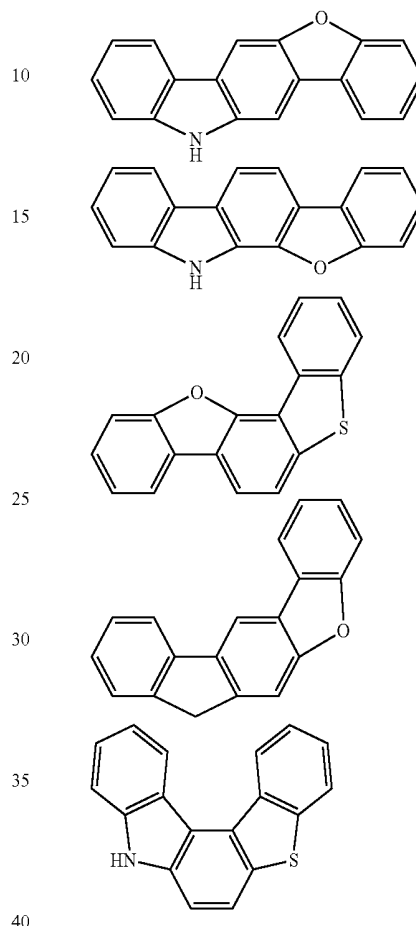


Benzothiophenodibenzothiophene (crosslinked, with a sulfur atom)



198

In addition to the foregoing, a n-conjugated heteroacene skeleton crosslinked with a combination of two or more of a carbon atom, a nitrogen atom, an oxygen atom, and a sulfur atom is also permitted. Specific examples of the n-conjugated heteroacene skeleton are shown below.



In addition, the above-mentioned material for an organic EL device of the present invention is preferably used as the material for an organic EL device.

The organic EL device may have an electron transporting layer between the light emitting layer and the cathode, and the electron transporting layer may contain the material for an organic EL device. Further, both the light emitting layer and the electron transporting layer each preferably contain the material for an organic EL device.

Alternatively, the organic EL device may have a hole transporting layer between the light emitting layer and the anode, and the hole transporting layer may contain the material for an organic EL device.

Further, the material for an organic EL device of the present invention is preferably incorporated into at least the light emitting layer. When the material is used in the light emitting layer, the lifetime of the organic EL device can be lengthened. When the material is used in the electron transporting layer or the electron injecting layer, the voltage at which the device is driven can be reduced. The material is preferably incorporated into each of two or more layers including the light emitting layer and the electron transporting layer or the electron injecting layer at the same time because both the reduced voltage and the lengthened lifetime can be achieved.

199

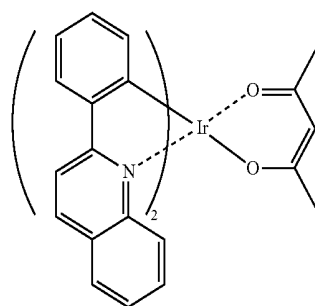
In particular, in addition to the electron transporting layer or the electron injecting layer, the light emitting layer preferably include the material for an organic EL device of the present invention as a host material. The light emitting layer preferably includes the material for an organic EL device represented by the general formula (5) or (6), or the general formula (9) or (12) as a host material, and more preferably includes the material for an organic EL device represented by the general formula (15) or (16), or the general formula (17) or (18) as a host material.

A multi-layer type organic EL device is obtained by laminating multiple layers; for example, the device is formed of an anode, a hole transporting layer (a hole injecting layer), a light emitting layer, and a cathode, of an anode, a light emitting layer, an electron transporting layer (an electron injecting layer), and a cathode, of an anode, a hole transporting layer (a hole injecting layer), a light emitting layer, an electron transporting layer (an electron injecting layer), and a cathode, or of an anode, a hole transporting layer (a hole injecting layer), a light emitting layer, a hole barrier layer, an electron transporting layer (an electron injecting layer), and a cathode.

In the organic EL device of the present invention, the light emitting layer preferably contains the material for an organic EL device as a host material. In addition, it is preferred that the light emitting layer be composed of a host material and a phosphorescent material, and the host material be the material for an organic EL device.

In addition, the material for an organic EL device may be a host material to be used together with a phosphorescent material, or may be an electron transporting material to be used together with a phosphorescent material. The material has a triplet energy gap of preferably 2.2 to 3.2 eV, or more preferably 2.5 to 3.2 eV.

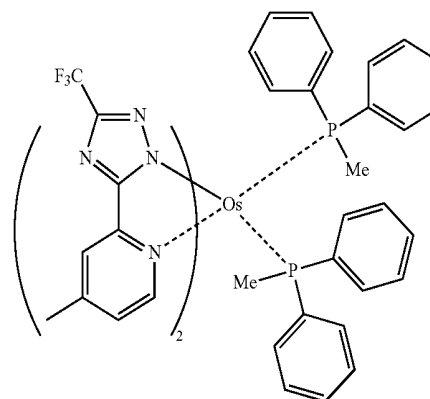
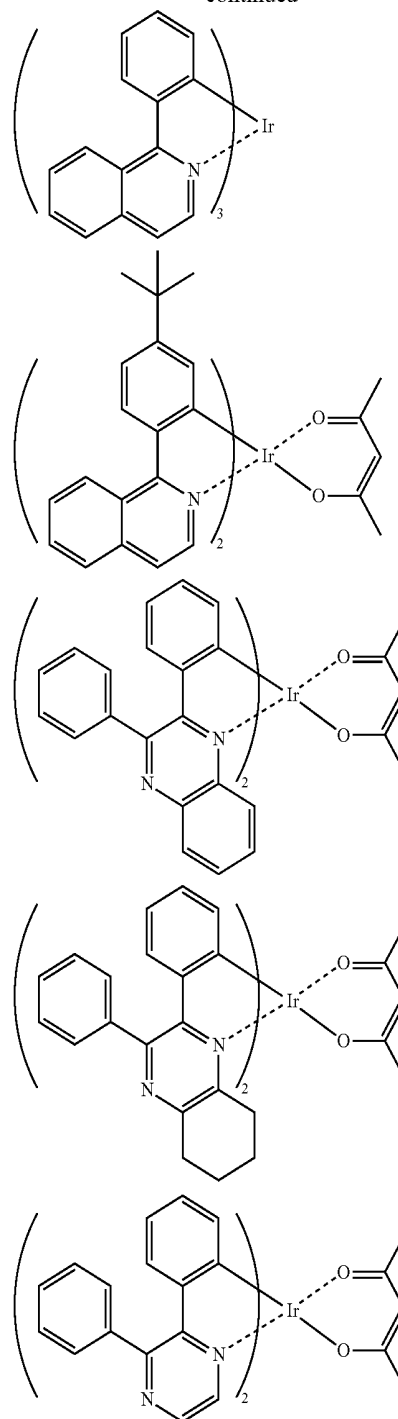
The phosphorescent material is preferably a compound containing iridium (Ir), osmium (Os), ruthenium (Ru), or platinum (Pt) because the compound has a high phosphorescent quantum yield, and can additionally improve the external quantum efficiency of the light emitting device. The material is more preferably a metal complex such as an iridium complex, an osmium complex, a ruthenium complex, or a platinum complex. Of those, the iridium complex and the platinum complex are still more preferable, and an orthometalated iridium complex is most preferable. Specific examples of the metal complex such as an iridium complex, an osmium complex, a ruthenium complex, or a platinum complex are shown below.



PQIr

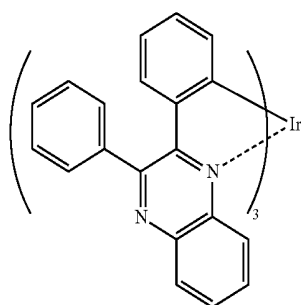
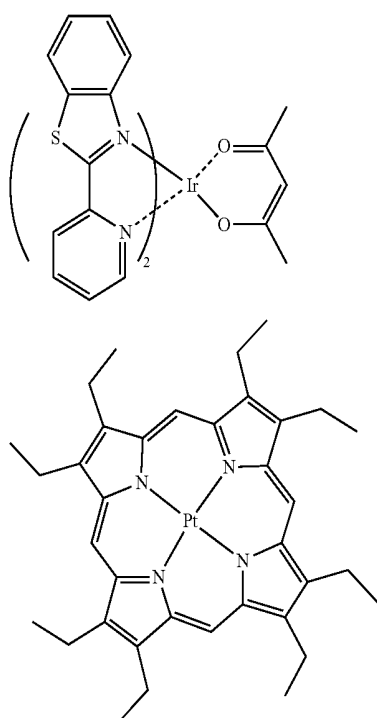
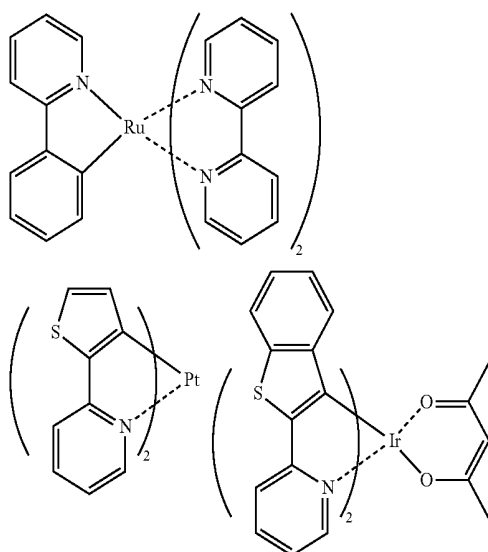
200

-continued



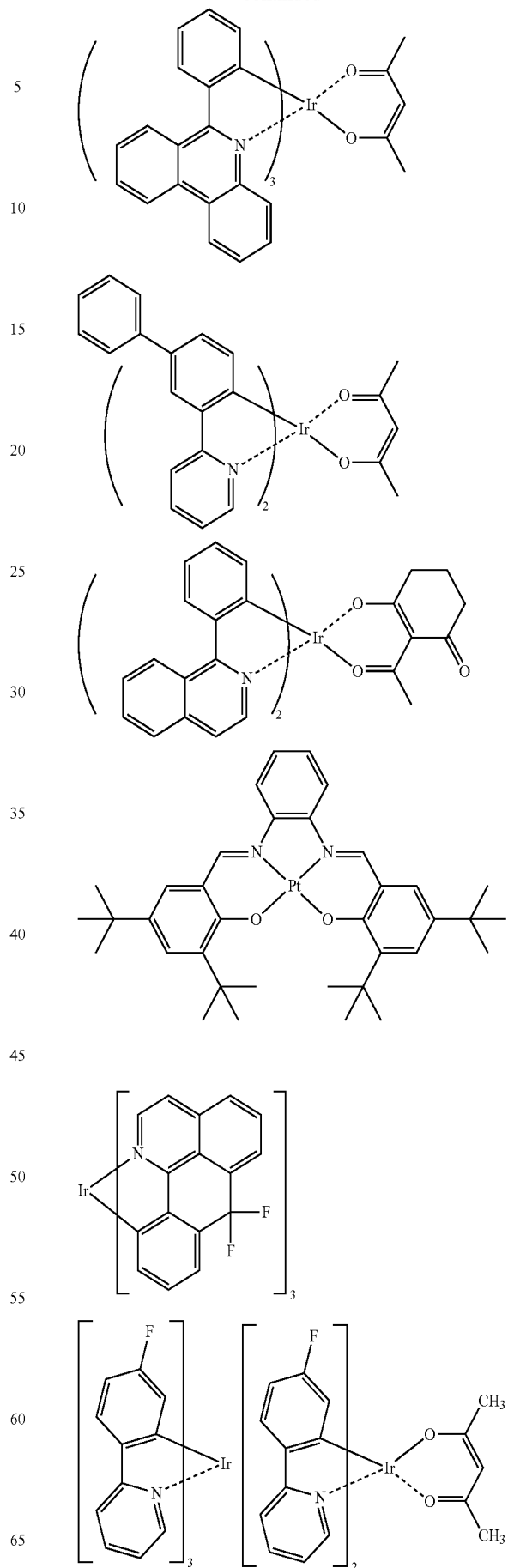
201

-continued



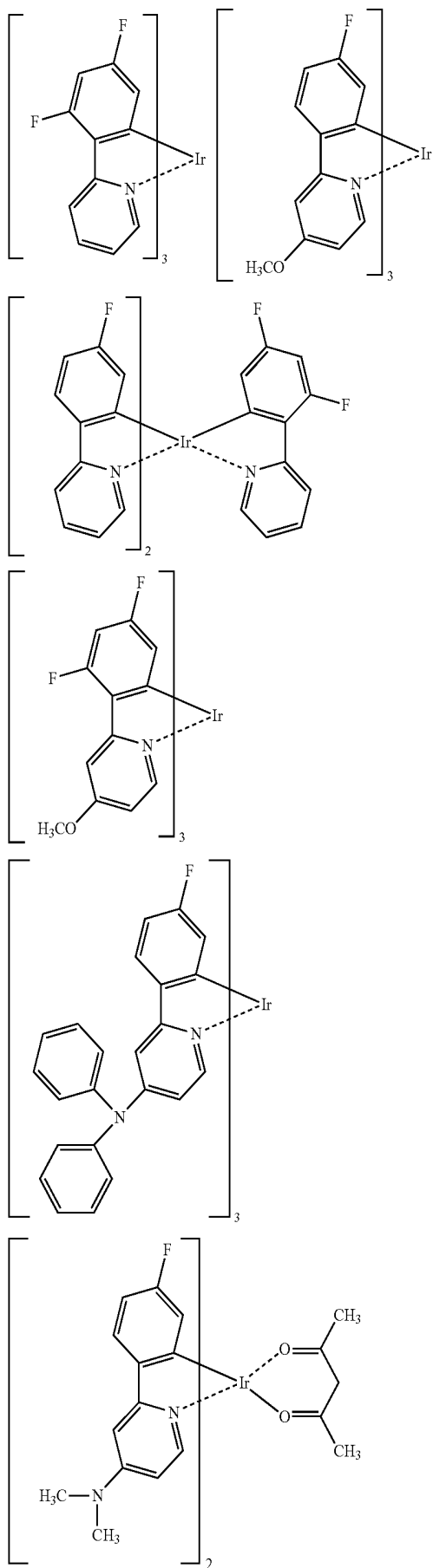
202

-continued

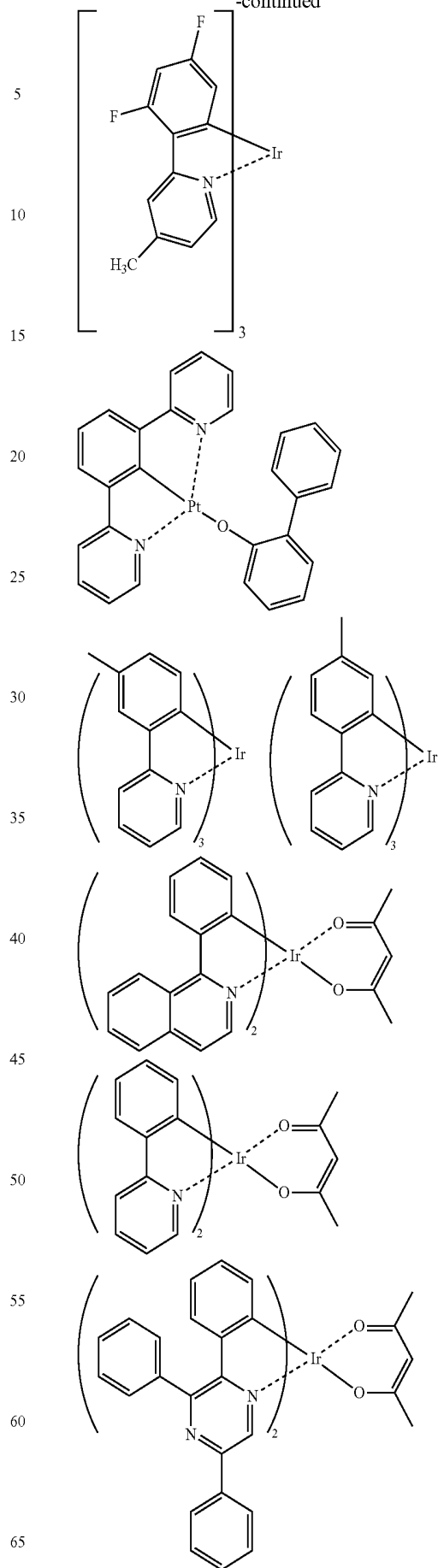


203

-continued

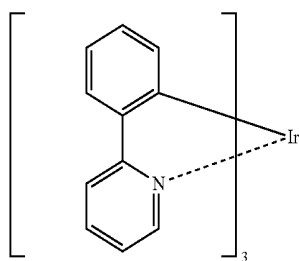
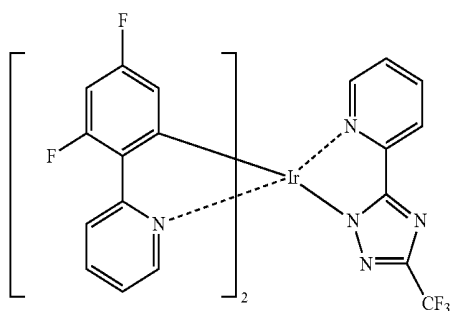
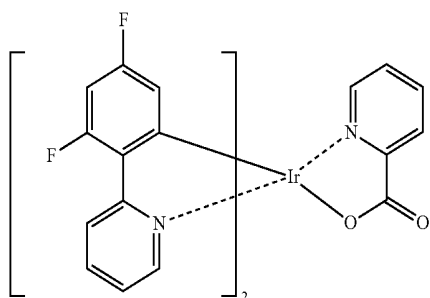
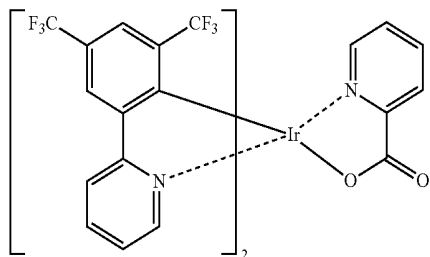
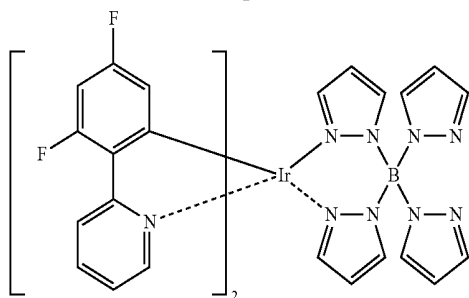
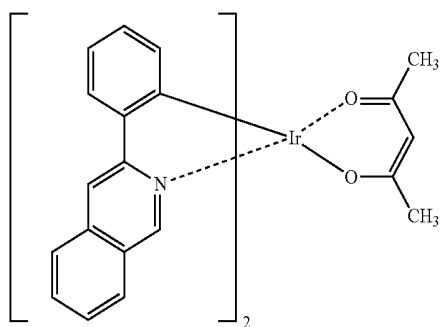
**204**

-continued

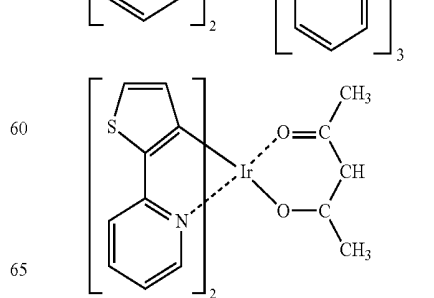
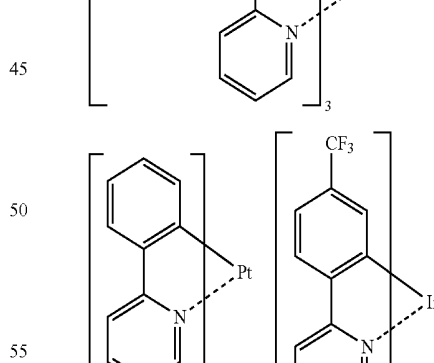
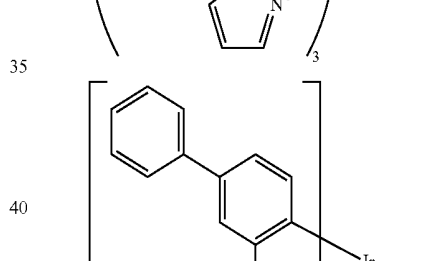
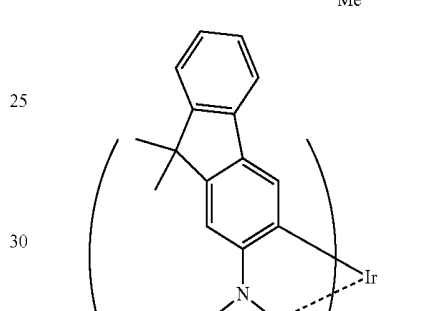
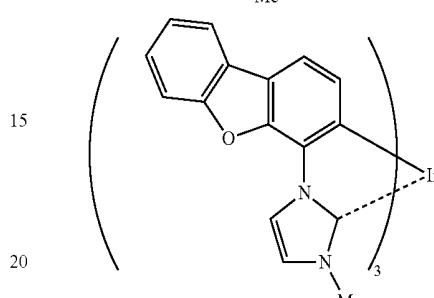
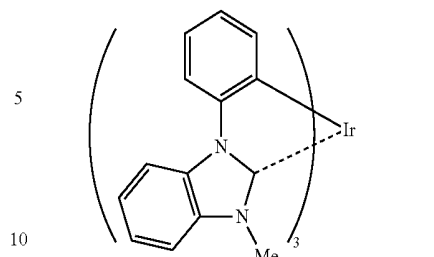


205

-continued

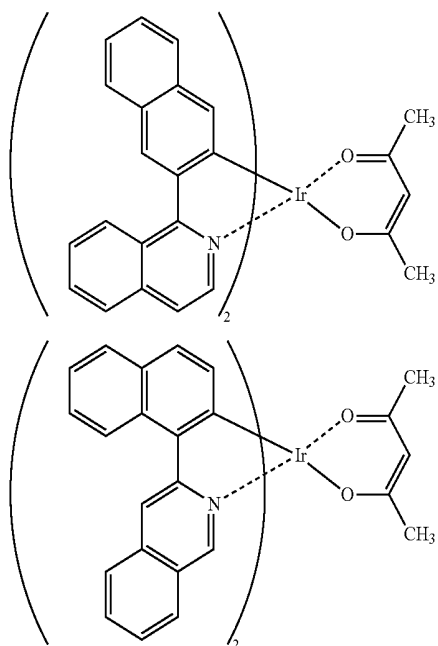
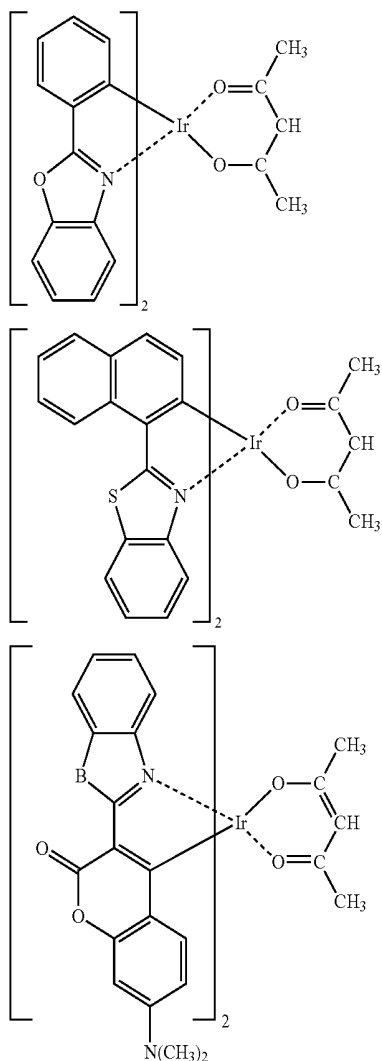
 Ir(ppy)_3 **206**

-continued



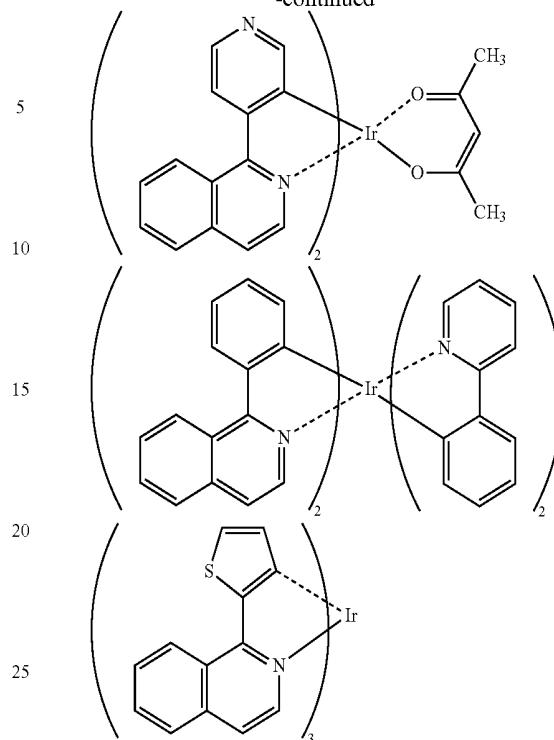
207

-continued



208

-continued



In addition, the organic EL device of the present invention is preferably such that the light emitting layer contains a host material and a phosphorescent material, and contains a metal complex having a local maximum luminous wavelength of 500 nm or less. Further, the material of the present invention can be used together with a fluorescent dopant. The material can be used together with a blue, green, or red fluorescent dopant. In particular, the material can be more preferably used together with the blue or green fluorescent dopant. Further, the material can be preferably used also as an electron transporting material for a fluorescent organic EL device.

The organic EL device of the present invention preferably has a reductive dopant in an interfacial region between the cathode and an organic thin layer (for example, an electron injecting layer or a light emitting layer). Examples of the reductive dopant include at least one kind selected from an alkali metal, an alkali metal complex, an alkali metal compound, an alkaline earth metal, an alkaline earth metal complex, an alkaline earth metal compound, a rare earth metal, a rare earth metal complex, and a rare earth metal compound.

Preferred examples of the alkali metal include an alkali metal having a work function of 2.9 eV or less, such as Na having a work function of 2.36 eV, K having a work function of 2.28 eV, Rb having a work function of 2.16 eV, and Cs having a work function of 1.95 eV. Of those, K, Rb, and Cs are more preferable, Rb or Cs is still more preferable, and Cs is most preferable.

Preferred examples of the alkali earth metal include an alkali earth metal having a work function of 2.9 eV or less, such as Ca having a work function of 2.9 eV, Sr having a work function of 2.0 to 2.5 eV, and Ba having a work function of 2.52 eV.

Preferred examples of the rare earth metal include a rare earth metal having a work function of 2.9 eV or less, such as Sc, Y, Ce, Tb, and Yb.

Of those metals, a preferable metal has a particularly high reductive ability, so improvement of light emission intensity and long life of organic EL device can be attained by adding a relatively small amount of the metal to an electron injecting region.

Examples of the alkali metal compound include an alkali oxide such as Li_2O , Cs_2O , or K_2O , and an alkali halide such as LiF , NaF , CsF , or KF . Of those, LiF , Li_2O , or NaF is preferable.

Examples of the alkali earth metal compound include BaO , SrO , CaO , and mixtures thereof such as $\text{Ba}_m\text{Sr}_{1-m}\text{O}$ ($0 < m < 1$) and $\text{Ba}_m\text{Ca}_{1-m}\text{O}$ ($0 < m < 1$). Of those, BaO , SrO , and CaO are preferable.

Examples of the rare earth metal compound include YbF_3 , ScF_3 , ScO_3 , Y_2O_3 , Ce_2O_3 , GdF_3 , and TbF_3 . Of those, YbF_3 , ScF_3 , and TbF_3 are preferable.

The alkali metal complex, alkali earth metal complex, and rare earth metal complex are not particularly limited as long as they each include as a metal ion at least one of alkali metal ions, alkali earth metal ions, and rare earth metal ions. Meanwhile, preferable examples of a ligand include, but not limited to, quinolinol, benzoquinolinol, acridinol, phenanthridinol, hydroxyphenyloxazole, hydroxyphenylthiazole, hydroxydiaryloxadiazole, hydroxydiarylthiadiazole, hydroxyphenylpyridine, hydroxyphenylbenzimidazole, hydroxybenzotriazole, hydroxyfluorane, bipyridyl, phenanthroline, phthalocyanine, porphyrin, cyclopentadiene, β -diketones, azomethines, and derivatives thereof.

For the addition form of the reductive dopant, it is preferable that the reductive dopant be formed in a shape of a layer or an island in the interfacial region. A preferable example of the forming method includes a method in which an organic substance which is a light emitting material or an electron injecting material for forming the interfacial region is deposited at the same time as the reductive dopant is deposited by a resistant heating deposition method, thereby dispersing the reductive dopant in the organic substance. The disperse concentration by molar ratio of the organic compound to the reductive dopant is 100:1 to 1:100, and is preferably 5:1 to 1:5.

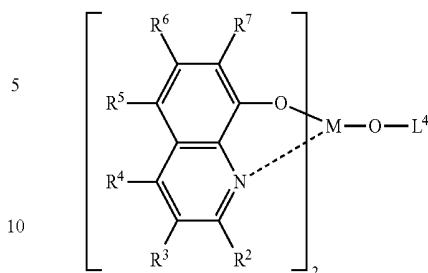
In a case where the reductive dopant is formed into the shape of a layer, the light emitting material or electron injecting material which serves as an organic layer in the interface is formed into the shape of a layer. After that, the reductive dopant is solely deposited by the resistant heating deposition method to form a layer preferably having a thickness of 0.1 to 15 nm.

In a case where the reductive dopant is formed into the shape of an island, the light emitting material or electron injecting material which serves as an organic layer in the interface is formed into the shape of an island. After that, the reductive dopant is solely deposited by the resistant heating deposition method to form an island preferably having a thickness of 0.05 to 1 nm.

When the organic EL device of the present invention has an electron injecting layer between the light emitting layer and the cathode, an electron transporting material to be used in the electron injecting layer is preferably an aromatic heterocyclic compound containing one or more heteroatoms in anyone of its molecules, or particularly preferably a nitrogen-containing ring derivative.

The nitrogen-containing ring derivative is preferably, for example, a nitrogen-containing ring metal chelate complex represented by the following general formula (A).

(A)



R^2 to R^7 each independently represent a hydrogen atom, a halogen atom, an amino group, a hydrocarbon group each having 1 to 40 carbon atoms, an alkoxy group, an aryloxy group, an alkoxycarbonyl group, or a heterocyclic group, each of which may be substituted.

Examples of the halogen atom represented by R^2 to R^7 include a fluorine atom, a chlorine atom, a bromine atom, and an iodine atom.

Examples of the amino group that may be substituted and represented by R^2 to R^7 include an alkylamino group, an arylamino group, and an aralkylamino group. Examples of the alkyl group in the alkylamino group include alkyl groups each having 1 to 40 carbon atoms such as a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, an n-nonyl group, an n-decyl group, an n-undecyl group, an n-dodecyl group, an n-tridecyl group, an n-tetradecyl group, an n-pentadecyl group, an n-hexadecyl group, an n-heptadecyl group, an n-octadecyl group, a neopentyl group, a 1-methylpentyl group, a 2-methylpentyl group, a 1-pentylhexyl group, a 1-butylpentyl group, a 1-heptyloctyl group, a 3-methylpentyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, a iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 1,2-dinitroethyl group, a 2,3-dinitro-t-butyl group, and a 1,2,3-trinitropropyl group. Preferred are alkyl groups each having 1 to 20 carbon atoms and more preferred are alkyl groups each having 1 to 10 carbon atoms.

Examples of the aryl group in the arylamino group include aryl groups each having a ring formed of 6 to 40 carbon atoms such as a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a

9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacenyl group, a 2-naphthacenyl group, a 9-naphthacenyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, an m-terphenyl-4-yl group, an m-terphenyl-3-yl group, an m-terphenyl-2-yl group, an o-tolyl group, an m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group, and a 4"-t-butyl-p-terphenyl-4-yl group. Preferred are aryl groups each having a ring formed of 6 to 20 carbon atoms and more preferred are aryl groups each having a ring formed of 6 to 10 carbon atoms.

Examples of the aralkyl group in the aralkylamino group include aralkyl groups each having 7 to 40 carbon atoms such as a benzyl group, a 1-phenylethyl group, a 2-phenylethyl group, a 1-phenylisopropyl group, a 2-phenylisopropyl group, a phenyl-t-butyl group, an α -naphthylmethyl group, a 1- α -naphthylethyl group, a 2- α -naphthylethyl group, a 1- α -naphthylisopropyl group, a 2- α -naphthylisopropyl group, a β -naphthylmethyl group, a 1- β -naphthylethyl group, a 2- β -naphthylethyl group, a 1- β -naphthylisopropyl group, a 2- β -naphthylisopropyl group, a 1-pyrrolylmethyl group, 2-(1-pyrrolyl)ethyl group, a p-methylbenzyl group, an m-methylbenzyl group, an o-methylbenzyl group, a p-chlorobenzyl group, an m-chlorobenzyl group, an o-chlorobenzyl group, a p-bromobenzyl group, an m-bromobenzyl group, an o-bromobenzyl group, a p-iodobenzyl group, an m-iodobenzyl group, an o-iodobenzyl group, a p-hydroxybenzyl group, an m-hydroxybenzyl group, an o-hydroxybenzyl group, a p-aminobenzyl group, an m-aminobenzyl group, an o-aminobenzyl group, a p-nitrobenzyl group, an m-nitrobenzyl group, an o-nitrobenzyl group, a p-cyanobenzyl group, an m-cyanobenzyl group, an o-cyanobenzyl group, a 1-hydroxy-2-phenylisopropyl group, and a 1-chloro-2-phenylisopropyl group. Preferred are aralkyl groups each having 7 to 20 carbon atoms and more preferred are aralkyl groups each having 7 to 10 carbon atoms.

Examples of the hydrocarbon groups each having 1 to 40 carbon atoms represented by R^2 to R^7 include substituted or unsubstituted alkyl groups, alkenyl groups, cycloalkyl groups, aryl groups, and aralkyl groups.

As the alkyl groups, the same examples of the alkyl groups in the above-mentioned alkylamino group are given, and alkyl groups each having 1 to 20 carbon atoms are preferred and alkyl groups each having 1 to 10 carbon atoms are more preferred.

Examples of the alkenyl group include alkenyl groups each having 2 to 40 carbon atoms such as a vinyl group, an allyl group, a 1-butenyl group, a 2-butenyl group, a 3-butenyl group, a 1,3-butanediyl group, a 1-methylvinyl group, a styryl group, a 2,2-diphenylvinyl group, a 1,2-diphenylvinyl group, a 1-methylaryl group, a 1,1-dimethylaryl group, a 2-methylallyl group, a 1-phenylallyl group, a 2-phenylallyl group, a 3-phenylallyl group, a 3,3-diphenylallyl group, a 1,2-dimethylallyl group, a 1-phenyl-1-butenyl group, and a 3-phenyl-1-butenyl group. Preferred are alkenyl groups each having 2 to 20 carbon atoms and more preferred are alkenyl groups each having 2 to 10 carbon atoms.

Examples of the cycloalkyl groups include cycloalkyl groups each having a ring formed of 3 to 40 carbon atoms such as a cyclopropyl group, a cyclobutyl group, a cyclo-

pentyl group, a cyclohexyl group, a 4-methylcyclohexyl group, a 1-adamantyl group, a 2-adamantyl group, a 1-norbornyl group, and a 2-norbornyl group. Preferred are cycloalkyl groups each having a ring formed of 3 to 10 carbon atoms are preferred.

As the aryl groups, the same examples of the aryl groups in the above-mentioned arylamino groups are given. Preferred are aryl groups each having a ring formed of 6 to 20 carbon atoms and more preferred are aryl groups each having a ring formed of 6 to 10 carbon atoms.

As the aralkyl groups, the same examples of the aralkyl groups in the above-mentioned aralkylamino groups are given. Preferred are aralkyl groups each having 7 to 20 carbon atoms and more preferred are aralkyl groups each having 7 to 10 carbon atoms.

As the alkoxy group that represented by R^2 to R^7 and may be substituted, the same examples of the alkyl groups in the above-mentioned alkylamino groups are given as alkyl group moieties. Preferred are alkoxy groups each having 1 to 20 carbon atoms and more preferred alkoxy groups each having 1 to 10 carbon atoms.

As the aryloxy group that represented by R^2 to R^7 and may be substituted, aryloxy groups each having the same aryl group in the above-mentioned arylamino group as an aryl group moiety are given. Preferred are aryl groups each having a ring formed of 6 to 20 carbon atoms and more preferred are aryl groups each having a ring formed of 6 to 10 carbon atoms.

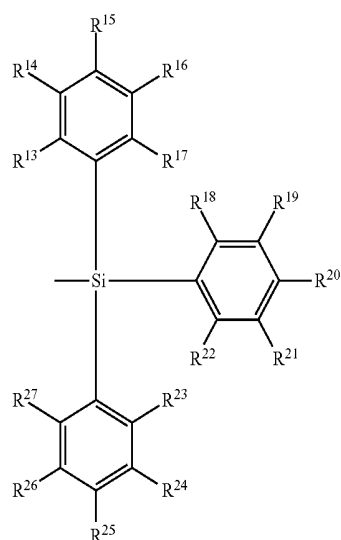
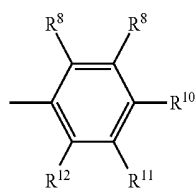
As the alkoxycarbonyl group that represented by R^2 to R^7 and may be substituted, alkoxycarbonyl groups each having the same alkyl group in the above-mentioned alkylamino group as the alkyl group moiety are given. Preferred are alkoxycarbonyl groups each having 2 to 20 carbon atoms and more preferred are alkoxycarbonyl groups each having 2 to 10 carbon atoms.

The heterocyclic group that represented by R^2 to R^7 and may be substituted is a monocycle or a fused ring. The heterocyclic group preferably has a ring formed of 1 to 20 carbon atoms, more preferably has a ring formed of 1 to 12 carbon atoms, and still more preferably has a ring formed of 2 to 10 carbon atoms. The heterocyclic group is an aromatic heterocyclic group having at least one hetero atom selected from a nitrogen atom, an oxygen atom, a sulfur atom, and selenium atom. Examples of the heterocyclic group include groups derived from pyrrolidine, piperidine, piperazine, morpholine, thiophene, selenophene, furan, pyrrole, imidazole, pyrazole, pyridine, pyrazine, pyridazine, pyrimidine, triazole, triazine, indole, indazole, purine, thiazoline, thiazole, thiadiazole, oxazoline, oxazole, oxadiazole, quinoline, isoquinoline, phthalazine, naphthyridine, quinoxaline, quinazoline, cinnoline, pteridine, acridine, phenanthroline, phanazine, tetrazole, benzoimidazole, benzoxazole, benzothiazole, benzotriazole, tetrazindene, carbazole, and azepine. Preferred are groups derived from furan, thiophene, pyridine, pyrazine, pyrimidine, pyridazine, triazine, quinoline, phthalazine, naphthyridine, quinoxaline, and quinazoline, more preferred are groups derived from furan, thiophene, pyridine, and quinoline, and still more preferred is a quinolinyl group.

M represents aluminum (Al), gallium (Ga), or indium (In). Indium is preferred.

L^4 in the formula (A) is a group represented by the following formula (A') or (A'').

213

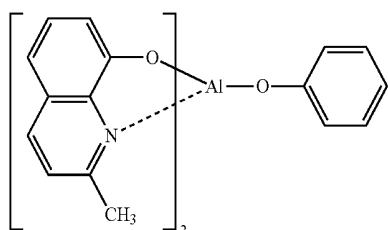


(In the formula, R⁸ to R¹² each independently represent a hydrogen atom, or a substituted or unsubstituted hydrocarbon group having 1 to 40 carbon atoms, and adjacent groups may form a cyclic structure. In addition, R¹³ to R²⁷ each independently represent a hydrogen atom, or a substituted or unsubstituted hydrocarbon group having 1 to 40 carbon atoms, and adjacent groups may form a cyclic structure.)

As the hydrocarbon group having 1 to 40 carbon atoms represented by R⁸ to R¹² in the formula (A') and R¹³ to R²⁷ in the formula (A''), the same specific examples of R² to R⁷ are given.

In addition, examples of the divalent group in R⁶ to R¹² and R¹³ to R²⁷ in the case where adjacent groups form a cyclic structure include a tetramethylene group, a pentamethylene group, a hexamethylene group, a diphenylmethane-2,2'-diyl group, a diphenylmethane-3,3'-diyl group, and diphenylpropane-4,4'-diyl group.

Specific examples of the nitrogen-containing ring metal chelate complex represented by the formula (A) are shown below. However, the present invention is not limited to these exemplified compounds.



(A-1)

60
65

214

-continued

(A')

5

(A'')

10

15

20

25

30

35

40

45

50

55

(A-2)

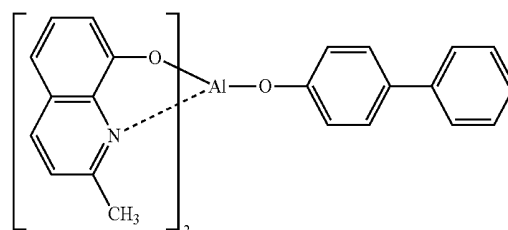
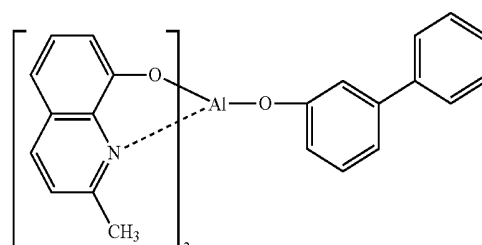
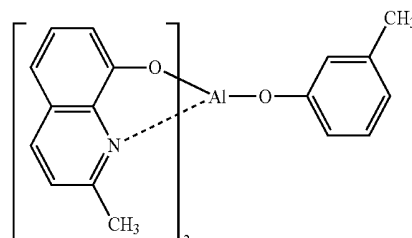
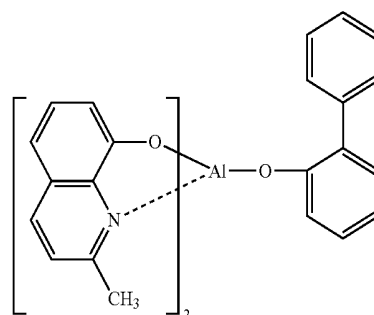
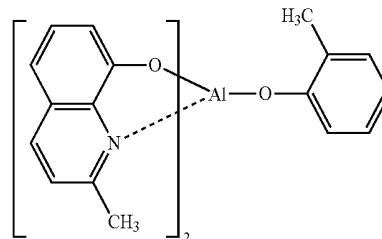
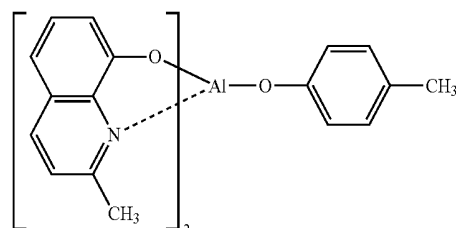
(A-3)

(A-4)

(A-5)

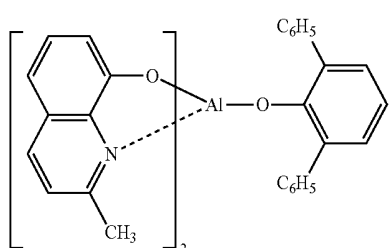
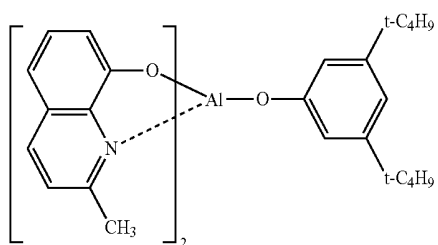
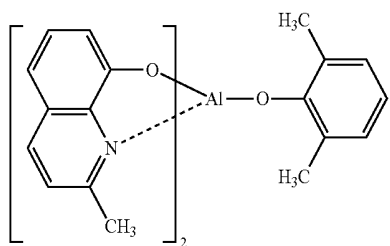
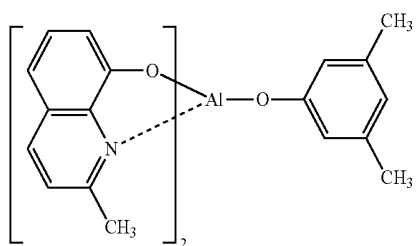
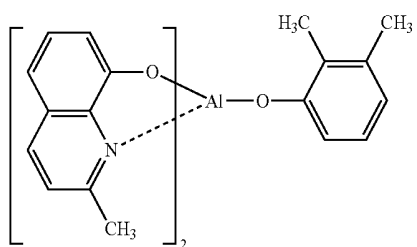
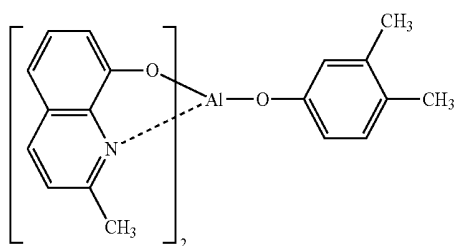
(A-6)

(A-7)

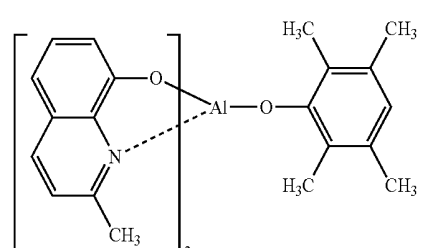
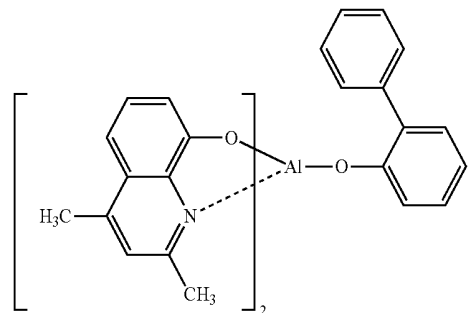
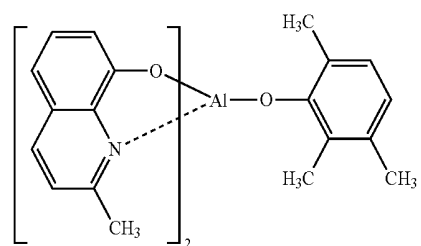
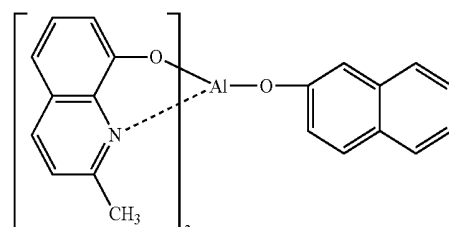
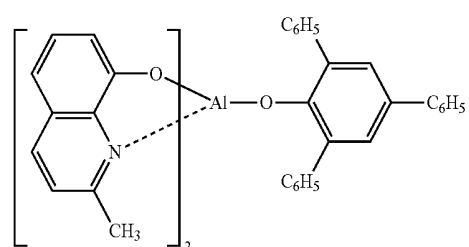
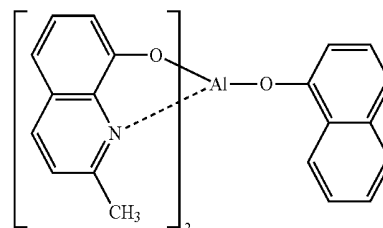


215

-continued

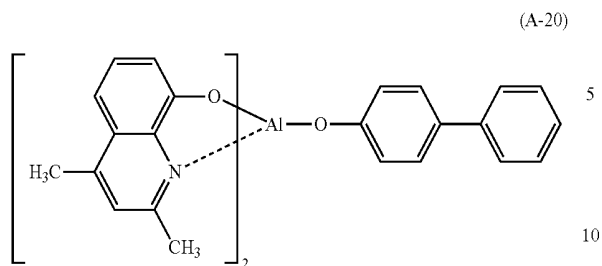
**216**

-continued

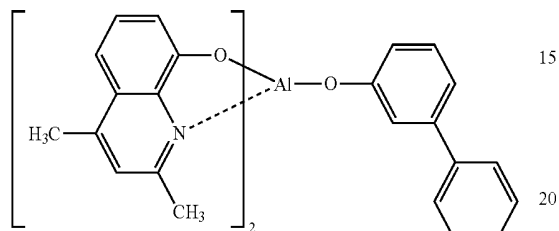


217

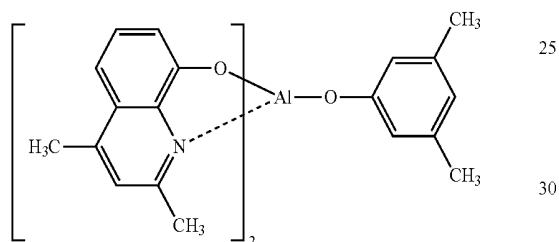
-continued



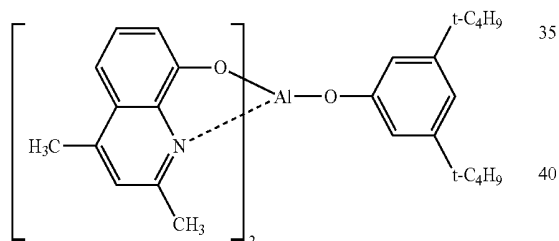
(A-21)



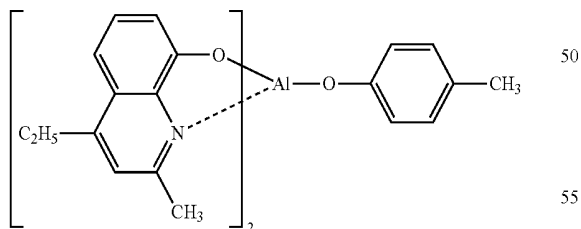
(A-22)



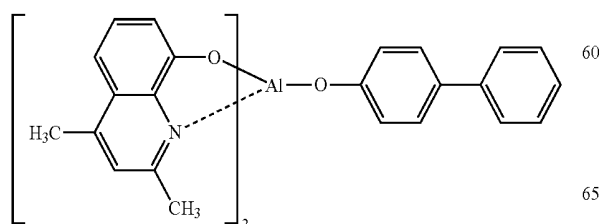
(A-23)



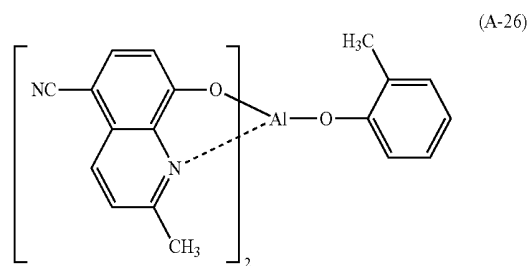
(A-24)



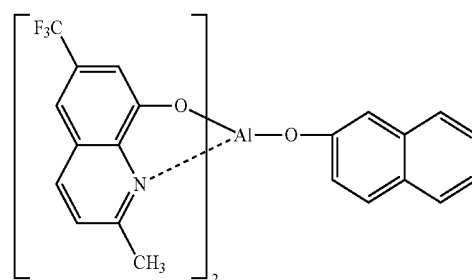
(A-25)

**218**

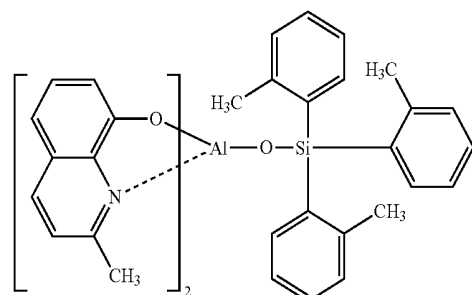
-continued



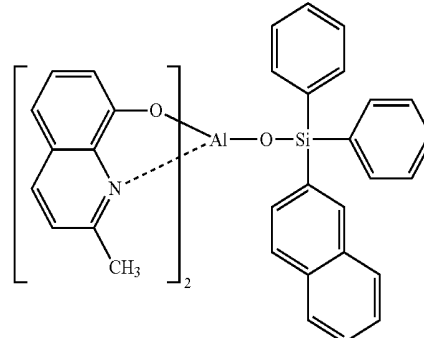
(A-27)



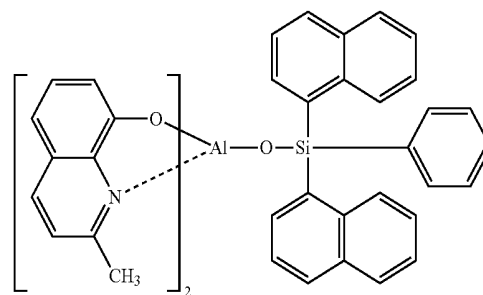
(A-28)



(A-29)

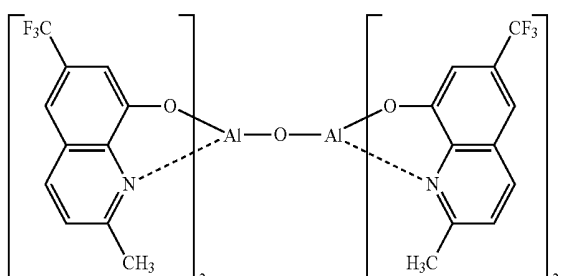
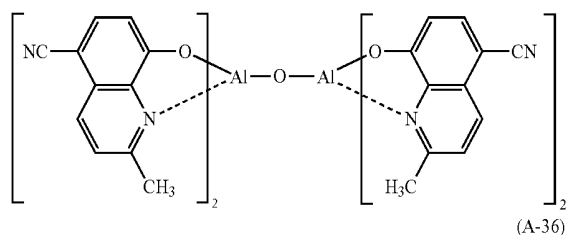
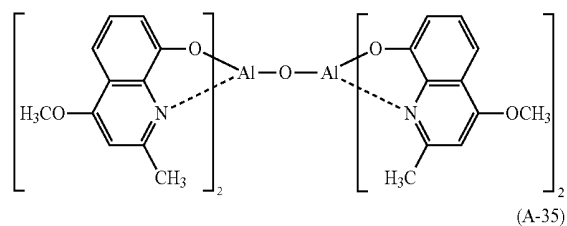
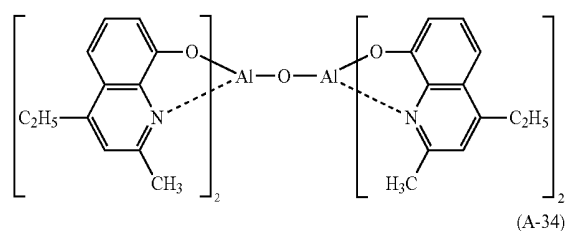
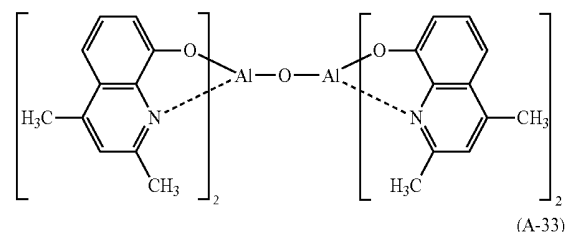
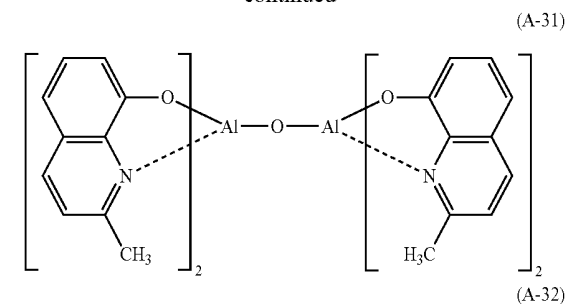


(A-30)



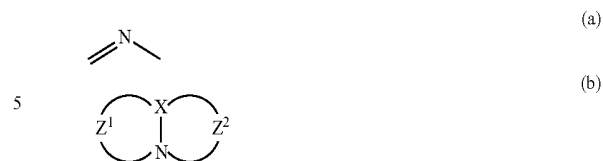
219

-continued



A nitrogen-containing heterocyclic derivative is a nitrogen-containing heterocyclic derivative composed of an organic compound having any one of the following general formulae, and a nitrogen-containing compound which is not a metal complex is also an example of the derivative. Examples of the derivative include a five- or six-membered ring containing a skeleton represented by the following formula (a) and a derivative of a structure represented by the following formula (b).

220

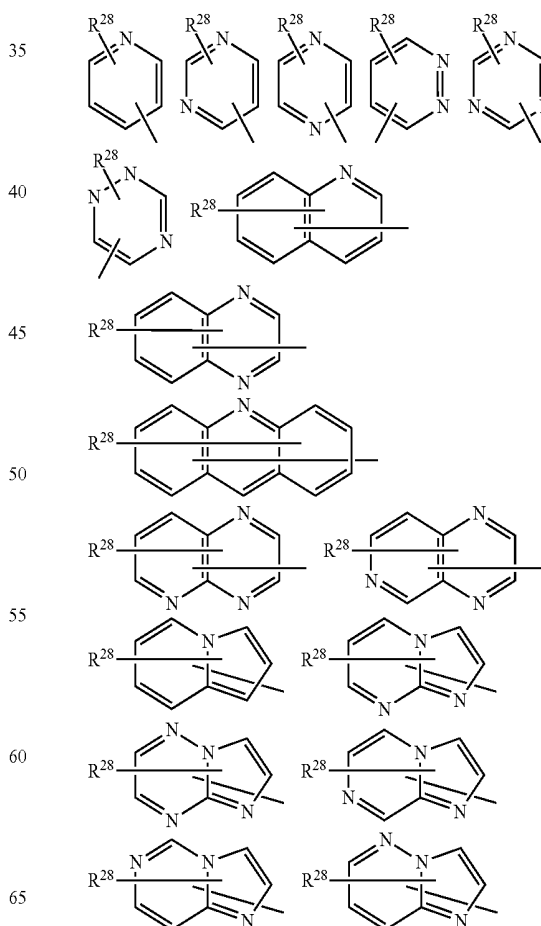


(In the formula (b), X represents a carbon atom or a nitrogen atom, and Z¹ and Z² each independently represent an atomic group capable of forming a nitrogen-containing heterocycle.)



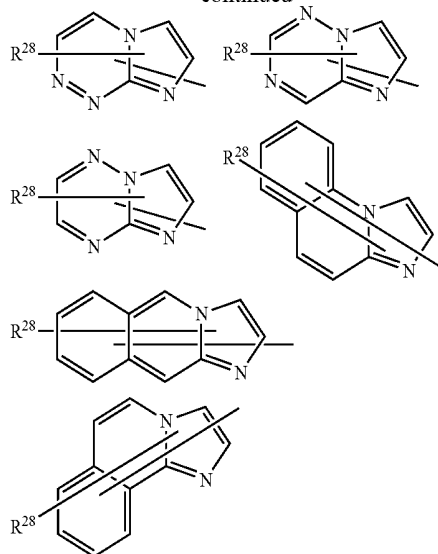
An organic compound having a nitrogen-containing aromatic polycycle composed of a five- or six-membered ring is preferable. In the case of such nitrogen-containing aromatic polycycle having multiple nitrogen atoms, a nitrogen-containing aromatic polycyclic aromatic organic compound having a skeleton obtained by combining the above formulae (a) and (b) or the above formulae (a) and (c) is more preferable.

The nitrogen-containing group of the nitrogen-containing organic compound is selected from, for example, nitrogen-containing heterocyclic groups represented by the following general formulae.



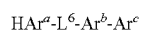
221

-continued



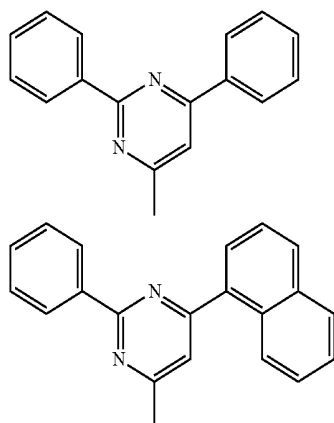
(In each of the formulae, R^{28} represents an aryl group having 6 to 40 carbon atoms, a heteroaryl group having 3 to 40 carbon atoms, an alkyl group having 1 to 20 carbon atoms, or an alkoxy group having 1 to 20 carbon atoms, n represents an integer of 0 to 5, and, when n represents an integer of 2 or more, multiple R^{28} s may be identical to or different from each other).

Further, a preferable specific compound is, for example, a nitrogen-containing heterocyclic derivative represented by the following formula.

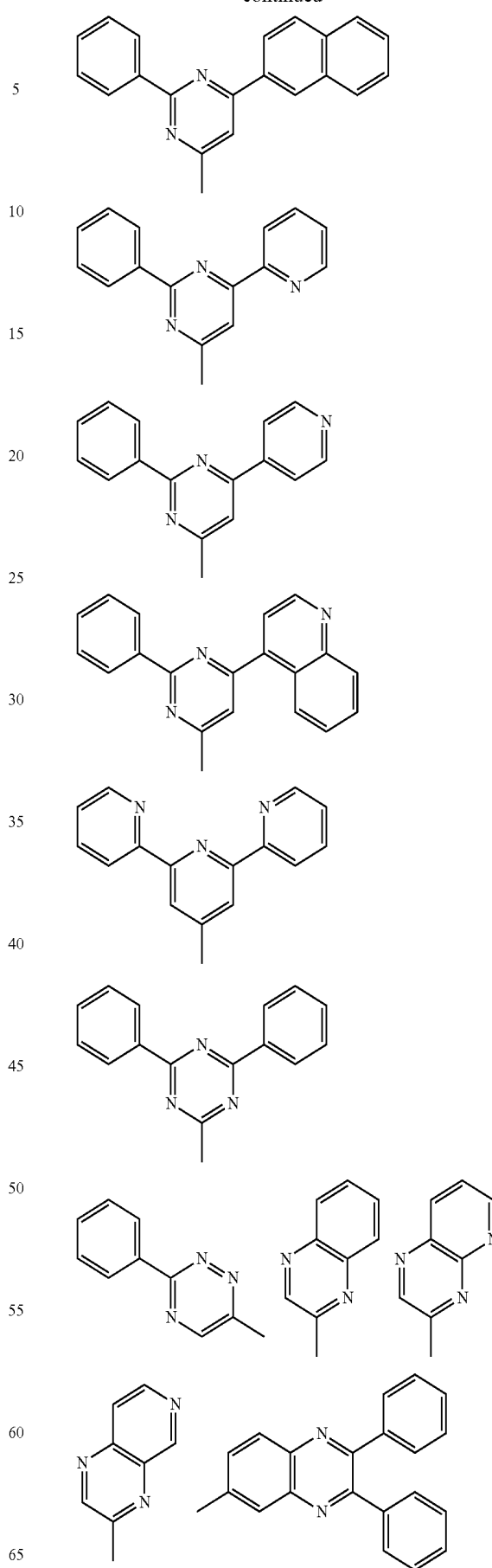


(In the formula, HAr^a represents a nitrogen-containing heterocycle which has 3 to 40 carbon atoms and which may have a substituent, L^6 represents a single bond, an arylene group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroarylene group which has 3 to 40 carbon atoms and which may have a substituent, Ar^b represents a divalent aromatic hydrocarbon group which has 6 to 40 carbon atoms and which may have a substituent, and Ar^c represents an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a substituent.)

HAr^a is selected from, for example, the following group.

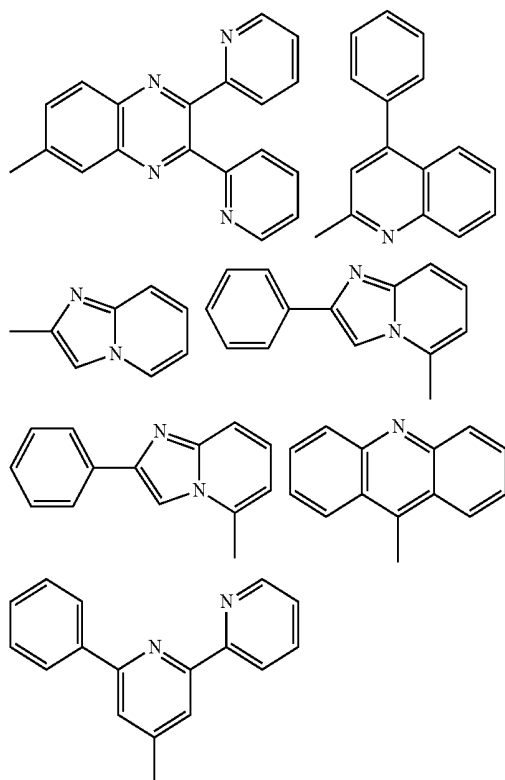
**222**

-continued

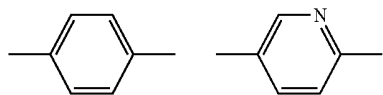


223

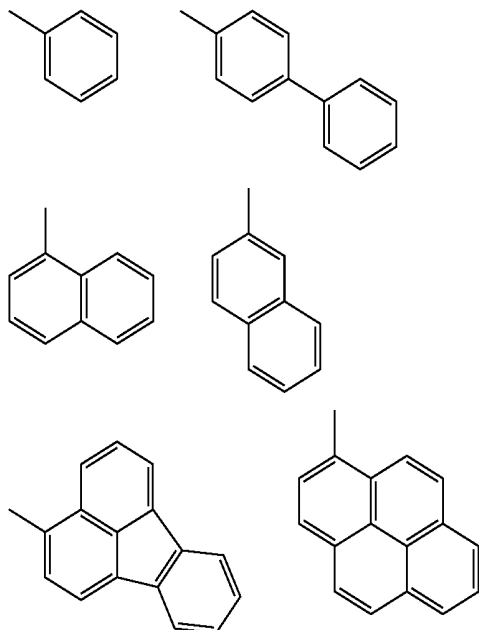
-continued



L^6 is selected from, for example, the following group.

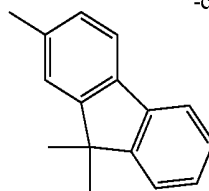


Ar^c is selected from, for example, the following group.

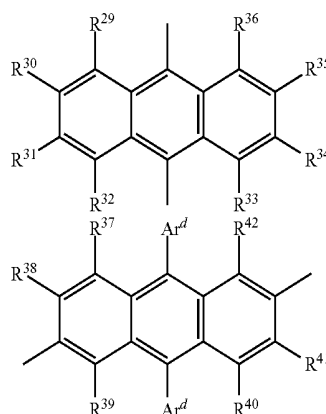


224

-continued

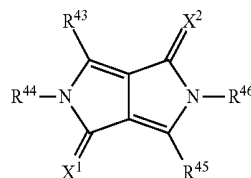


Ar^b is selected from, for example, the following arylanthranil group.



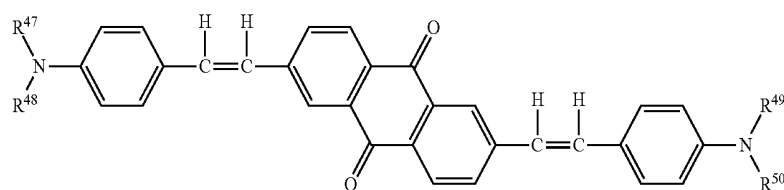
(In the formulae, R^{29} to R^{42} each independently represent a hydrogen atom, a halogen atom, an alkyl group having 1 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aryloxy group having 6 to 40 carbon atoms, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group having 3 to 40 carbon atoms, and Ar^d represents an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group having 3 to 40 carbon atoms.) In addition, a nitrogen-containing heterocyclic derivative in which R^{29} to R^{36} in Ar^b represented by the above formula each represent a hydrogen atom is preferable.

In addition to the foregoing, the following compound (see JP 09-3448 A) is also suitably used.

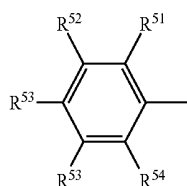


(In the formula, R^{43} to R^{46} each independently represent a hydrogen atom, a substituted or unsubstituted aliphatic group, a substituted or unsubstituted alicyclic group, a substituted or unsubstituted carbocyclic aromatic ring group, or a substituted or unsubstituted heterocyclic group, and X^1 and X^2 each independently represent an oxygen atom, a sulfur atom, or a dicyanomethylene group.)

In addition to the foregoing, the following compound (see JP 2000-173774 A) is also suitably used.



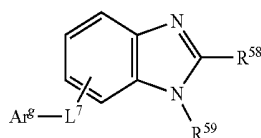
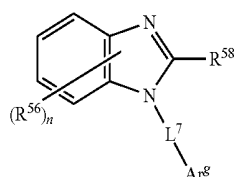
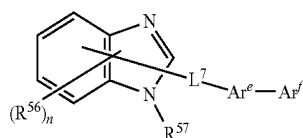
In the formula, R^{47} , R^{48} , R^{49} , and R^{50} represent groups identical to or different from one another, and each represent an aryl group represented by the following formula.



(In the formula, R^{51} , R^{52} , R^{53} , R^{54} , and R^{55} represent groups identical to or different from one another, and each may represent a hydrogen atom, or at least one of them may represent a saturated or unsaturated alkoxy, alkyl, amino, or alkylamino group.)

Further, a polymer compound containing the nitrogen-containing heterocyclic group or nitrogen-containing heterocyclic derivative is also permitted.

In addition, the electron transporting layer preferably contains at least one of the nitrogen-containing heterocyclic derivatives represented by the following general formulae (201) to (203).



In the formulae (201) to (203), R^{56} represents a hydrogen atom, an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, n represents an integer of 0 to 4, R^{57} represents an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a

quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group having 1 to 20 carbon atoms, R^{58} and R^{59} each independently represent a hydrogen atom, an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, L^7 represents a single bond, an arylene group which has 6 to 60 carbon atoms and which may have a substituent, a pyridylene group which may have a substituent, a quinolylene group which may have a substituent, or a fluorenylene group which may have a substituent, Ar^e represents an arylene group which has 6 to 60 carbon atoms and which may have a substituent, a pyridylene group which may have a substituent, or a quinolylene group which may have a substituent, and Ar^f represents a hydrogen atom, an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent.

In the formulae, Ar^e represents an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, or a group represented by $-Ar^e-Ar^f$ (Ar^e and Ar^f each have the same meaning as that described above).

It should be noted that, in the formulae (201) to (203), R^{56} represents a hydrogen atom, an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent.

The aryl group which has 6 to 60 carbon atoms is preferably an aryl group having 6 to 40 carbon atoms, or more preferably an aryl group having 6 to 20 carbon atoms, and specific examples of such groups include a phenyl group, a naphthyl group, an anthryl group, a phenanthryl group, a naphthacenyl group, a chrysenyl group, a pyrenyl group, a biphenyl group, a terphenyl group, a tolyl group, a t-butylphenyl group, a (2-phenylpropyl)phenyl group, a fluoranthenyl group, a fluorenyl group, a monovalent group composed of spirobifluorene, a perfluorophenyl group, a perfluoronaphthyl group, a perfluoroanthryl group, a perfluorobiphenyl group, a monovalent group composed of 9-phenylanthracene, a monovalent group composed of 9-(1'-naphthyl) anthracene, a monovalent group composed of 9-(2'-naphthyl)anthracene, a monovalent group composed of

227

6-phenylchrysene, and a monovalent group composed of 9-[4-(diphenylamino)phenyl]anthracene; a phenyl group, a naphthyl group, a biphenyl group, a terphenyl group, a 9-(10-phenyl)anthryl group, a 9-[10-(1'-naphthyl)]anthryl group, a 9-[10-(2'-naphthyl)]anthryl group, or the like is preferable.

The alkyl group which has 1 to 20 carbon atoms is preferably an alkyl group having 1 to 6 carbon atoms, and specific examples of such group include a methyl group, an ethyl group, a propyl group, a butyl group, a pentyl group, a hexyl group, and a haloalkyl group such as a trifluoromethyl group. An alkyl group having 3 or more carbon atoms may be linear, cyclic, or branched.

The alkoxy group which has 1 to 20 carbon atoms is preferably an alkoxy group having 1 to 6 carbon atoms, and specific examples of such group include a methoxy group, an ethoxy group, a propoxy group, a butoxy group, a pentyloxy group, and a hexyloxy group. An alkoxy group having 3 or more carbon atoms may be linear, cyclic, or branched.

Examples of the substituent of each group represented by R^{56} include a halogen atom, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, an aryloxy group which has 6 to 40 carbon atoms and which may have a substituent, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a substituent.

Examples of the halogen atom include fluorine, chlorine, bromine, and iodine.

Examples of the alkyl group which has 1 to 20 carbon atoms, the alkoxy group which has 1 to 20 carbon atoms, and the aryl group which has 6 to 40 carbon atoms include the same examples as those described above.

Examples of the aryloxy group which has 6 to 40 carbon atoms include a phenoxy group and a biphenyloxy group.

Examples of the heteroaryl group which has 3 to 40 carbon atoms include a pyrrolyl group, a furyl group, a thienyl group, a silolyl group, a pyridyl group, a quinolyl group, an isoquinolyl group, a benzofuryl group, an imidazolyl group, a pyrimidyl group, a carbazolyl group, a selenophenyl group, an oxadiazolyl group, and a triazolyl group.

n represents an integer of 0 to 4, or preferably 0 to 2.

In the formula (201), R^{57} represents an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group having 1 to 20 carbon atoms.

Specific examples of the respective groups, and preferable carbon numbers and preferable substituents of those groups are the same as those described for R^{56} .

In the formulae (202) and (203), R^{58} and R^{59} each independently represent a hydrogen atom, an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent.

Specific examples of the respective groups, and preferable carbon numbers and preferable substituents of those groups are the same as those described for R^{56} .

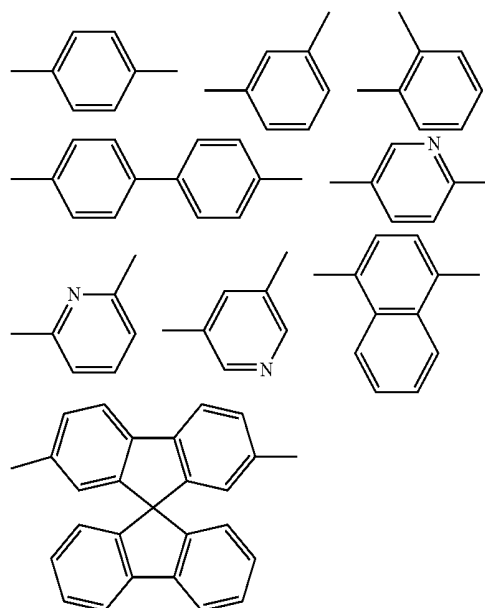
In the formulae (201) to (203), L^7 represents a single bond, an arylene group which has 6 to 60 carbon atoms and which may have a substituent, a pyridinylene group which

228

may have a substituent, a quinolinylenylene group which may have a substituent, or a fluorenylenylene group which may have a substituent.

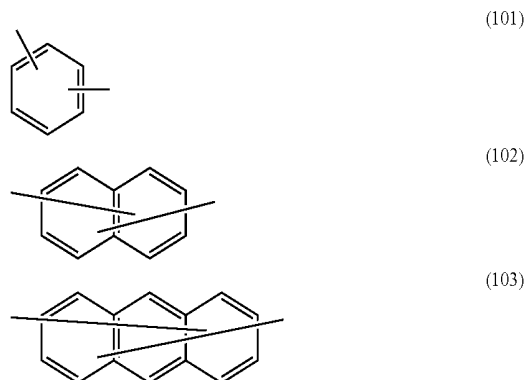
The arylene group which has 6 to 60 carbon atoms is preferably an arylene group having 6 to 40 carbon atoms, or more preferably an arylene group having 6 to 20 carbon atoms, and specific examples of such groups include divalent groups each formed by removing one hydrogen atom from the aryl group described for R . Examples of the substituent of each group represented by L^7 include the same examples as those described for R^{56} .

In addition, L^7 preferably represents a group selected from the group consisting of the following groups.



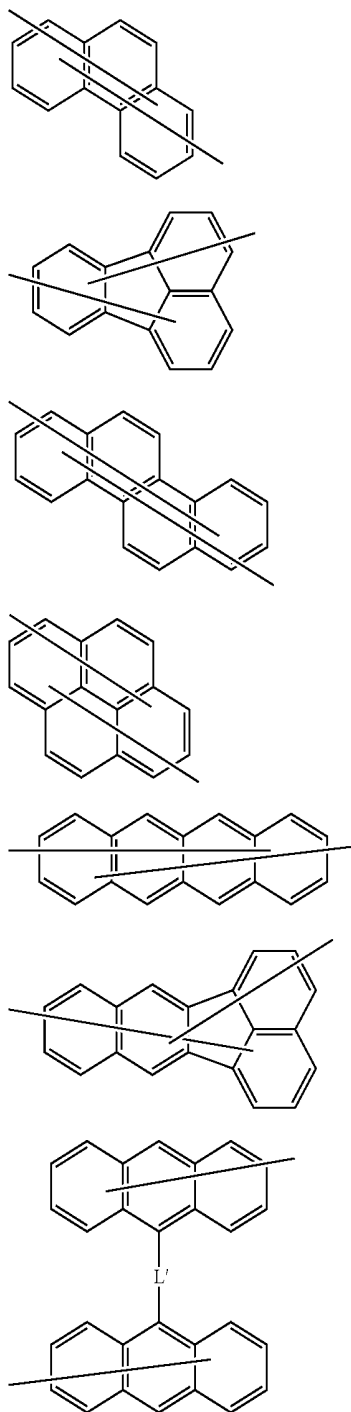
In the formula (201), Ar^e represents an arylene group which has 6 to 60 carbon atoms and which may have a substituent, a pyridinylene group which may have a substituent, or a quinolinylenylene group which may have a substituent. Examples of the substituents of the respective groups represented by Ar^e and Ar^g include the same examples as those described for R^{56} .

In addition, Ar^e preferably represents any one of the groups selected from fused ring groups represented by the following formulae (101) to (110).



229

-continued



In the formulae (101) to (110), each fused ring may be bonded with a bonding group composed of a halogen atom, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, an aryloxy group which has 6 to 40 carbon atoms and which may have a substituent, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a substituent, and, when multiple bonding groups of this kind are present, the bonding groups may be identical to or different from each other. Specific examples of the respective groups include the same examples as those described above.

230

In the formula (110), L' represents a single bond or a group selected from the group consisting of the following groups.

(104)

5

(105)

10

(106)

15

20

(107)

25

(108)

30

(109)

35

(110)

40

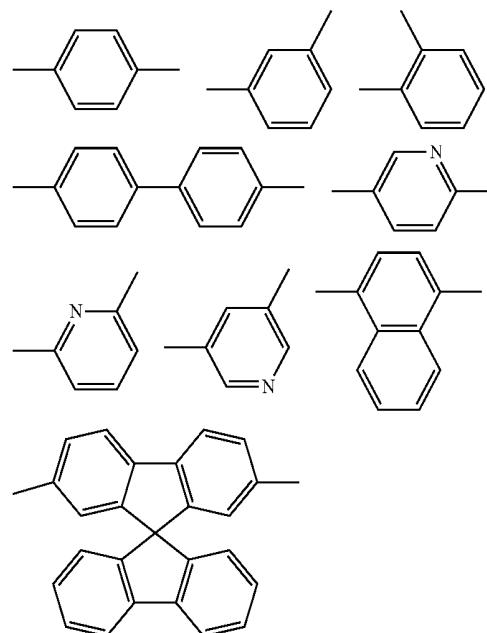
45

50

55

60

65



The formula (103) represented by Ar^e is preferably a fused ring group represented by the following formulae (111) to (125).

(109)

35

(111)

40

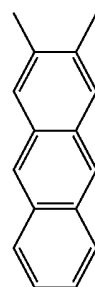
(110)

45

(112)

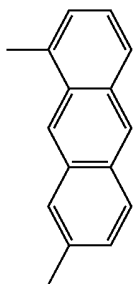
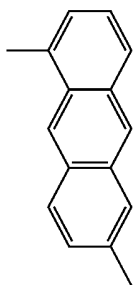
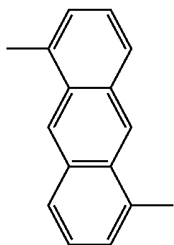
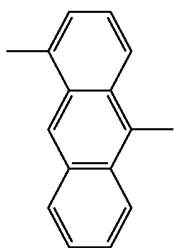
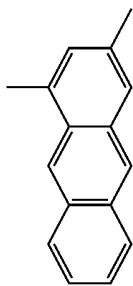
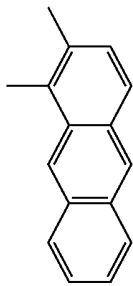
50

(113)



231

-continued



(114)

5

10

(115)

15

20

(116) 25

30

(117) 35

40

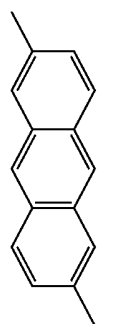
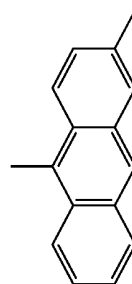
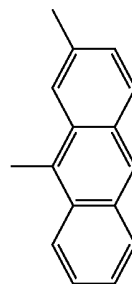
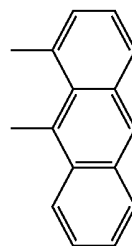
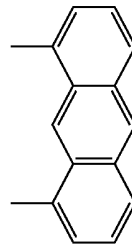
(118) 45

50

(119) 55

60

65



232

-continued

(120)

(121)

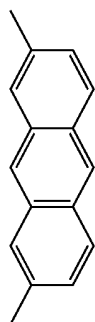
(122)

(123)

(124)

233

-continued



In the formulae (111) to (125), each fused ring may be bonded with a bonding group composed of a halogen atom, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, an aryloxy group which has 6 to 40 carbon atoms and which may have a substituent, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a substituent, and, when multiple bonding groups of this kind are present, the bonding groups may be identical to or different from each other. Specific examples of the respective groups include the same examples as those described above.

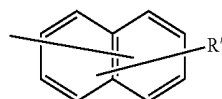
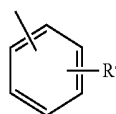
In the formula (201), Ar^f represents a hydrogen atom, an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, or an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent.

Specific examples of the respective groups, and preferable carbon numbers and preferable substituents of those groups are the same as those described for R^{56} .

In the formulae (202) and (203), Ar^g represents an aryl group which has 6 to 60 carbon atoms and which may have a substituent, a pyridyl group which may have a substituent, a quinolyl group which may have a substituent, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, or a group represented by $-Ar^e-Ar^f$ (Ar^e and Ar^f each have the same meaning as that described above).

Specific examples of the respective groups, and preferable carbon numbers and preferable substituents of those groups are the same as those described for R^{56} .

In addition, Ar^e preferably represents any one of the groups selected from fused ring groups represented by the following formulae (126) to (135).

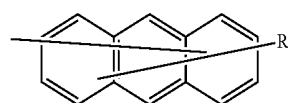


234

-continued

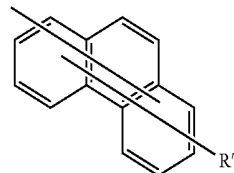
(125)

5



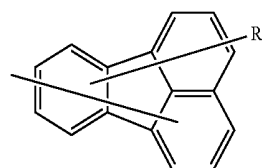
(128)

10



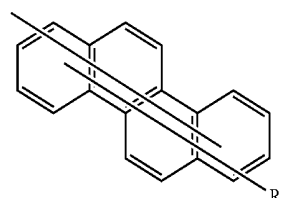
(129)

15



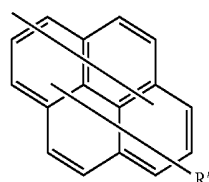
(130)

20



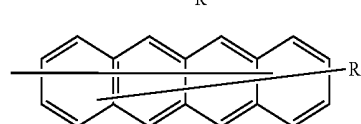
(131)

25



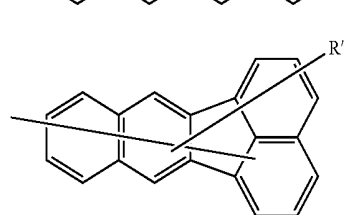
(132)

30



(133)

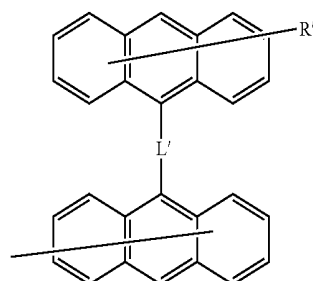
35



(134)

40

45



(135)

50

55

(126)

(127)

60

65

In the formulae (126) to (135), each fused ring may be bonded with a bonding group composed of a halogen atom, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, an aryloxy group which has 6 to 40 carbon atoms and which may have a substituent, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a

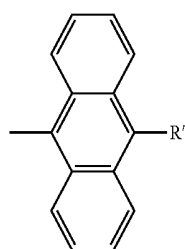
235

substituent, and, when multiple bonding groups of this kind are present, the bonding groups may be identical to or different from each other. Specific examples of the respective groups include the same examples as those described above.

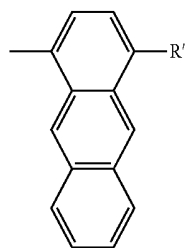
In the formula (135), L' is the same as that described above.

In the formulae (126) to (135), R' represents a hydrogen atom, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a substituent. Specific examples of the respective groups include the same examples as those described above.

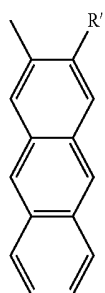
The general formula (128) represented by Ar^g is preferably a fused ring group represented by the following formulae (136) to (158).



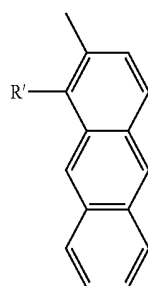
(136)



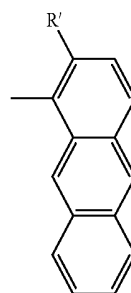
(137)



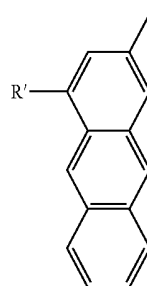
(138)



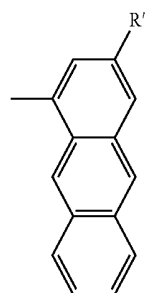
(139)



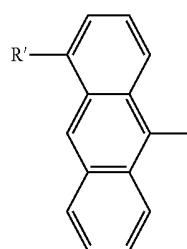
(140)



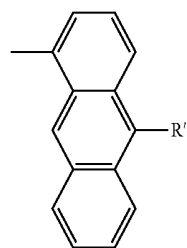
(141)



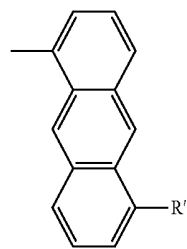
(142)



(143)



(144)



(145)

236

-continued

5

10

15

20

25

30

35

40

45

50

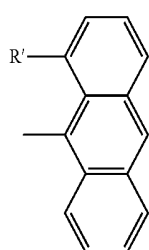
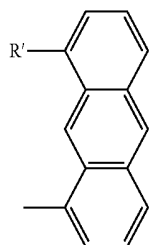
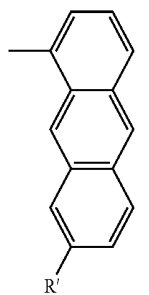
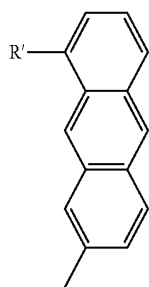
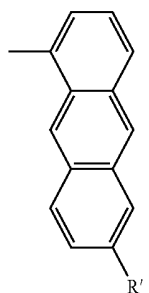
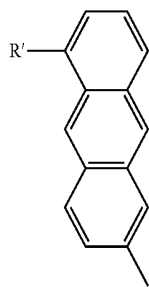
55

60

65

237

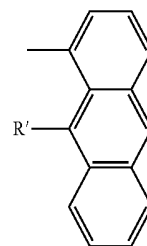
-continued

**238**

-continued

(146)

5



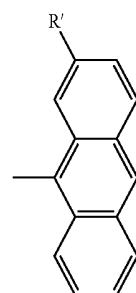
10

(147)

15

20

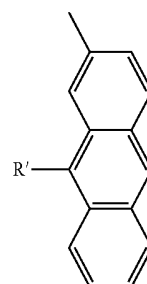
(148) 25



30

(149) 35

(149)



40

45

(150)

50

55

(151)

60

65



(152)

(153)

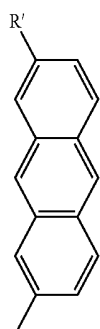
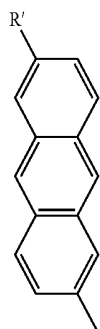
(154)

(155)

(156)

239

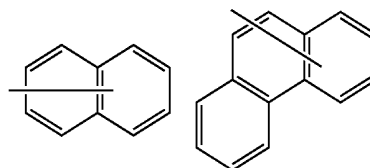
-continued

**240**

-continued

(157)

5



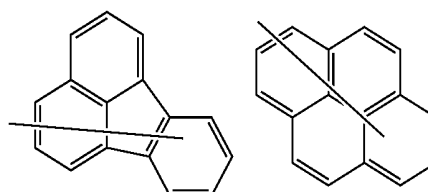
10

(158)

15

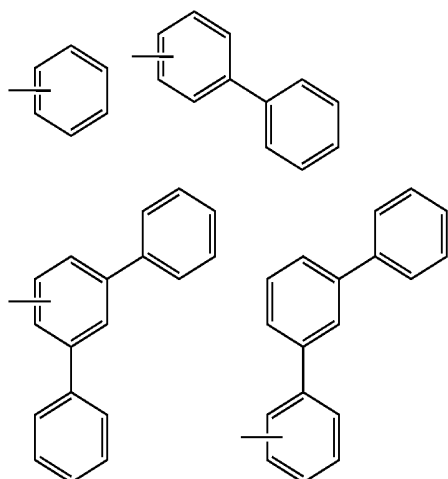
20

25



In the formulae (136) to (158), each fused ring may be bonded with a bonding group composed of a halogen atom, an alkyl group which has 1 to 20 carbon atoms and which may have a substituent, an alkoxy group which has 1 to 20 carbon atoms and which may have a substituent, an aryloxy group which has 6 to 40 carbon atoms and which may have a substituent, an aryl group which has 6 to 40 carbon atoms and which may have a substituent, or a heteroaryl group which has 3 to 40 carbon atoms and which may have a substituent, and, when multiple bonding groups of this kind are present, the bonding groups may be identical to or different from each other. Specific examples of the respective groups include the same examples as those described above. R' is the same as that described above.

In addition, it is preferred that Ar' and Ar⁶ each independently represent a group selected from the group consisting of the following groups.



Specific examples of the nitrogen-containing heterocyclic derivatives represented by the formulae (201) to (203) of the present invention are shown below. However, the present invention is not limited to these exemplified compounds.

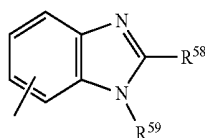
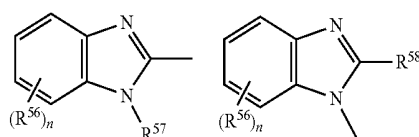
It should be noted that HAr in the following tables represent any one of the following parts in the formulae (201) to (203).

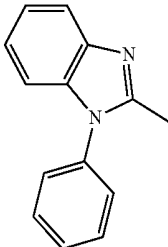
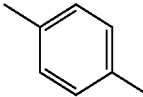
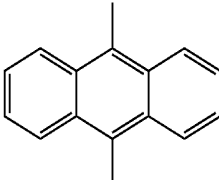
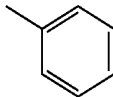
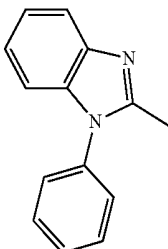
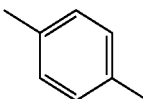
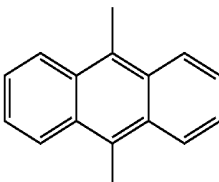
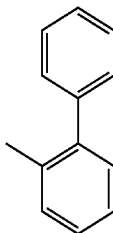
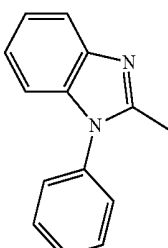
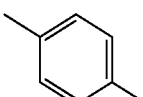
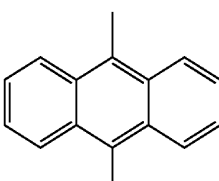
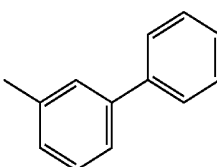
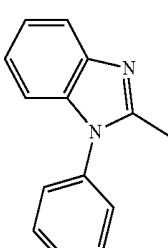
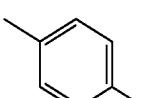
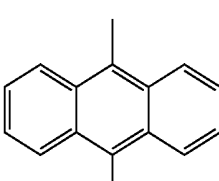
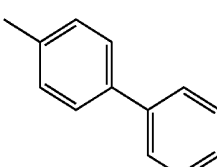
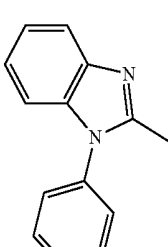
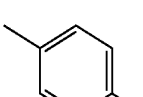
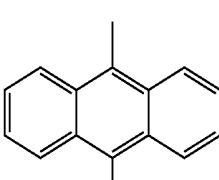
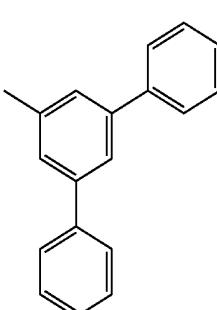
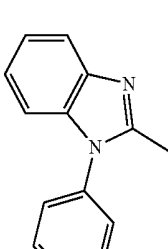
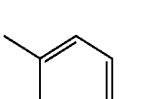
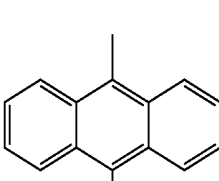
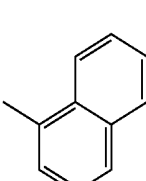
50

55

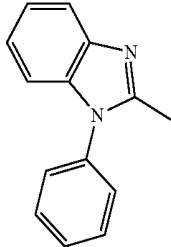
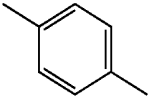
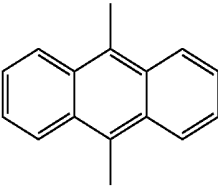
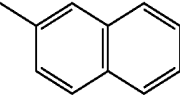
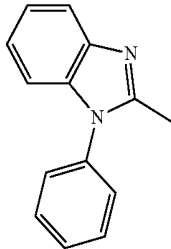
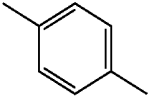
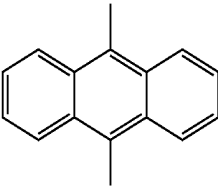
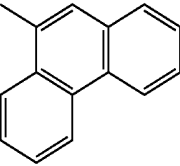
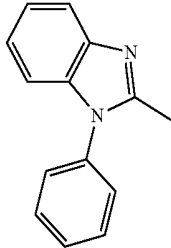
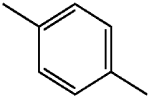
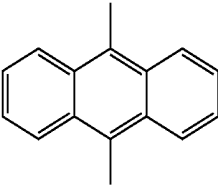
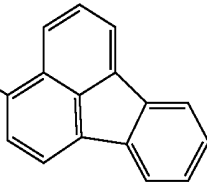
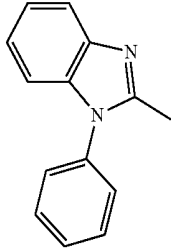
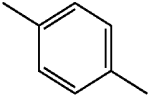
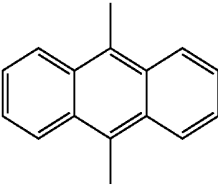
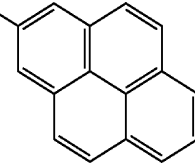
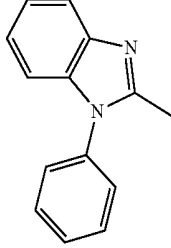
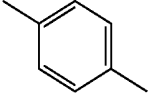
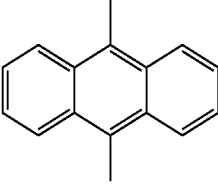
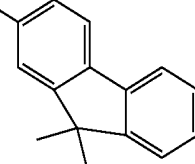
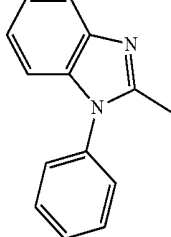
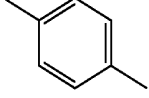
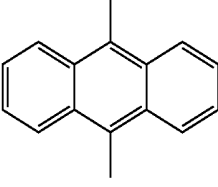
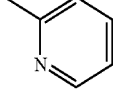
60

65

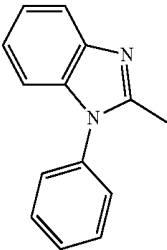
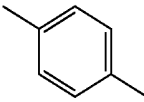
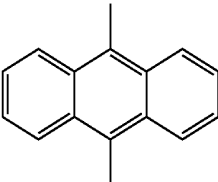
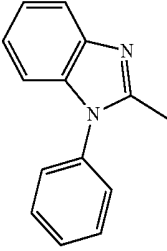
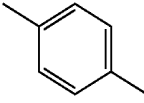
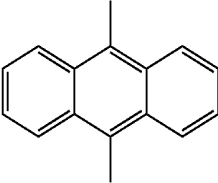


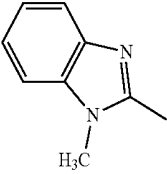
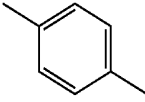
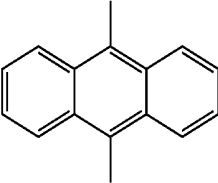
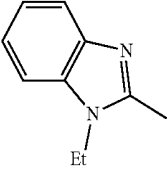
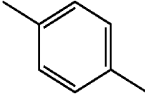
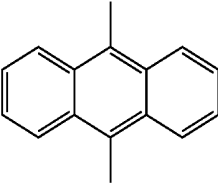
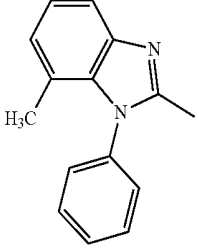
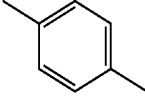
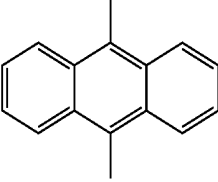
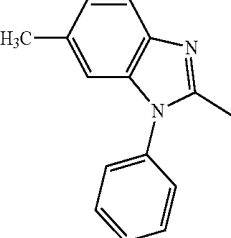
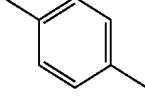
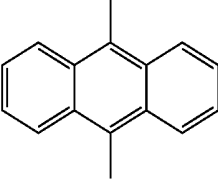
HAr—L ⁷ —Ar ^e —Ar ^f				
	HAr	L ⁷	Ar ^e	Ar ^f
1-1				
2				
3				
4				
5				
6				

-continued

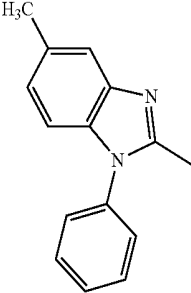
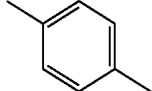
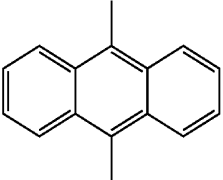
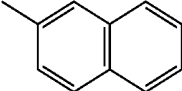
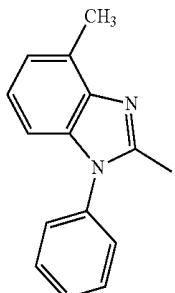
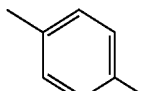
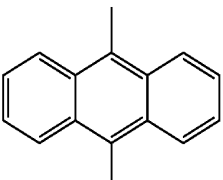
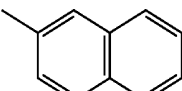
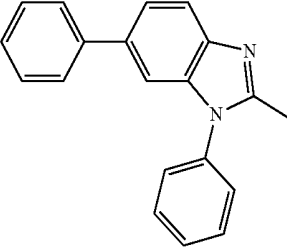
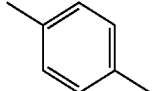
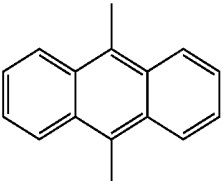
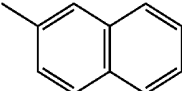
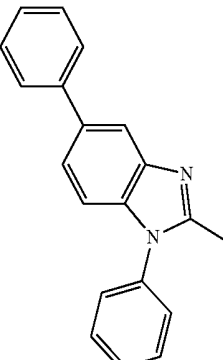
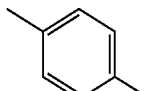
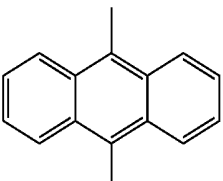
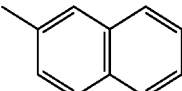
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
7 			
8 			
9 			
10 			
11 			
12 			

-continued

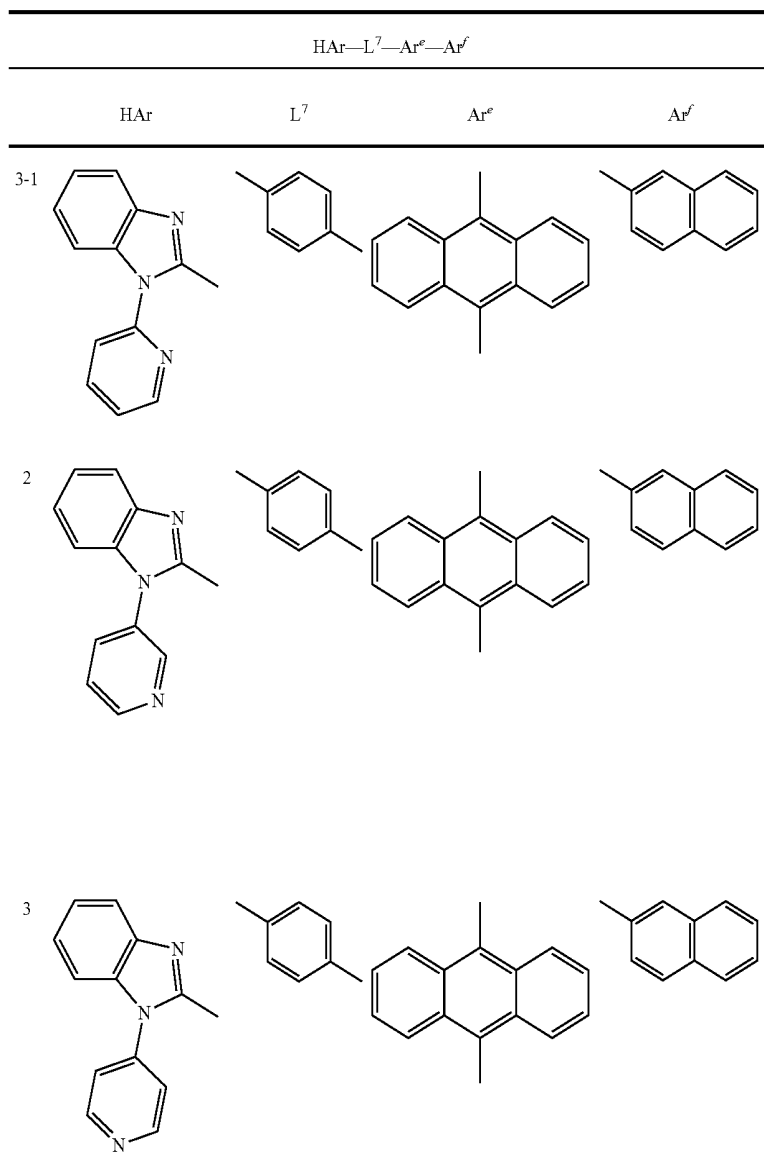
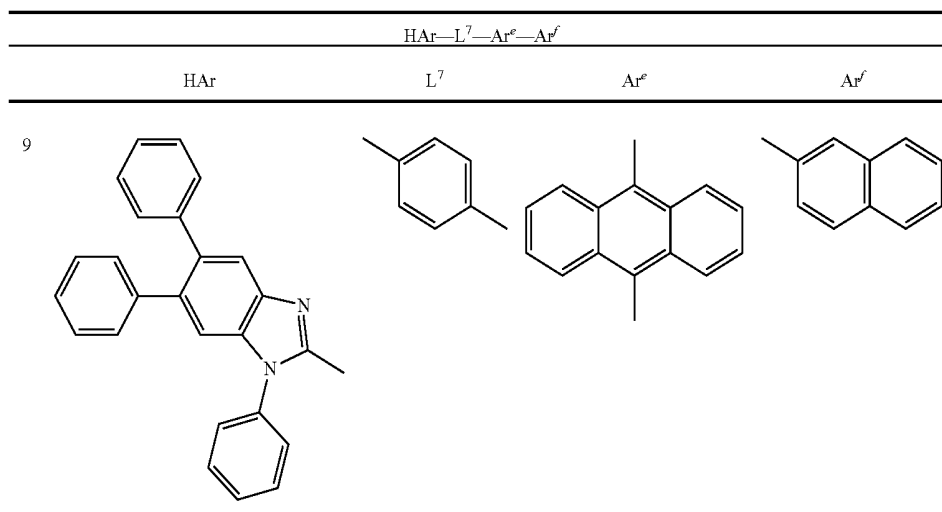
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
13			
14			

HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
2-1			
2			
3			
4			

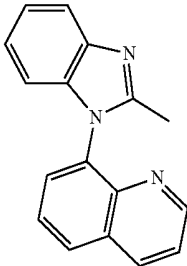
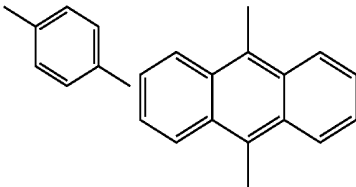
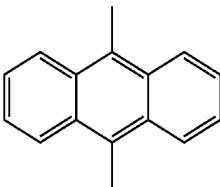
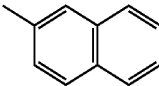
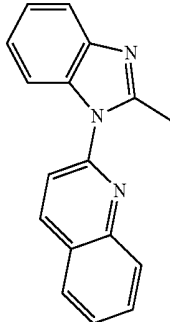
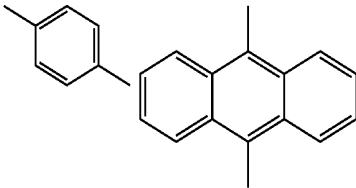
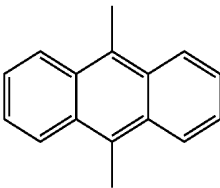
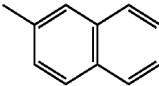
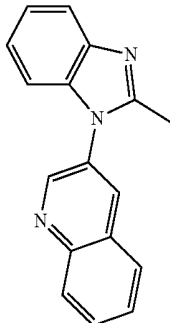
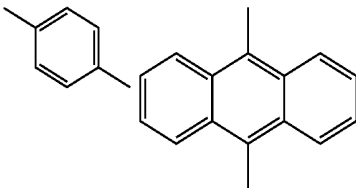
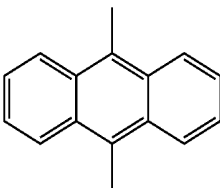
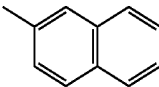
-continued


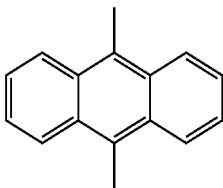
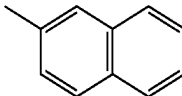
$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
5 			
6 			
7 			
8 			

-continued

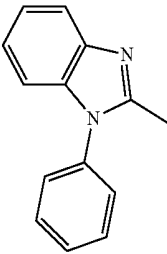
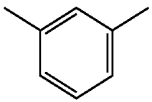
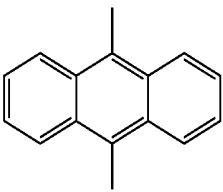
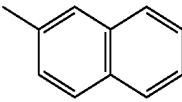
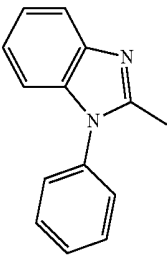
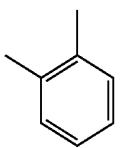
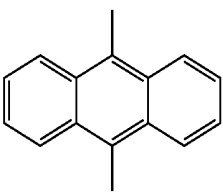
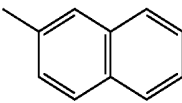
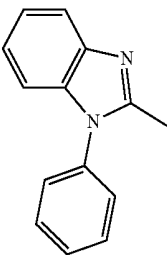
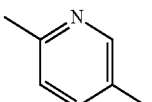
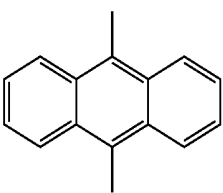
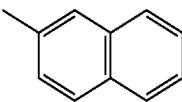
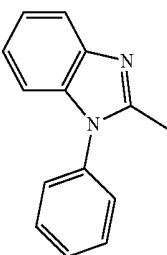
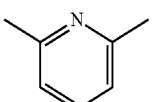
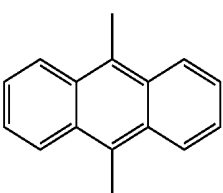
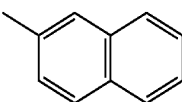
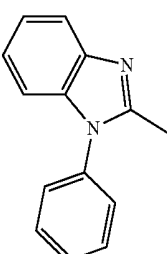
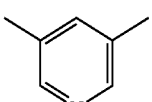
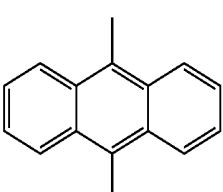
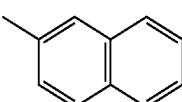
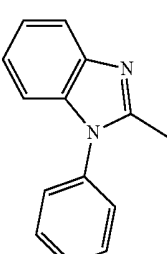
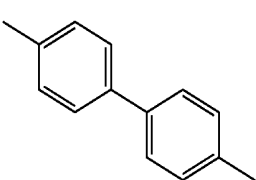
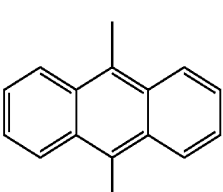
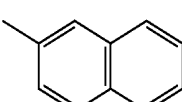


-continued

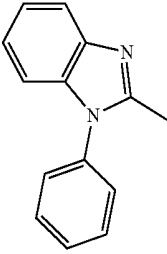
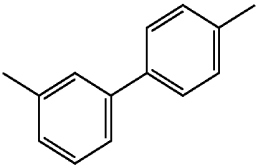
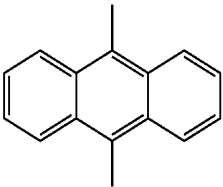
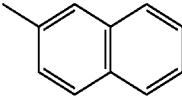
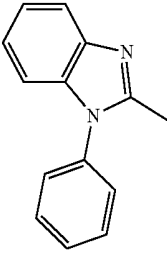
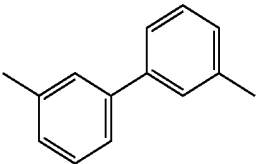
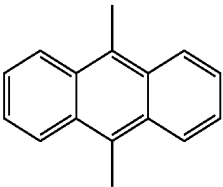
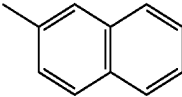
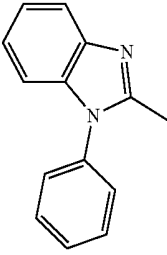
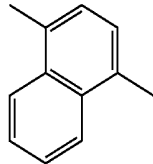
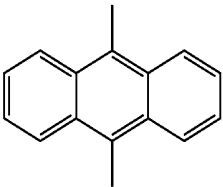
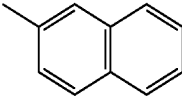
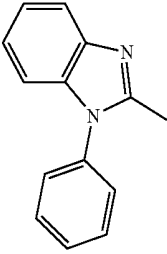
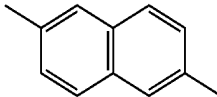
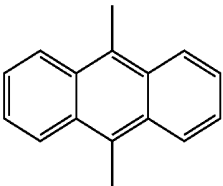
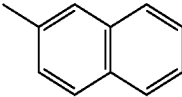
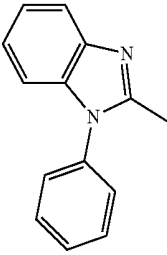
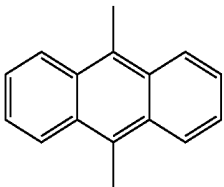
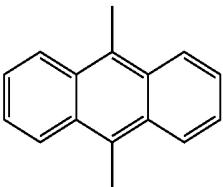
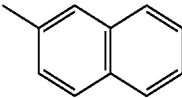
HAr—L ⁷ —Ar ^e —Ar ^f				
	HAr	L ⁷	Ar ^e	Ar ^f
4				
5				
6				

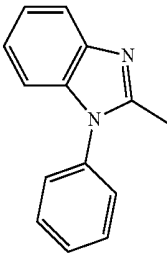
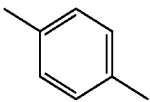
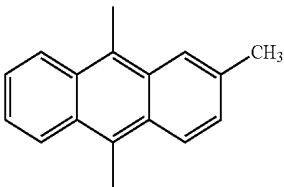
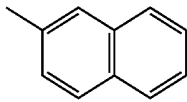
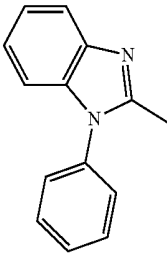
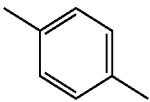
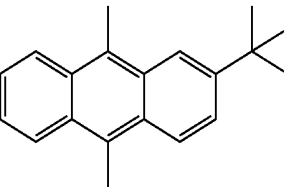
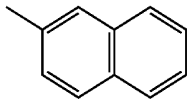
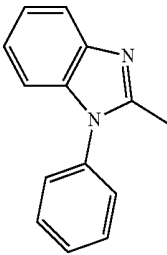
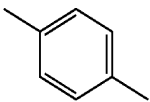
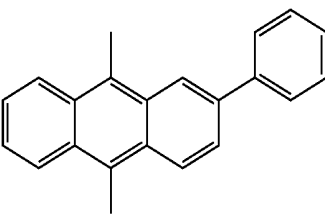
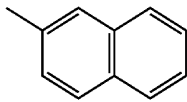
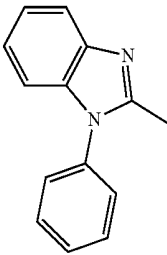
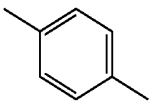
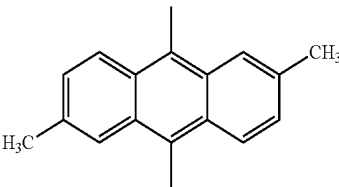
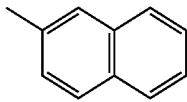
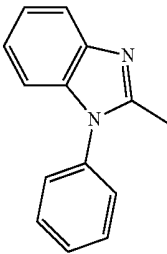
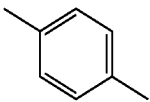
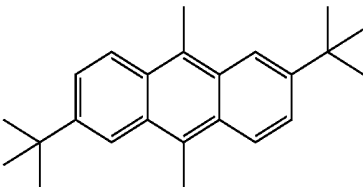
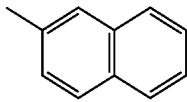
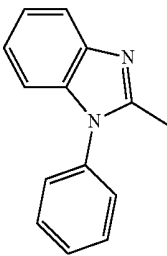
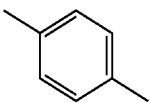
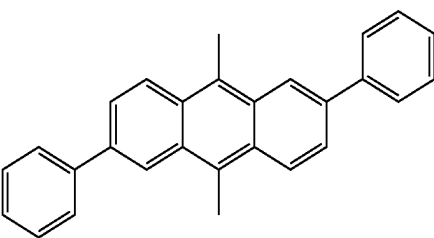
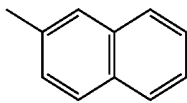
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
4-1			

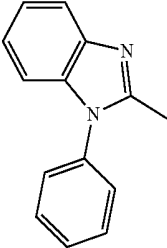
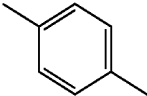
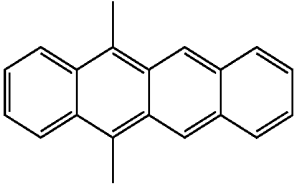
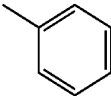
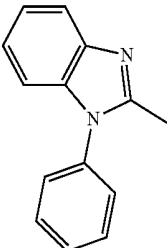
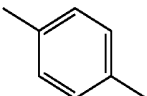
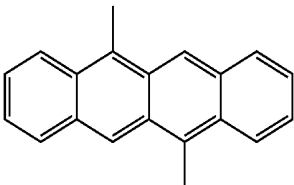
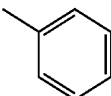
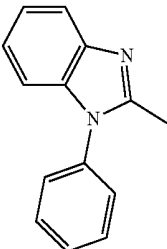
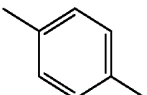
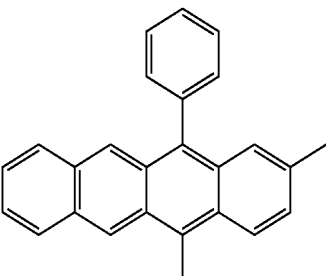
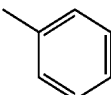
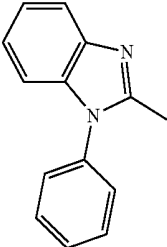
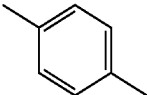
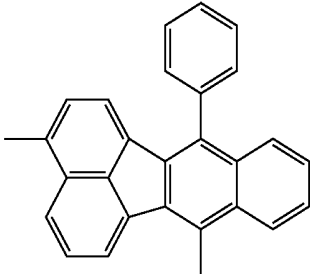
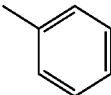
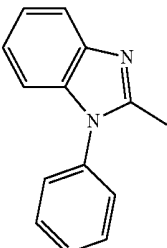
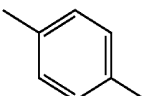
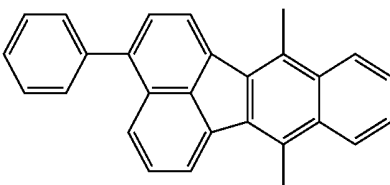
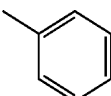
-continued

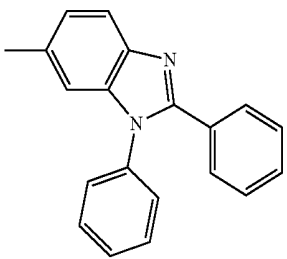
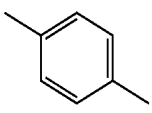
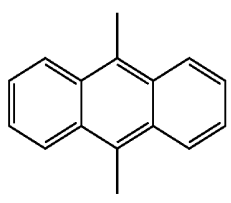
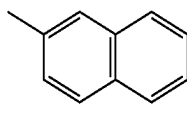
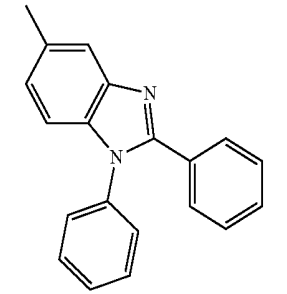
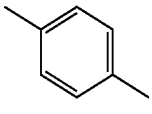
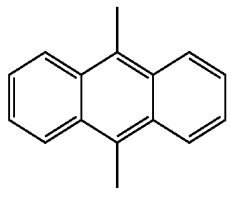
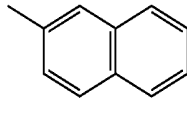
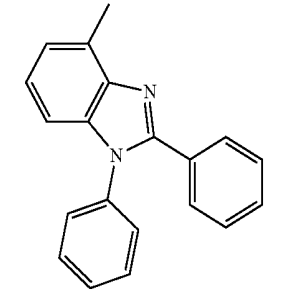
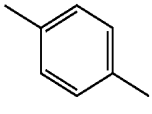
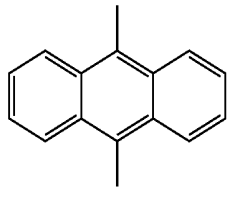
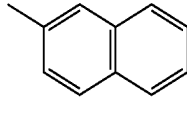
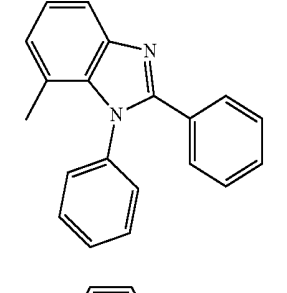
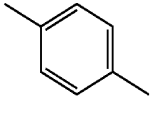
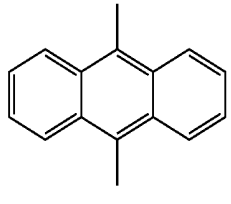
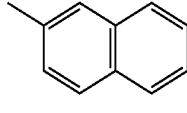
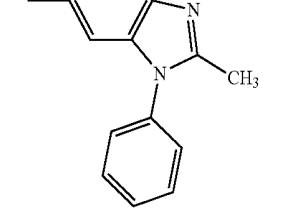
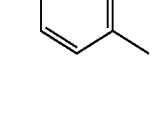
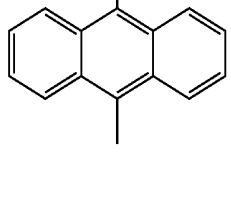
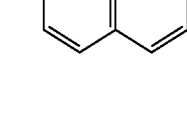
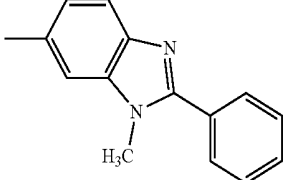
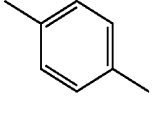
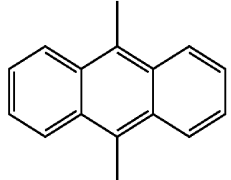
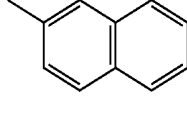
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
2 			
3 			
4 			
5 			
6 			
7 			

-continued

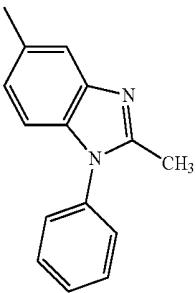
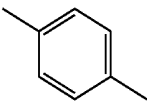
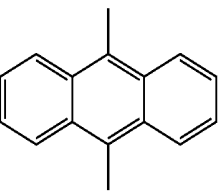
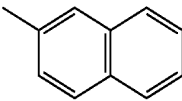
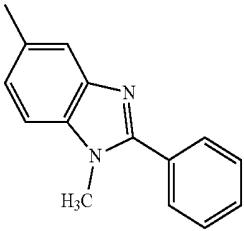
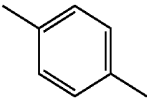
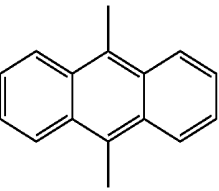
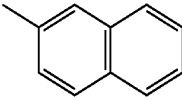
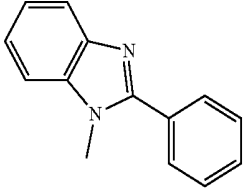
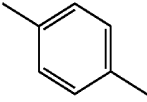
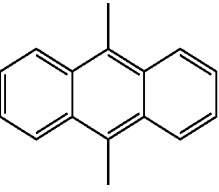
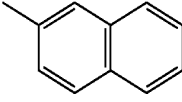
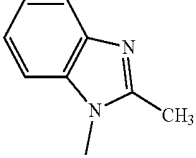
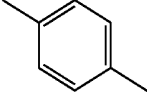
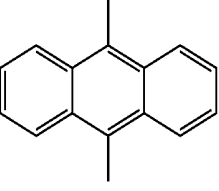
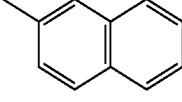
$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
8 			
9 			
10 			
11 			
12 			

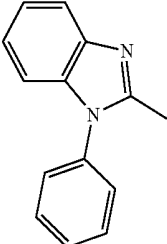
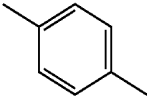
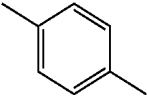
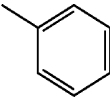
$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
5-1 			
2 			
3 			
4 			
5 			
6 			

$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
6-1 			
2 			
3 			
4 			
5 			

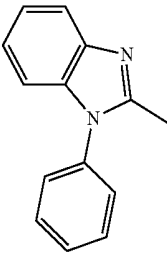
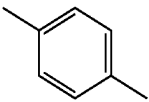
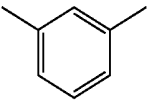
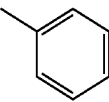
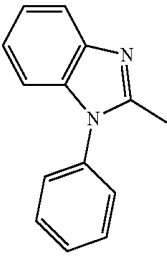
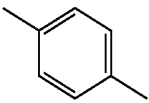
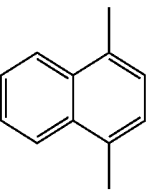
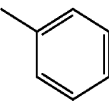
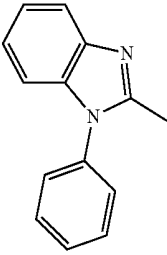
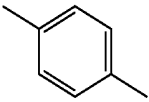
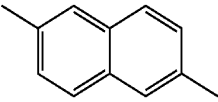
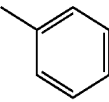
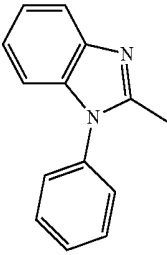
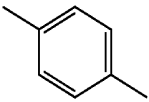
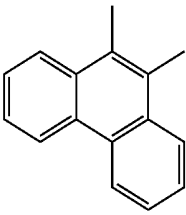
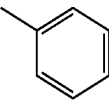
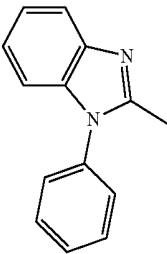
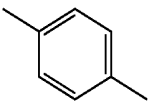
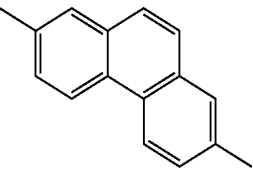
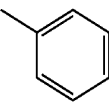
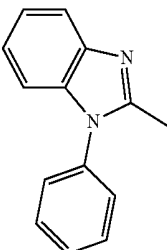
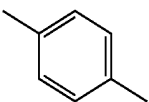
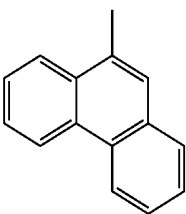

	$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
	HAr	L^7	Ar^e	Ar^f
7-1				
2				
3				
4				
5				
6				

-continued

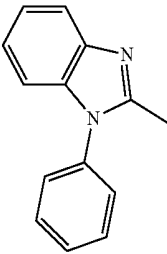
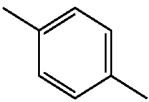
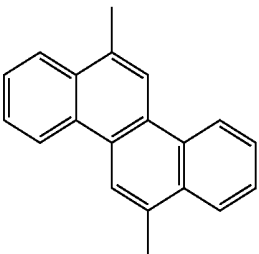
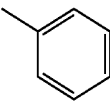
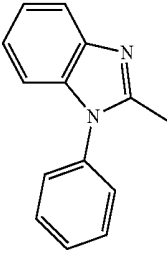
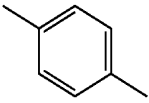
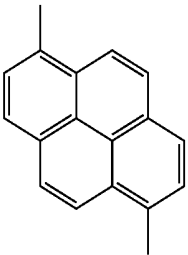
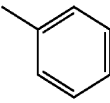
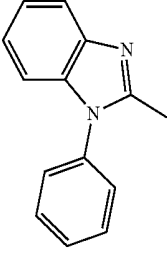
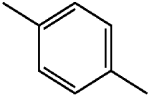
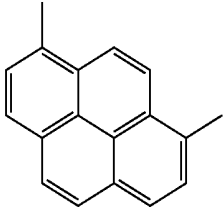
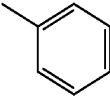
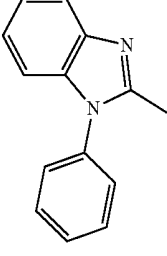
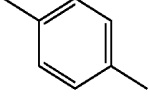
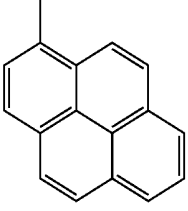

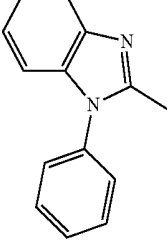
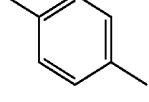
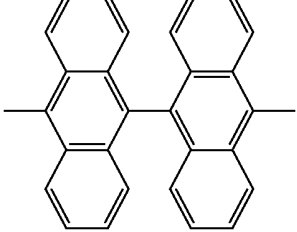
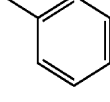
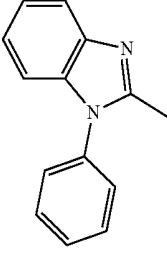
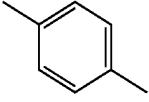
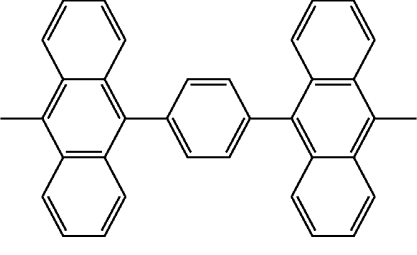
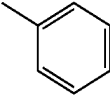
$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
7 			
8 			
9 			
10 			

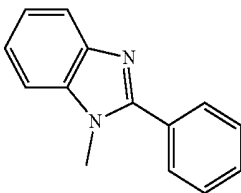
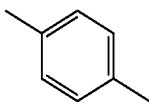
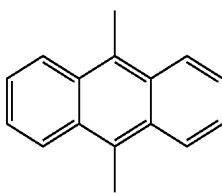
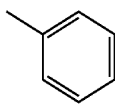
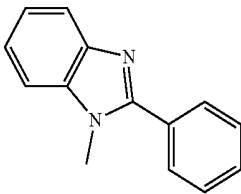
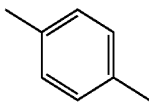
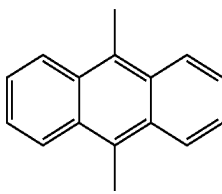
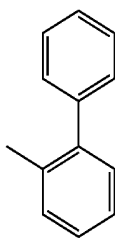
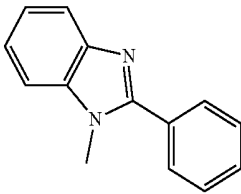
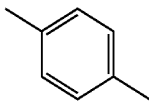
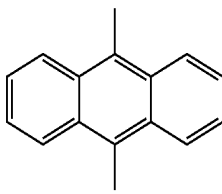
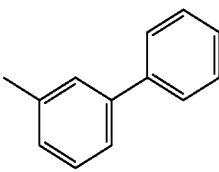
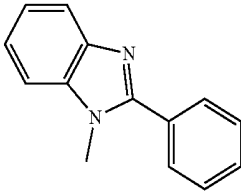
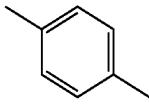
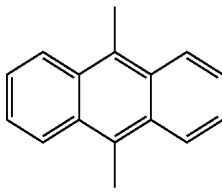
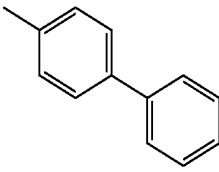
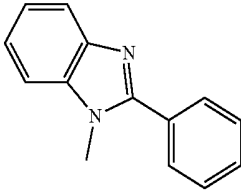
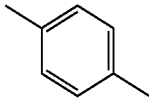
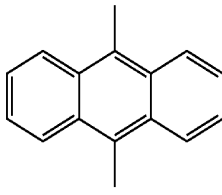
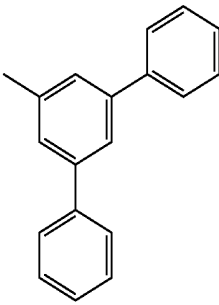
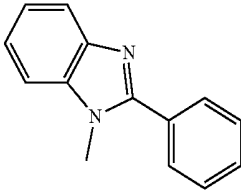
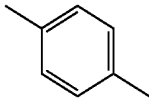
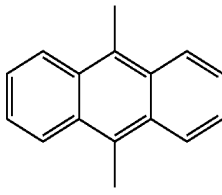
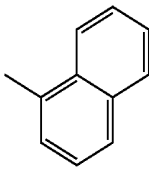
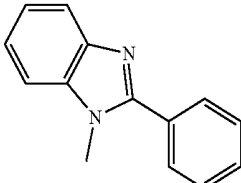
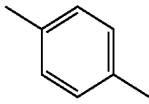
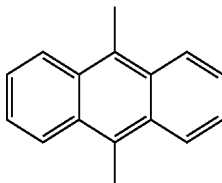
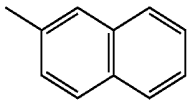
$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
8-1 			

-continued

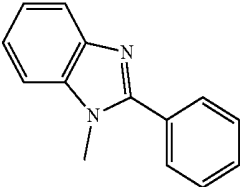
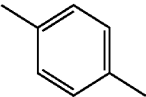
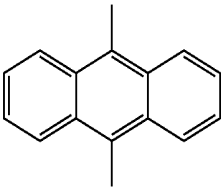
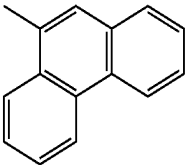
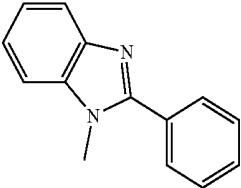
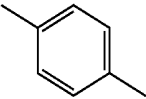
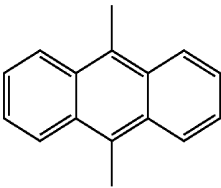
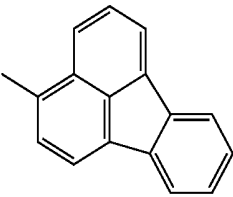
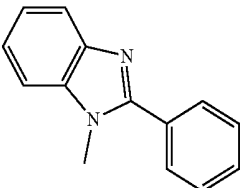
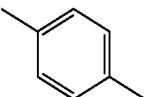
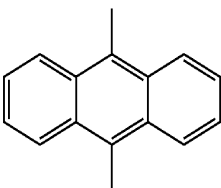
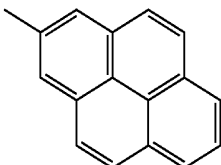
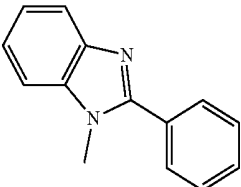
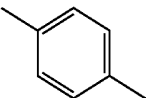
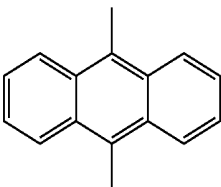
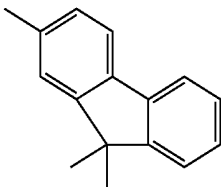
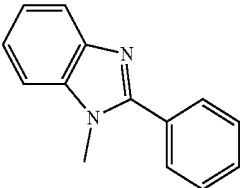
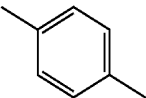
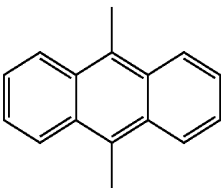
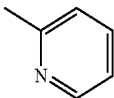
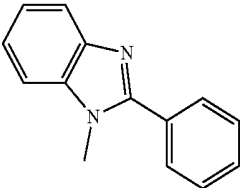
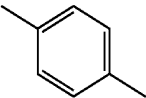
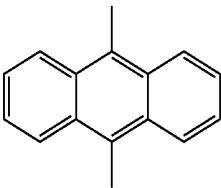
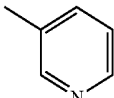
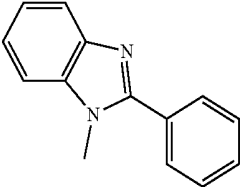
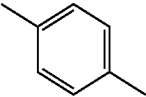
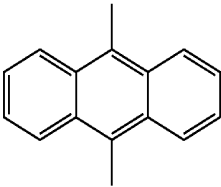
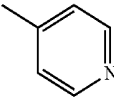
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
2 			
3 			
4 			
5 			
6 			
7 			

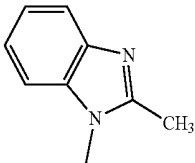
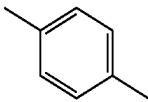
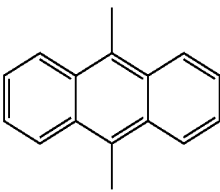
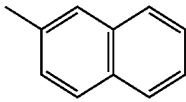
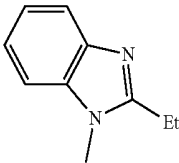
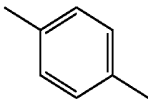
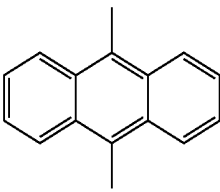
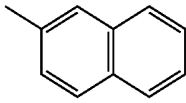
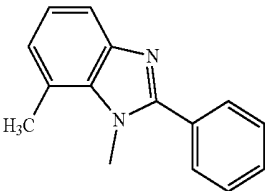
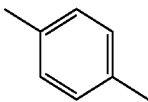
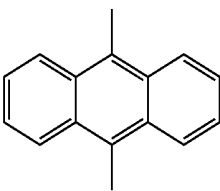
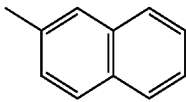
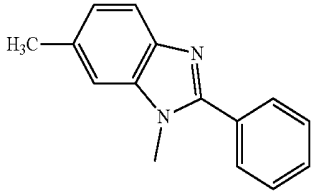
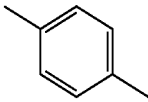
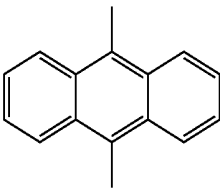
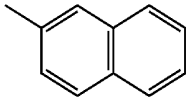
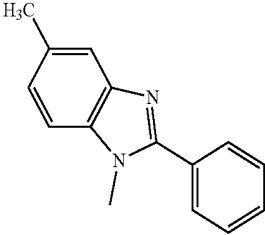
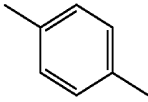
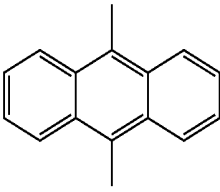
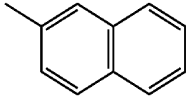
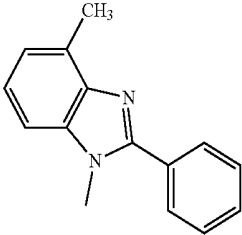
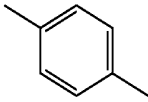
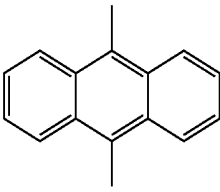
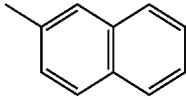
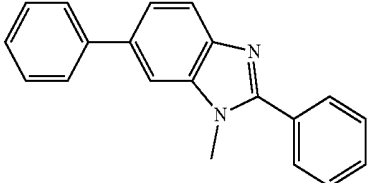
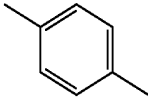
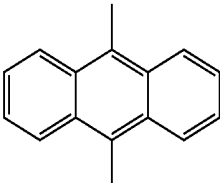
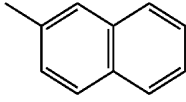
-continued

$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$			
HAr	L^7	Ar^e	Ar^f
8 			
9 			
10 			
11 			
12 			
13 			

HAr—L ⁷ —Ar ^e —Ar ^f				
	HAr	L ⁷	Ar ^e	Ar ^f
9-1				
2				
3				
4				
5				
6				
7				

-continued

HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
8 			
9 			
10 			
11 			
12 			
13 			
14 			

$\text{HAr}-\text{L}^7-\text{Ar}^e-\text{Ar}^f$				
	HAr	L^7	Ar^e	Ar^f
10-1				
2				
3				
4				
5				
6				
7				

275

276

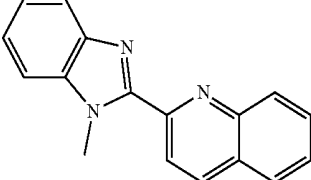
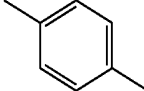
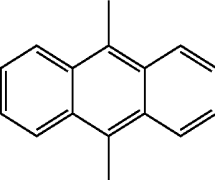
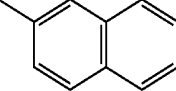
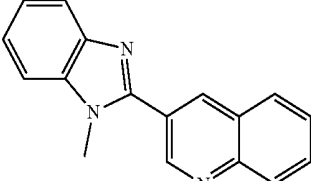
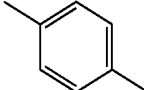
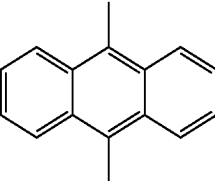
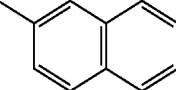
-continued

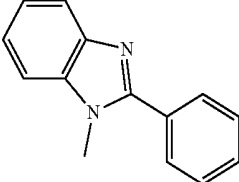

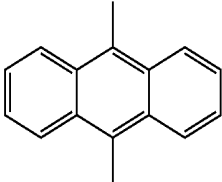
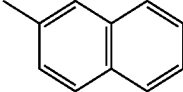
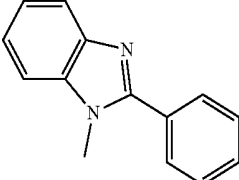
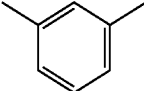
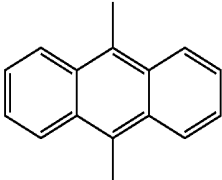
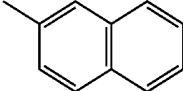
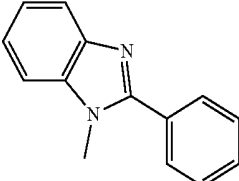
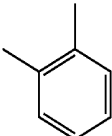
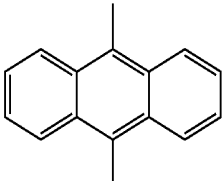
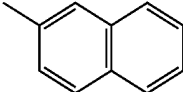
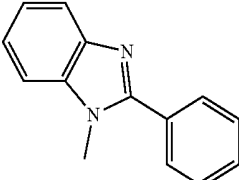
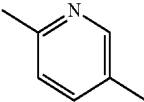
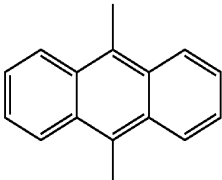
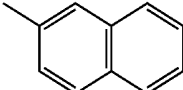
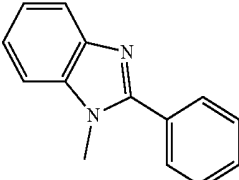
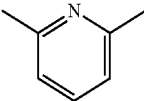
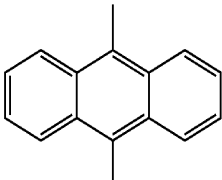
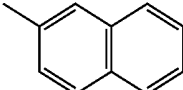
HAr—L ⁷ —Ar ^e —Ar ^f				
	HAr	L ⁷	Ar ^e	Ar ^f
8				
9				

30

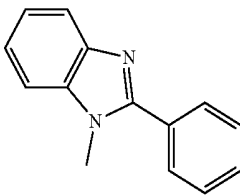
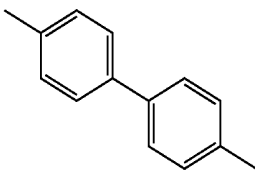
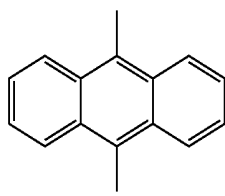
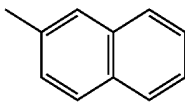
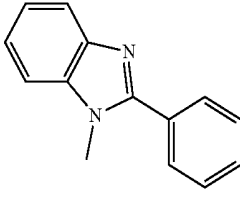
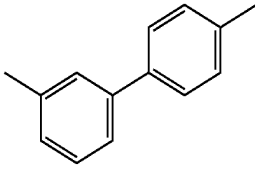
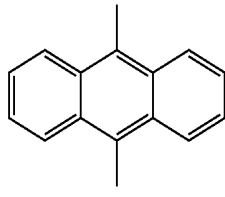
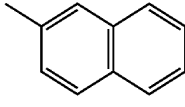
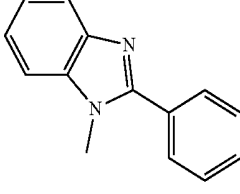
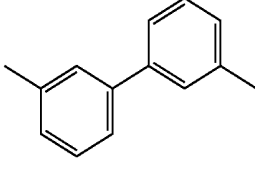
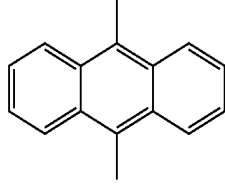
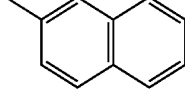
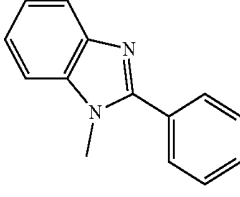
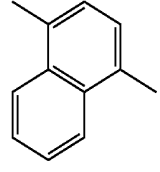
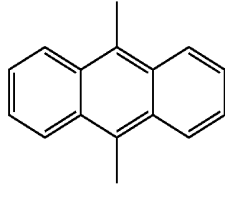
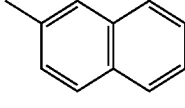
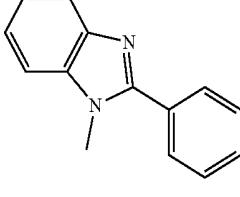
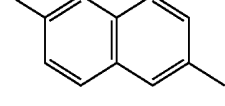
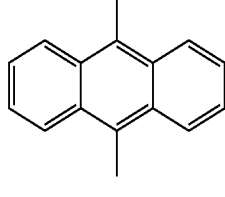
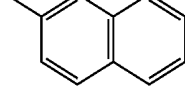
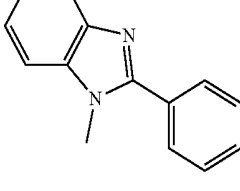
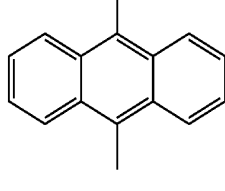
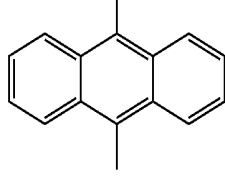
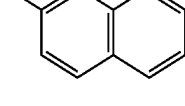
HAr—L ⁷ —Ar ^e —Ar ^f				
	HAr	L ⁷	Ar ^e	Ar ^f
11-1				
2				
3				
4				

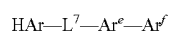
-continued

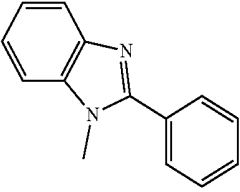
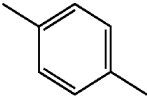
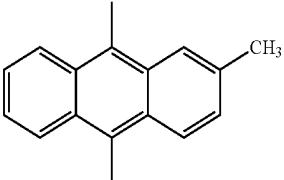
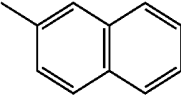
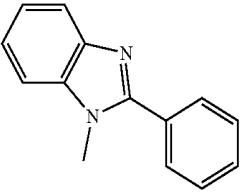
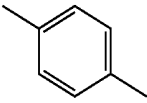
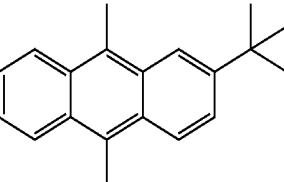
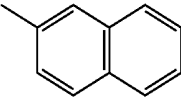
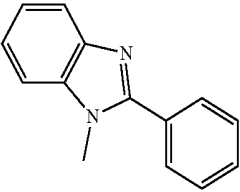
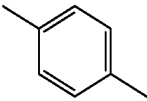
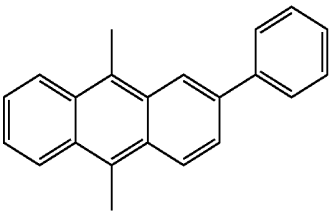
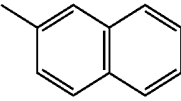
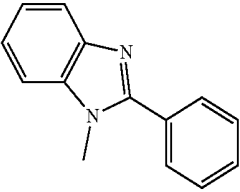
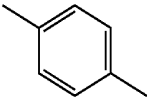
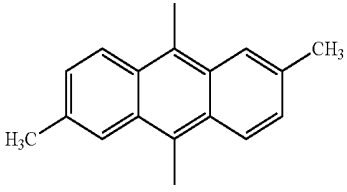
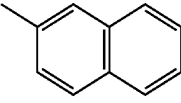
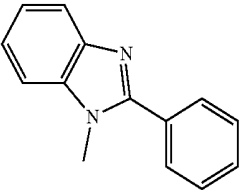
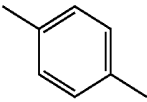
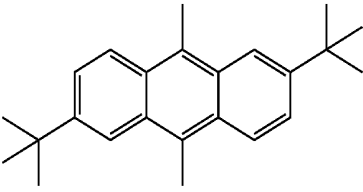
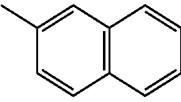
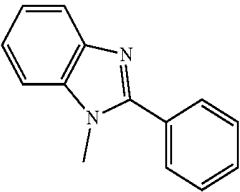
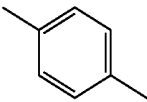
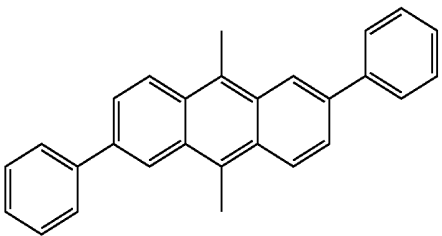
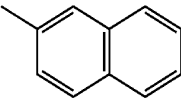
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
5 			
6 			

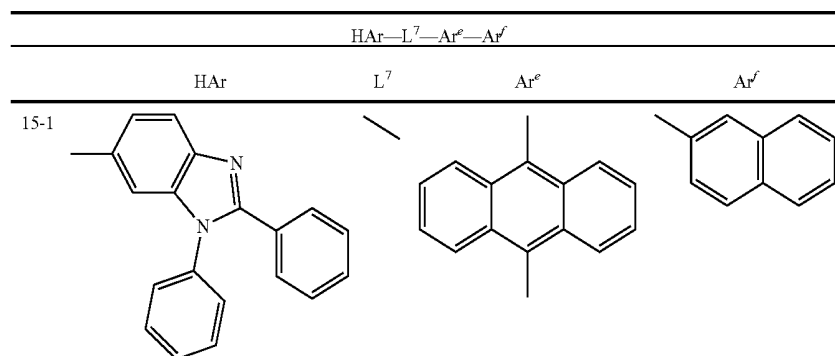
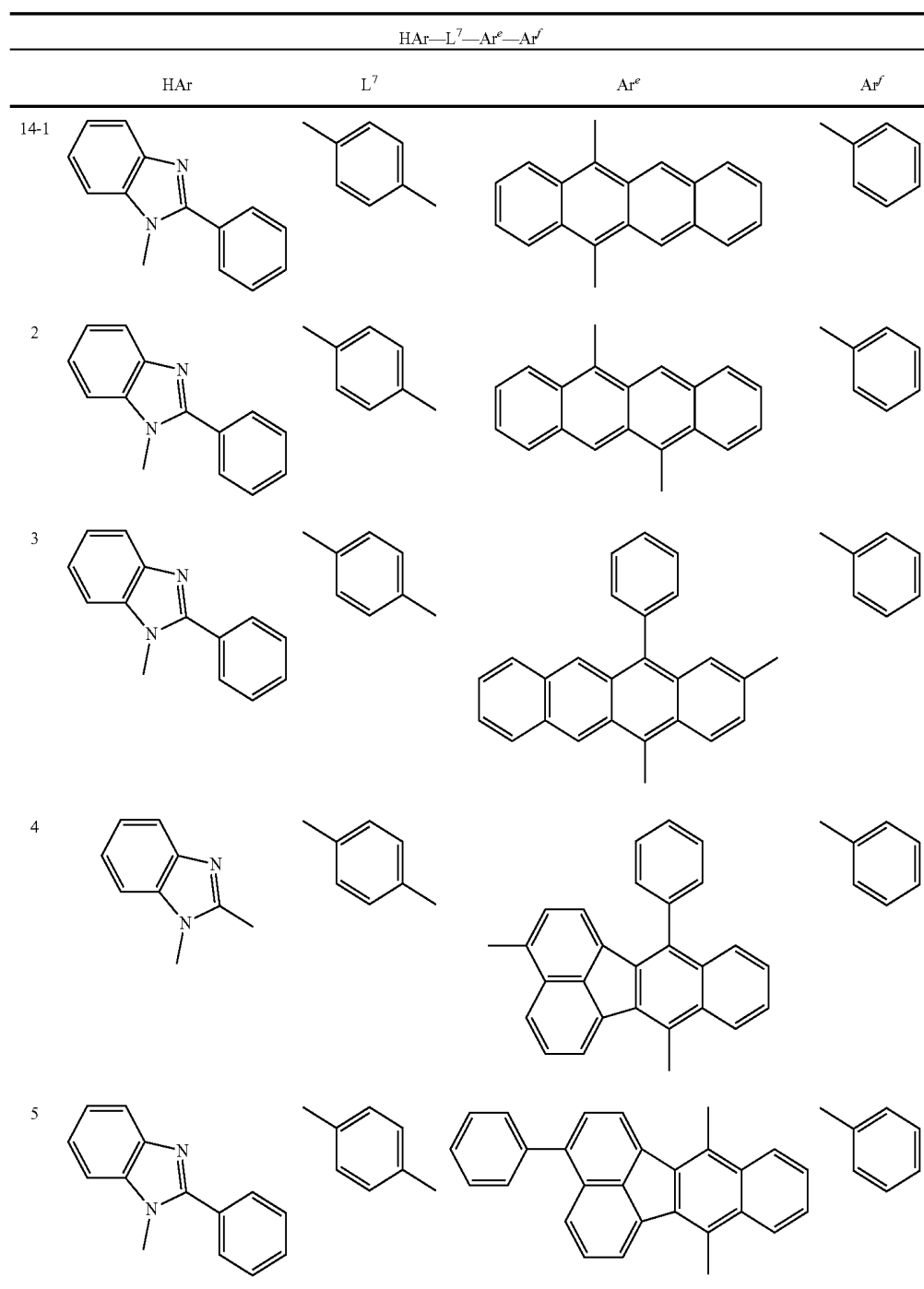
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
12-1 			
2 			
3 			
4 			
5 			

-continued

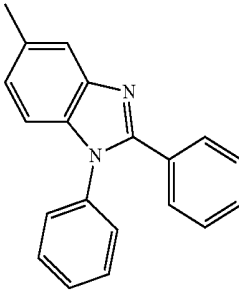

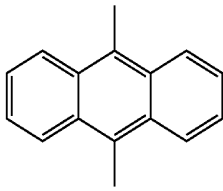
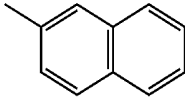
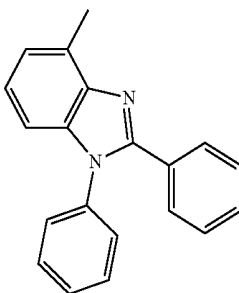

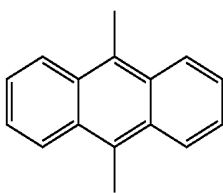
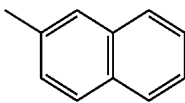
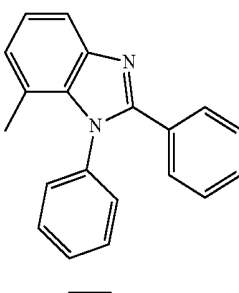

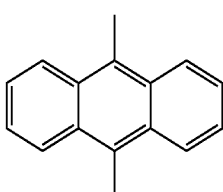
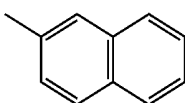
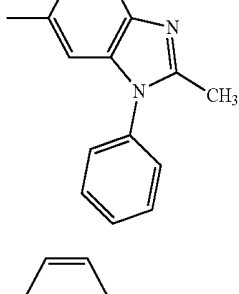

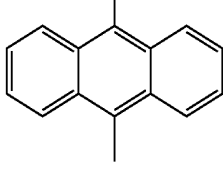
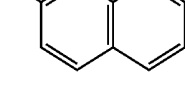
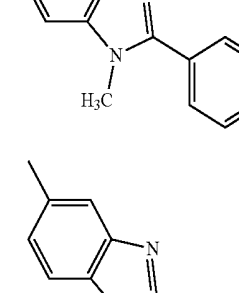

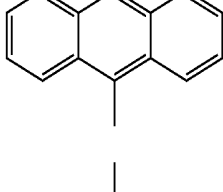
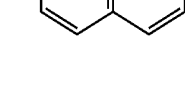
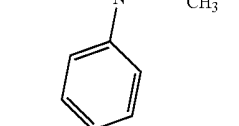



HAr—L ⁷ —Ar ^e —Ar ^f				
	HAr	L ⁷	Ar ^e	Ar ^f
6				
7				
8				
9				
10				
11				



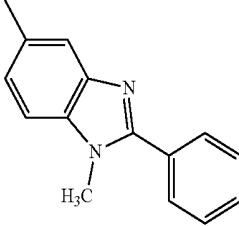

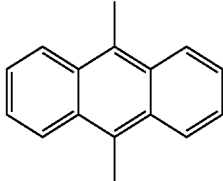
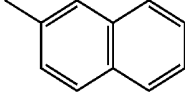
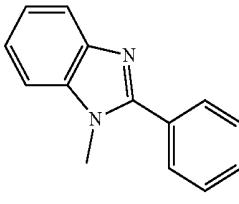

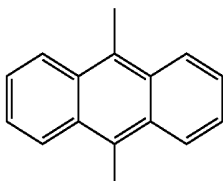
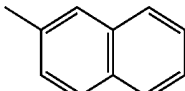
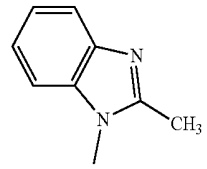

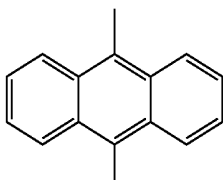
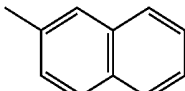
	HAr	L^7	Ar^e	Ar^f
13-1				
2				
3				
4				
5				
6				

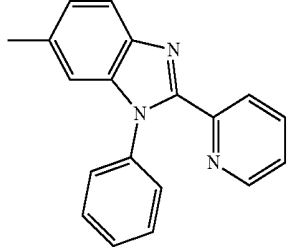

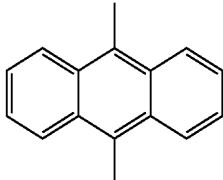
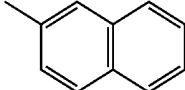
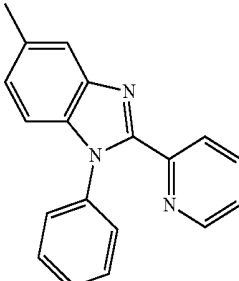

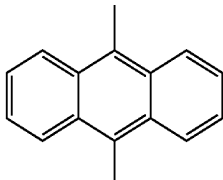
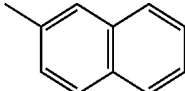


-continued

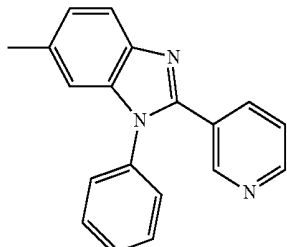

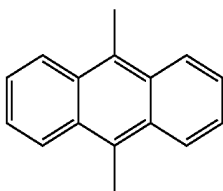
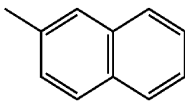
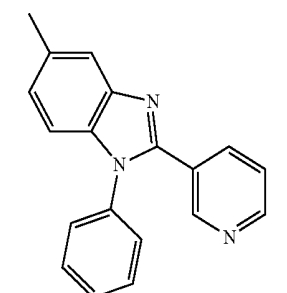

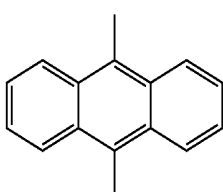
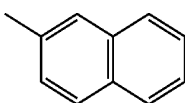
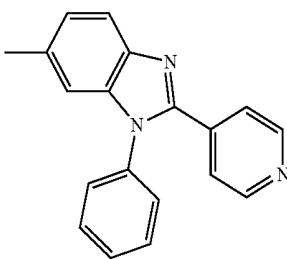

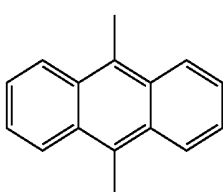
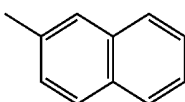
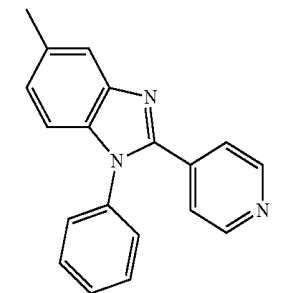

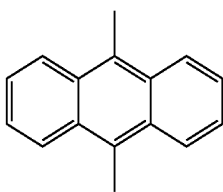
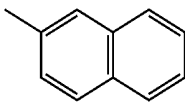
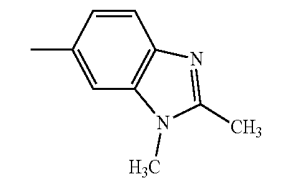

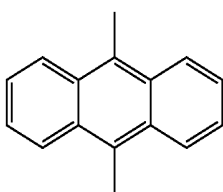
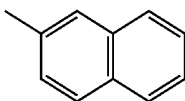
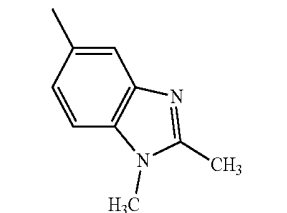

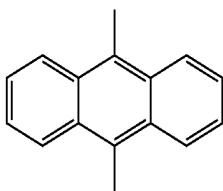
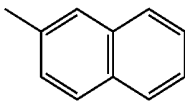
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
2 			
3 			
4 			
5 			
6 			
7 			

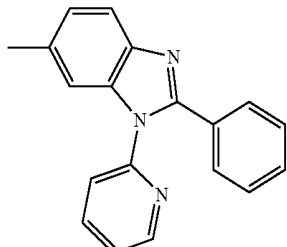

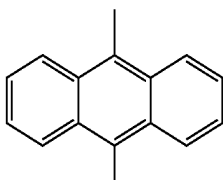
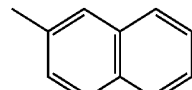
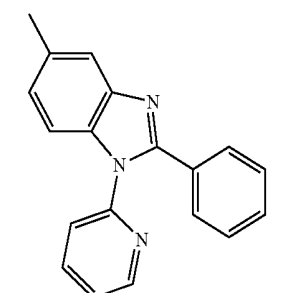

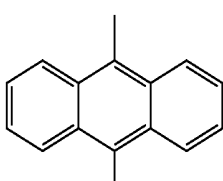
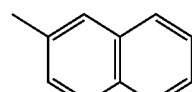
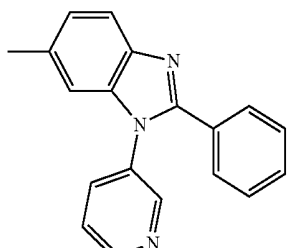

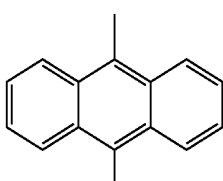
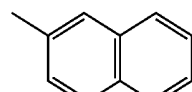
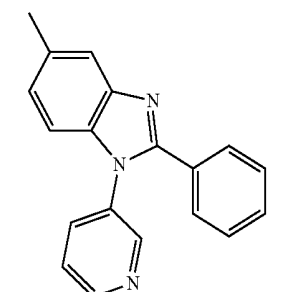

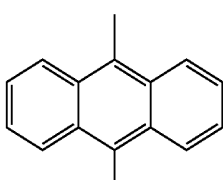
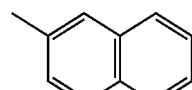
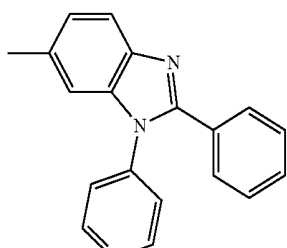

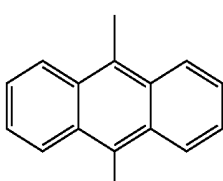
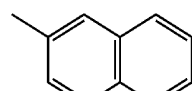
-continued

HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
8 			
9 			
10 			

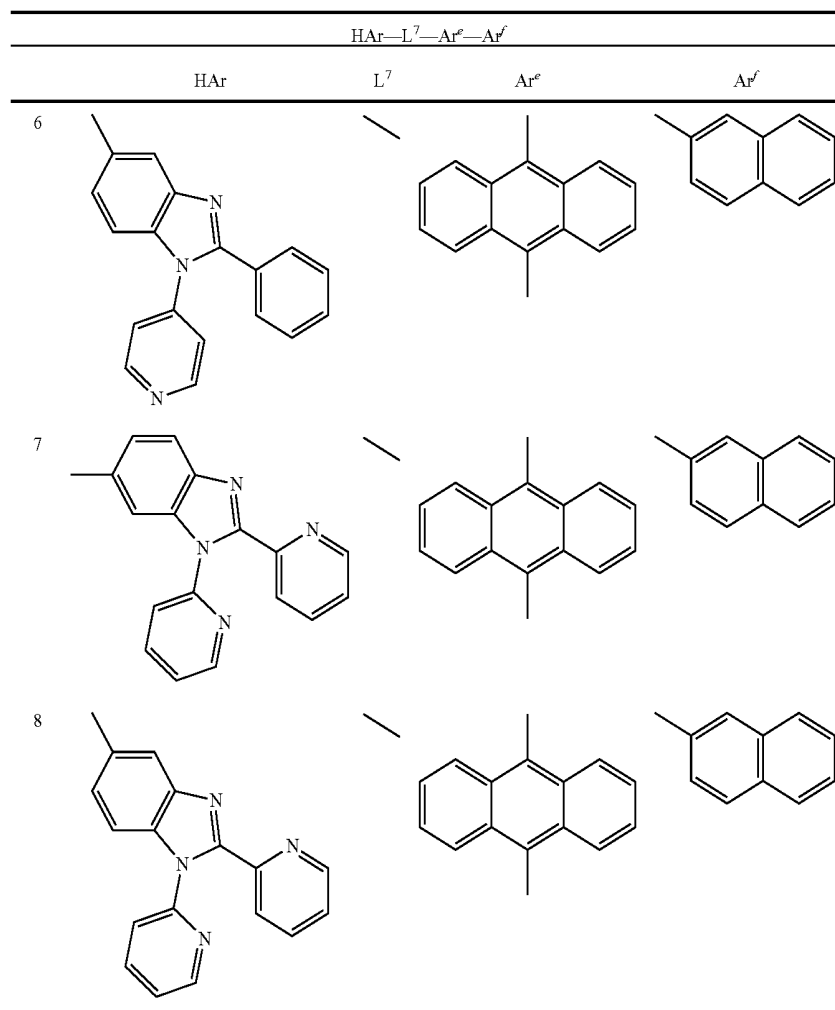
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
16-1 			
2 			

-continued

HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
3 			
4 			
5 			
6 			
7 			
8 			

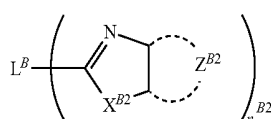
HAr—L ⁷ —Ar ^e —Ar ^f			
HAr	L ⁷	Ar ^e	Ar ^f
17-1 			
2 			
3 			
4 			
5 			

-continued



Of those specific examples, (1-1), (1-5), (1-7), (2-1), (3-1), (4-2), (4-6), (7-2), (7-7), (7-8), (7-9), (9-1), and (9-7) are particularly preferred.

In addition, as the nitrogen-containing ring derivative, nitrogen-containing five-membered ring derivative are also preferably exemplified. Examples of the nitrogen-containing five-membered ring include an imidazole ring, a triazole ring, a tetrazole ring, an oxadiazole ring, a thiadiazole ring, an oxatriazole ring, and a thiatriazole ring. Examples of the nitrogen-containing five-membered ring derivative include a benzoimidazole ring, a benzotriazole ring, a pyridinoimidazole ring, a pyrimidinoimidazole ring, and a pyridazinoimidazole ring. Particularly preferred is the compound represented by the following general formula (B).

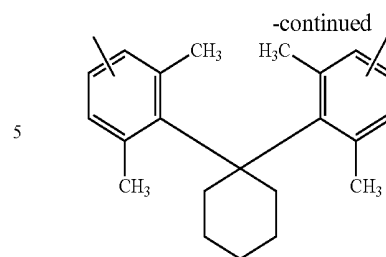
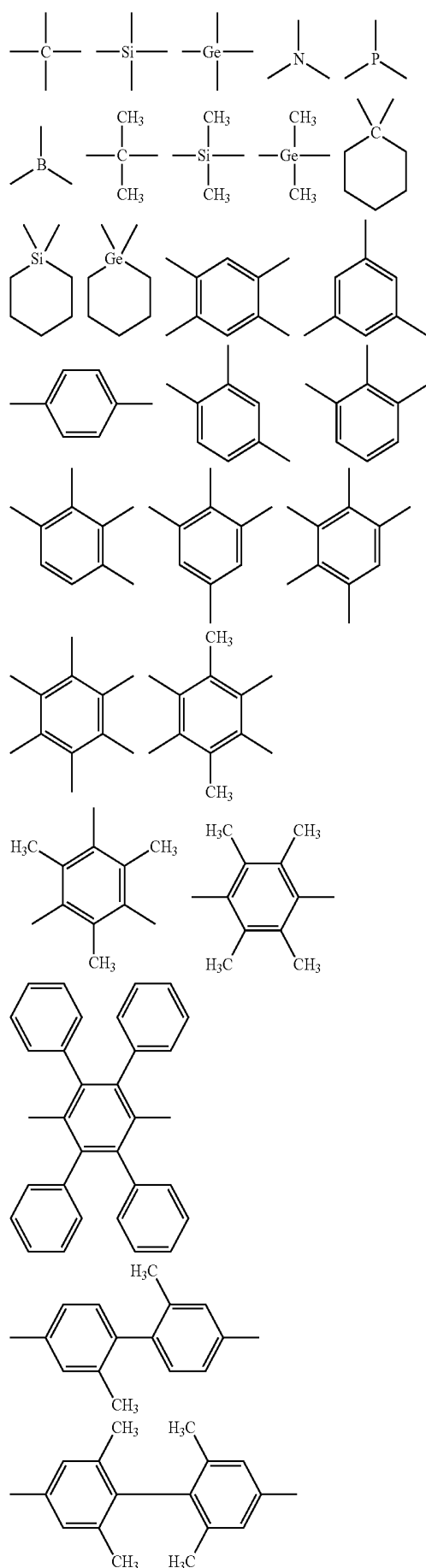


In the general formula (B), L^B represents a divalent or more bonding group. Examples thereof include a carbon atom, a silicon atom, a nitrogen atom, a boron atom, an oxygen atom, a sulfur atom, metal atoms (for example, a barium atom, a beryllium atom), aromatic hydrocarbon

rings, and aromatic heterocycles. Of those, preferred are a carbon atom, a nitrogen atom, a silicon atom, a boron atom, an oxygen atom, a sulfur atom, aromatic hydrocarbon rings, and aromatic heterocyclic groups, and more preferred are a carbon atom, a silicon atom, aromatic hydrocarbon rings, and aromatic heterocyclic groups.

The aromatic hydrocarbon rings and aromatic heterocyclic groups represented by L^B may have a substituent. Examples of the substituent include alkyl groups, alkenyl groups, aryl groups, amino groups, alkoxy groups, aryloxy groups, acyl groups, alkoxycarbonyl groups, aryloxy carbonyl groups, acyloxy groups, acylamino groups, alkoxycarbonylamino groups, aryloxy carbonylamino groups, sulfonylamino groups, sulfamoyl groups, carbamoyl groups, alkylthio groups, arylthio groups, sulfonyl groups, halogen atoms, cyano groups, and aromatic heterocyclic groups. Preferred are alkyl groups, aryl groups, alkoxy groups, aryloxy groups, halogen atoms, cyano groups, and aromatic heterocyclic groups, more preferred are alkyl groups, aryl groups, alkoxy groups, aryloxy groups, and aromatic heterocyclic groups, and particularly preferred are alkyl groups, aryl groups, alkoxy groups, and aromatic heterocyclic groups.

Specific examples of L^B include compounds represented below.



X^{B2} in the general formula (B) represents $-\text{O}-$, $-\text{S}-$, or $-\text{N}(\text{R}^{B2})-$. R^{B2} represents a hydrogen atom, an aliphatic hydrocarbon group, an aryl group, or a heterocyclic group.

15 The aliphatic hydrocarbon group represented by R^{B2} is a linear or branched alkyl group (having preferably 1 to 20, more preferably 1 to 12, or particularly preferably 1 to 8 carbon atoms such as a methyl group, an ethyl group, an isopropyl group, a t-butyl group, an n-octyl group, an
20 n-decyl group, or an n-hexadecyl group), a cycloalkyl group (having a ring formed of preferably 3 to 10 carbon atoms such as a cyclopropyl group, acyclopentyl group, or a cyclohexyl group), an alkenyl group (having preferably 2 to 20, more preferably 2 to 12, or particularly preferably 2 to
25 8 carbon atoms such as a vinyl group, an aryl group, a 2-butenyl group, or a 3-pentenyl group), or an alkynyl group (having preferably 2 to 20, more preferably 2 to 12, or particularly preferably 2 to 8 carbon atoms such as a propargyl group or a 3-pentynyl group), or is preferably an
30 alkyl group.

The aryl group represented by R^{B2} is a monocycle or a fused ring, and is an aryl group having a ring formed of preferably 6 to 30, more preferably 6 to 20, or still more preferably 6 to 12 carbon atoms. Examples of such groups include a phenyl group, a 2-methylphenyl group, a 3-methylphenyl group, a 4-methylphenyl group, a 2-methoxyphenyl group, a 3-trifluoromethylphenyl group, a pentafluorophenyl group, a 1-naphthyl group, and a 2-naphthyl group. Of those, a phenyl group or a 2-methylphenyl group is preferable.

The heterocyclic group represented by R^{B2} is a monocycle or a fused ring, and is a heterocyclic group having a ring formed of preferably 1 to 20, more preferably 1 to 12, or still more preferably 2 to 10 carbon atoms. The heterocyclic group is an aromatic heterocyclic group containing at least one heteroatom selected from a nitrogen atom, an oxygen atom, a sulfur atom, and a selenium atom. Examples of the heterocyclic group include groups derived from pyrrolidine, piperidine, piperazine, morpholine, thiophene, selenophene, furan, pyrrole, imidazole, pyrazole, pyridine, pyrazine, pyridazine, pyrimidine, triazole, triazine, indole, indazole, purine, thiazoline, thiazole, thiadiazole, oxazoline, oxazole, oxadiazole, quinoline, isoquinoline, phthalazine, naphthyridine, quinoxaline, quinoxaline, cinnoline, pteridine, acridine, phenanthroline, phanazine, tetrazole, benzoimidazole, benzoxazole, benzothiazole, benzotriazole, tetrazaindene, carbazole, azepine, and the like. Preferred are groups derived from furan, thiophene, pyridine, pyrazine, pyrimidine, pyridazine, triazine, quinoline, phthalazine, naphthyridine, quinoxaline, and quinoxaline, more preferred are groups derived from furan, thiophene, pyridine, and quinoline, and still more preferred is a quinolinyl group.

The aliphatic hydrocarbon group, the aryl group, and the heterocyclic group each represented by R^{B2} may each have a substituent, and the substituent is preferably an alkyl group, an alkenyl group, an alkynyl group, an aryl group, an amino group, an alkoxy group, an aryloxy group, an acyl

297

group, an alkoxycarbonyl group, an aryloxycarbonyl group, an acyloxy group, an acylamino group, an alkoxycarbonylamino group, an aryloxycarbonylamino group, a sulfonylamino group, a sulfamoyl group, a carbamoyl group, an alkylthio group, an arylthio group, a sulfonyl group, a halogen atom, a cyano group, or an aromatic heterocyclic group, more preferably an alkyl group, an aryl group, an alkoxy group, an aryloxy group, a halogen atom, a cyano group, or an aromatic heterocyclic group, still more preferably an alkyl group, an aryl group, an alkoxy group, an aryloxy group, or an aromatic heterocyclic group, or particularly preferably an alkyl group, an aryl group, an alkoxy group, or an aromatic heterocyclic group.

R^{B2} preferably represents an aliphatic hydrocarbon group, an aryl group, or a heterocyclic group, more preferably represents an aliphatic hydrocarbon group (having preferably 6 to 30, more preferably 6 to 20, or still more preferably 6 to 12 carbon atoms) or an aryl group, or still more preferably represents an aliphatic hydrocarbon group (having preferably 1 to 20, more preferably 1 to 12, or still more preferably 2 to 10 carbon atoms).

X^{B2} preferably represents $-O-$ or $-N(R^{B2})-$, or more preferably represents $-N(R^{B2})-$.

Z^{B2} represents atoms necessary for forming an aromatic ring. The aromatic ring formed of Z^{B2} is any one of aromatic hydrocarbon rings and aromatic heterocyclic rings. Specific examples thereof include a benzene ring, a pyridine ring, a pyrazine ring, a pyrimidine ring, a pyridazine ring, a triazine ring, a pyrrole ring, a furan ring, a thiophene ring, a selenophene ring, a tellurophene ring, an imidazole ring, a thiazole ring, a selenazole ring, a tellulazole ring, a thiadiazole ring, an oxadiazole ring, and a pyrazole ring. Preferred are a benzene ring, a pyridine ring, a pyrazine ring, a pyrimidine ring, and a pyridazine ring, more preferred are a benzene ring, a pyridine ring, and a pyrazine ring, still more preferred are a benzene ring and a pyridine ring, and particularly preferred is a pyridine ring.

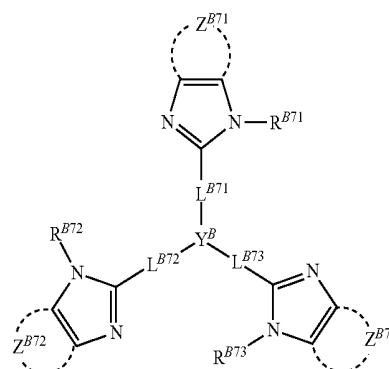
The aromatic ring formed of Z^{B2} may further form a fused ring with any other rings, or may have a substituent. Examples of the substituent include the same examples as those described for the substituent of the group represented by L^B , and the substituent is preferably an alkyl group, an alkenyl group, an alkynyl group, an aryl group, an amino group, an alkoxy group, an aryloxy group, an acyl group, an alkoxycarbonyl group, an aryloxycarbonyl group, an acyloxy group, an acylamino group, an alkoxycarbonylamino group, an aryloxycarbonylamino group, a sulfonylamino group, a sulfamoyl group, a carbamoyl group, an alkylthio group, an arylthio group, a sulfonyl group, a halogen atom, a cyano group, or a heterocyclic group, more preferably an alkyl group, an aryl group, an alkoxy group, an aryloxy group, a halogen atom, a cyano group, or a heterocyclic group, still more preferably an alkyl group, an aryl group, an alkoxy group, an aryloxy group, or an aromatic heterocyclic group, or particularly preferably an alkyl group, an aryl group, an alkoxy group, or an aromatic heterocyclic group.

n^{B2} represents an integer of 1 to 4, or preferably 2 or 3.

Of the nitrogen-containing five-membered ring derivatives each represented by the general formula (B), a derivative represented by the following general formula (B') is more preferable.

298

(B')



In the general formula (B'), R^{B71} , R^{B72} and R^{B73} each have the same meaning the same meaning as that of R^{B2} in the general formula (B), and the preferable ranges of R^{B71} , R^{B72} , and R^{B73} are also the same as those of R^{B2} .

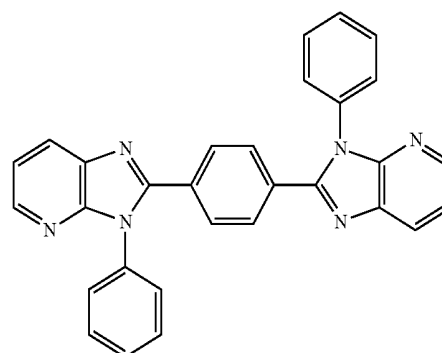
In the formula, Z^{B71} , Z^{B72} , and Z^{B73} each have the same meaning as that of Z^{B2} in the general formula (B), and the preferable ranges of Z^{B71} , Z^{B72} and Z^{B73} are also the same as those of Z^{B2} .

In the formula, L^{B71} , L^{B72} , and L^{B73} each represent a linking group, and examples of the linking group include examples obtained by making the examples of L^B in the general formula (B) divalent. The linking group is preferably a single bond, a divalent aromatic hydrocarbon ring group, a divalent aromatic heterocyclic group, or a linking group composed of a combination of two or more of them, or is more preferably a single bond. L^{B71} , L^{B72} , and L^{B73} may each have a substituent. Examples of the substituent include the same examples as those described for the substituent of the group represented by L^B in the general formula (B), and preferable examples of the substituent also include the same preferable examples as those described for the substituent of the group represented by L^B in the general formula (B).

In the formula, Y^B represents a nitrogen atom, a 1,3,5-benzenetriyl group, or a 2,4,6-triazinetriyl group. The 1,3,5-benzenetriyl group may have a substituent at any one of its 2-, 4-, and 6-positions, and examples of the substituent include an alkyl group, an aromatic hydrocarbon ring group, and a halogen atom.

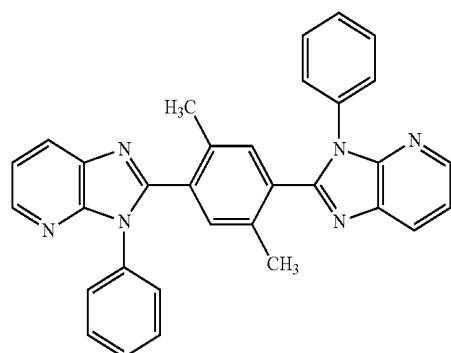
Specific examples of the nitrogen-containing five-membered ring derivative represented by the general formula (B) or (B') are shown below. However, the present invention is not limited to these exemplified compounds.

(B-1)



299

-continued



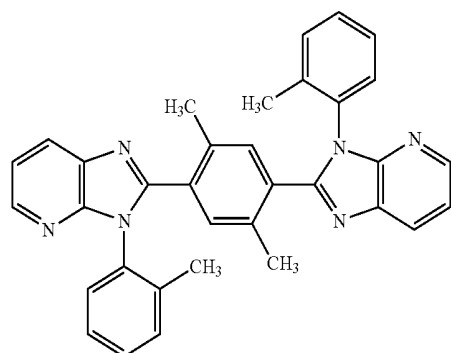
(B-2)

5

10

15

(B-3)



20

25

30

(B-4)

35

40

45

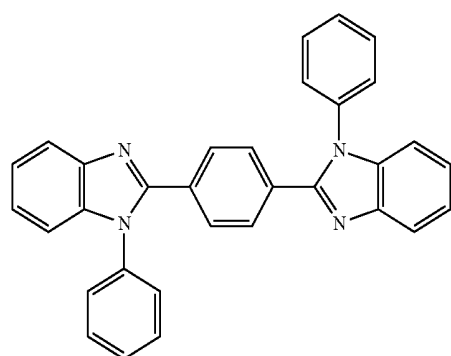
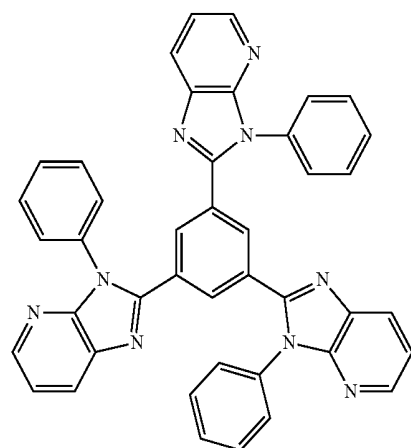
50

(B-5)

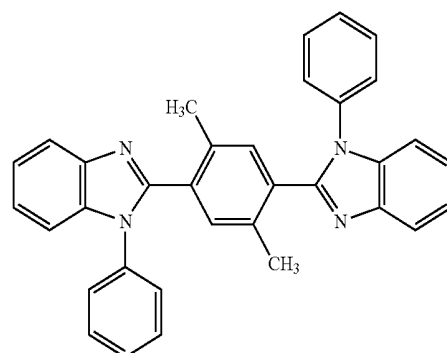
55

60

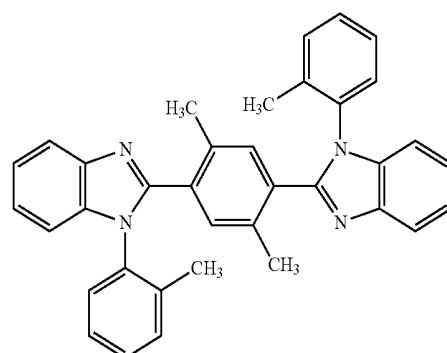
65

**300**

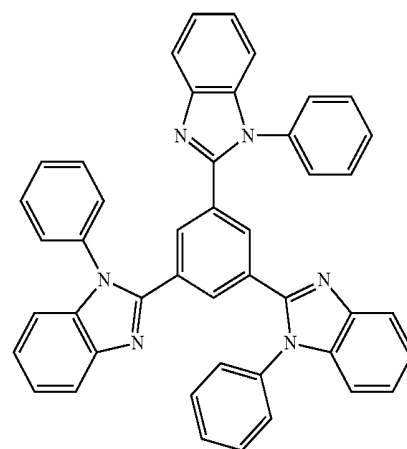
-continued



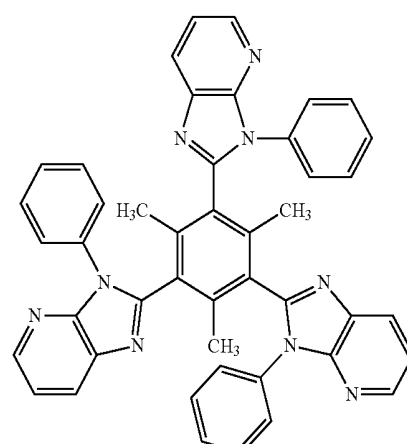
(B-6)



(B-7)



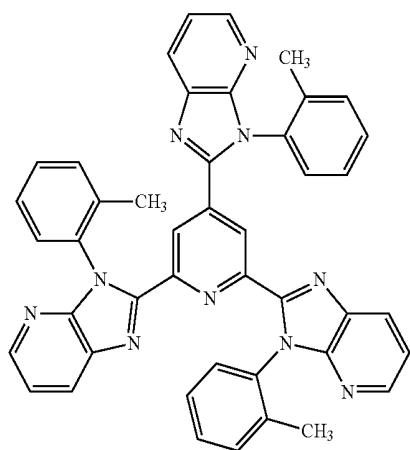
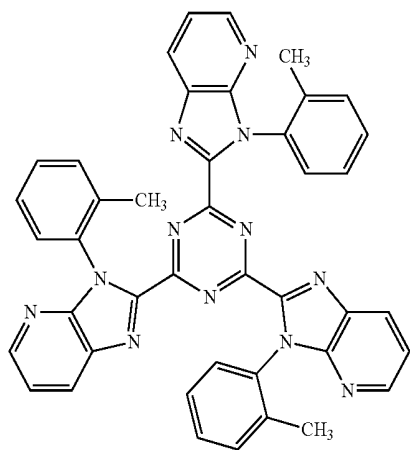
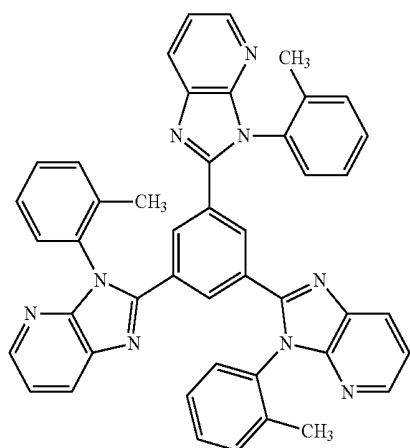
(B-8)



(B-9)

301

-continued

**302**

-continued

(B-10)

5

10

15

20

25

30

(B-11)

35

40

45

(B-12)

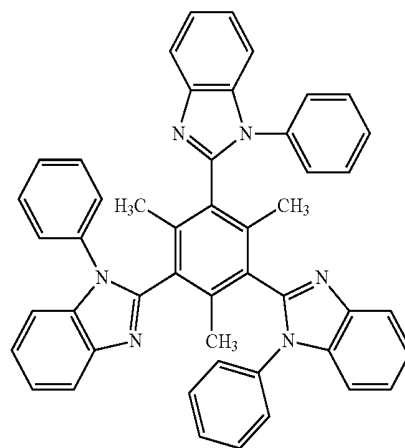
50

55

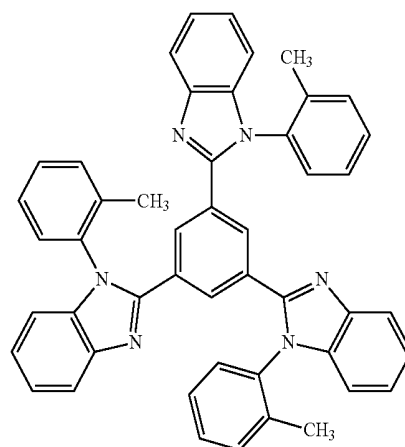
60

65

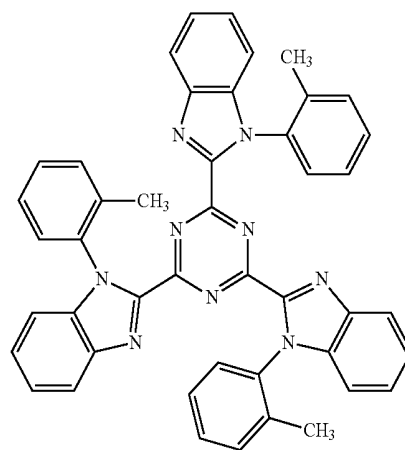
(B-13)



(B-14)

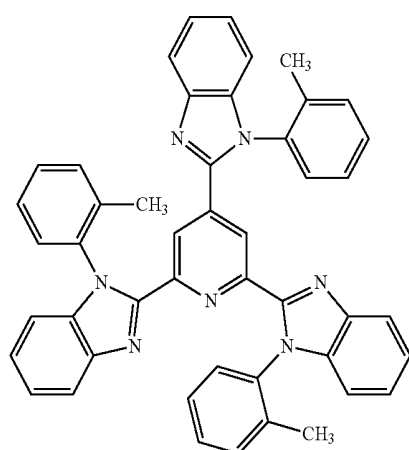


(B-15)



303

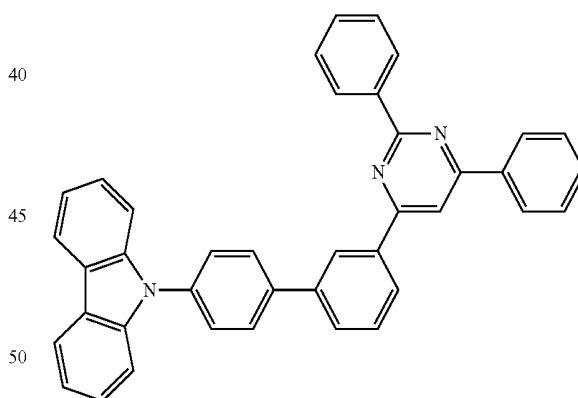
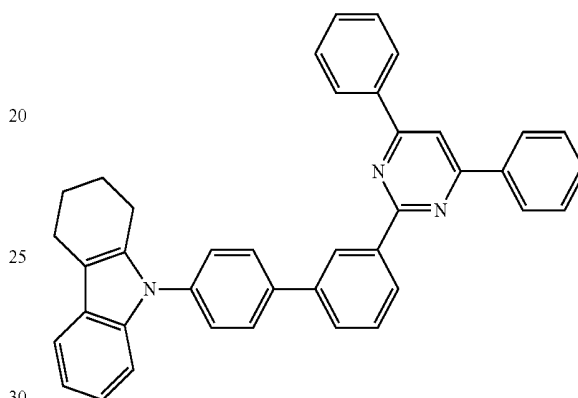
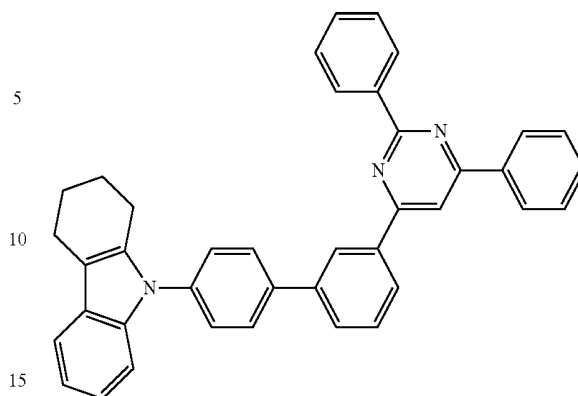
-continued



(B-16)

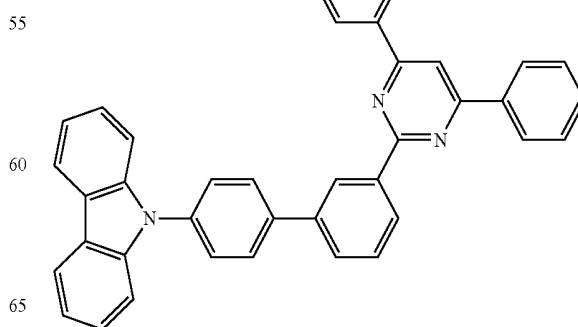
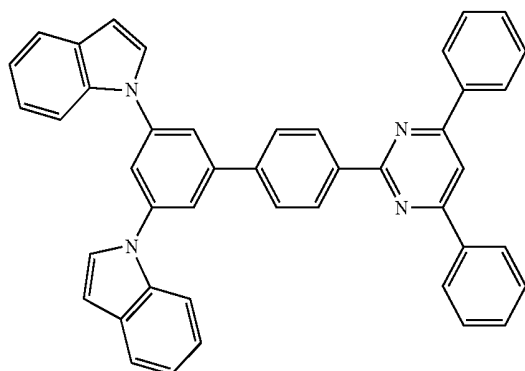
304

-continued



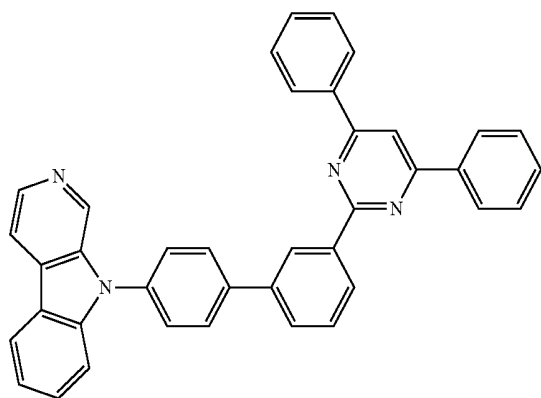
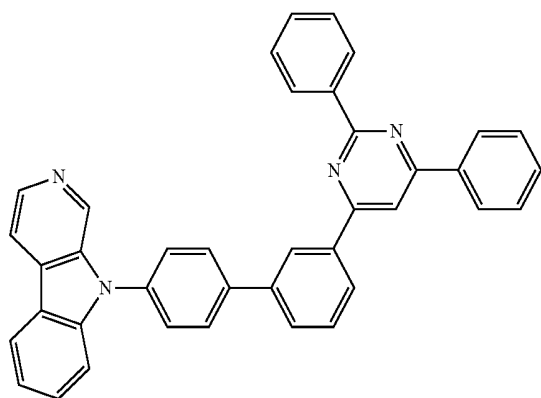
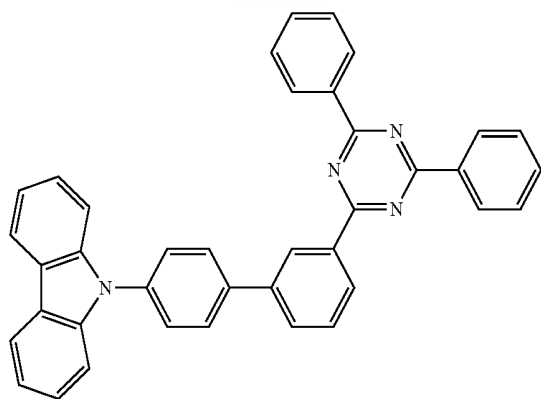
A compound of which each of the electron injecting layer and the electron transporting layer is constituted is, for example, a compound having a structure obtained by combining an electron-deficient, nitrogen-containing five-membered ring skeleton or electron-deficient, nitrogen-containing six-membered ring skeleton and a substituted or unsubstituted indole skeleton, substituted or unsubstituted carbazole skeleton, or substituted or unsubstituted azacarbazole skeleton as well as the material for an organic EL device of the present invention. In addition, a suitable electron-deficient, nitrogen-containing five-membered ring skeleton or electron-deficient, nitrogen-containing six-membered ring skeleton is a molecular skeleton such as a pyridine, pyrimidine, pyrazine, triazine, triazole, oxadiazole, pyrazole, imidazole, quinoxaline, or pyrrole skeleton, or benzimidazole or imidazopyridine obtained when two or more of them fuse with each other. Of those combinations, a preferable combination is, for example, a combination of a pyridine, pyrimidine, pyrazine, or triazine skeleton and a carbazole, indole, azacarbazole, or quinoxaline skeleton. The above-mentioned skeleton may be substituted or unsubstituted.

Specific examples of an electron transportable compound are shown below. However, the present invention is not particularly limited to these examples.



305

-continued

**306**

-continued

5

10

15

20

25

30

35

40

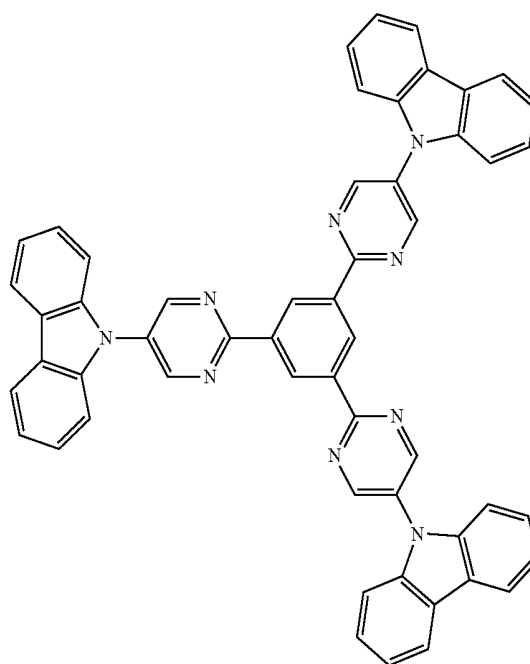
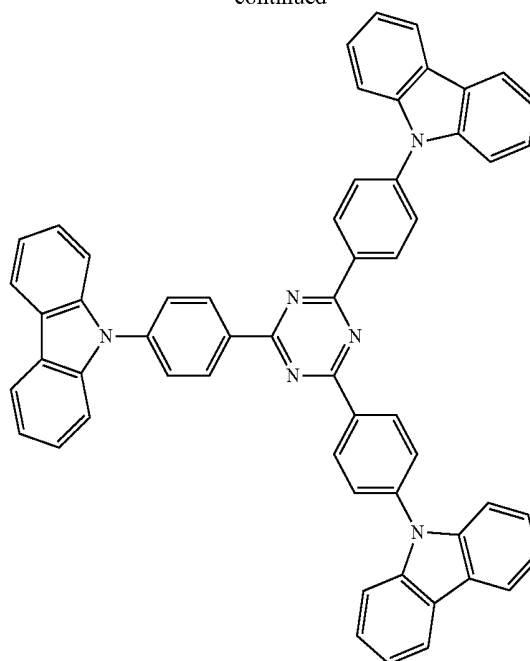
45

50

55

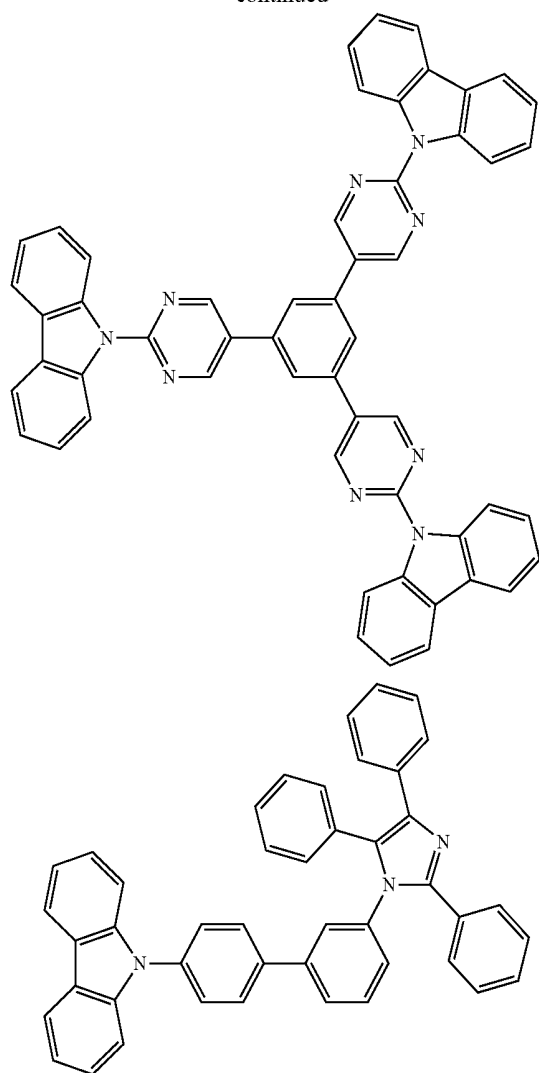
60

65



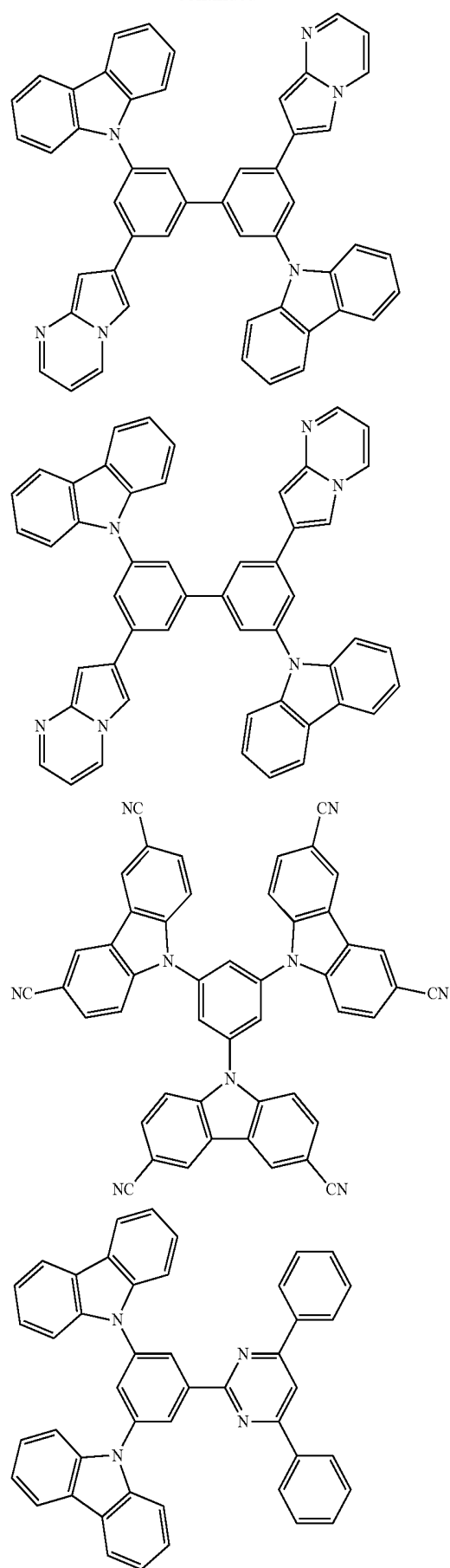
307

-continued



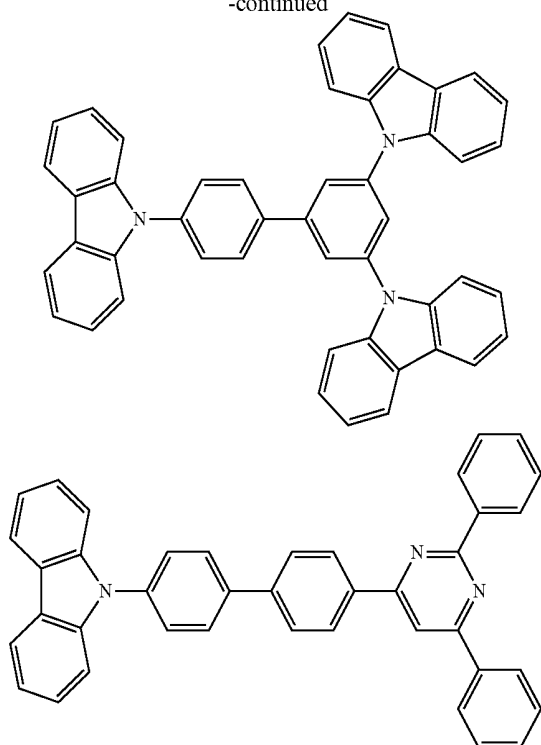
308

-continued



309

-continued



Each of the electron injecting layer and the electron transporting layer may be of a monolayer structure composed of one or two or more kinds of the above materials, or may be of a multi-layered structure composed of multiple layers identical to or different from each other in composition. Materials for those layers each preferably have a n-electron-deficient, nitrogen-containing heterocyclic group.

In addition, an insulator or semiconductor serving as an inorganic compound as well as the nitrogen-containing ring derivative is preferably used as a component of the electron injecting layer. When the electron injecting layer is constituted of an insulator or semiconductor, current leakage can be effectively prevented, and the electron injecting property of the layer can be improved.

As the insulator, at least one metal compound selected from the group consisting of alkali metal chalcogenides, alkaline earth metal chalcogenides, alkali metal halides, and alkaline earth metal halides is preferably used. It is preferable that the electron injecting layer be composed of the above-mentioned substance such as the alkali metal chalcogenide since the electron injecting property can be further improved. To be specific, preferable examples of the alkali metal chalcogenide include Li_2O , K_2O , Na_2S , Na_2Se , and Na_2O , and preferable examples of the alkaline earth metal chalcogenide include CaO , BaO , SrO , BeO , BaS , and CaSe . Preferable examples of the alkali metal halide include LiF , NaF , KF , LiCl , KCl , and NaCl . Preferable examples of the alkaline earth metal halide include fluorides such as CaF_2 , BaF_2 , SrF_2 , MgF_2 , and BeF_2 and halides other than the fluorides.

In addition, examples of the semiconductor include oxides, nitrides, and oxide nitrides containing at least one element selected from the group consisting of Ba, Ca, Sr, Yb, Al, Ga, In, Li, Na, Cd, Mg, Si, Ta, Sb, and Zn, and they may be used alone or in combination of two or more. It is preferable that the inorganic compound composing the electron injecting layer form a crystallite or amorphous insulat-

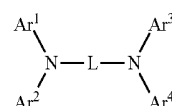
310

ing thin film. When the electron injecting layer is composed of the insulating thin film described above, a more uniform thin film can be formed, and defects of pixels such as dark spots can be decreased. Examples of the inorganic compound include alkali metal chalcogenides, alkaline earth metal chalcogenides, alkali metal halides, and alkaline earth metal halides.

In addition, the above-mentioned reducing dopant can be preferably incorporated into the electron injecting layer in the present invention.

It should be noted that the thickness of each of the electron injecting layer and the electron transporting layer, which is not particularly limited, is preferably 1 to 100 nm.

An aromatic amine compound such as an aromatic amine derivative represented by a general formula (I) is suitably used in the hole injecting layer or hole transporting layer (a hole injecting/transporting layer is also included in this category).



(I)

In the general formula (I), Ar^1 to Ar^4 each represent a substituted or unsubstituted aryl group having a ring formed of 6 to 50 carbon atoms, or a substituted or unsubstituted heteroaryl group having a ring formed of 5 to 50 atoms.

Examples of the substituted or unsubstituted aryl group having a ring formed of 6 to 50 carbon atoms include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacenyl group, a 2-naphthacenyl group, a 9-naphthacenyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, an m-terphenyl-4-yl group, an m-terphenyl-3-yl group, an m-terphenyl-2-yl group, an o-tolyl group, an m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group, a 4''-t-butyl-p-terphenyl-4-yl group, a fluoranthonyl group, and a fluorenyl group.

Examples of the substituted or unsubstituted heteroaryl group having a ring formed of 5 to 50 atoms include a 1-pyrrolyl group, a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 1-indolyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isindolyl group, a 2-isindolyl group, a 3-isindolyl group, a 4-isindolyl group, a 5-isindolyl group, a 6-isindolyl group, a 7-isindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, an 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a

5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, an 8-isoquinolyl group, a 2-quinoxalyl group, a 5-quinoxalyl group, a 6-quinoxalyl group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 9-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, an 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 10-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 10-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, and a 4-t-butyl-3-indolyl group. Preferred are a phenyl group, a naphthyl group, a biphenyl group, an anthranyl group, a phenanthryl group, a pyrenyl group, a chrysenyl group, a fluoranthenyl group, and a fluorenyl group.

L represents a linking group, and specifically, a substituted or unsubstituted arylene group having a ring formed of 6 to 50 carbon atoms, a substituted or unsubstituted heteroarylene group having a ring formed of 5 to 50 atoms, or a divalent group in which two or more arylene groups or heteroarylene groups are bonded by a single bond, an ether

bond, a thioether bond, with an alkylene group having 1 to 20 carbon atoms, an alkenylene group having 2 to 20 carbon atoms, and an amino group. Examples of the arylene group having a ring formed of 6 to 50 carbon atoms include a 1,4-phenylene group, a 1,2-phenylene group, a 1,3-phenylene group, a 1,4-naphthylene group, a 2,6-naphthylene group, a 1,5-naphthylene group, a 9,10-anthranylene group, a 9,10-phenanthrenylene group, a 3,6-phenanthrenylene group, a 1,6-pyrenylene group, a 2,7-pyrenylene group, a 6,12-chrysenylene group, a 4,4'-biphenylene group, a 3,3'-biphenylene group, a 2,2'-biphenylene group, and a 2,7-fluorenylene group. Examples of the arylene group having a ring formed of 5 to 50 atoms include a 2,5-thiophenylene group, a 2,5-silolylene group, and a 2,5-oxadiazolylene group. Preferred are a 1,4-phenylene group, a 1,2-phenylene group, a 1,3-phenylene group, a 1,4-naphthylene group, a 9,10-anthranylene group, a 6,12-chrysenylene group, a 4,4'-biphenylene group, a 3,3'-biphenylene group, a 2,2'-biphenylene group, and a 2,7-fluorenylene group.

In the case where L represents a linking group formed of two or more arylene groups or heteroarylene groups, adjacent arylene groups or heteroarylene groups may be bonded to each other through a divalent group to form a ring. Examples of the divalent group forming a ring include a tetramethylene group, a pentamethylene group, a hexamethylene group, a diphenylmethane-2,2'-diyl group, a diphenyl ethane-3, 3'-diyl group, and a diphenylpropane-4,4'-diyl group.

The substituent of each of Ar¹ to Ar⁴ and L is, for example, a substituted or unsubstituted aryl group having a ring formed of 6 to 50 carbon atoms, a substituted or unsubstituted heteroaryl group having a ring formed of 5 to 50 atoms, a substituted or unsubstituted alkyl group having 1 to 50 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 50 carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms, a substituted or unsubstituted aryloxy group having a ring formed of 6 to 50 carbon atoms, a substituted or unsubstituted heteroaryloxy group having a ring formed of 5 to 50 atoms, a substituted or unsubstituted arylthio group having a ring formed of 6 to 50 carbon atoms, a substituted or unsubstituted heteroarylthio group having a ring formed of 5 to 50 atoms, a substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms, an amino group substituted by a substituted or unsubstituted aryl group having a ring formed of 6 to 50 carbon atoms or by a substituted or unsubstituted heteroaryl group having a ring formed of 5 to 50 atoms, a halogen group, a cyano group, a nitro group, or a hydroxyl group.

Examples of the substituted or unsubstituted aryl group having a ring formed of 6 to 50 carbon atoms include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacenyl group, a 2-naphthacenyl group, a 9-naphthacenyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, an m-terphenyl-4-yl group, an m-terphenyl-3-yl group, an m-terphenyl-2-yl group, an o-tolyl group, an m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl

group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group, a 4"-t-butyl-p-terphenyl-4-yl group, a fluoranthenyl group, and a fluorenyl group.

Examples of the substituted or unsubstituted heteroaryl group having a ring formed of 5 to 50 atoms include a 1-pyrrolyl group, a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 1-indolyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isindolyl group, a 2-isindolyl group, a 3-isindolyl group, a 4-isindolyl group, a 5-isindolyl group, a 6-isindolyl group, a 7-isindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, an 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, an 8-isoquinolyl group, a 2-quinoxalanyl group, a 5-quinoxalanyl group, a 6-quinoxalanyl group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 9-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, an 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 10-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 10-phenoxazi-

nyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, and a 4-t-butyl-3-indolyl group.

Examples of the substituted or unsubstituted alkyl group having 1 to 50 carbon atoms include a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, and 1,2,3-trinitropropyl group.

Examples of the substituted or unsubstituted cycloalkyl group having 3 to 50 carbon atoms include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, a 4-methylcyclohexyl group, a 1-adamantyl group, a 2-adamantyl group, a 1-norbornyl group, and a 2-norbornyl group.

The substituted or unsubstituted alkoxy group having 1 to 50 carbon atoms is a group represented by —OY. Examples of Y include a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-

tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, and 1,2,3-trinitropropyl group.

Examples of the substituted or unsubstituted aralkyl group having 7 to 50 carbon atoms include a benzyl group, a 1-phenylethyl group, a 2-phenylethyl group, a 1-phenylisopropyl group, a 2-phenylisopropyl group, a phenyl-t-butyl group, an α -naphthylmethyl group, a 1- α -naphthylethyl group, a 2- α -naphthylethyl group; a 1- α -naphthylisopropyl group, a 2- α -naphthylisopropyl group, a β -naphthylmethyl group, a 1- β -naphthylethyl group, a 2- β -naphthylethyl group, a 1- β -naphthylisopropyl group, a 2- β -naphthylisopropyl group, a 1-pyrrolyl methyl group, a 2-(1-pyrrolyl)ethyl group, a p-methylbenzyl group, an m-methylbenzyl group, an o-methylbenzyl group, a p-chlorobenzyl group, an m-chlorobenzyl group, an o-chlorobenzyl group, a p-bromobenzyl group, an m-bromobenzyl group, an o-bromobenzyl group, a p-iodobenzyl group, an m-iodobenzyl group, an o-iodobenzyl group, a p-hydroxybenzyl group, an m-hydroxybenzyl group, an o-hydroxybenzyl group, a p-aminobenzyl group, an m-aminobenzyl group, an o-aminobenzyl group, a p-nitrobenzyl group, an m-nitrobenzyl group, an o-nitrobenzyl group, a p-cyanobenzyl group, an m-cyanobenzyl group, an o-cyanobenzyl group, a 1-hydroxy-2-phenylisopropyl group, and a 1-chloro-2-phenylisopropyl group.

Examples of the substituted or unsubstituted aryloxy group having a ring formed of 6 to 50 carbon atoms is represented by —OY'. Examples of Y' include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthaceny group, a 2-naphthaceny group, a 9-naphthaceny group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, an m-terphenyl-4-yl group, an m-terphenyl-3-yl group, an m-terphenyl-2-yl group, an o-tolyl group, an m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group, and a 4"-t-butyl-p-terphenyl-4-yl group.

Examples of the substituted or unsubstituted heteroaryloxy group having a ring formed of 5 to 50 atoms is represented by —OZ'. Examples of Z' include a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isoidolyl group, a 3-isoidolyl group, a 4-isoidolyl group, a 5-isoidolyl group, a 6-isoidolyl group, a 7-isoidolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzo-

furanyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a 2-quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, an 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, an 8-isoquinolyl group, a 2-quinoxaliny group, a 5-quinoxaliny group, a 6-quinoxaliny group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, an 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthrolin-2-yl group, a 1,7-phenanthrolin-3-yl group, a 1,7-phenanthrolin-4-yl group, a 1,7-phenanthrolin-5-yl group, a 1,7-phenanthrolin-6-yl group, a 1,7-phenanthrolin-8-yl group, a 1,7-phenanthrolin-9-yl group, a 1,7-phenanthrolin-10-yl group, a 1,8-phenanthrolin-2-yl group, a 1,8-phenanthrolin-3-yl group, a 1,8-phenanthrolin-4-yl group, a 1,8-phenanthrolin-5-yl group, a 1,8-phenanthrolin-6-yl group, a 1,8-phenanthrolin-7-yl group, a 1,8-phenanthrolin-9-yl group, a 1,8-phenanthrolin-10-yl group, a 1,9-phenanthrolin-2-yl group, a 1,9-phenanthrolin-3-yl group, a 1,9-phenanthrolin-4-yl group, a 1,9-phenanthrolin-5-yl group, a 1,9-phenanthrolin-6-yl group, a 1,9-phenanthrolin-7-yl group, a 1,9-phenanthrolin-8-yl group, a 1,9-phenanthrolin-9-yl group, a 1,9-phenanthrolin-10-yl group, a 1,10-phenanthrolin-2-yl group, a 1,10-phenanthrolin-3-yl group, a 1,10-phenanthrolin-4-yl group, a 1,10-phenanthrolin-5-yl group, a 2,9-phenanthrolin-1-yl group, a 2,9-phenanthrolin-3-yl group, a 2,9-phenanthrolin-4-yl group, a 2,9-phenanthrolin-5-yl group, a 2,9-phenanthrolin-6-yl group, a 2,9-phenanthrolin-7-yl group, a 2,9-phenanthrolin-8-yl group, a 2,9-phenanthrolin-9-yl group, a 2,9-phenanthrolin-10-yl group, a 2,8-phenanthrolin-1-yl group, a 2,8-phenanthrolin-3-yl group, a 2,8-phenanthrolin-4-yl group, a 2,8-phenanthrolin-5-yl group, a 2,8-phenanthrolin-6-yl group, a 2,8-phenanthrolin-7-yl group, a 2,8-phenanthrolin-9-yl group, a 2,8-phenanthrolin-10-yl group, a 2,7-phenanthrolin-1-yl group, a 2,7-phenanthrolin-3-yl group, a 2,7-phenanthrolin-4-yl group, a 2,7-phenanthrolin-5-yl group, a 2,7-phenanthrolin-6-yl group, a 2,7-phenanthrolin-8-yl group, a 2,7-phenanthrolin-9-yl group, a 2,7-phenanthrolin-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 1-phenoxadiny group, a 2-phenoxadiny group, a 3-phenoxadiny group, a 4-phenoxadiny group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, and a 4-t-butyl-13-indolyl group.

The substituted or unsubstituted arylthio group having a ring formed of 6 to 50 carbon atoms is represented by —SY". Examples of Y" include a phenyl group, a 1-naph-

thyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacetyl group, a 2-naphthacetyl group, a 9-naphthacetyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, an m-terphenyl-4-yl group, an m-terphenyl-3-yl group, an m-terphenyl-2-yl group, an o-tolyl group, an m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group, and a 4"-t-butyl-p-terphenyl-4-yl group.

The substituted or unsubstituted heteroarylthio group having a ring formed of 5 to 50 atoms is represented by —SZ". Examples of Z" include a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isoindolyl group, a 3-isoindolyl group, a 4-isoindolyl group, a 5-isoindolyl group, a 6-isoindolyl group, a 7-isoindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a 2-quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, an 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, an 8-isoquinolyl group, a 2-quinoxaliny group, a 5-quinoxaliny group, a 6-quinoxaliny group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, an 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, and a 4-t-butyl-3-indolyl group.

throlin-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, and a 4-t-butyl-3-indolyl group.

The substituted or unsubstituted alkoxycarbonyl group having 2 to 50 carbon atoms is represented by —COOZ. Examples of Z include a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl group, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 2,3-dihydroxy-t-butyl group, a 1,2,3-trihydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 2,3-dichloro-t-butyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 2,3-dibromo-t-butyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 2,3-diiodo-t-butyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 2,3-diamino-t-butyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 2,3-dicyano-t-butyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 2,3-dinitro-t-butyl group, and 1,2,3-trinitropropyl group.

The substituted or unsubstituted aryl group having a ring formed of 6 to 50 carbon atoms or an amino group substituted with a substituted or unsubstituted heteroaryl group having a ring formed of 5 to 50 atoms is represented by —NPQ. Examples of P and Q include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacetyl group, a 2-naphthacetyl group, a 9-naphthacetyl group, a 1-pyrenyl group, a 2-pyrenyl group, a 4-pyrenyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a p-ter-

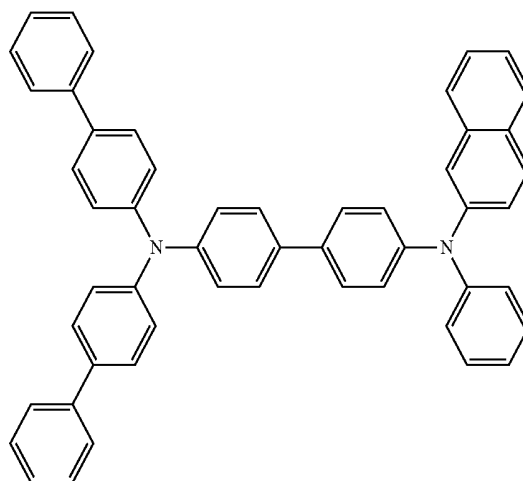
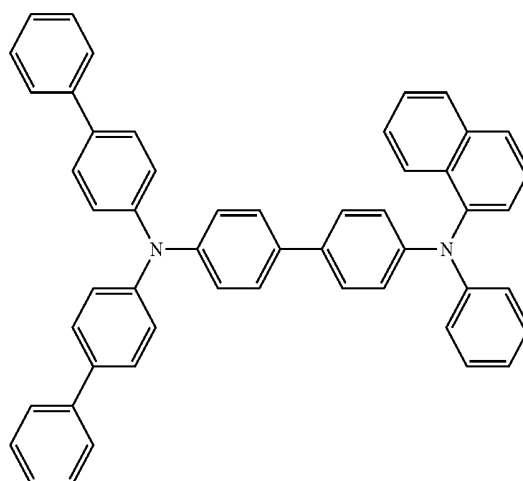
319

phenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, an m-terphenyl-4-yl group, an m-terphenyl-3-yl group, an m-terphenyl-2-yl group, an o-tolyl group, an m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group, and a 4"-t-butyl-p-terphenyl-4-yl group, a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isoindolyl group, a 3-isoindolyl group, a 4-isoindolyl group, a 5-isoindolyl group, a 6-isoindolyl group, a 7-isoindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a 2-quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, an 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, an 8-isoquinolyl group, a 2-quinoxalanyl group, a 5-quinoxalanyl group, a 6-quinoxalanyl group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, an 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl

320

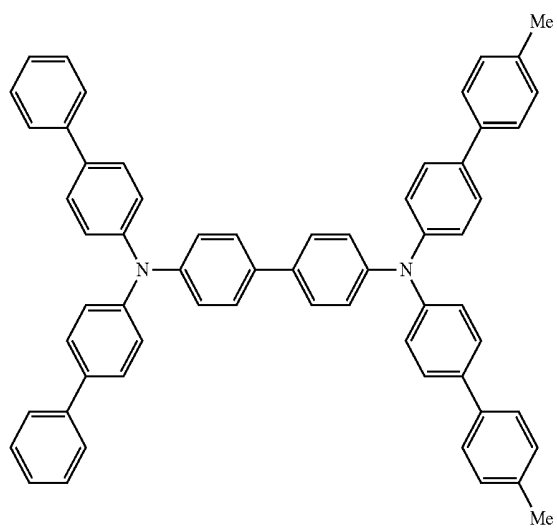
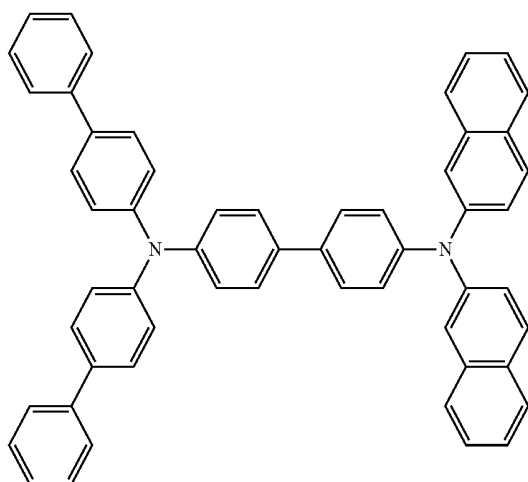
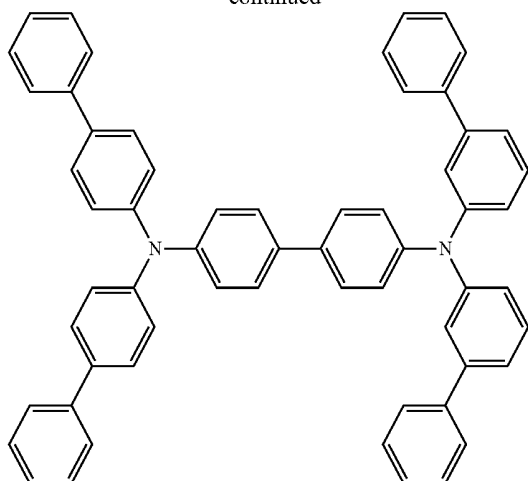
group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group, and a 4-t-butyl-3-indolyl group.

Specific examples of the compound represented by the general formula (I) are shown below. However, the present invention is not limited to these examples.



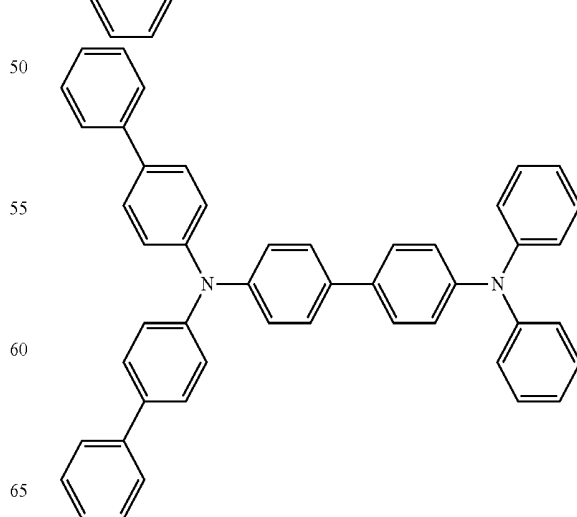
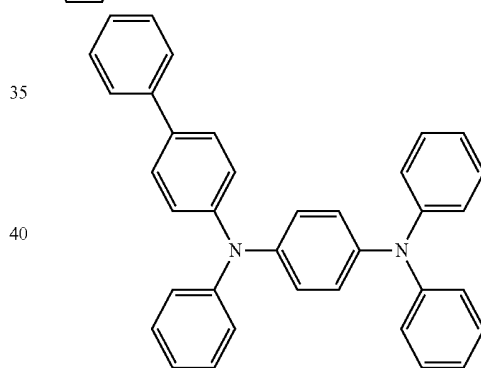
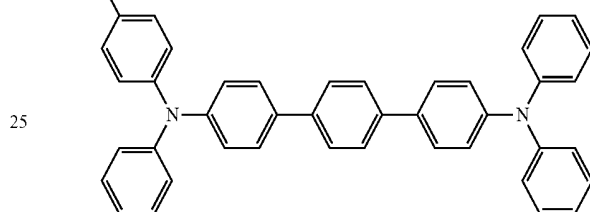
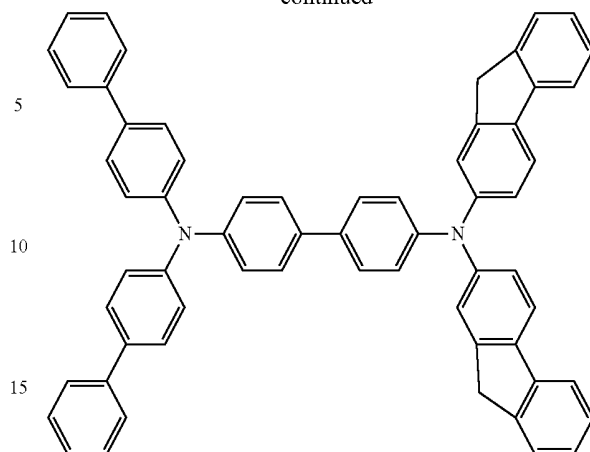
321

-continued



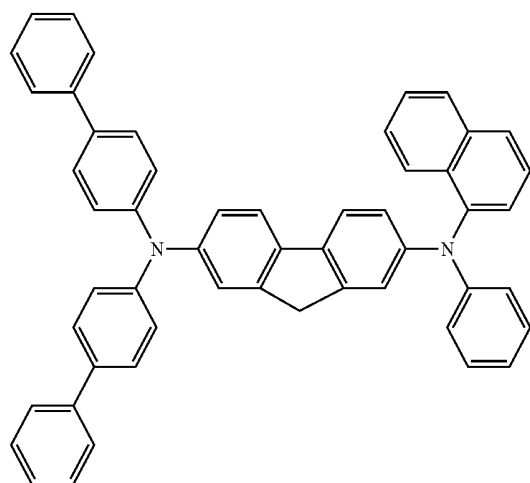
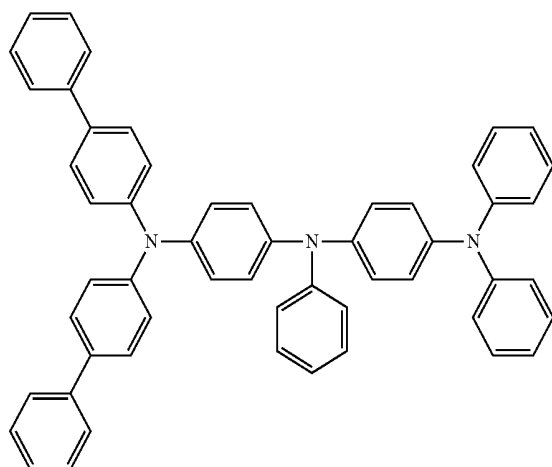
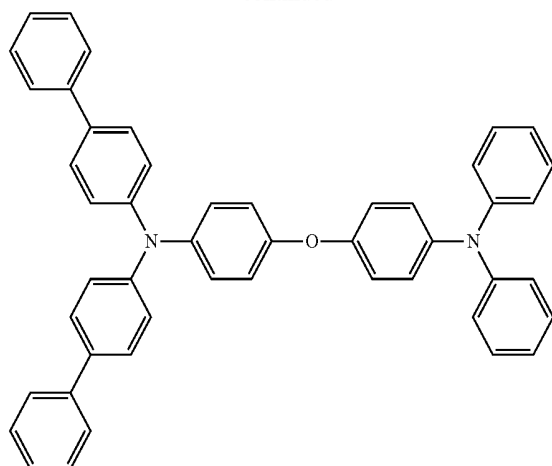
322

-continued

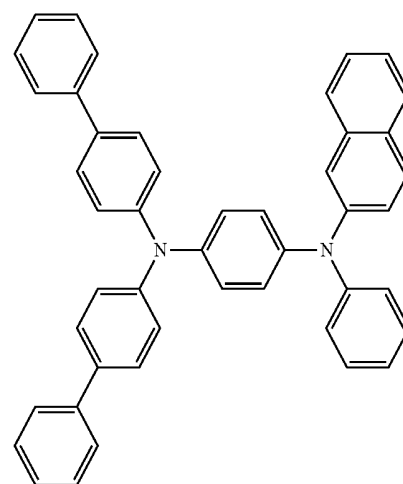
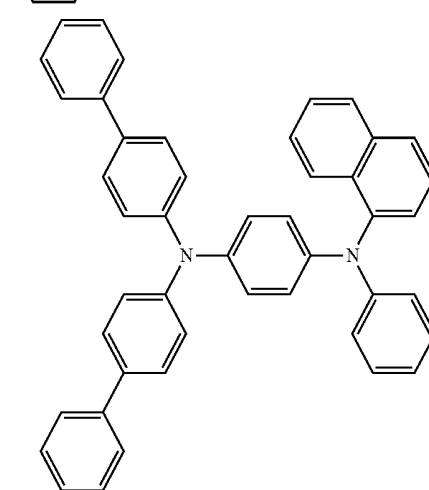
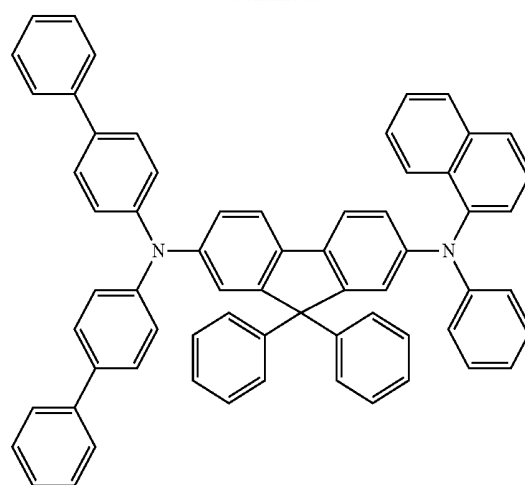


323

-continued

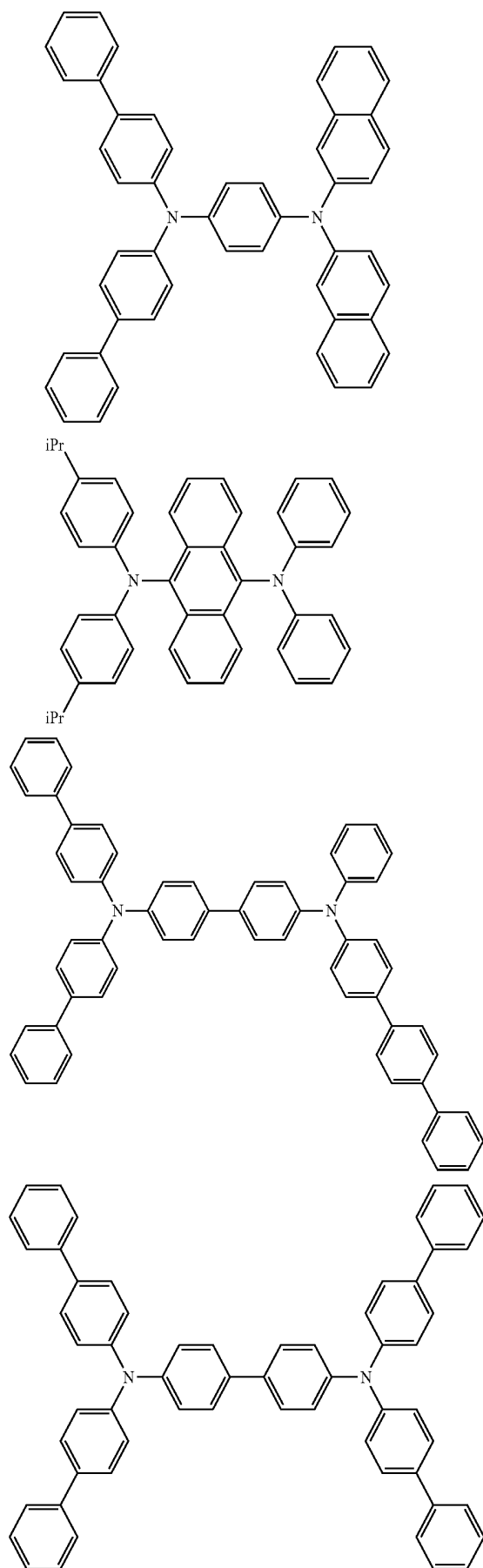
**324**

-continued

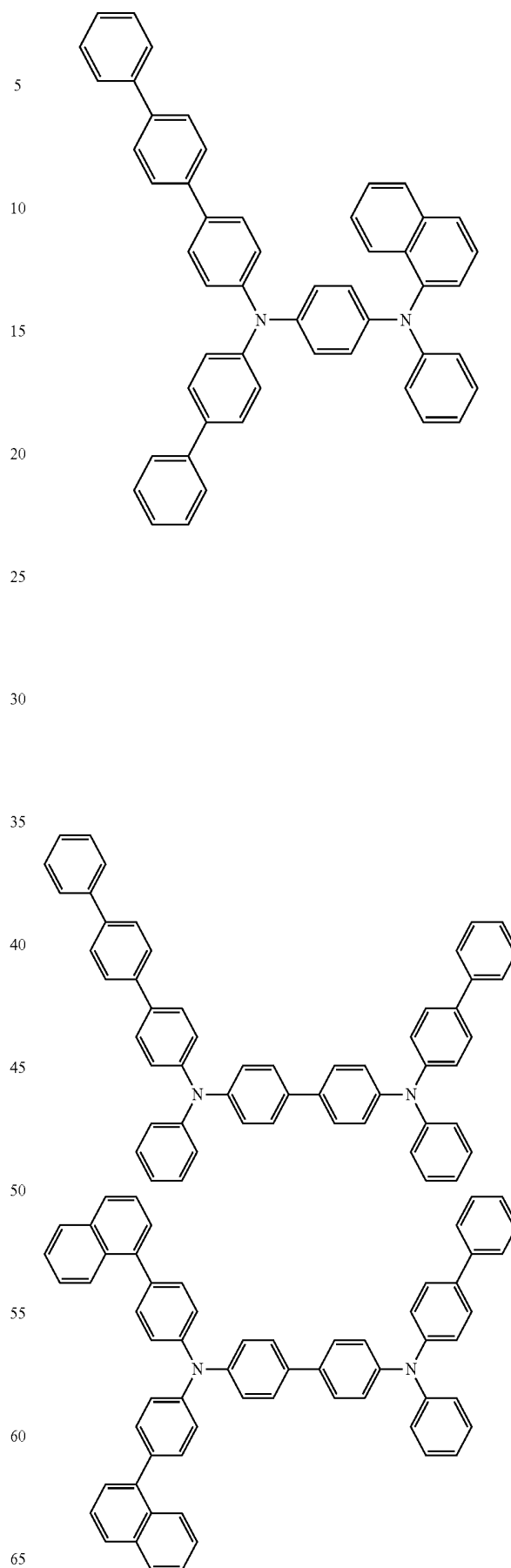


325

-continued

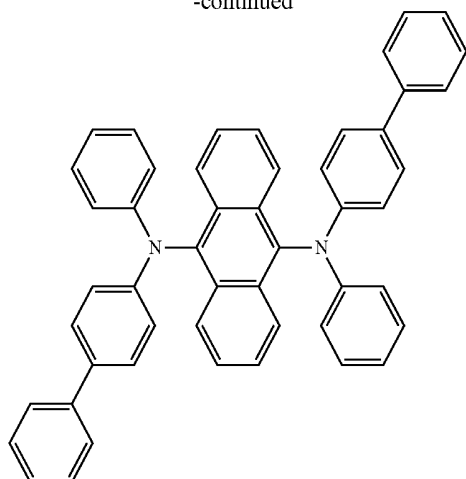
**326**

-continued



327

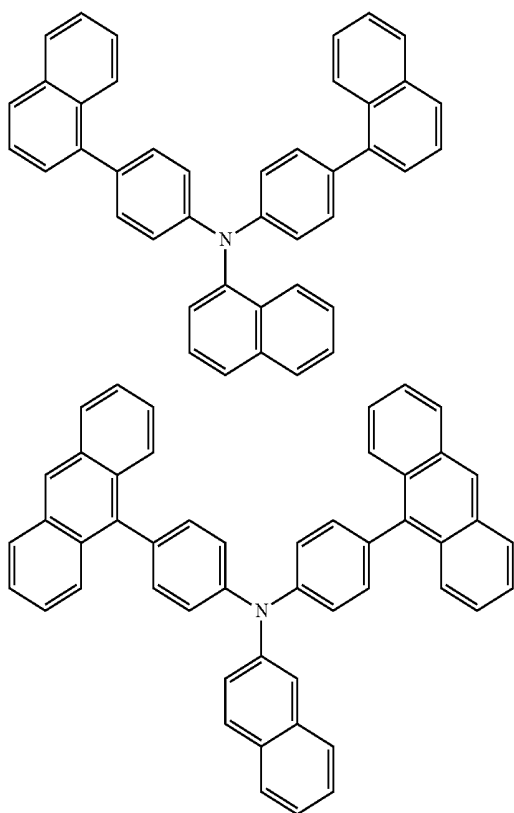
-continued



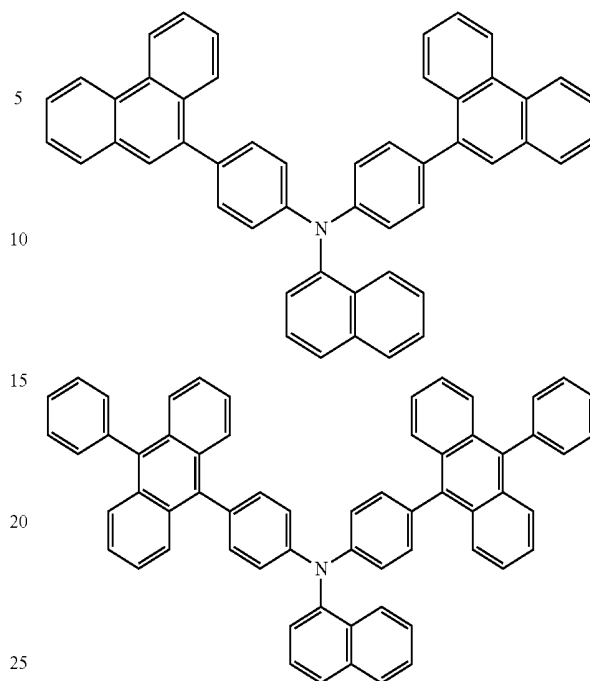
In addition, an aromatic amine represented by the following general formula (II) is also suitably used in the formation of the hole injecting layer or hole transporting layer.



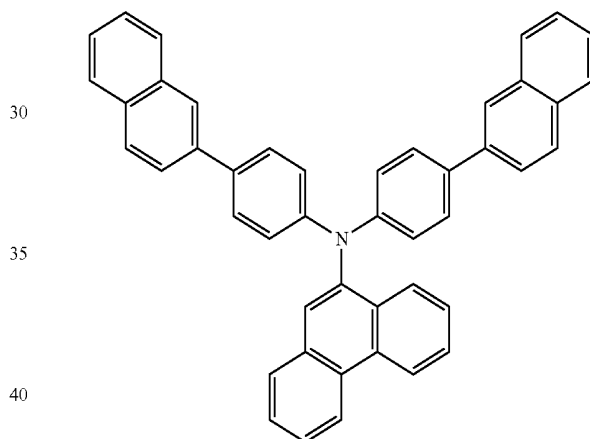
In the general formula (II), the definition of Ar₁ to Ar₃ is the same as that of Ar₁ to Ar₄ in the general formula (I). Specific examples of the compound represented by the general formula (II) are shown below. However, the present invention is not limited to these examples.

**328**

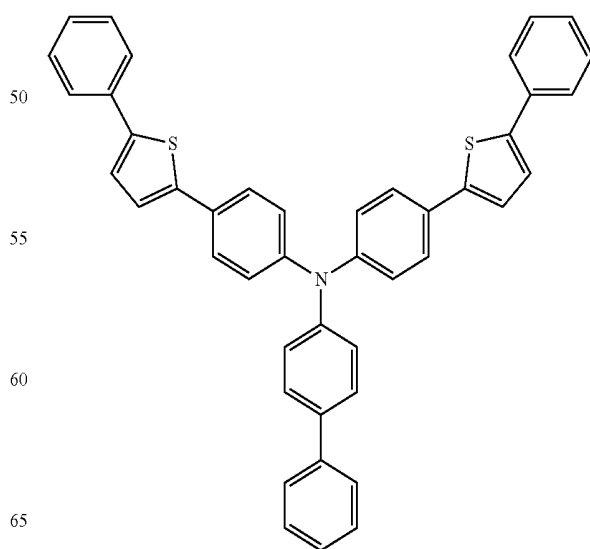
-continued



(II) 25



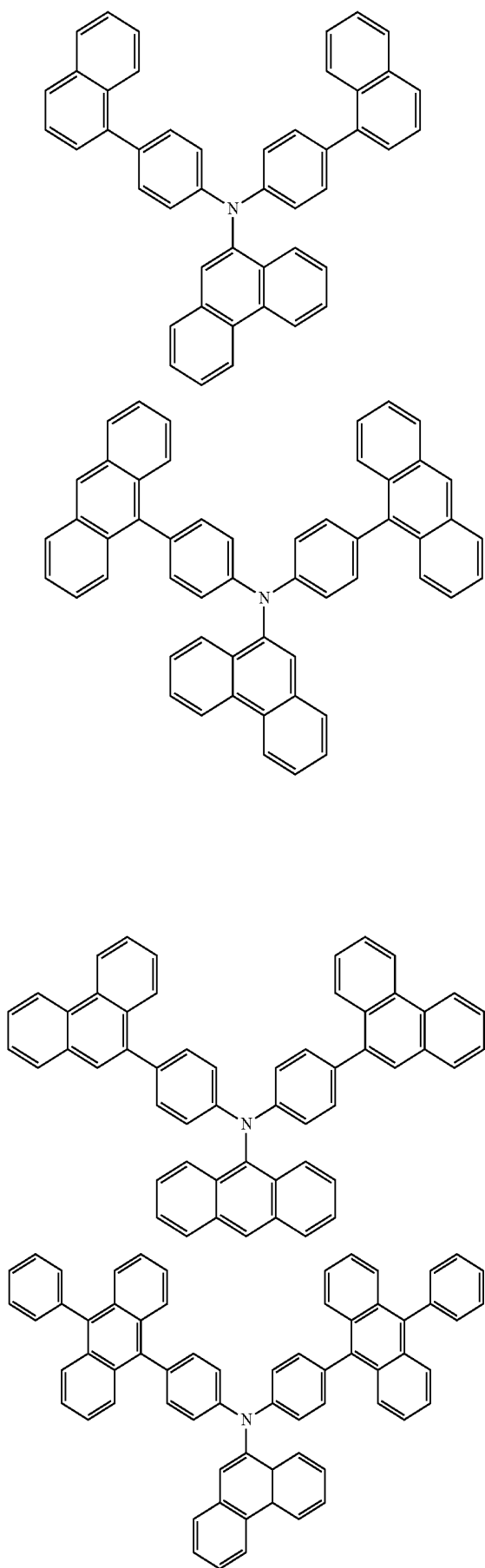
45



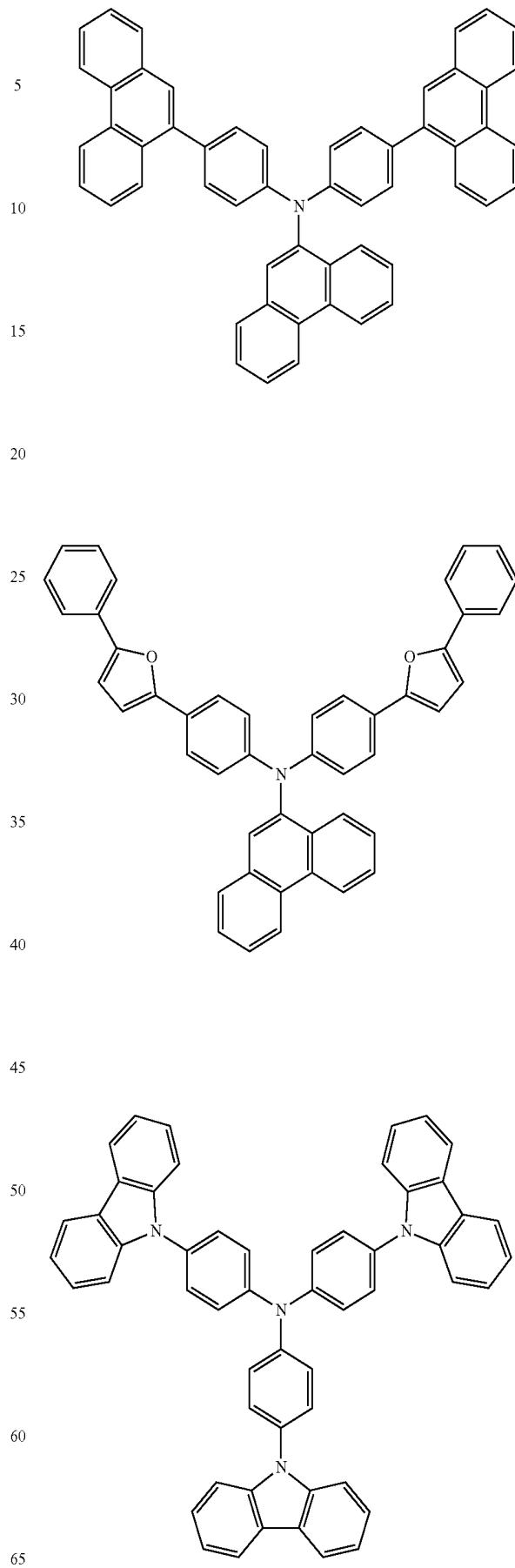
65

329

-continued

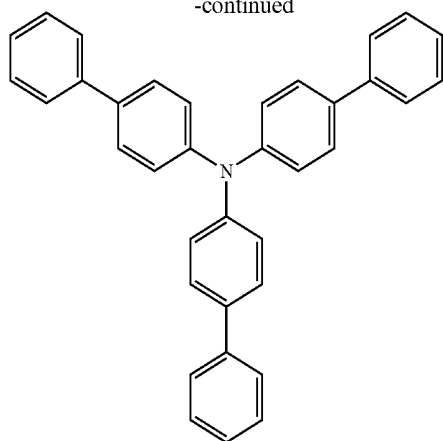
**330**

-continued



331

-continued



The compound of the present invention can be used in each of the hole injecting layer, the hole transporting layer, the electron injecting layer, and the electron transporting layer because the compound can transport both a hole and an electron.

In the present invention, the anode in the organic EL device has the function of injecting holes into the hole transporting layer or the light emitting layer. It is effective that the anode has a work function of 4.5 eV or greater. Specific examples of the material for the anode used in the present invention include indium tin oxide alloys (ITO), tin oxide (NESA), gold, silver, platinum, and copper. In addition, as the cathode, a material having a small work function is preferred in view to inject an electron into an electron injecting layer or a light emitting layer. Examples of the cathode material are not particularly limited, and specifically, indium, aluminum, magnesium, an indium-magnesium alloy, an aluminum-magnesium alloy, an aluminum-lithium alloy, an aluminum-scandium-lithium alloy, and a magnesium-silver alloy may be used.

The method of forming the layers in the organic EL device of the present invention is not particularly limited. A conventionally known process such as the vacuum vapor deposition process or the spin coating process can be used. The organic thin film layer which is used in the organic EL device of the present invention and includes the compound represented by general formula (1) described above can be formed in accordance with a known process such as the vacuum vapor deposition process or the molecular beam epitaxy process (MBE process) or, using a solution prepared by dissolving the compounds into a solvent, in accordance with a coating process such as the dipping process, the spin coating process, the casting process, the bar coating process, or the roll coating process.

The thickness of each organic layer in the organic EL device of the present invention is not particularly limited. In general, an excessively thin layer tends to have defects such as pin holes, whereas an excessively thick layer requires a high applied voltage to decrease the efficiency. Therefore, a thickness in the range of several nanometers to 1 μm is preferable.

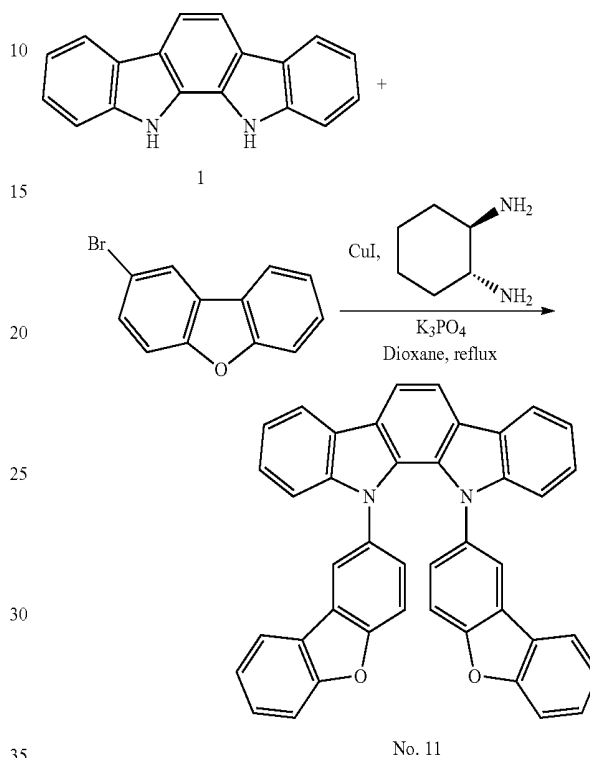
EXAMPLES

Next, the present invention is described in detail by way of examples, but the present invention is not limited to the following examples. Note that, in the synthesis examples below, DMF refers to dimethylformamide, THF refers to tetrahydrofuran, DME refers to dimethoxyethane, NBS

332

refers to N-bromosuccinimide, Ph refers to a phenyl group, AcOEt refers to ethyl acetate, and NMP refers to N-methylpyrrolidone.

Synthesis Example 1 (Synthesis of Compound No. 11)

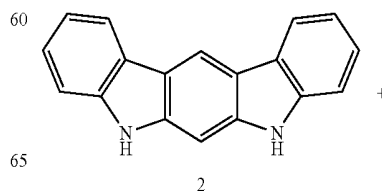


Compound 1 (2.6 g, 10 mmol), 2-bromobenzofuran (5.0 g, 20 mmol), CuI (1.9 g, 10 mmol), trans-cyclohexane 1,2-diamine (3.4 g, 30 mmol), K_3PO_4 (8.5 g, 40 mmol), and 1,4-dioxane (10 mL) were loaded into a three-necked flask, and the mixture was refluxed under an argon atmosphere for 10 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 11) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 0.7 g in 12% yield.

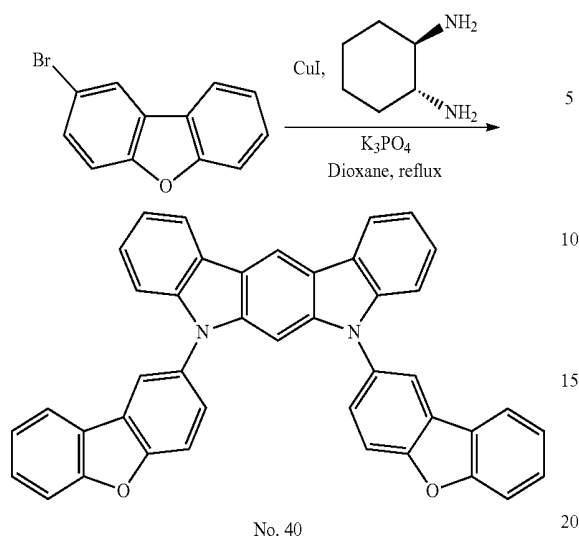
FD-MS $\text{C}_{42}\text{H}_{24}\text{N}_2\text{O}_2$: theoretical value 588, observed value 588

Synthesis Example 2 (Synthesis of Compound No. 40)



333

-continued

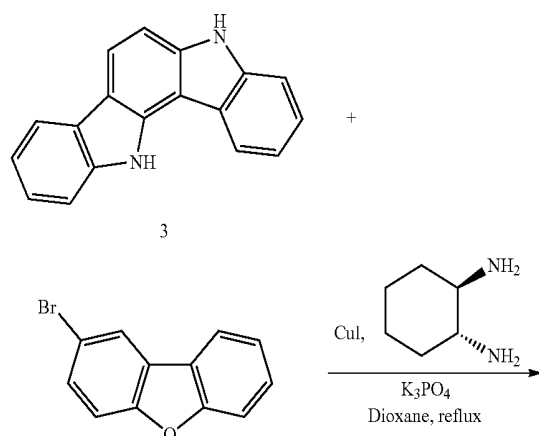


Compound 2 (2.6 g, 10 mmol), 2-bromobenzofuran (5.0 g, 20 mmol), CuI (1.9 g, 10 mmol), trans-cyclohexane 1,2-diamine (3.4 g, 30 mmol), K₃PO₄ (8.5 g, 40 mmol), and 1,4-dioxane (10 mL) were loaded into a three-necked flask, and the mixture was refluxed under an argon atmosphere for 10 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH₂Cl₂. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 40) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.9 g in 33% yield.

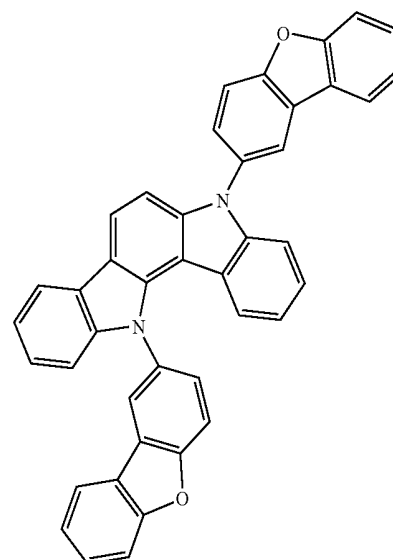
FD-MS C₄₂H₂₄N₂O₂: theoretical value 588, observed value 588

Synthesis Example 3 (Synthesis of Compound No. 47)



334

-continued

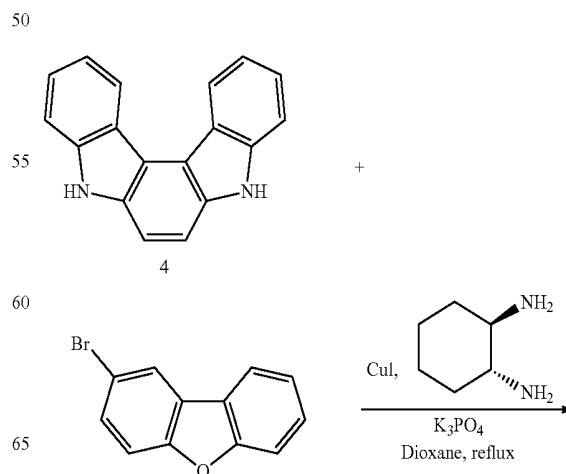


Compound 3 (2.6 g, 10 mmol), 2-bromobenzofuran (5.0 g, 20 mmol), CuI (1.9 g, 10 mmol), trans-cyclohexane 1,2-diamine (3.4 g, 30 mmol), K₃PO₄ (8.5 g, 40 mmol), and 1,4-dioxane (10 mL) were loaded into a three-necked flask, and the mixture was refluxed under an argon atmosphere for 10 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH₂Cl₂. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 47) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.5 g in 25% yield.

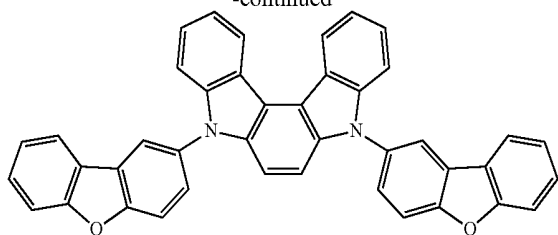
FD-MS C₄₂H₂₄N₂O₂: theoretical value 588, observed value 588

Synthesis Example 4 (Synthesis of Compound No. 66)



335

-continued



No. 66

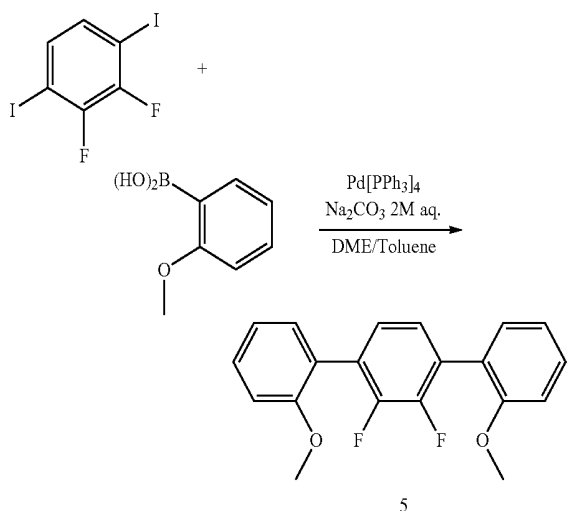
Compound 4 (2.6 g, 10 mmol), 2-bromobenzofuran (5.0 g, 20 mmol), CuI (1.9 g, 10 mmol), transcyclohexane 1,2-diamine (3.4 g, 30 mmol), K_3PO_4 (8.5 g, 40 mmol), and 1,4-dioxane (10 mL) were loaded into a three-necked flask, and the mixture was refluxed under an argon atmosphere for 10 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 66) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.4 g in 40% yield.

FD-MS $C_{42}H_{24}N_2O_2$: theoretical value 588, observed value 588

Synthesis Example 5 (Synthesis of Compound No. 100)

(1) Synthesis of Compound 5



1,2-difluoro-3,6-diiodobenzene (65.9 g, 180.0 mmol), 2-methoxyphenylboronic acid (65.6 g, 432.0 mmol), a 2 M aqueous solution of Na_2CO_3 (360 mL, 720 mmol), DME (360 mL), toluene (360 mL), and $Pd[PPh_3]_4$ (20.8 g, 18.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

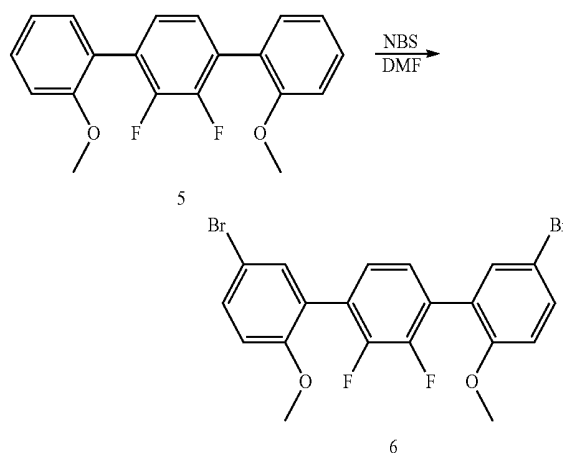
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted

336

with CH_2Cl_2 . The extract was dried with $MgSO_4$, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 38.2 g in 65% yield.

FD-MS $C_{20}H_{16}F_2O_2$: theoretical value 326, observed value 326

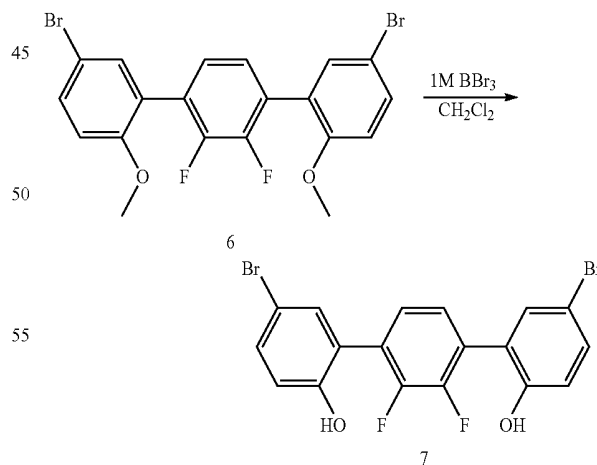
(2) Synthesis of Compound 6



Compound 5 (38.0 g, 116.4 mmol), NBS (41.5 g, 232.9 mmol), and DMF (1,000 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at room temperature for 8 hours. After the completion of the reaction, the resultant sample was transferred to a separating funnel, and water (1,000 mL) was charged into the funnel. Then, the mixture was extracted with AcOEt. The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 45.1 g in 80% yield.

FD-MS $C_{20}H_{14}Br_2F_2O_2$: theoretical value 484, observed value 484

(3) Synthesis of Compound 7



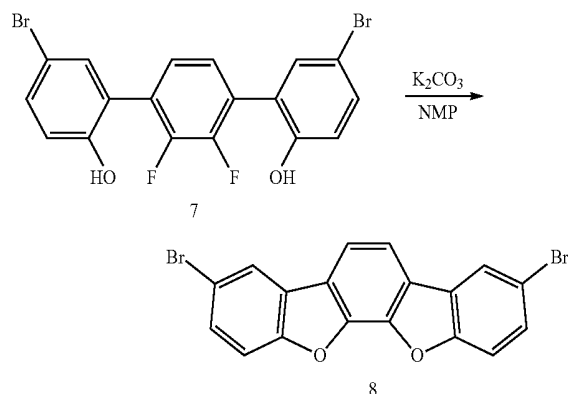
Compound 6 (45.0 g, 93.0 mmol), a 1 M solution of BBr_3 in CH_2Cl_2 (218 mL, 218 mmol), and CH_2Cl_2 (560 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 0° C. for 8 hours. After that, the mixture was left to stand at room temperature overnight. After the completion of the reaction, the resultant was

337

neutralized with a saturated aqueous solution of NaHCO_3 . The resultant sample was transferred to a separating funnel, and was extracted with CH_2Cl_2 . The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 35.2 g in 83% yield.

FD-MS $\text{C}_{18}\text{H}_{10}\text{Br}_2\text{F}_2\text{O}_2$: theoretical value 456, observed value 456

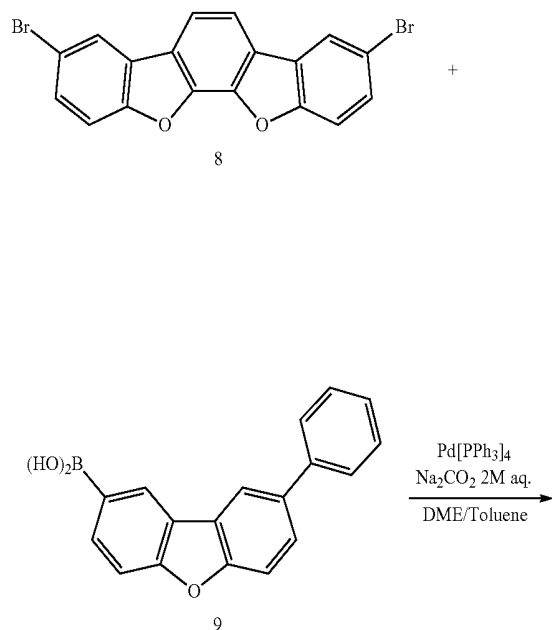
(4) Synthesis of Compound 8



Compound 7 (35.0 g, 76.7 mmol), K_2CO_3 (23.3 g, 168.8 mmol), and NMP (320 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 150°C . for 8 hours. After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted with AcOEt . The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 27.1 g in 85% yield.

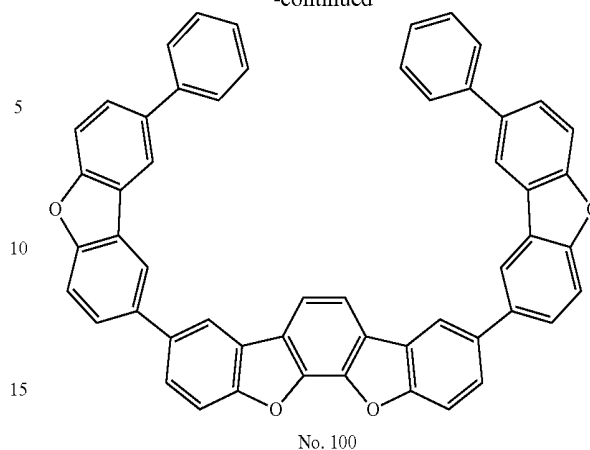
FD-MS $\text{C}_{18}\text{H}_8\text{Br}_2\text{O}_2$: theoretical value 416, observed value 416

(5) Synthesis of Compound No. 100



338

-continued



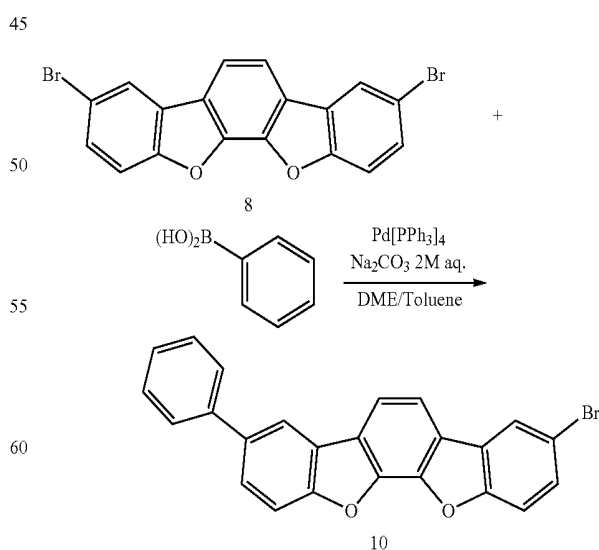
Compound 8 (2.5 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 100) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.0 g in 45% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_4$: theoretical value 742, observed value 742

Synthesis Example 6 (Synthesis of Compound No. 103)

(1) Synthesis of Compound 10



Compound 8 (16.8 g, 40 mmol), phenylboronic acid (4.8 g, 40 mmol), a 2 M aqueous solution of Na_2CO_3 (80 mL, 160

339

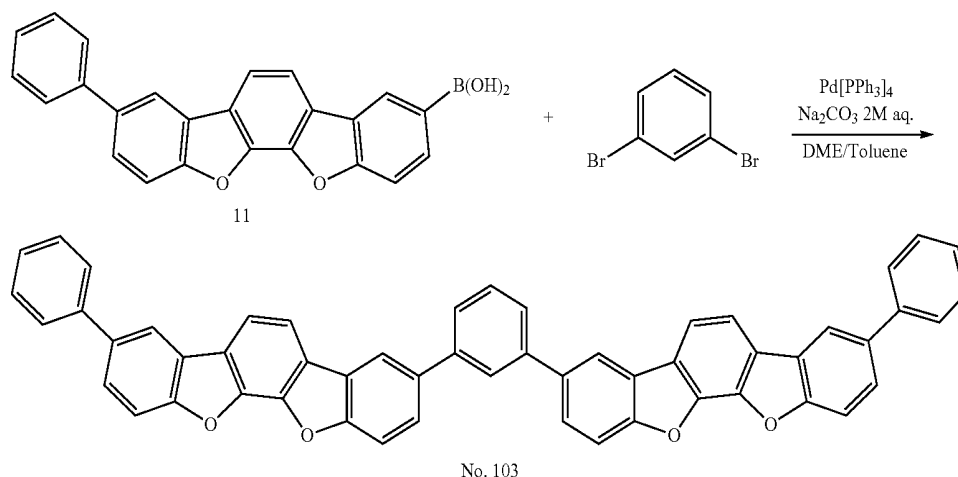
mmol), DME (80 mL), toluene (80 mL), and $\text{Pd}[\text{PPh}_3]_4$ (2.3 g, 2.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (150 mL) was charged into the funnel. Then, the mixture was extracted

340

with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by recrystallization (toluene-hexane), whereby a white solid was obtained in an amount of 7.1 g in 65% yield.

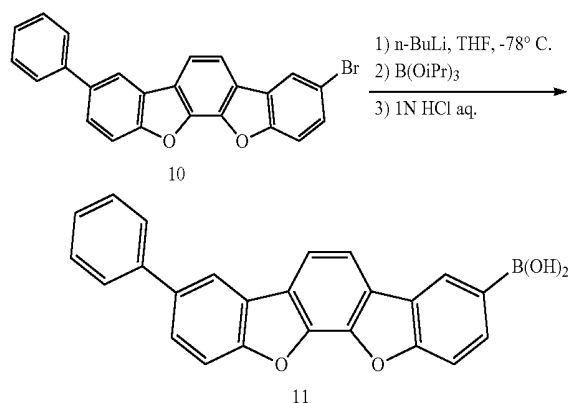
(3) Synthesis of Compound No. 103



with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 12.4 g in 75% yield.

FD-MS $\text{C}_{24}\text{H}_{13}\text{BrO}_2$: theoretical value 413, observed value 413

(2) Synthesis of Compound 11



Compound 10 (12.0 g, 29.0 mmol) and THF (288 mL) were loaded into a three-necked flask, and the mixture was cooled to -78°C . Then, $n\text{-BuLi}$ (1.65 M solution in $n\text{-hexane}$, 19.4 mL, 31.9 mmol) was added dropwise to the flask, and the resultant mixture was stirred at -78°C . for 20 minutes. Triisopropyl borate (16.4 g, 87.0 mmol) was added to the resultant, and the mixture was stirred at -78°C . for 1 hour. After that, the resultant was left to stand overnight at room temperature. Then, 1 N HCl (100 mL) was charged into the resultant, and the mixture was stirred at room temperature for 1 hour. The resultant sample was concentrated, and was then transferred to a separating funnel. Water (100 mL) was charged into the funnel, and the mixture was

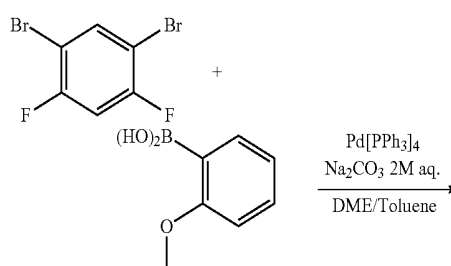
Compound 11 (5.5 g, 14.5 mmol), 1,3-dibromobenzene (1.7 g, 7.3 mmol), a 2 M aqueous solution of Na_2CO_3 (15 mL, 30 mmol), DME (15 mL), toluene (15 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.42 g, 0.37 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 103) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.4 g in 45% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_4$: theoretical value 742, observed value 742

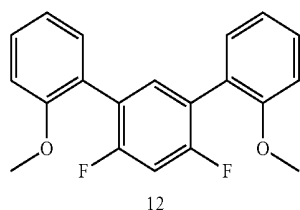
Synthesis Example 7 (Synthesis of Compound No. 116)

(1) Synthesis of Compound 12



341

-continued

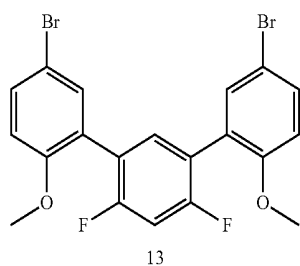
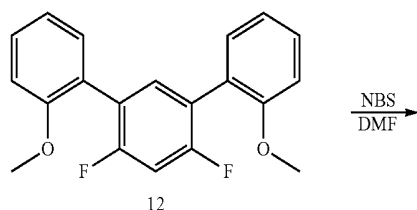


1,3-dibromo-4,6-difluorobenzene (50.0 g, 183.9 mmol), 2-methoxyphenylboronic acid (67.1 g, 441.1 mmol), and a 2 M aqueous solution of Na_2CO_3 (368 mL, 736 mmol), DME (370 mL), toluene (370 mL), and $\text{Pd}[\text{PPh}_3]_4$ (21 g, 18.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 40.2 g in 67% yield.

FD-MS $\text{C}_{20}\text{H}_{16}\text{F}_2\text{O}_2$: theoretical value 326, observed value 326

(2) Synthesis of Compound 13

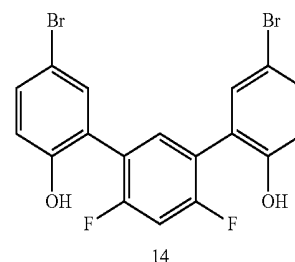
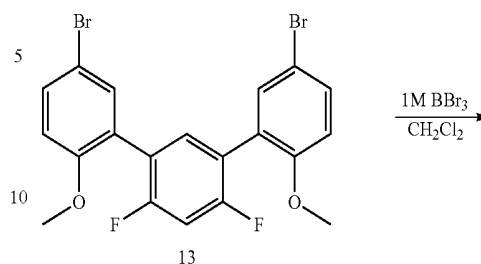


Compound 12 (40.0 g, 122.6 mmol), NBS (43.6 g, 245 mmol), and DMF (1,000 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at room temperature for 8 hours. After the completion of the reaction, the resultant sample was transferred to a separating funnel, and water (1,000 mL) was charged into the funnel. Then, the mixture was extracted with AcOEt. The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 42.1 g in 71% yield.

FD-MS $\text{C}_{20}\text{H}_{14}\text{Br}_2\text{F}_2\text{O}_2$: theoretical value 484, observed value 484

342

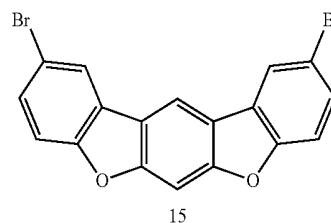
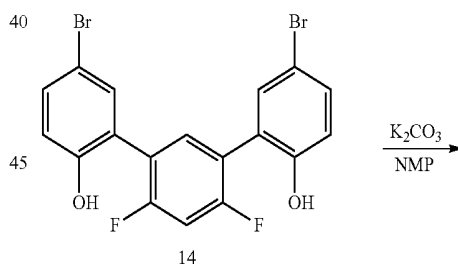
(3) Synthesis of Compound 14



Compound 13 (40.0 g, 82.6 mmol), a 1 M solution of BBr_3 in CH_2Cl_2 (194 mL, 194 mmol), and CH_2Cl_2 (500 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 0°C . for 8 hours. After that, the mixture was left to stand at room temperature overnight. After the completion of the reaction, the resultant was neutralized with a saturated aqueous solution of NaHCO_3 . The resultant sample was transferred to a separating funnel, and was extracted with CH_2Cl_2 . The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 30.2 g in 80% yield.

FD-MS $\text{C}_{18}\text{H}_{10}\text{Br}_2\text{F}_2\text{O}_2$: theoretical value 456, observed value 456

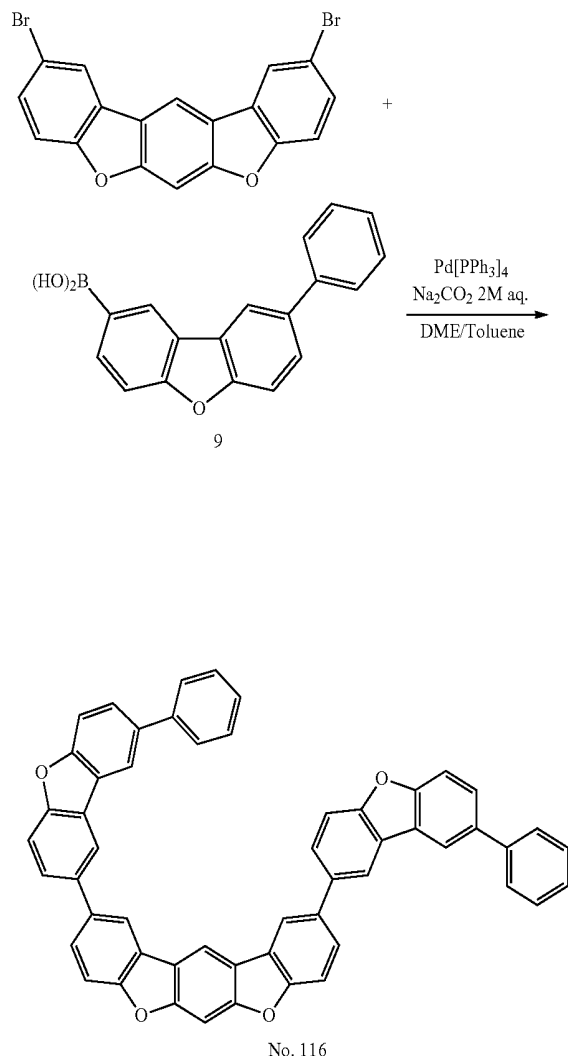
(4) Synthesis of Compound 15



Compound 14 (30.0 g, 65.7 mmol), K_2CO_3 (19.9 g, 144.5 mmol), and NMP (270 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 150°C . for 8 hours. After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted with AcOEt. The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 21.9 g in 80% yield.

343FD-MS $C_{18}H_8Br_2O_2$: theoretical value 416, observed value 416

(5) Synthesis of Compound No. 116



Compound 15 (2.5 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $Pd[PPh_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

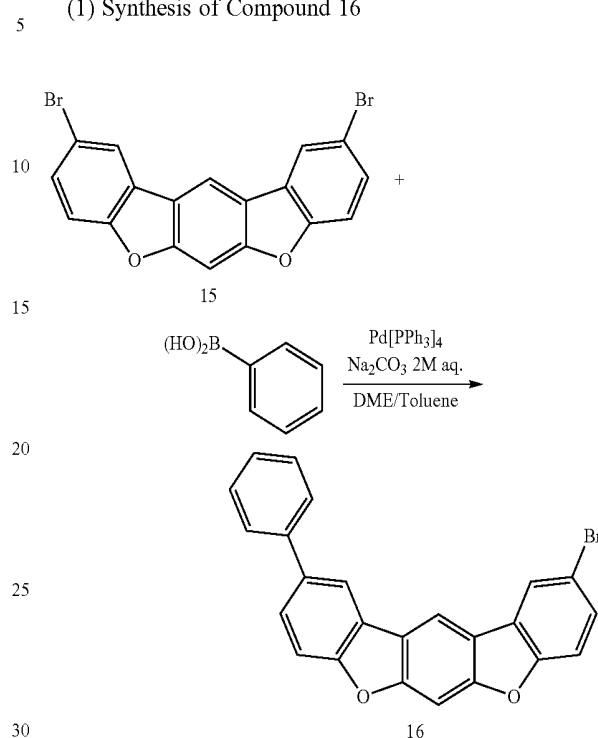
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with $MgSO_4$, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 116) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.7 g in 60% yield.

FD-MS $C_{54}H_{30}O_4$: theoretical value 742, observed value 742

344

Synthesis Example 8 (Synthesis of Compound No. 119)

(1) Synthesis of Compound 16

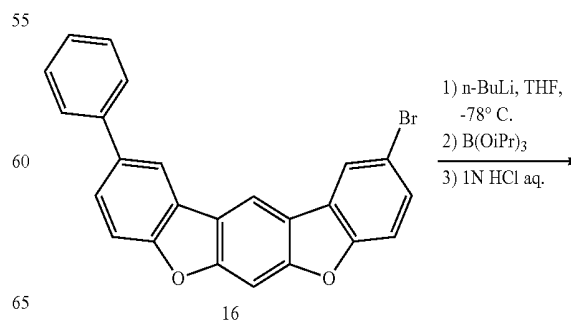


Compound 15 (16.8 g, 40 mmol), phenylboronic acid (4.8 g, 40 mmol), a 2 M aqueous solution of Na_2CO_3 (80 mL, 160 mmol), DME (80 mL), toluene (80 mL), and $Pd[PPh_3]_4$ (2.3 g, 2.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (150 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with $MgSO_4$, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 11.6 g in 70% yield.

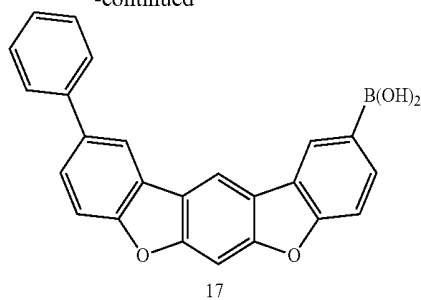
FD-MS $C_{24}H_{13}BrO_2$: theoretical value 413, observed value 413

(2) Synthesis of Compound 17



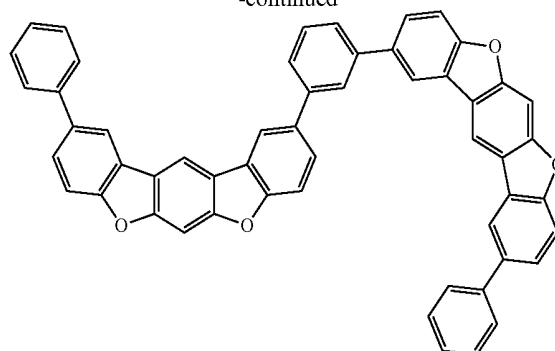
345

-continued



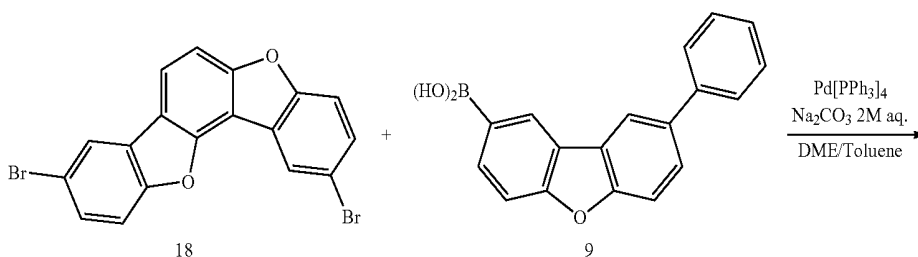
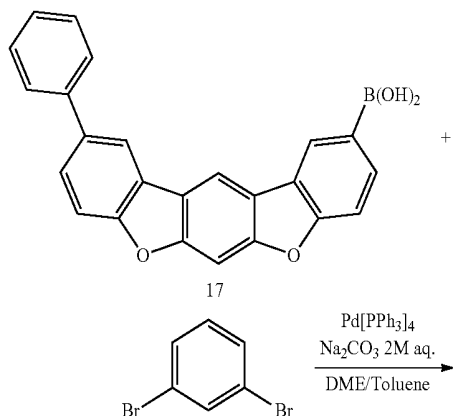
346

-continued



Compound 16 (11.0 g, 26.6 mmol) and THF (264 mL) were loaded into a three-necked flask, and the mixture was cooled to -78°C . Then, *n*-BuLi (1.65 M solution in *n*-hexane, 17.7 mL, 29.3 mmol) was added dropwise to the flask, and the resultant mixture was stirred at -78°C . for 20 minutes. Triisopropyl borate (15.1 g, 80 mmol) was added to the resultant, and the mixture was stirred at -78°C . for 1 hour. After that, the resultant was left to stand overnight at room temperature. Then, 1 N HCl (100 mL) was charged into the resultant, and the mixture was stirred at room temperature for 1 hour. The resultant sample was concentrated, and was then transferred to a separating funnel. Water (100 mL) was charged into the funnel, and the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by recrystallization (toluene-hexane), whereby a white solid was obtained in an amount of 6.1 g in 61% yield.

(3) Synthesis of Compound No. 119



Compound 17 (5.5 g, 14.5 mmol), 1,3-dibromobenzene (1.7 g, 7.3 mmol), a 2 M aqueous solution of Na_2CO_3 (15 mL, 30 mmol), DME (15 mL), toluene (15 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.42 g, 0.37 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 119) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.9 g in 35% yield.

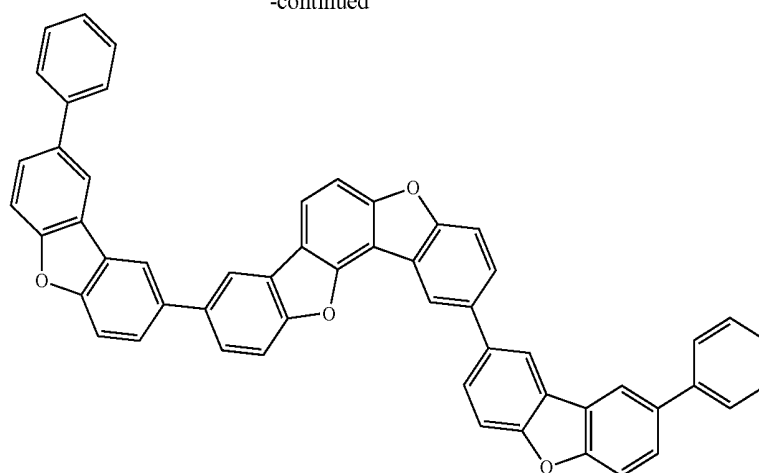
FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_4$: theoretical value 742, observed value 742

Synthesis Example 9 (Synthesis of Compound No. 134)

347

348

-continued



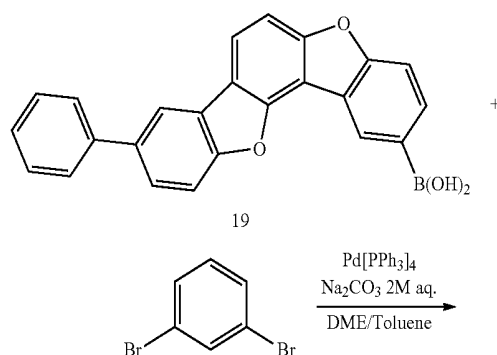
No. 134

Compound 18 (2.5 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

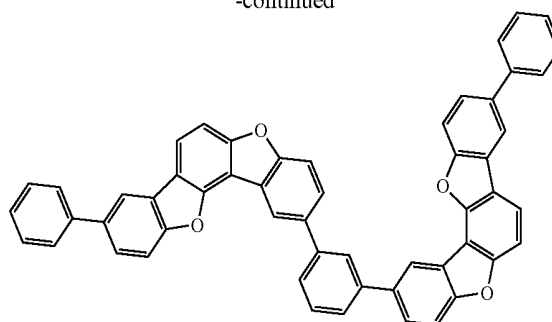
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 134) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.8 g in 41% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_4$: theoretical value 742, observed value 742

Synthesis Example 10 (Synthesis of Compound No. 139)



-continued



No. 139

Compound 19 (5.0 g, 13.2 mmol), 1,3-dibromobenzene (1.5 g, 6.6 mmol), a 2 M aqueous solution of Na_2CO_3 (14 mL, 28 mmol), DME (14 mL), toluene (14 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.38 g, 0.34 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

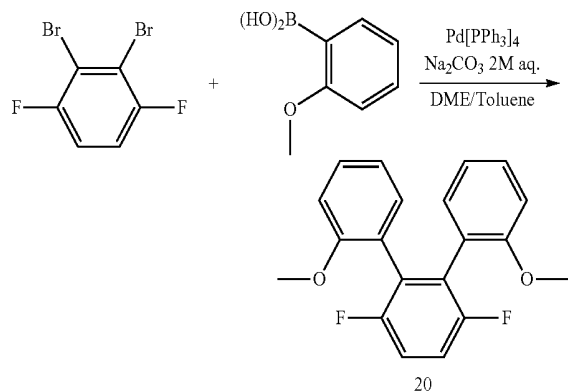
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 139) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.9 g in 39% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_4$: theoretical value 742, observed value 742

349

Synthesis Example 11 (Synthesis of Compound No. 154)

(1) Synthesis of Compound 20

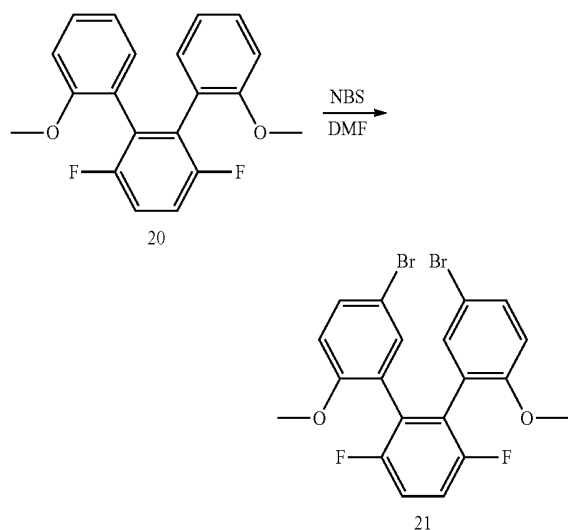


1,2-dibromo-3,6-difluorobenzene (50.0 g, 183.9 mmol), 2-methoxyphenylboronic acid (67.1 g, 441.4 mmol), and a 2 M aqueous solution of Na_2CO_3 (368 mL, 736 mmol), DME (370 mL), toluene (370 mL), and $\text{Pd}[\text{PPh}_3]_4$ (21.3 g, 18.4 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 30.6 g in 51% yield.

FD-MS $\text{C}_{20}\text{H}_{16}\text{F}_2\text{O}_2$: theoretical value 326, observed value 326

(2) Synthesis of Compound 21



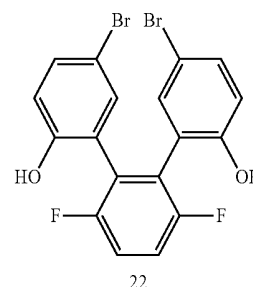
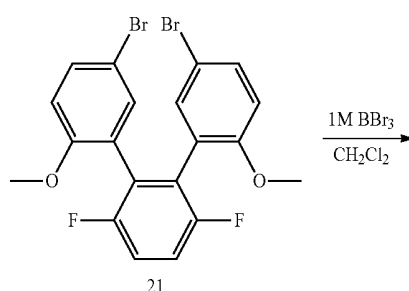
Compound 20 (30.0 g, 91.9 mmol), NBS (32.8 g, 184 mmol), and DMF (820 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at room temperature for 8 hours. After the completion of the reaction, the resultant sample was transferred to a separating

350

funnel, and water (1,000 mL) was charged into the funnel. Then, the mixture was extracted with AcOEt. The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 32 g in 72% yield.

FD-MS $\text{C}_{20}\text{H}_{14}\text{Br}_2\text{F}_2\text{O}_2$: theoretical value 484, observed value 484

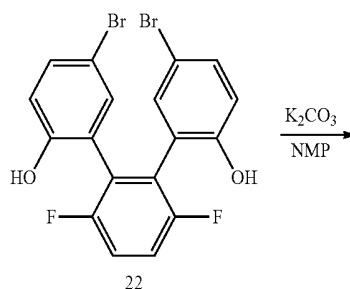
(3) Synthesis of Compound 22



Compound 21 (32.0 g, 66.1 mmol), a 1 M solution of BBr_3 in CH_2Cl_2 (155 mL, 155 mmol), and CH_2Cl_2 (430 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 0°C . for 8 hours. After that, the mixture was left to stand at room temperature overnight. After the completion of the reaction, the resultant was neutralized with a saturated aqueous solution of NaHCO_3 . The resultant sample was transferred to a separating funnel, and was extracted with CH_2Cl_2 . The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 24.1 g in 80% yield.

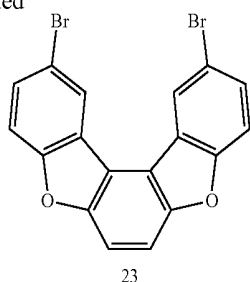
FD-MS $\text{C}_{18}\text{H}_{10}\text{Br}_2\text{F}_2\text{O}_2$: theoretical value 456, observed value 456

(4) Synthesis of Compound 23



351

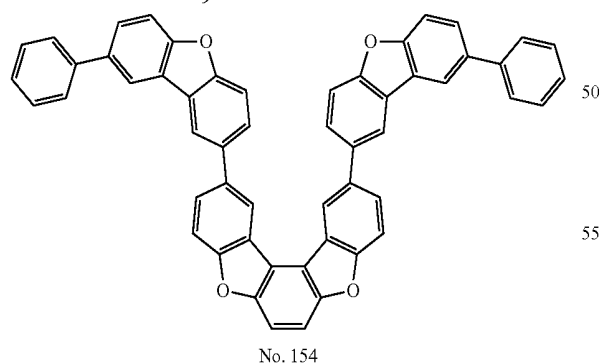
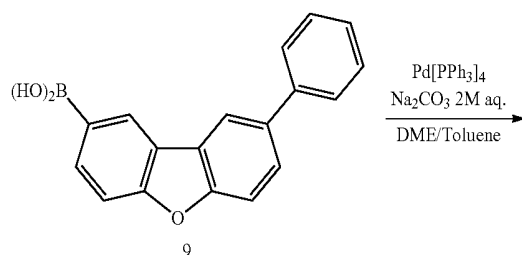
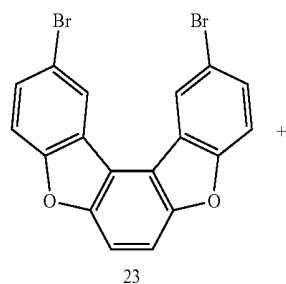
-continued



Compound 22 (24.1 g, 52.8 mmol), K_2CO_3 (16.0 g, 116 mmol), and NMP (220 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 150° C. for 8 hours. After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted with AcOEt. The resultant sample was purified by column chromatography, whereby a white solid was obtained in an amount of 18.7 g in 85% yield.

FD-MS $C_{18}H_8Br_2O_2$: theoretical value 416, observed value 416

(5) Synthesis of Compound No. 154



Compound 23 (2.5 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $Pd[PPh_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

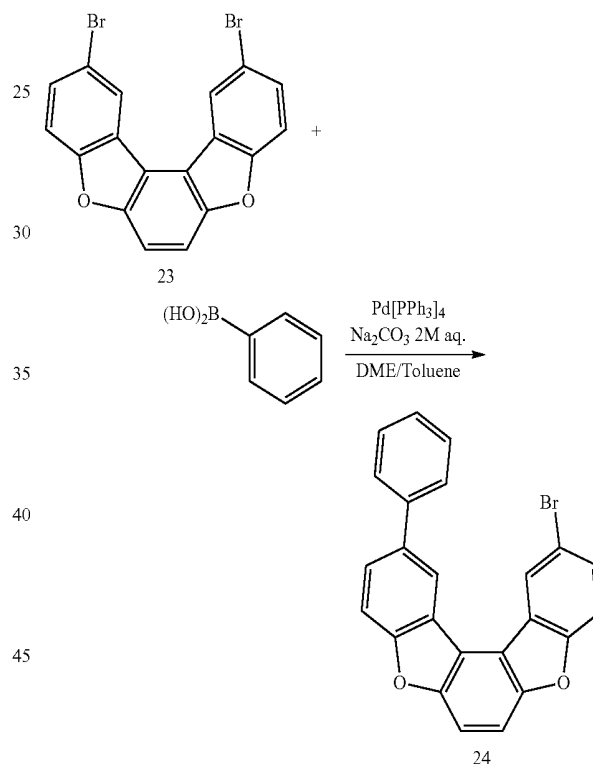
352

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with $MgSO_4$, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 154) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 0.9 g in 20% yield.

FD-MS $C_{54}H_{30}O_4$: theoretical value 742, observed value 742

Synthesis Example 12 (Synthesis of Compound No. 157)

(1) Synthesis of Compound 24



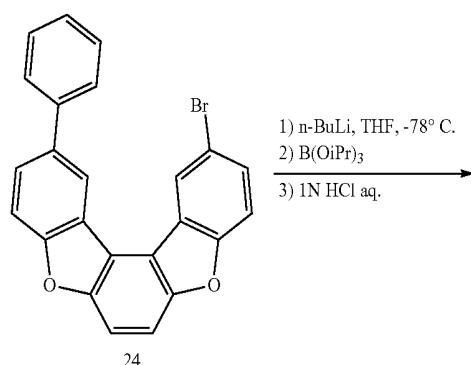
Compound 23 (16.8 g, 40.0 mmol), phenylboronic acid (4.8 g, 40 mmol), a 2 M aqueous solution of Na_2CO_3 (80 mL, 360 mmol), DME (80 mL), toluene (80 mL), and $Pd[PPh_3]_4$ (2.3 g, 2.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (150 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with $MgSO_4$, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 9.1 g in 55% yield.

FD-MS $C_{24}H_{13}BrO_2$: theoretical value 413, observed value 413

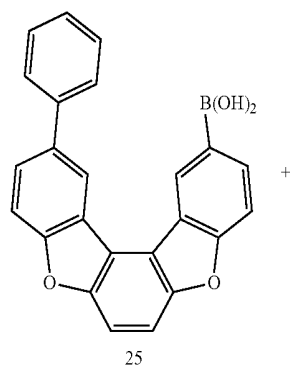
353

(2) Synthesis of Compound 25



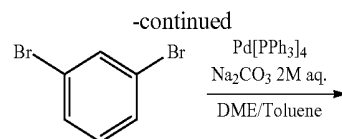
Compound 24 (9.0 g, 21.8 mmol) and THF (220 mL) were loaded into a three-necked flask, and the mixture was cooled to -78°C . Then, n-BuLi (1.65 M solution in n-hexane, 14.5 mL, 23.9 mmol) was added dropwise to the flask, and the resultant mixture was stirred at -78°C . for 20 minutes. Triisopropyl borate (12.3 g, 65.3 mmol) was added to the resultant, and the mixture was stirred at -78°C . for 1 hour. After that, the resultant was left to stand overnight at room temperature. Then, 1 N HCl (100 mL) was charged into the resultant, and the mixture was stirred at room temperature for 1 hour. The resultant sample was concentrated, and was then transferred to a separating funnel. Water (100 mL) was charged into the funnel, and the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by recrystallization (toluene-hexane), whereby a white solid was obtained in an amount of 4.1 g in 50% yield.

(3) Synthesis of Compound No. 157



354

-continued



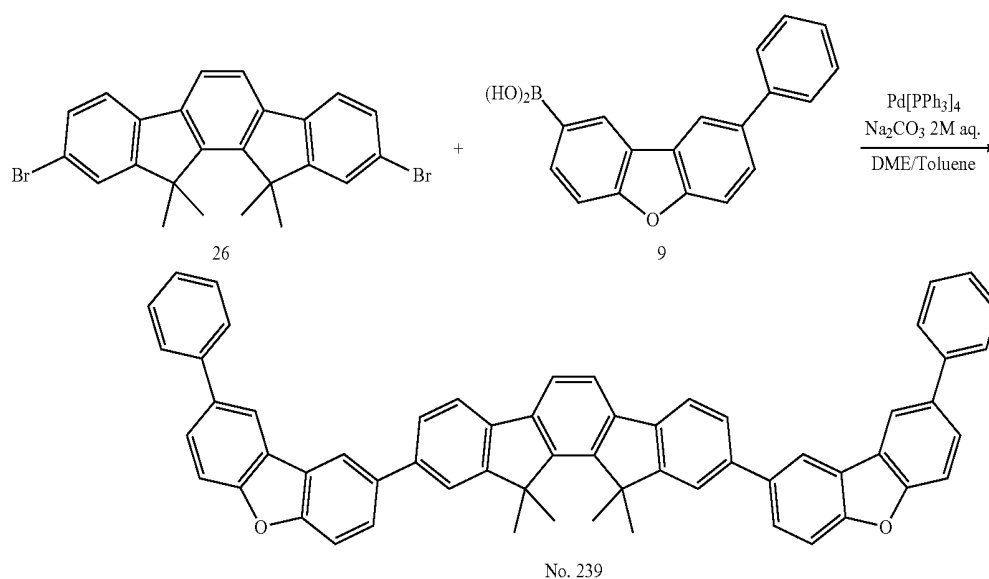
Compound 25 (4.0 g, 10.6 mmol), 1,3-dibromobenzene (1.2 g, 5.3 mmol), a 2 M aqueous solution of Na_2CO_3 (11 mL, 22 mmol), DME (11 mL), toluene (11 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.31 g, 0.27 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 157) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 0.63 g in 16% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_4$: theoretical value 742, observed value 742

355

Synthesis Example 13 (Synthesis of Compound No. 239)

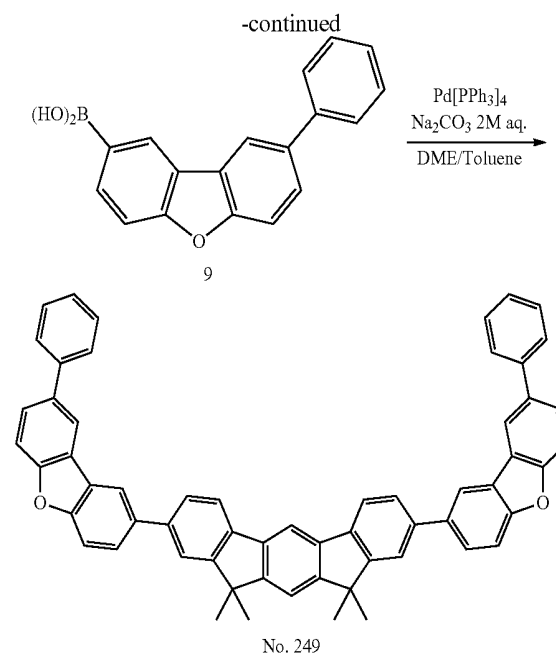
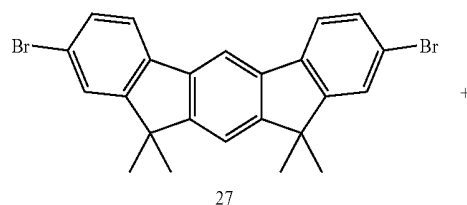


Compound 26 (2.8 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 239) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.1 g in 45% yield.

FD-MS $\text{C}_{60}\text{H}_{42}\text{O}_2$: theoretical value 794, observed value 794

Synthesis Example 14 (Synthesis of Compound No. 249)



Compound 27 (2.8 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

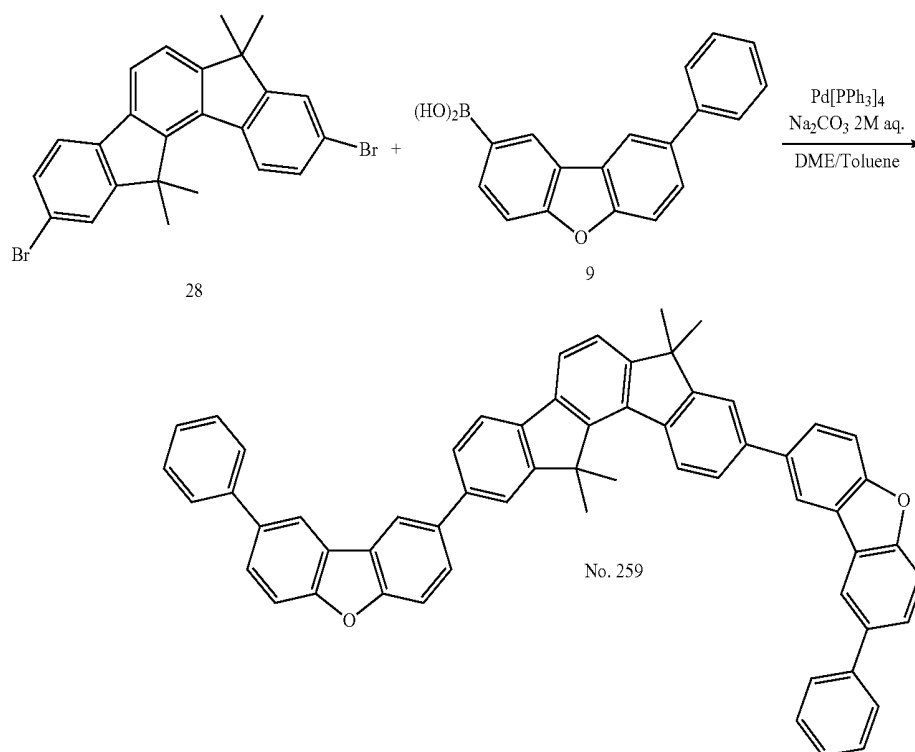
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 249) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.5 g in 52% yield.

357

358

FD-MS $C_{60}H_{42}O_2$: theoretical value 794, observed value 794

Synthesis Example 15 (Synthesis of Compound No. 259)

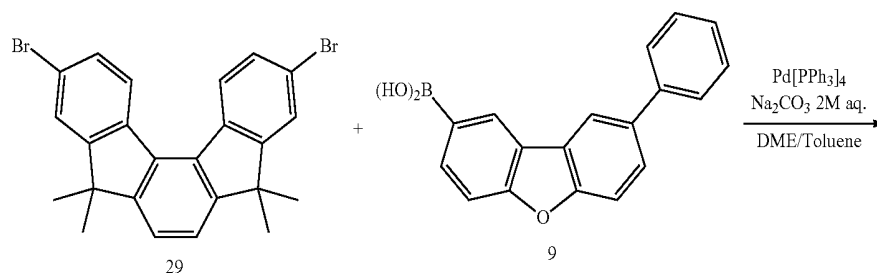


Compound 28 (2.8 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $Pd[PPh_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with $MgSO_4$, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 259) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.9 g in 40% yield.

FD-MS $C_{60}H_{42}O_2$: theoretical value 794, observed value 794

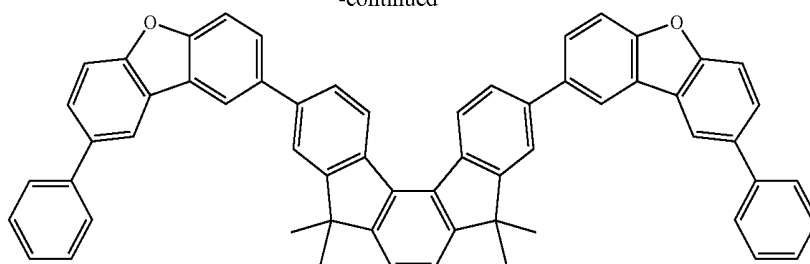
Synthesis Example 16 (Synthesis of Compound No. 269)



359

360

-continued



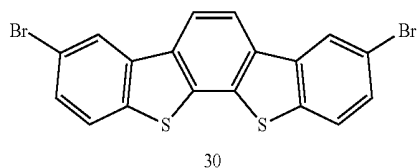
No. 269

Compound 29 (2.8 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

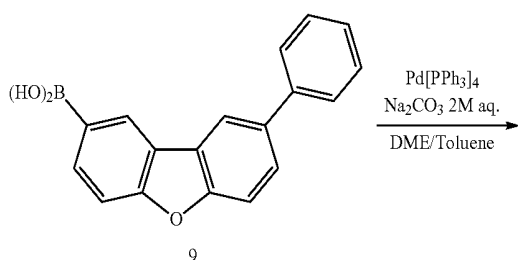
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 269) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.0 g in 21% yield.

FD-MS $\text{C}_{60}\text{H}_{42}\text{O}_2$: theoretical value 794, observed value 794

Synthesis Example 17 (Synthesis of Compound No. 233)

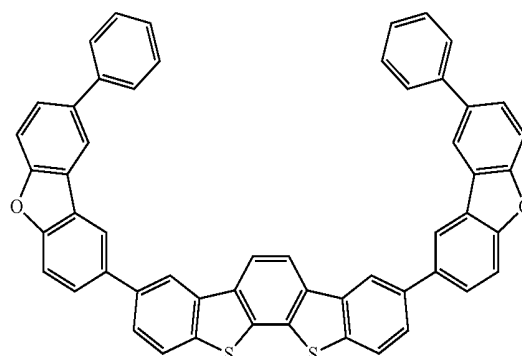


30



9

-continued



No. 233

Compound 30 (2.7 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

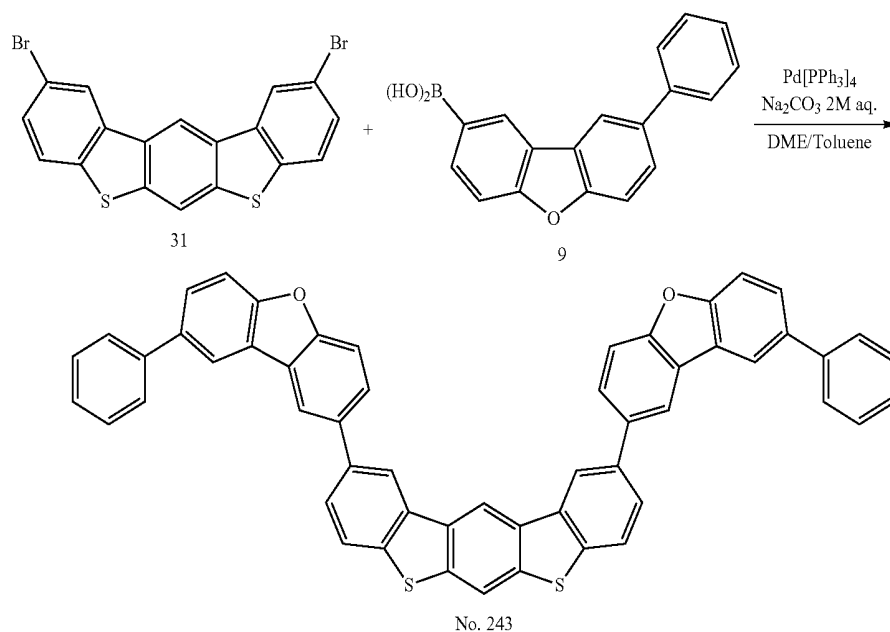
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 233) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.9 g in 40% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_2\text{S}_2$: theoretical value 774, observed value 774

361

362

Synthesis Example 18 (Synthesis of Compound No. 243)

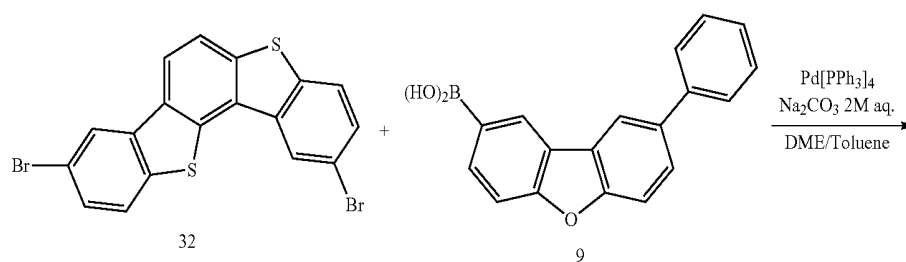


Compound 31 (2.7 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 243) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.1 g in 45% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_2\text{S}_2$: theoretical value 774, observed value 774

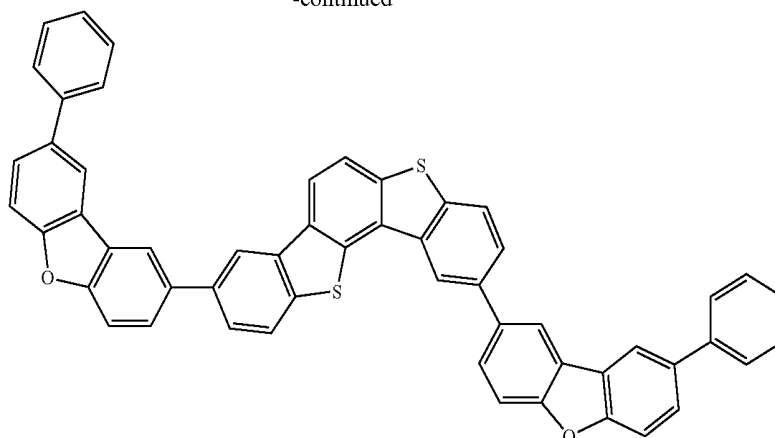
Synthesis Example 19 (Synthesis of Compound No. 253)



363

364

-continued



No. 253

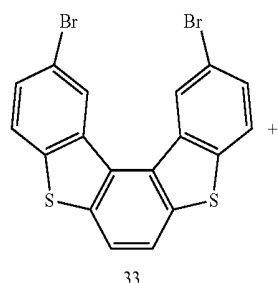
20

Compound 32 (2.7 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

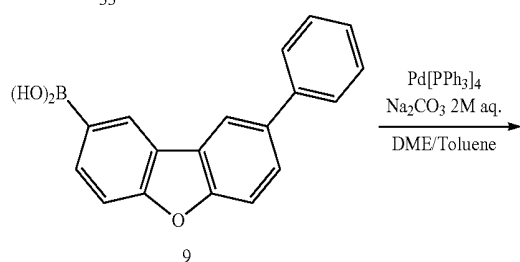
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 253) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.8 g in 38% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_2\text{S}_2$: theoretical value 774, observed value 774

Synthesis Example 20 (Synthesis of Compound No. 263)

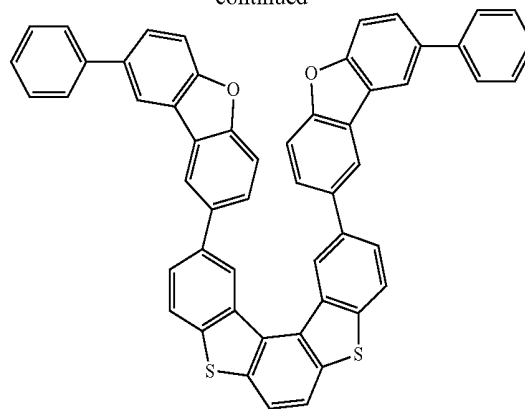


33



9

-continued



No. 263

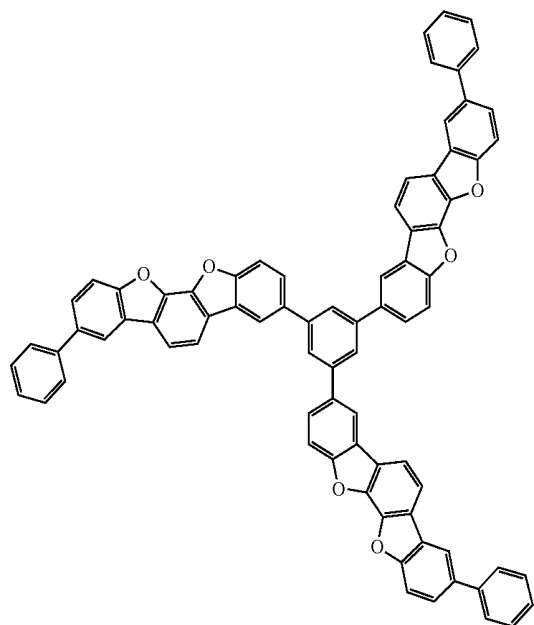
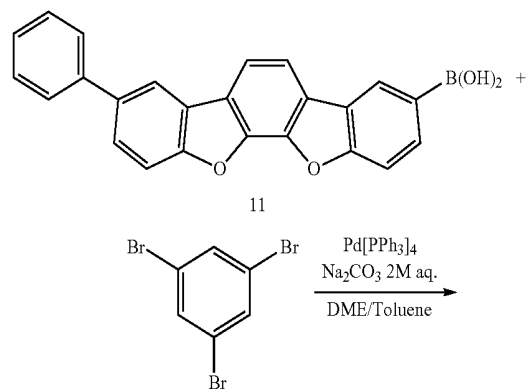
Compound 33 (2.7 g, 6.0 mmol), Compound 9 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 263) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 0.6 g in 13% yield.

FD-MS $\text{C}_{54}\text{H}_{30}\text{O}_2\text{S}_2$: theoretical value 774, observed value 774

365

Synthesis Example 21 (Synthesis of Compound No. 272)



No. 272

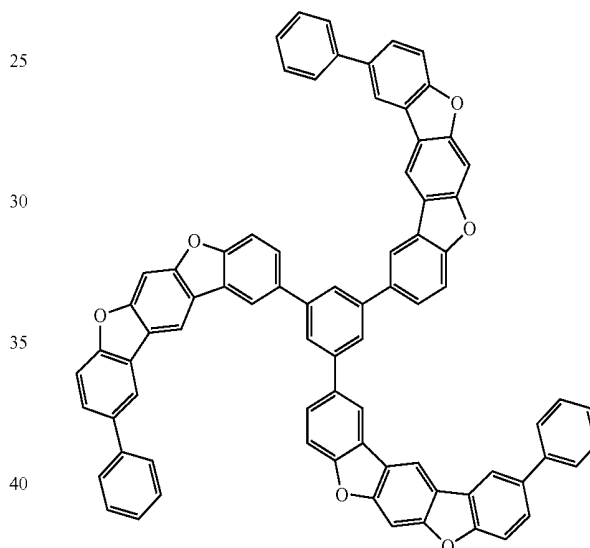
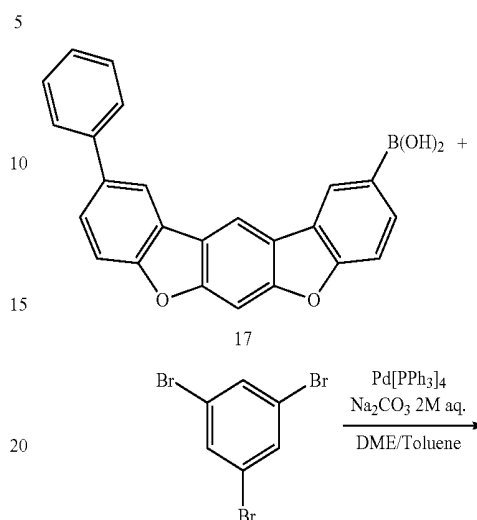
Compound 11 (8.3 g, 21.9 mmol), 1,3,5-tribromobenzene (2.3 g, 7.3 mmol), a 2 M aqueous solution of Na_2CO_3 (22.5 mL, 45 mmol), DME (15 mL), toluene (15 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.63 g, 0.56 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 272) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.0 g in 13% yield.

FD-MS $\text{C}_{78}\text{H}_{42}\text{O}_6$: theoretical value 1,075, observed value 1,075

366

Synthesis Example 22 (Synthesis of Compound No. 273)



No. 273

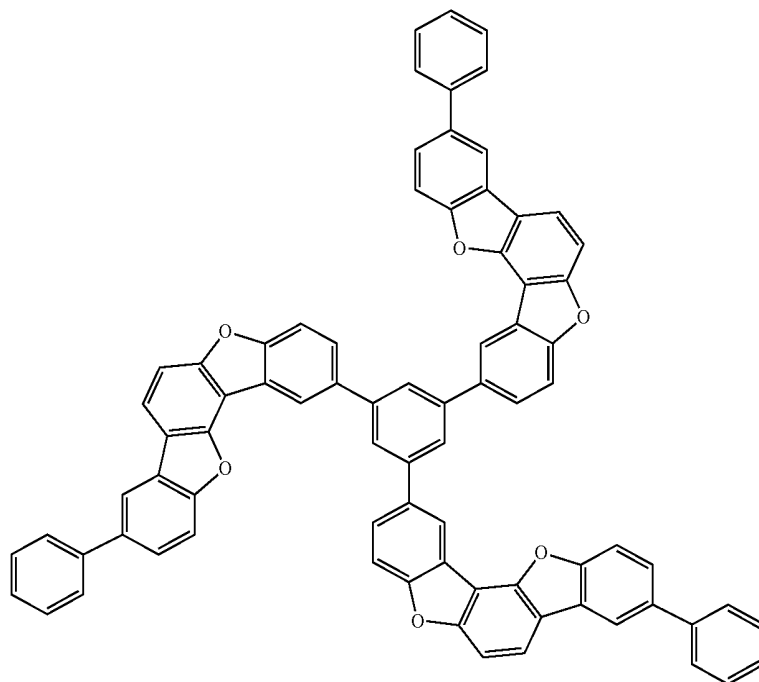
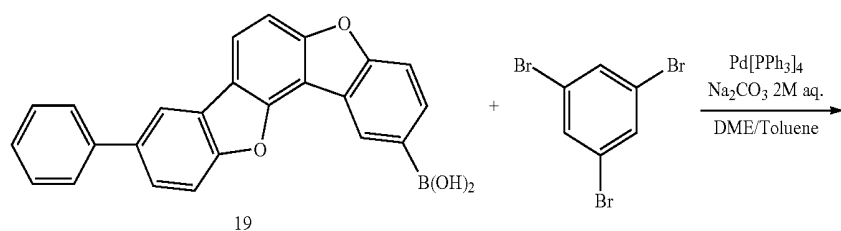
Compound 17 (8.3 g, 21.9 mmol), 1,3,5-tribromobenzene (2.3 g, 7.3 mmol), a 2 M aqueous solution of Na_2CO_3 (22.5 mL, 45 mmol), DME (15 mL), toluene (15 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.63 g, 0.56 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 273) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.2 g in 15% yield.

FD-MS $\text{C}_{78}\text{H}_{42}\text{O}_6$: theoretical value 1,075, observed value 1,075

367

Synthesis Example 23 (Synthesis of Compound No. 274)



No. 274

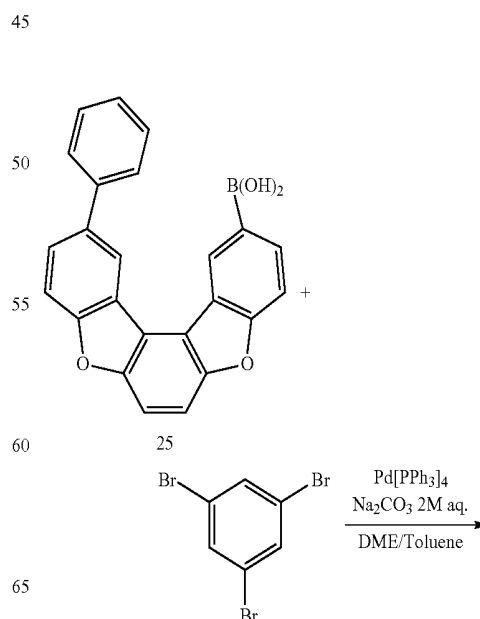
Compound 19 (8.3 g, 21.9 mmol), 1,3,5-tribromobenzene (2.3 g, 7.3 mmol), a 2 M aqueous solution of Na₂CO₃ (22.5 mL, 45 mmol), DME (15 mL), toluene (15 mL), and Pd[PPh₃]₄ (0.63 g, 0.56 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH₂Cl₂. The extract was dried with MgSO₄, and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 274) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 0.94 g in 12% yield.

FD-MS C₇₈H₄₂O₆: theoretical value 1,075, observed value 1,075

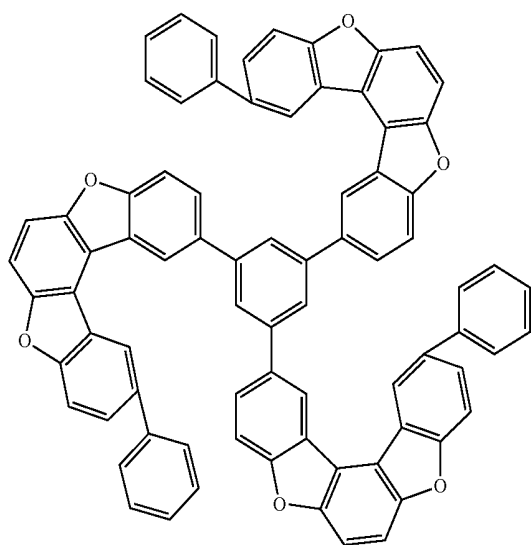
368

Synthesis Example 24 (Synthesis of Compound No. 276)



369

-continued



No. 276

Compound 25 (8.3 g, 21.9 mmol), 1,3,5-tribromobenzene (2.3 g, 7.3 mmol), a 2 M aqueous solution of Na_2CO_3 (22.5

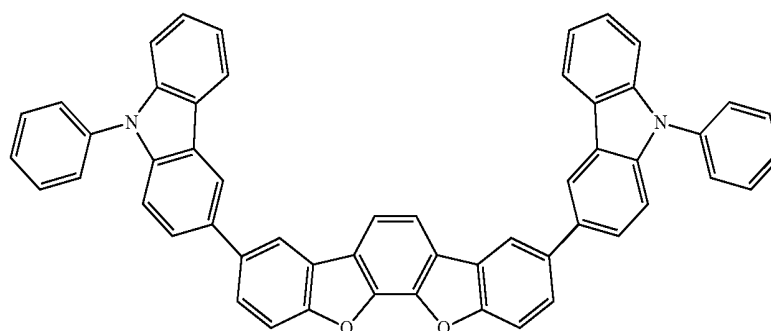
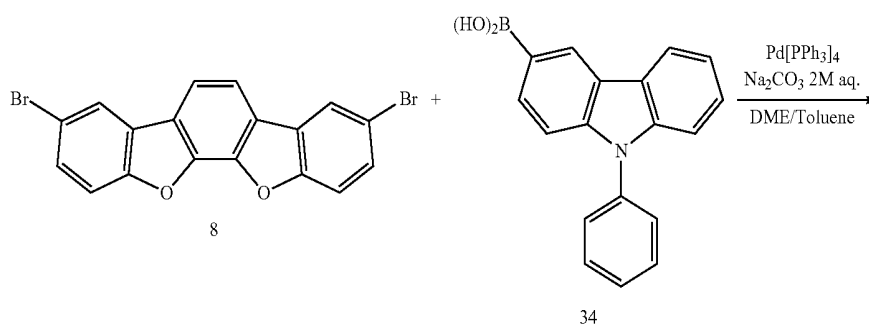
370

mL, 45 mmol), DME (15 mL), toluene (15 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.63 g, 0.56 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

5 After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified
10 product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 276) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of
15 0.55 g in 7% yield.

FD-MS $\text{C}_{78}\text{H}_{42}\text{O}_6$: theoretical value 1,075, observed value 1,075

Synthesis Example 25 (Synthesis of Compound No. 1)



No. 1

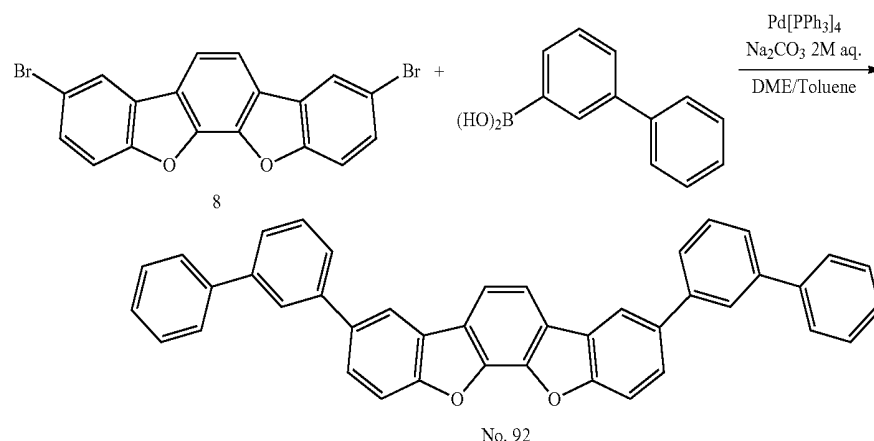
371

Compound 8 (2.5 g, 6.0 mmol), compound 34 (3.8 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 1) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.2 g in 27% yield.

FD-MS $\text{C}_{54}\text{H}_{32}\text{N}_2\text{O}_2$: theoretical value 740, observed value 740

Synthesis Example 26 (Synthesis of Compound No. 92)



Compound 8 (2.5 g, 6.0 mmol), 3-biphenylboronic acid (2.6 g, 13.2 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

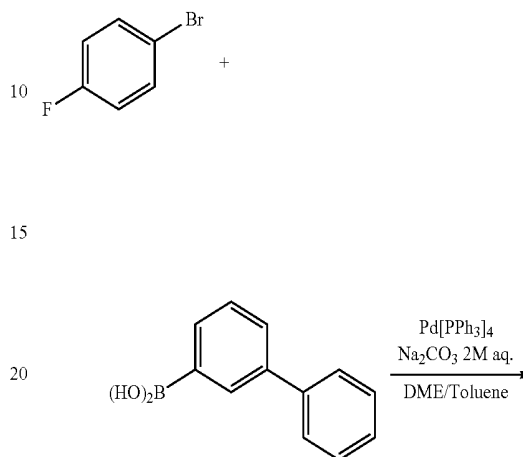
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 92) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.1 g in 32% yield.

FD-MS $\text{C}_{42}\text{H}_{26}\text{O}_2$: theoretical value 562, observed value 562

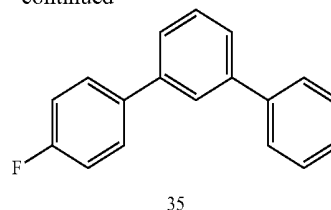
372

Synthesis Example 27 (Synthesis of Compound No. 108)

(1) Synthesis of Compound 35



-continued



4-bromofluorobenzene (81.55 g, 466 mmol), 3-biphenylboronic acid (92.33 g, 466 mmol), a 2 M aqueous solution of Na_2CO_3 (530 mL), $\text{Pd}[\text{PPh}_3]_4$ (14.7 g, 12.7 mmol), DME (500 mL), and toluene (500 mL) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 6 hours.

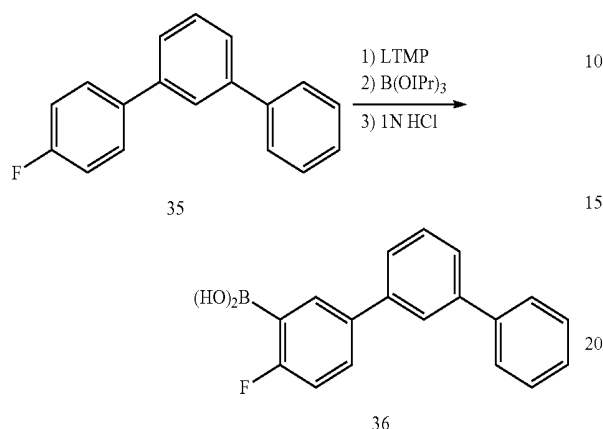
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (350 mL) was charged into the funnel. Then, the mixture was extracted with toluene. The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified

373

product was concentrated and exsiccated, and was then recrystallized, whereby a white solid was obtained in an amount of 31.7 g in 27% yield.

FD-MS $C_{18}H_{13}F$: theoretical value 248, observed value 248

(2) Synthesis of Compound 36

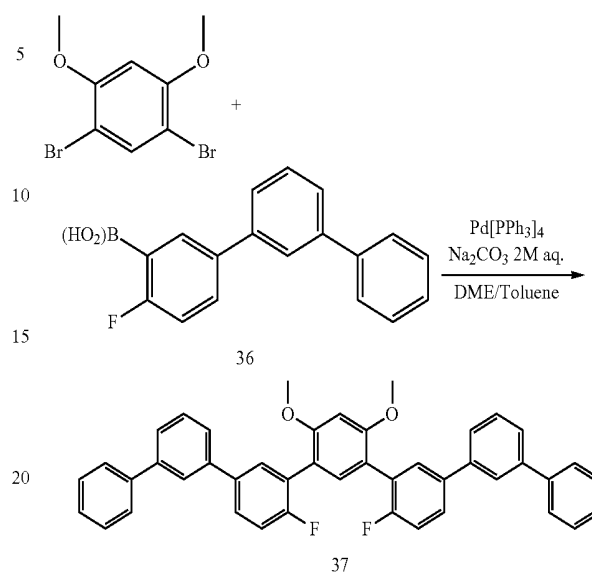


Compound 35 (31.7 g, 127 mmol) and THF (200 mL) were loaded into a three-necked flask, and the mixture was cooled to -78°C . Then, lithium 2,2,6,6-tetramethyl piperidine solution preliminarily prepared from $n\text{-BuLi}$ (1.55 M solution in hexane, 82 mL, 127 mmol), 2,2,6,6-tetramethyl piperidine (17.9 g, 127 mmol), and THF (50 mL) were added to the flask, and the resultant mixture was stirred at -78°C under an Ar atmosphere for 2 hours. After that, triisopropyl borate (71.6 g, 381 mmol) was added to the mixture, followed by stirring at -78°C for 2 hours. Then, the temperature of the obtained mixture was returned to room temperature slowly and the mixture was left to stand overnight.

After the completion of the reaction, methanol (50 mL) was added to inactivate the resultant, and the resultant was concentrated to about the half volume. CH_2Cl_2 (200 mL) and 2 N HCl (120 mL) were added, followed by stirring at room temperature for 2 hours. The resultant sample was transferred to a separating funnel, and extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then subjected to dispersion washing with toluene, whereby a white solid was obtained in an amount of 27.5 g in 74% yield.

374

(3) Synthesis of Compound 37

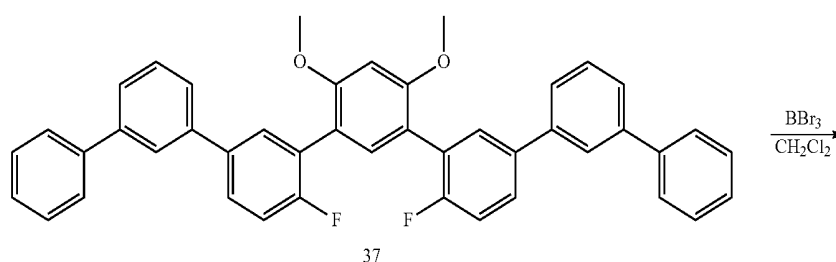


1,3-dibromo-4,6-dimethoxybenzene (5.92 g, 20 mmol), Compound 36 (14.02 g, 48 mmol), a 2 M aqueous solution of Na_2CO_3 (40 mL), $\text{Pd[PPh}_3\text{]}_4$ (1.15 g, 1 mmol), DME (20 mL), and toluene (20 mL) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 36 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (100 mL) was charged into the funnel. Then, the mixture was extracted with toluene. The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized, whereby a white solid was obtained in an amount of 9.49 g in 75% yield.

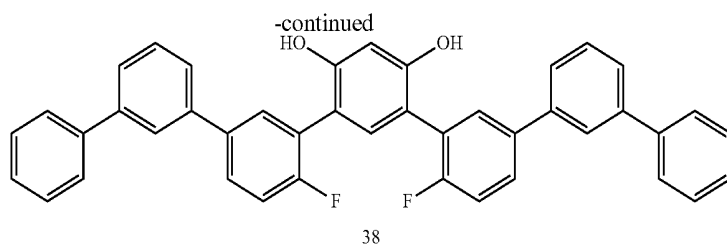
FD-MS $C_{44}H_{32}F_2O_2$: theoretical value 630, observed value 630

(4) Synthesis of Compound 38



375

376



Compound 37 (9.49 g, 5 mmol) and CH_2Cl_2 (75 mL) were loaded into a three-necked flask, and the mixture was cooled to 0°C . Then, BBr_3 (15.03 g, 60 mmol) was added to the flask, and the resultant mixture was stirred under an Ar atmosphere at room temperature for 24 hours.

After the completion of the reaction, the obtained solution was cooled to -78°C ., and inactivated using methanol (50 mL) and water (100 mL). The sample was transferred to a separating funnel, and water (100 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtered and concentrated. The obtained sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, whereby a white solid was obtained in an amount of 9.04 g in 100% yield.

FD-MS $\text{C}_{42}\text{H}_{28}\text{F}_2\text{O}_2$: theoretical value 602, observed value 602

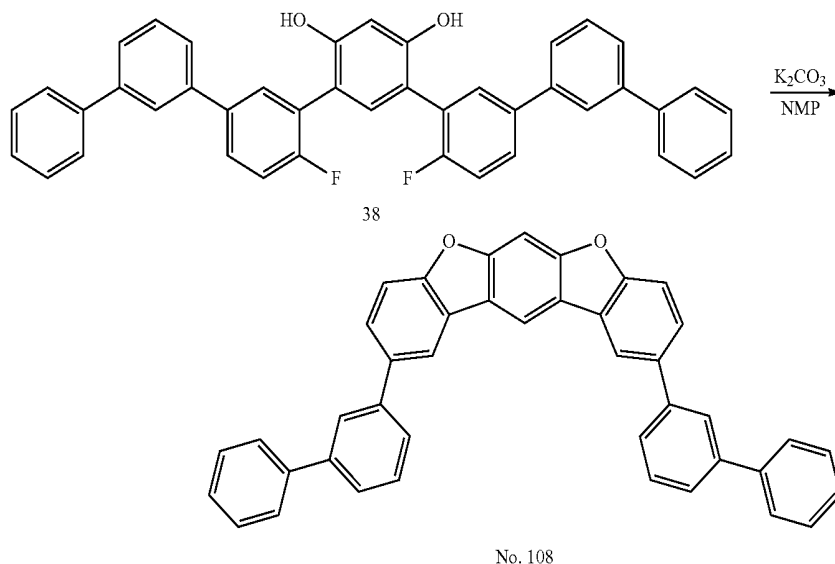
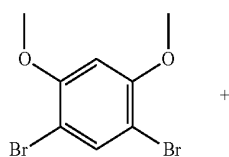
(5) Synthesis of Compound No. 108

cated, and was then recrystallized, whereby a white powder (Compound No. 108) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 3.37 g in 40% yield.

FD-MS $\text{C}_{42}\text{H}_{26}\text{O}_2$: theoretical value 562, observed value 562

Synthesis Example 28 (Synthesis of Compound No. 281)

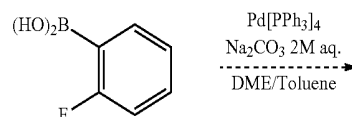
(1) Synthesis of Compound 39



Compound 38 (9.04 g, 15 mmol) and NMP (150 mL) were loaded into a three-necked flask, and Compound 38 was dissolved completely. K_2CO_3 (8.30 g, 60 mmol) was added to the flask, followed by stirring at 200°C . for 2 hours.

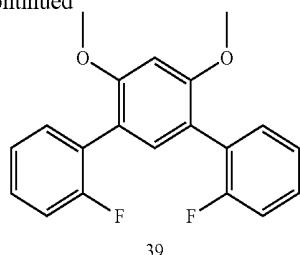
After the completion of the reaction, the obtained solution was cooled to room temperature. Toluene (1.5 L) was added to the resultant sample, and the sample was transferred to a separating funnel and washed with water. The resultant was dried with MgSO_4 and then filtered and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated.

-continued



377

-continued

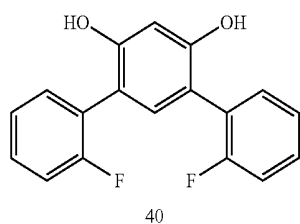
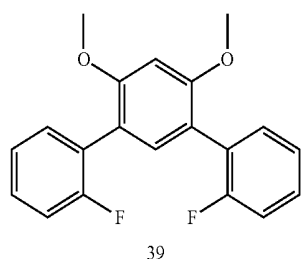


1,3-dibromo-4,6-dimethoxybenzene (88.8 g, 300 mmol), 2-fluorophenyl boric acid (100.7 g, 720 mmol), 2 M aqueous solution of Na_2CO_3 (600 mL), $\text{Pd}[\text{PPh}_3]_4$ (6.73 g, 6 mmol), DME (150 mL), and toluene (150 mL) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 36 hours.

After the completion of the reaction, the obtained solution was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (500 mL) was charged into the funnel. Then, the mixture was extracted with toluene. After being dried with MgSO_4 , the extract was filtered and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized, whereby a white solid was obtained in an amount of 86.5 g in 88% yield.

FD-MS $\text{C}_{20}\text{H}_{16}\text{F}_2\text{O}_2$: theoretical value 326, observed value 326

(2) Synthesis of Compound 40



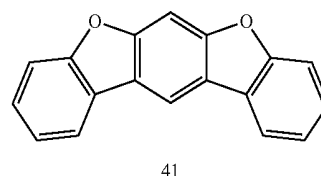
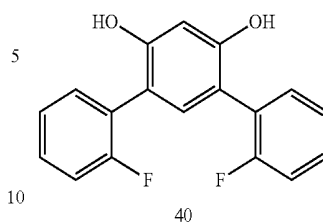
Compound 39 (48.3 g, 148 mmol) and CH_2Cl_2 (740 mL) were loaded into a three-necked flask, and the mixture was cooled to 0°C . Then, BBr_3 (89.0 g, 355 mmol) was added to the flask, and the resultant mixture was stirred at room temperature for 24 hours.

After the completion of the reaction, the obtained solution was cooled to -78°C ., and inactivated using methanol (50 mL) and water (100 mL). The sample was transferred to a separating funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtered and concentrated. The obtained sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, whereby a white solid was obtained in an amount of 44.14 g in 100% yield.

FD-MS $\text{C}_{18}\text{H}_{12}\text{F}_2\text{O}_2$: theoretical value 298, observed value 298

378

(3) Synthesis of Compound 41

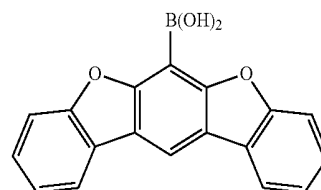
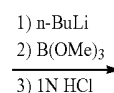
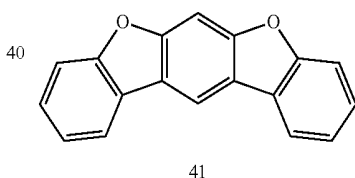


Compound 40 (44.14 g, 148 mmol) and NMP (888 mL) were loaded into a three-necked flask, and Compound 40 was dissolved completely. K_2CO_3 (81.8 g, 592 mmol) was added to the flask, followed by stirring at 200°C . for 2 hours.

After the completion of the reaction, the obtained solution was cooled to room temperature. The sample was transferred to a separating funnel, toluene (2 L) was added, and the resultant was washed with water. The resultant was dried with MgSO_4 and then filtered and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized, whereby a white solid was obtained in an amount of 27.9 g in 73% yield.

FD-MS $\text{C}_{18}\text{H}_{10}\text{O}_2$: theoretical value 258, observed value 258

(4) Synthesis of Compound 42



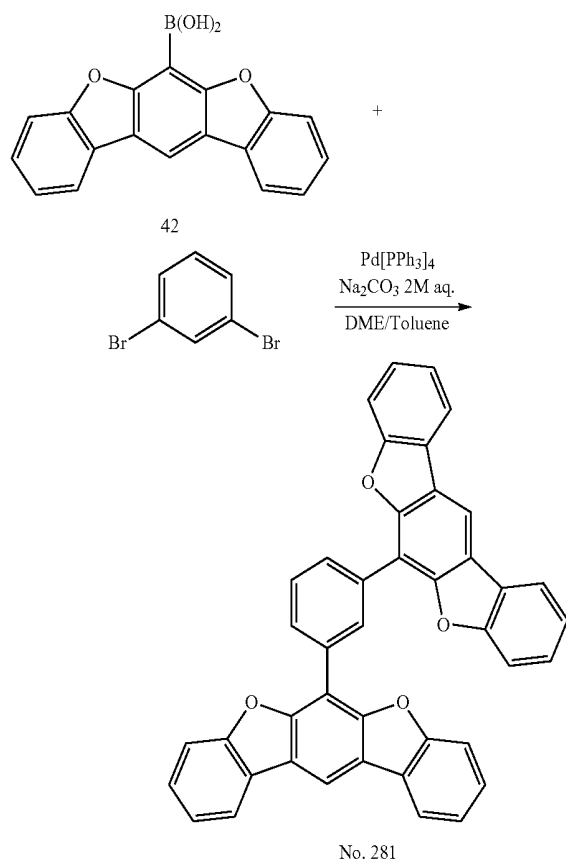
Compound 41 (12.9 g, 50 mmol) and THF (300 mL) were loaded into a three-necked flask, and the mixture was cooled to -78°C . Then, n-BuLi (2.63 M solution in hexane, 20.0 mL, 52.5 mmol) was added to the flask, and the resultant mixture was stirred at room temperature under an Ar atmosphere for 1 hour. Next, the resultant was cooled to -78°C . again, trimethyl borate (10.4 g, 100 mmol) was added to the resultant. After being stirred at -78°C . for 10 minutes, the mixture was stirred at room temperature for 1 hour.

After the completion of the reaction, the resultant was concentrated to about the half volume. 1 N HCl (200 mL) was added to the concentrated resultant, followed by stirring at room temperature for 1 hour. The resultant sample was

379

transferred to a separating funnel, and the mixture was extracted with ethyl acetate. After being dried with MgSO_4 , the extract was concentrated. The concentrated product was subjected to dispersion washing with a toluene/hexane mixed solvent, whereby a white solid was obtained in an amount of 13.7 g in 91% yield.

(5) Synthesis of Compound No. 281



Compound 42 (3.8 g, 12.6 mmol), 1,3-dibromobenzene (1.4 g, 6.0 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.3 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

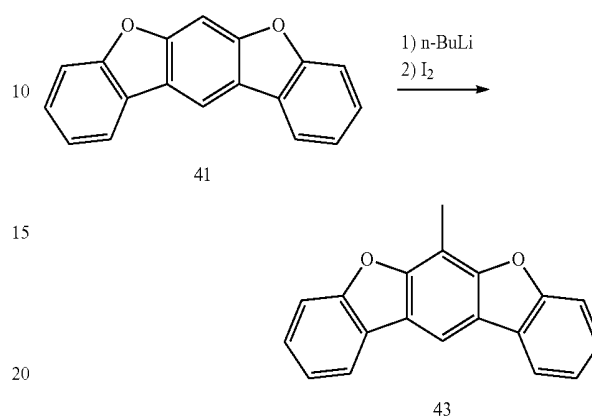
After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 281) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.3 g in 37% yield.

FD-MS $\text{C}_{42}\text{H}_{22}\text{O}_4$: theoretical value 590, observed value 590

380

Synthesis Example 29 (Synthesis of Compound No. 284)

(1) Synthesis of Compound 43

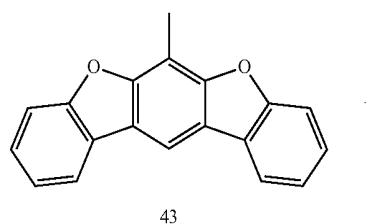


Compound 41 (2.69 g, 10.4 mmol) and THF (62 mL) were loaded into a three-necked flask, and the mixture was cooled to -78°C . Then, $n\text{-BuLi}$ (1.66 M solution in hexane, 6.6 mL, 10.9 mmol) was added to the flask, and the resultant mixture was stirred at room temperature for 30 minutes. Next, the resultant was cooled to -78°C . again, I_2 (2.69 g, 10.6 mmol) was added to the resultant. After being stirred at -78°C . for 10 minutes, the mixture was stirred at room temperature for 1 hour.

After the completion of the reaction, water (30 mL) was added to inactivate the obtained solution, followed by concentration. After being subjected to dispersion washing with water, the sample was collected by filtration and then dissolved in toluene. After being dried with MgSO_4 , the resultant was filtered and concentrated. The obtained sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized, whereby a white solid was obtained in an amount of 3.77 g in 94% yield.

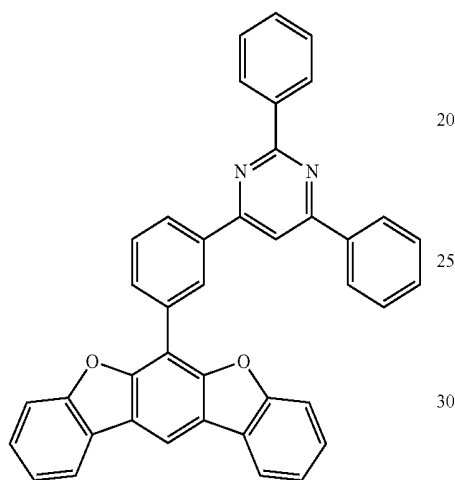
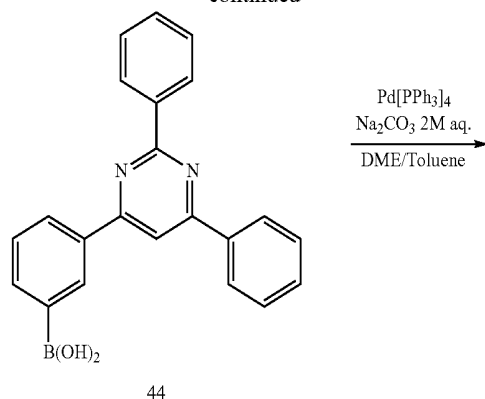
FD-MS $\text{C}_{18}\text{H}_9\text{IO}_2$: theoretical value 384, observed value 384

(2) Synthesis of Compound No. 284



381

-continued



Compound 43 (2.3 g, 6.0 mmol), Compound 44 (2.2 g, 6.3 mmol), a 2 M aqueous solution of Na_2CO_3 (12 mL, 24 mmol), DME (12 mL), toluene (12 mL), and $\text{Pd}[\text{PPh}_3]_4$ (0.35 g, 0.30 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (50 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound

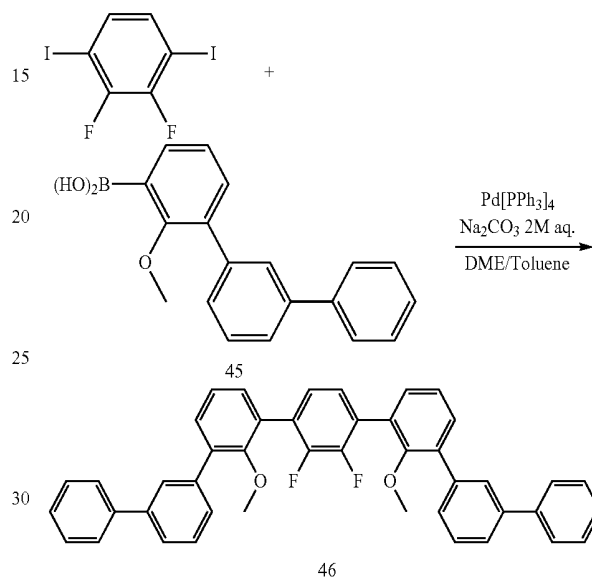
382

No. 284) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 1.0 g in 30% yield.

FD-MS $\text{C}_{40}\text{H}_{24}\text{N}_2\text{O}_2$: theoretical value 564, observed value 564

Synthesis Example 30 (Synthesis of Compound No. 306)

(1) Synthesis of Compound 46

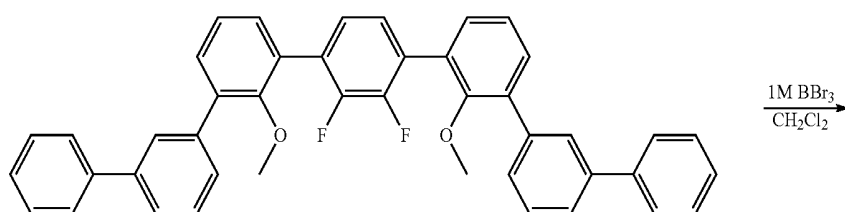


1,2-difluoro-3,6-diiodobenzene (7.3 g, 20.0 mmol), Compound 45 (12.8 g, 42.0 mmol), a 2 M aqueous solution of Na_2CO_3 (40 mL, 80.0 mmol), DME (40 mL), toluene (40 mL), and $\text{Pd}[\text{PPh}_3]_4$ (1.2 g, 1.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (100 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 8.2 g in 65% yield.

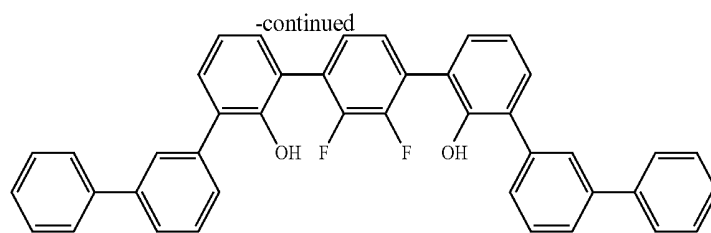
FD-MS $\text{C}_{44}\text{H}_{32}\text{F}_2\text{O}_2$: theoretical value 630, observed value 630

(2) Synthesis of Compound 47



383

384



47

Compound 46 (8.2 g, 13.0 mmol), a 1 M solution of BBr_3 in CH_2Cl_2 (32 mL, 32.0 mmol), and CH_2Cl_2 (100 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 0°C . for 8 hours. After that, the mixture was left to stand at room temperature overnight.

After the completion of the reaction, the resultant was neutralized with a saturated aqueous solution of NaHCO_3 . The resultant sample was transferred to a separating funnel, and was extracted with CH_2Cl_2 . The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 7.6 g in 97% yield.

FD-MS $\text{C}_{42}\text{H}_{28}\text{F}_2\text{O}_2$: theoretical value 602, observed value 602

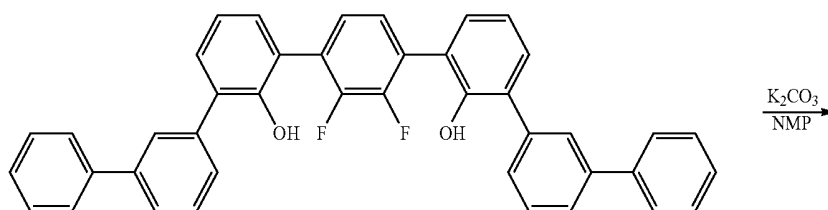
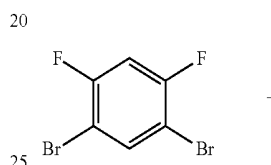
(3) Synthesis of Compound No. 306

FD-MS $\text{C}_{42}\text{H}_{26}\text{O}_2$: theoretical value 562, observed value

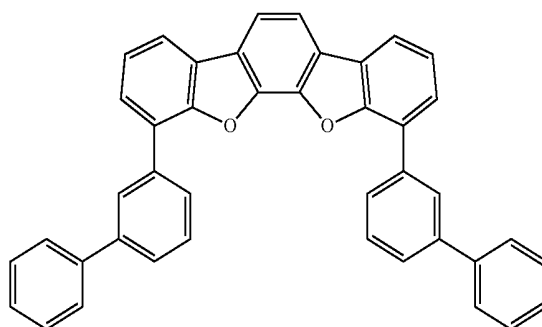
15 562

Synthesis Example 31 (Synthesis of Compound No. 329)

(1) Synthesis of Compound 48

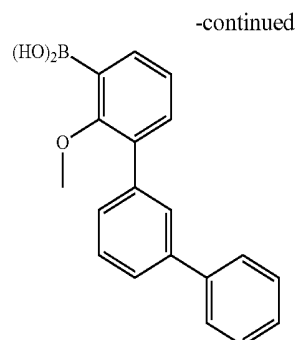


47

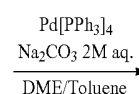


No. 306

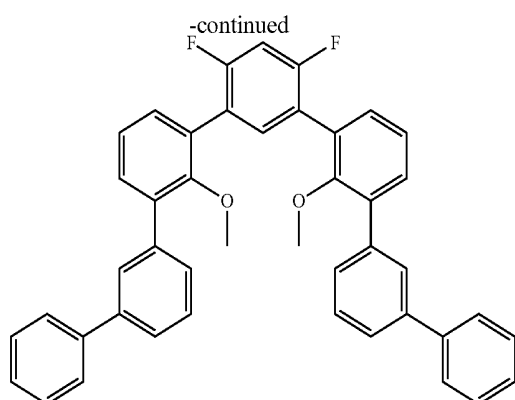
Compound 47 (7.6 g, 12.6 mmol), K_2CO_3 (7.0 g, 50.4 mmol), and NMP (50 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 200°C . for 3 hours. After the completion of the reaction, the resultant was cooled to room temperature. Toluene (500 mL) was charged into the resultant sample. The mixture was transferred to a separating funnel, and was washed with water. The washed product was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 306) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.9 g in 41% yield.



45



385



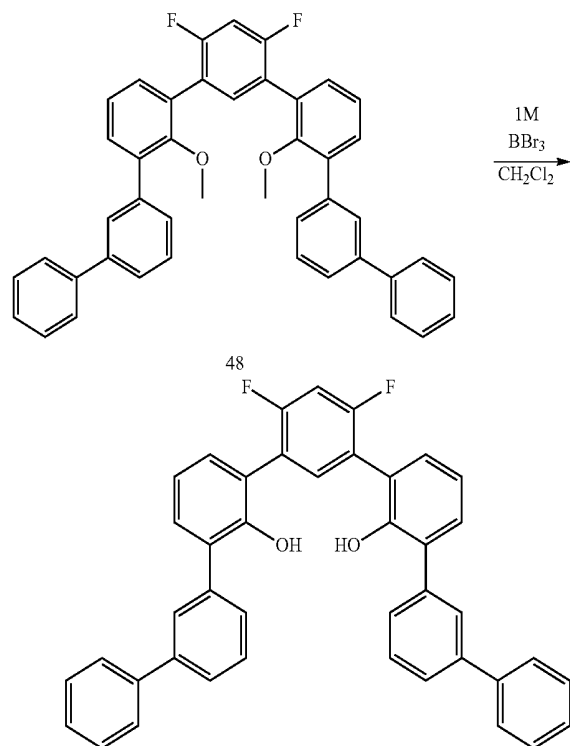
48

1,3-dibromo-4,6-difluorobenzene (5.4 g, 20.0 mmol), Compound 45 (12.8 g, 42.0 mmol), a 2 M aqueous solution of Na_2CO_3 (40 mL, 80.0 mmol), DME (40 mL), toluene (40 mL), and $\text{Pd}[\text{PPh}_3]_4$ (1.2 g, 1.0 mmol) were loaded into a three-necked flask, and the mixture was refluxed under an Ar atmosphere for 8 hours.

After the completion of the reaction, the resultant was cooled to room temperature. The resultant sample was transferred to a separating funnel, and water (100 mL) was charged into the funnel. Then, the mixture was extracted with CH_2Cl_2 . The extract was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 7.2 g in 57% yield.

FD-MS $\text{C}_{44}\text{H}_{32}\text{F}_2\text{O}_2$: theoretical value 630, observed value 630

(2) Synthesis of Compound 49



49

Compound 46 (7.2 g, 11.4 mmol), a 1 M solution of BBr_3 in CH_2Cl_2 (28 mL, 28.0 mmol), and CH_2Cl_2 (85 mL) were

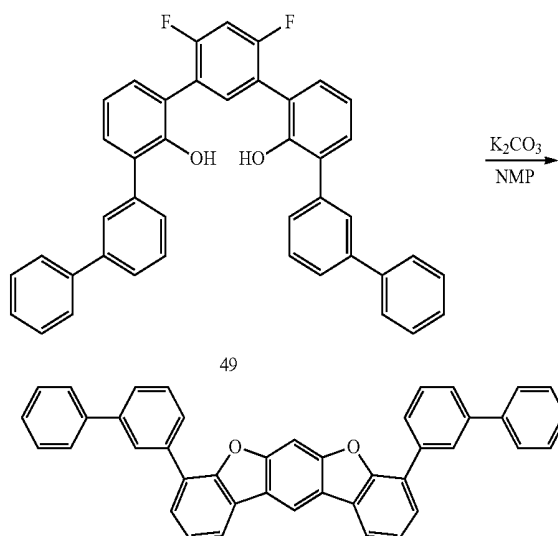
386

loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 0°C . for 8 hours. After that, the mixture was left to stand at room temperature overnight.

After the completion of the reaction, the resultant was neutralized with a saturated aqueous solution of NaHCO_3 . The resultant sample was transferred to a separating funnel, and was extracted with CH_2Cl_2 . The resultant sample was purified by silica gel column chromatography, whereby a white solid was obtained in an amount of 6.9 g in 100% yield.

FD-MS $\text{C}_{42}\text{H}_{28}\text{F}_2\text{O}_2$: theoretical value 602, observed value 602

(3) Synthesis of Compound No. 329



No. 329

Compound 47 (6.9 g, 11.4 mmol), K_2CO_3 (6.3 g, 45.6 mmol), and NMP (50 mL) were loaded into a three-necked flask, and the mixture was stirred under an Ar atmosphere at 200°C . for 3 hours.

After the completion of the reaction, the resultant was cooled to room temperature. Toluene (500 mL) was charged into the resultant sample. The mixture was transferred to a separating funnel, and was washed with water. The washed product was dried with MgSO_4 , and was then filtrated and concentrated. The resultant sample was purified by silica gel column chromatography. The purified product was concentrated and exsiccated, and was then recrystallized twice, whereby a white powder (Compound No. 329) was obtained. The powder was purified by sublimation, whereby a white solid was obtained in an amount of 2.3 g in 36% yield.

FD-MS $\text{C}_{42}\text{H}_{26}\text{O}_2$: theoretical value 562, observed value 562

An apparatus and measurement conditions adopted for field desorption mass spectrometry (FD-MS) in each of Synthesis Examples 1 to 31 are shown below.

Apparatus: HX110 (manufactured by JEOL Ltd.)

Conditions: accelerating voltage 8 kV

scan range $m/z=50$ to 1,500

emitter kind: carbon

emitter current: 0 mA \rightarrow 2 mA/min \rightarrow 40 mA (held for 10 minutes)

387

Example 1

(Production of Organic EL Device)

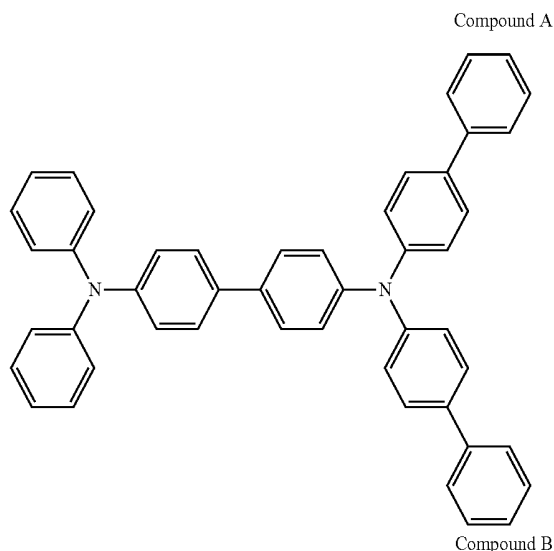
A glass substrate provided with an ITO transparent electrode measuring 25 mm by 75 mm by 1.1 mm (manufactured by GEOMATEC Co., Ltd.) was subjected to ultrasonic cleaning in isopropyl alcohol for 5 minutes. Further, the substrate was subjected to ultraviolet (UV)-ozone cleaning for 30 minutes.

The glass substrate provided with a transparent electrode thus cleaned was mounted on a substrate holder of a vacuum deposition apparatus. First, Compound A was deposited from the vapor onto the surface of the glass substrate on the side where a transparent electrode line was formed so as to cover the transparent electrode, whereby a hole transporting layer having a thickness of 30 nm was obtained.

Compound No. 11 as a host for phosphorescence and Ir(Ph-ppy)₃ as a dopant for phosphorescence were co-deposited from the vapor onto the hole transporting layer, whereby a phosphorescent layer having a thickness of 30 nm was obtained. The concentration of Ir(Ph-ppy)₃ was 5 mass %.

Subsequently, Compound B having a thickness of 10 nm, Compound C having a thickness of 20 nm, LiF having a thickness of 1 nm, and metal Al having a thickness of 80 nm were sequentially laminated on the phosphorescent layer, whereby a cathode was obtained. It should be noted that LiF as an electron injectable electrode was formed at a rate of 1 Å/min.

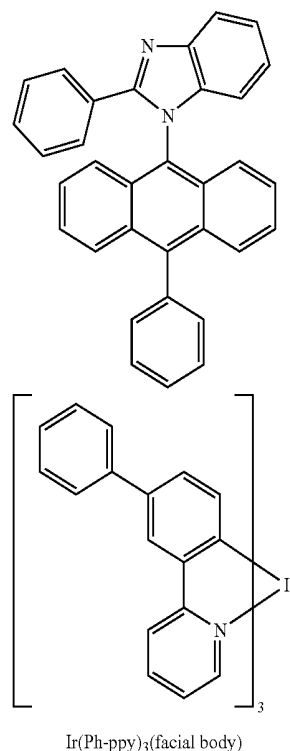
Compound



388

-continued

Compound C



(Evaluation of Organic EL Device for Light Emitting Performance)

The organic EL device thus produced was caused to emit light by being driven with a direct current. The luminance (L) of the emitted light and the current density at which the device started to emit the light were measured. Then, the current efficiency (L/J) of the device at a luminance of 1,000 cd/m² was determined. Further, the lifetime of the device at a luminance of 20,000 cd/m² was determined. Table 1 shows the results.

Examples 2 to 26

Organic EL devices were each produced in the same manner as in Example 1 except that a host material listed in Table 1 was used instead of Host Compound No. 11 in Example 1, and the devices were each evaluated in the same manner as in Example 1. Table 1 shows the results of the evaluation for light emitting performance.

Comparative Examples 1 to 7

Organic EL devices were each produced in the same manner as in Example 1 except that the following compounds (a) to (g) described in EP 0908787 A was used as a host material instead of Host Compound No. 11 in Example 1, and the devices were each evaluated in the same manner as in Example 1. Table 1 shows the results of the evaluation for light emitting performance.

Comparative Examples 8 to 11

Organic EL devices were each produced in the same manner as in Example 1 except that the following compounds (h) to (k) described in WO 2006-122630 was used as a host material instead of Host Compound No. 11 in Example 1, and the devices were each evaluated in the same

389

manner as in Example 1. Table 1 shows the results of the evaluation for light emitting performance.

Comparative Examples 12 and 13

An organic EL device was produced in the same manner as in Example 1 except that the following compound (1) or (m) described in WO 2007-063754 was used as a host material instead of Host Compound No. 11 in Example 1, and the device was evaluated in the same manner as in Example 1. Table 1 shows the results of the evaluation for light emitting performance.

Comparative Example 14

An organic EL device was produced in the same manner as in Example 1 except that the following compound (n) described in US 2002-0132134 A and US 2003-0044646 A was used as a host material instead of Host Compound No. 11 in Example 1, and the device was evaluated in the same manner as in Example 1. Table 1 shows the results of the evaluation for light emitting performance.

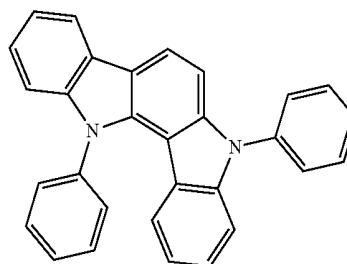
Comparative Example 15

An organic EL device was produced in the same manner as in Example 1 except that the following compound (o) described in JP 2008-81494 A was used as a host material instead of Host Compound No. 11 in Example 1, and the device was evaluated in the same manner as in Example 1. Table 1 shows the results of the evaluation for light emitting performance.

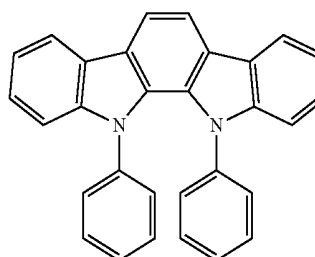
390

-continued

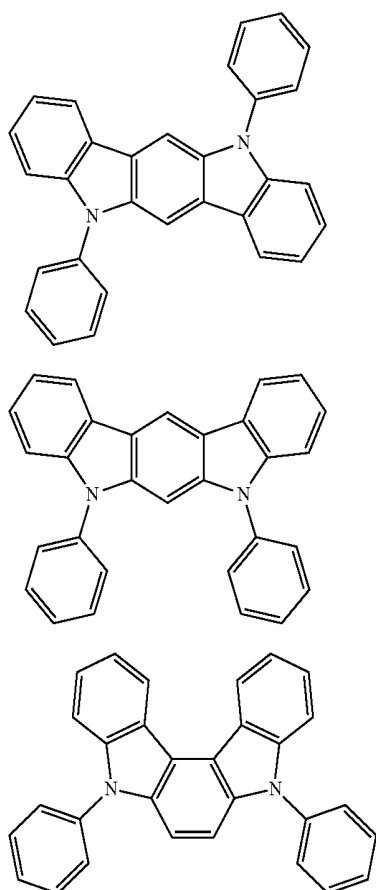
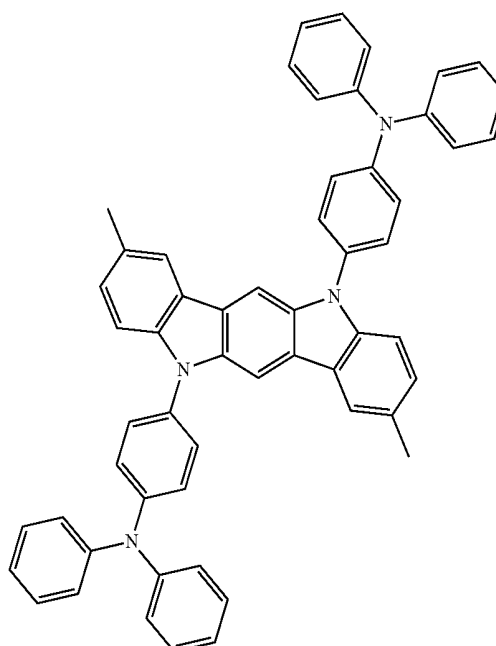
(d)



(e)



(f)



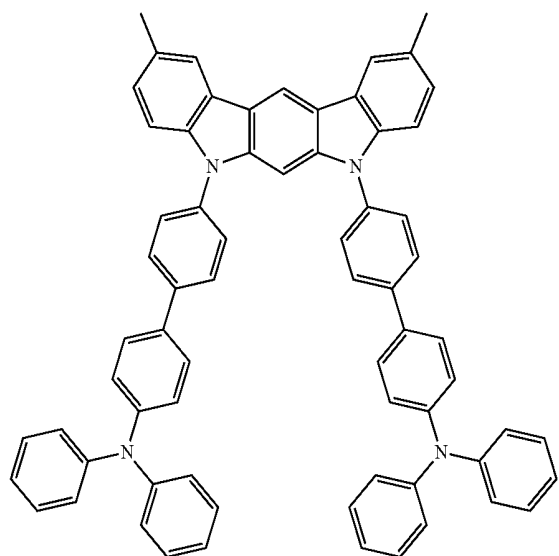
(a)

(b)

(c)

391

-continued



(g)

5

10

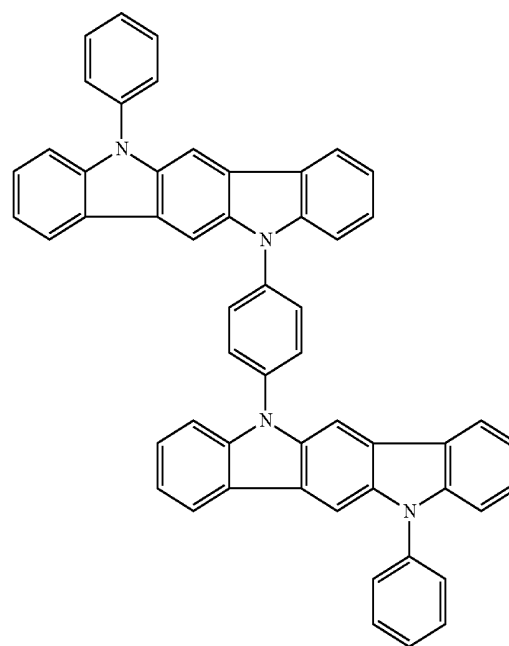
15

20

25

392

-continued



(l)

(h)

30

35

(i)

40

45

(j)

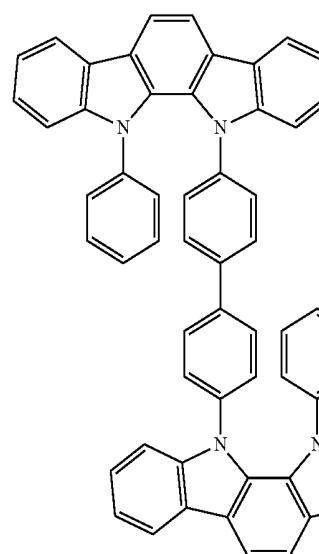
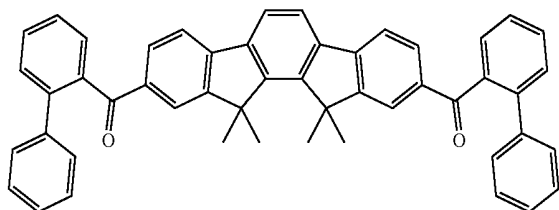
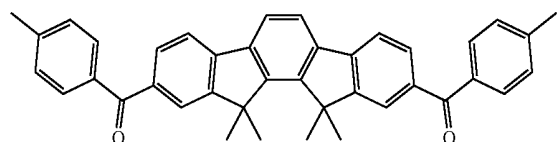
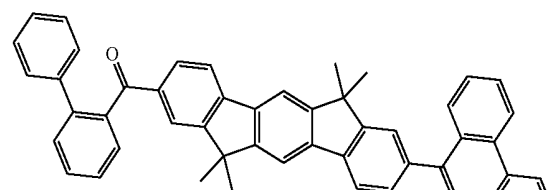
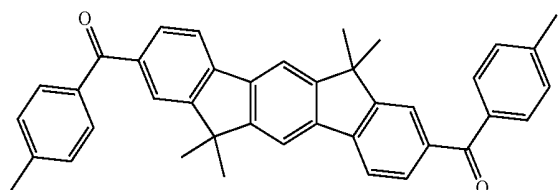
50

55

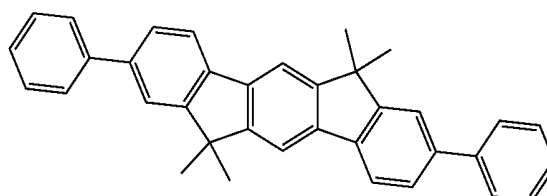
(k)

60

65



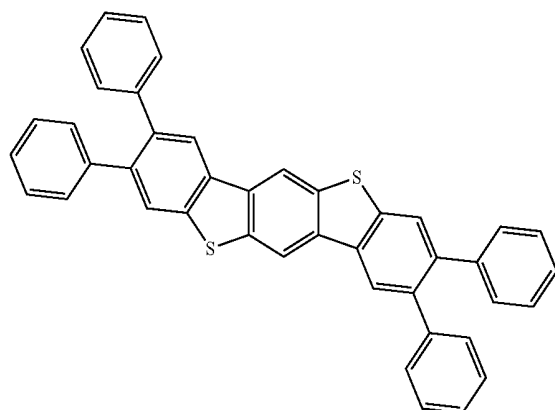
(m)



(n)

393

-continued



394

(o) transparent electrode line was formed so as to cover the transparent electrode, whereby a hole transporting layer having a thickness of 30 nm was obtained.

5 Compound No. 108 as a host for phosphorescence and Ir(Ph-ppy)₃ as a dopant for phosphorescence were co-deposited from the vapor onto the hole transporting layer, whereby a phosphorescent layer having a thickness of 30 nm
10 was obtained. The concentration of Ir(Ph-ppy)₃ was 10 mass %.

Subsequently, Compound No. 92 having a thickness of 10 nm, Compound C having a thickness of 20 nm, LiF having
15 a thickness of 1 nm, and metal Al having a thickness of 80 nm were sequentially laminated on the phosphorescent layer, whereby a cathode was obtained. It should be noted that LiF as an electron injectable electrode was formed at a rate of 1 Å/min.

TABLE 1

	Host compound	Voltage (V) @20 mA/cm ²	Efficiency (cd/A) @1,000 cd/m ²	Life time (hr) @20,000 cd/m ²
Example 1	(11)	5.3	47.6	190
Example 2	(40)	5.2	46.2	200
Example 3	(47)	5.3	47.1	200
Example 4	(66)	5.4	49.1	160
Example 5	(100)	5.5	58.2	250
Example 6	(103)	5.6	59.1	230
Example 7	(116)	5.5	58.3	300
Example 8	(119)	5.5	57.1	320
Example 9	(134)	5.2	54.9	290
Example 10	(139)	5.3	55.3	280
Example 11	(154)	5.5	59.3	200
Example 12	(157)	5.6	60.1	180
Example 13	(233)	5.3	54.3	150
Example 14	(239)	5.5	58.5	420
Example 15	(243)	5.5	55.9	90
Example 16	(249)	5.6	58.3	440
Example 17	(253)	5.6	56.6	80
Example 18	(259)	5.8	59.7	400
Example 19	(263)	5.7	57.2	70
Example 20	(269)	5.9	59.8	360
Example 21	(272)	5.5	55.7	420
Example 22	(273)	5.4	55.8	470
Example 23	(274)	5.4	59.7	410
Example 24	(276)	5.6	59.9	250
Example 25	(1)	5.4	54.3	510
Example 26	(108)	6.1	58.7	530
Comparative Example 1	(a)	4.6	26.5	50
Comparative Example 2	(b)	4.7	28.9	60
Comparative Example 3	(c)	4.5	23.1	50
Comparative Example 4	(d)	4.7	28.1	60
Comparative Example 5	(e)	4.7	26.1	30
Comparative Example 6	(f)	4.2	17.6	30
Comparative Example 7	(g)	4.3	18.5	30
Comparative Example 8	(h)	4.9	37.5	50
Comparative Example 9	(i)	4.7	35.9	60
Comparative Example 10	(j)	4.7	35.5	50
Comparative Example 11	(k)	4.5	35.7	50
Comparative Example 12	(l)	4.3	17.3	30
Comparative Example 13	(m)	4.5	17.7	20
Comparative Example 14	(n)	5.4	28.7	60
Comparative Example 15	(o)	5.5	38.2	50

Example 27

(Production of Organic EL Device)

The glass substrate provided with a transparent electrode cleaned in the same manner as described above was mounted on a substrate holder of a vacuum deposition apparatus. First, Compound A was deposited from the vapor onto the surface of the glass substrate on the side where a

60 (Evaluation of Organic EL Device for Light Emitting Performance)

The organic EL device thus produced was caused to emit light by being driven with a direct current. The luminance (L) of the emitted light and the current density at which the device started to emit the light were measured. Then, the current efficiency (L/J) of the device at a luminance of 1,000 cd/m² was determined. Further, the lifetime of the device at

395

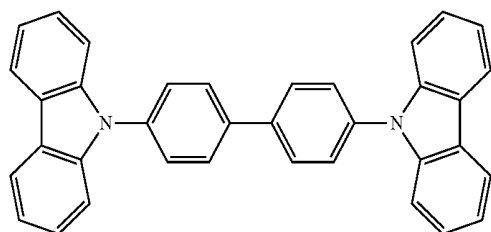
a luminance of 20,000 cd/m² was determined. Table 2 shows the results.

Examples 28 to 37

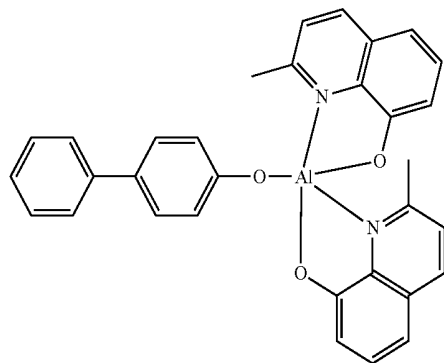
Organic EL devices were each produced in the same manner as in Example 27 except that a host compound and an electron transportable compound listed in Table 2 were used instead of Host Compound No. 108 and Electron Transportable Compound No. 92 in Example 27, and the devices were each evaluated in the same manner as in Example 27. Table 2 shows the results of the evaluation for light emitting performance.

Comparative Example 16

An organic EL device was produced in the same manner as in Example 27 except that: CBP was used instead of Host Compound No. 108 in Example 27; and BALq was used instead of Electron Transportable Compound No. 92 in Example 27. Then, the device was evaluated in the same manner as in Example 27. Table 2 shows the results of the evaluation for light emitting performance.



CBP



BALq

TABLE 2

	Host compound	Electron transportable compound	Voltage (V) @20 mA/cm ²	Efficiency (cd/A) @1,000 cd/m ²	Life time (hr) @20,000 cd/m ²
Example 27	(108)	(92)	5.8	60.2	580
Example 28	(108)	(306)	5.7	62.1	560
Example 29	(108)	(108)	6.0	63.7	600
Example 30	(108)	(329)	5.9	62.3	550
Example 31	(1)	(92)	4.8	55.6	550
Example 32	(103)	(92)	5.5	66.1	590
Example 33	(119)	(92)	5.7	68.9	570
Example 34	CBP	(92)	5.7	48.5	100
Example 35	CBP	(306)	5.6	49.6	120
Example 36	CBP	(108)	5.9	48.2	100
Example 37	CBP	(329)	5.8	49.3	120
Comparative Example 16	CBP	BALq	6.5	45.1	30

396

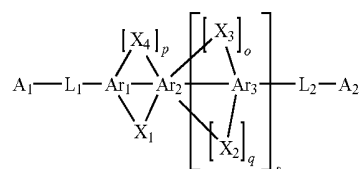
Each of the organic EL devices of the comparative examples showed a lower current efficiency, was driven at a higher voltage, and had a shorter lifetime than those of each of the organic EL devices of the examples.

INDUSTRIAL APPLICABILITY

As described above in detail, the utilization of the material for an organic EL device of the present invention can provide an organic EL device which shows high luminous efficiency, is free of any pixel defect, and has a long lifetime. Accordingly, the organic EL device of the present invention is extremely useful as, for example, a light source for various electronic instruments. In addition, the material can be effectively used also as a material for an organic electron device, and is extremely useful in an organic solar cell, organic semiconductor laser, a sensor using organic matter, or an organic TFT.

The invention claimed is:

1. A compound represented by the following general formula (1):



where:

Ar₁, Ar₂, and Ar₃ are each independently selected from a group consisting of benzene, naphthalene, biphenyl, terphenyl, fluorene, phanthrene, pyridine, pyridazine, pyrimidine, pyrazine, 1,3,5-triazine, carbazole, dibenzofuran, dibenzothiophene, phenoxazine, phenothiazine, and dihydroacridine, provided that Ar₁, Ar₂, and Ar₃ each may have one substituent Y or multiple substituents Ys, in the case of multiple substituents Ys, the substituent Ys may be different from each other, Y represents an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted

397

aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁, Ar₂, or Ar₃ through a carbon-carbon bond;

X₁ represents N—R₁, X₂, X₃, and X₄ each independently represent O or S;

R₁ represents a substituted aromatic hydrocarbon group wherein the aromatic hydrocarbon group is selected from the group consisting of phenyl, naphthyl, biphenyl, terphenyl, fluorenyl, phenanthrenyl, triphenylenyl, perylenyl, chrysenyl, fluoranthene, benzo-fluorenyl, benzotriphenylenyl, benzochrysenyl and anthracenyl, and wherein the substituent of said substituted aromatic hydrocarbon group is an aromatic heterocyclic group having a ring formed of 3 to 40 atoms; or

R₁ represents a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, wherein the substituent of said substituted aromatic heterocyclic group is selected from the group consisting of an unsubstituted phenyl group, an aromatic heterocyclic group having a ring formed of 3 to 40 atoms, an amino group substituted with an aromatic hydrocarbon group having a ring formed of 6 to 40 carbon atoms, an ester group having an aromatic hydrocarbon group having a ring formed of 6 to 40 carbon atoms, a cyano group, a nitro group and a halogen atom;

p represents 0, o and q each represent 0 or 1, and o+q=1, and s represents 1, 2 or 3;

L₁ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁ through a carbon-carbon bond;

L₂ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₃ through a carbon-carbon bond, provided that, when both X₁ and X₂ represent CR₂R₃, o and p each represent 0, q represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X₁ and X₃ represent CR₂R₃, p and q each represent 0, o represents 1, and both L₁ and L₂ represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, a case where L₁ and L₂ are simultaneously linked at para positions with respect to Ar₂ is excluded;

A₁ represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to

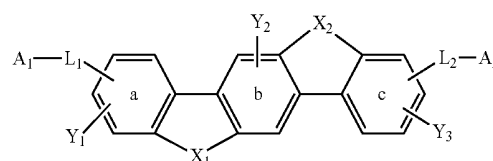
398

20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L₁ through a carbon-carbon bond, provided that, when L₁ represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A₁ represents a hydrogen atom is excluded;

A₂ represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L₂ through a carbon-carbon bond, provided that, when L₂ represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A₂ represents a hydrogen atom is excluded, and, when X₁ and X₂ each represent O, S, or CR₂R₃, o and p each represent 0, q represents 1, and both L₁ and L₂ represent single bonds, or when both X₁ and X₃ each represent O, S, or CR₂R₃, p and q each represent 0, o represents 1, and both L₁ and L₂ represent single bonds, a case where A₁ and A₂ simultaneously represent hydrogen atoms is excluded;

A₁, A₂, L₁, and L₂ are each free of any carbonyl group: a case where the formula (1) has a structure represented by the following general formula (3) is excluded;

(3)



provided that, X₁, X₂, A₁, A₂, L₁, and L₂ in the formula (3) has the same meaning of X₁, X₂, A₁, A₂, L₁, and L₂ in the formula (1), respectively;

Y₁, Y₂, and Y₃ in the formula (3) each represent an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with a benzene ring a, b, or c through a carbon-carbon bond, a number of each of Y₁ and Y₃ is 0, 1, 2, or 3, and a number of Y₂ is 0, 1, or 2.

2. The compound of claim 1, wherein Ar₁, Ar₂, and Ar₃ are each independently selected from a group consisting of benzene, naphthalene, biphenyl, terphenyl, fluorene, and phenanthrene, provided that Ar₁, Ar₂, and Ar₃ each may have one substituent Y or multiple substituents Ys, in the case of multiple substituents Ys, the substituent Ys may be different from each other.

3. The compound of claim 1, wherein Ar₁, Ar₂, and Ar₃ each independently represent a substituted or unsubstituted benzene, a substituted or unsubstituted naphthalene, a sub-

399

stituted or unsubstituted fluorene, or a substituted or unsubstituted carbazole, a substituted or unsubstituted dibenzofuran, a substituted or unsubstituted dibenzothiophene, or a substituted or unsubstituted phenoxazine.

4. The compound of claim 1, wherein Ar₁, Ar₂, and Ar₃ each independently represent a substituted or unsubstituted benzene, a substituted or unsubstituted naphthalene.

5. The compound of claim 1, wherein s represents 1.

6. The compound of claim 1, wherein o represents 1, and q represents 0.

7. The compound of claim 1, wherein L₁ and L₂ are a single bond.

8. The compound of claim 1, wherein A₁ and A₂ are hydrogen.

9. The compound of claim 1, wherein L₁ and L₂ are a single bond;

A₁ and A₂ are hydrogen.

10. The compound of claim 1, wherein the number of each of Y and Ys is 0.

11. The compound of claim 1, wherein Ar₁, Ar₂, and Ar₃ each independently represent a substituted or unsubstituted benzene, a substituted or unsubstituted naphthalene;

L₁ and L₂ are a single bond;

A₁ and A₂ are hydrogen.

12. The compound of claim 1, wherein R₁ is a substituted or unsubstituted monovalent fused aromatic heterocyclic group having 8 to 24 carbon atoms.

400

13. The compound of claim 1, wherein Ar₁, Ar₂, and Ar₃ are each independently selected from a group consisting of benzene and naphthalene;

R₁ is a substituted or unsubstituted monovalent fused aromatic heterocyclic group having 8 to 24 carbon atoms.

14. An organic electroluminescence device comprising one or more organic thin film layers including a light emitting layer between a cathode and an anode, wherein at least one layer of the organic thin film layers contains the compound according to claim 1.

15. The organic electroluminescence device according to claim 14, wherein the light emitting layer contains the compound as a host material.

16. The organic electroluminescence device according to claim 15, wherein the light emitting layer further contains a phosphorescent material.

17. The organic electroluminescence device according to claim 14, wherein the light emitting layer contains a host material and a phosphorescent material, and the phosphorescent material comprises an orthometalated complex of an iridium (Ir), osmium (Os), or platinum (Pt) metal.

18. The compound of claim 1, wherein the substituent of said substituted aromatic heterocyclic group for R₁ is selected from the group consisting of an unsubstituted phenyl group, and an unsubstituted aromatic heterocyclic group having a ring formed of 3 to 40 atoms.

* * * * *

专利名称(译)	用于有机电致发光器件的材料和使用其的有机电致发光器件		
公开(公告)号	US10026907	公开(公告)日	2018-07-17
申请号	US15/785749	申请日	2017-10-17
申请(专利权)人(译)	出光兴产股份有限公司.		
当前申请(专利权)人(译)	出光兴产股份有限公司.		
[标]发明人	KATO TOMOKI NUMATA MASAKI NISHIMURA KAZUKI IWAKUMA TOSHIHIRO HOSOKAWA CHISHIO		
发明人	KATO, TOMOKI NUMATA, MASAKI NISHIMURA, KAZUKI IWAKUMA, TOSHIHIRO HOSOKAWA, CHISHIO		
IPC分类号	H01L51/00 C07D495/04 C09K11/02 C09K11/06 C07D487/04 C07D493/04 C07D307/91 H01L51/50		
CPC分类号	H01L51/0073 C07D487/04 C07D493/04 C07D495/04 C09K11/025 C09K11/06 H01L51/0055 H01L51/0067 H01L51/0072 H01L51/0074 H01L51/0085 C07D307/91 H01L51/5016 C09K2211/1007 C09K2211/1029 C09K2211/185		
优先权	2008148514 2008-06-05 JP		
其他公开文献	US20180040835A1		
外部链接	Espacenet		

摘要(译)

本发明提供一种有机电致发光器件，其显示出高发光效率，没有任何像素缺陷，并且具有长寿命，以及用于实现该器件的有机电致发光器件的材料。用于有机电致发光器件的材料是具有与碳原子，氮原子，氧原子或硫原子交联的n-共轭杂并苯骨架的化合物。有机电致发光器件具有一个或多个有机薄膜层，所述有机薄膜层包括在阴极和阳极之间的发光层，并且至少一层有机薄膜层包含用于有机电致发光器件的材料。

