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

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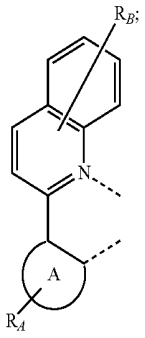
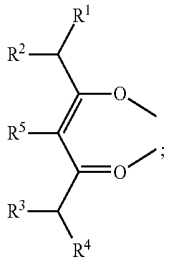
(57) **ABSTRACT**

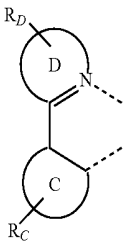
A compound having a formula $M(L_A)_x(L_B)_y(L_C)$ where ligand $L_A$ is



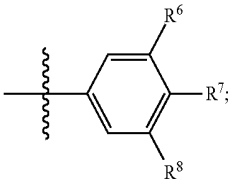
ligand $L_B$ is



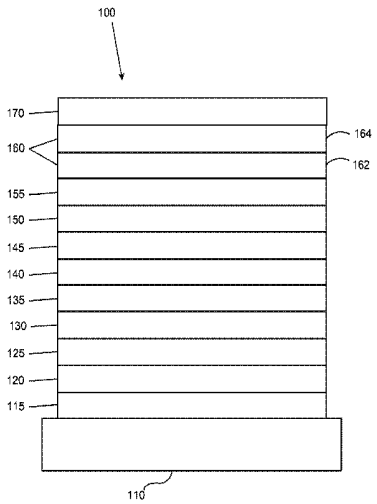
and ligand $L_C$ is



is disclosed. In the formula, M is a heavy metal, x and y are 1, or 2, and z is 0, 1, or 2, where x+y+z is the oxidation state of metal M. $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl, and at least one of $R^1$, $R^2$, $R^3$, and $R^4$ has at least two C atoms. Rings A, C, and D are each independently a 5 or 6-membered carbocyclic or heterocyclic ring; at least one $R_B$ has the following structure



and at least one of $R^6$, $R^7$, and $R^8$ is alkyl, cycloalkyl, halide, and combinations thereof. Any adjacent substitutents of $R_A$, $R_B$, $R_C$, and $R_D$ are optionally joined to form a ring.



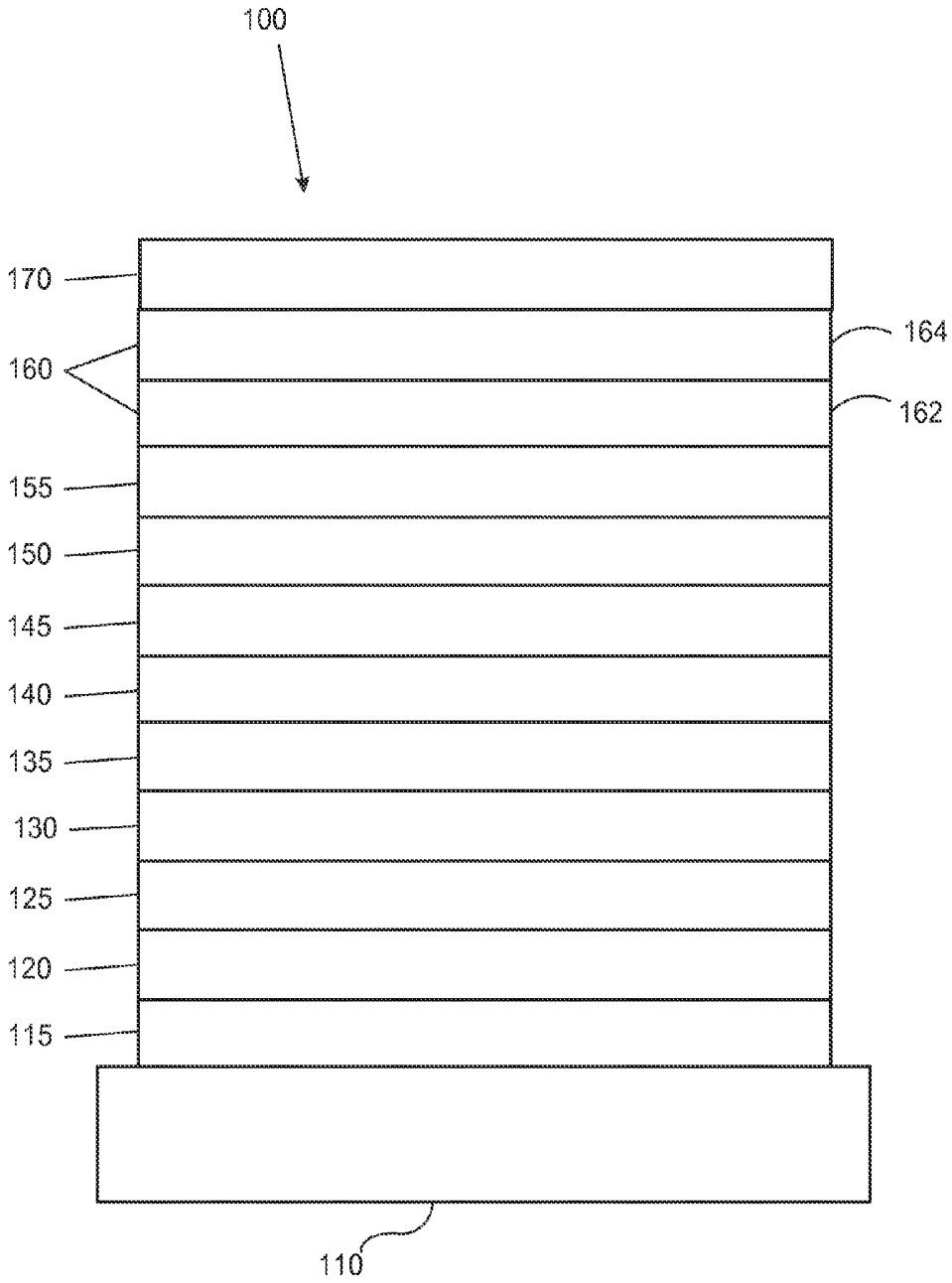



FIGURE 1

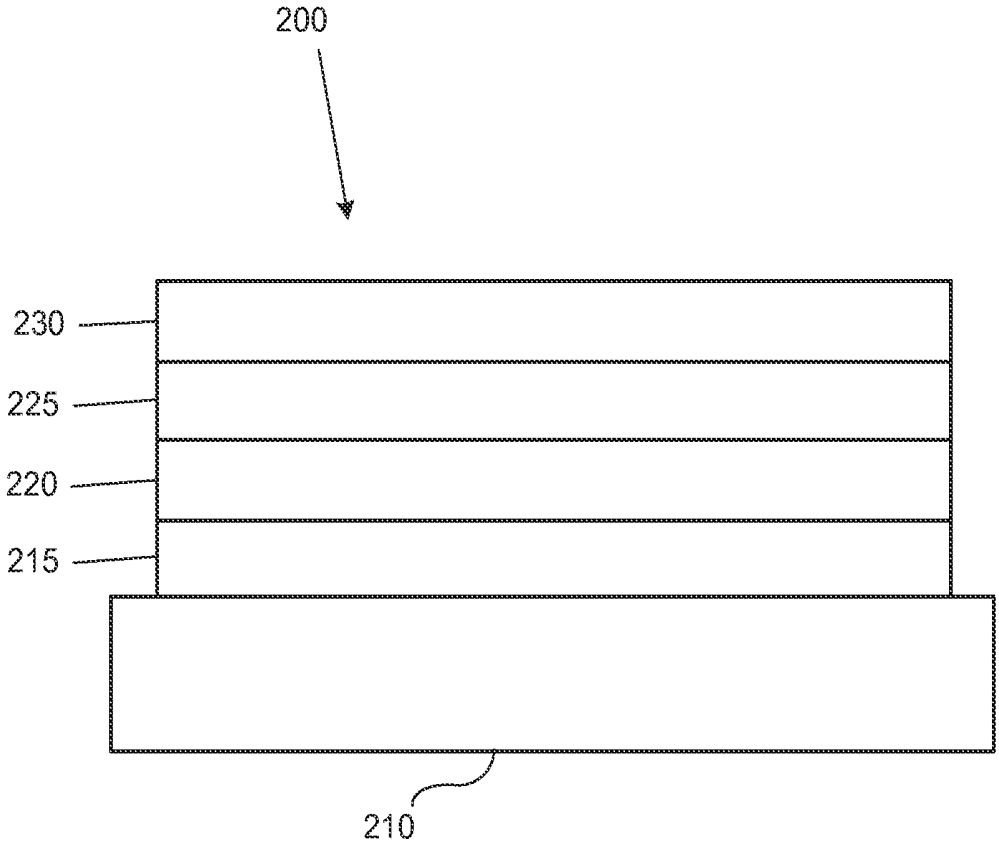
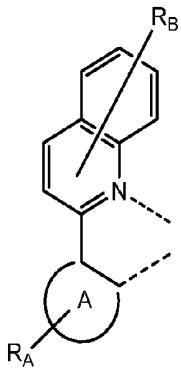
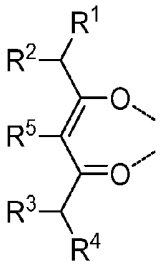


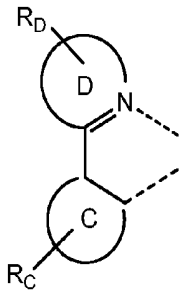

FIGURE 2




Ligand $L_A$




Ligand $L_B$




Ligand $L_C$

Figure 3

# ORGANIC ELECTROLUMINESCENT MATERIALS AND DEVICES

## PARTIES TO A JOINT RESEARCH AGREEMENT

**[0001]** The claimed invention was made by, on behalf of, and/or in connection with one or more of the following parties to a joint university corporation research agreement: Regents of the University of Michigan, Princeton University, University of Southern California, and the Universal Display Corporation. The agreement was in effect on and before the date the claimed invention was made, and the claimed invention was made as a result of activities undertaken within the scope of the agreement.

## FIELD OF THE INVENTION

**[0002]** The present invention relates to compounds for use as emitters and devices, such as organic light emitting diodes, including the same.

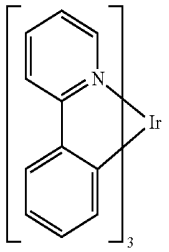
## BACKGROUND

**[0003]** Opto-electronic devices that make use of organic materials are becoming increasingly desirable for a number of reasons. Many of the materials used to make such devices are relatively inexpensive, so organic opto-electronic devices have the potential for cost advantages over inorganic devices. In addition, the inherent properties of organic materials, such as their flexibility, may make them well suited for particular applications such as fabrication on a flexible substrate. Examples of organic opto-electronic devices include organic light emitting devices (OLEDs), organic phototransistors, organic photovoltaic cells, and organic photodetectors. For OLEDs, the organic materials may have performance advantages over conventional materials. For example, the wavelength at which an organic emissive layer emits light may generally be readily tuned with appropriate dopants.

**[0004]** OLEDs make use of thin organic films that emit light when voltage is applied across the device. OLEDs are becoming an increasingly interesting technology for use in applications such as flat panel displays, illumination, and backlighting. Several OLED materials and configurations are described in U.S. Pat. Nos. 5,844,363, 6,303,238, and 5,707,745, which are incorporated herein by reference in their entirety.

**[0005]** One application for phosphorescent emissive molecules is a full color display. Industry standards for such a display call for pixels adapted to emit particular colors, referred to as "saturated" colors. In particular, these standards call for saturated red, green, and blue pixels. Color may be measured using CIE coordinates, which are well known to the art.

**[0006]** One example of a green emissive molecule is tris(2-phenylpyridine) iridium, denoted $Ir(ppy)_3$, which has the following structure:




**[0007]** In this, and later figures herein, we depict the dative bond from nitrogen to metal (here, Ir) as a straight line.

**[0008]** As used herein, the term "organic" includes polymeric materials as well as small molecule organic materials that may be used to fabricate organic opto-electronic devices. "Small molecule" refers to any organic material that is not a polymer, and "small molecules" may actually be quite large. Small molecules may include repeat units in some circumstances. For example, using a long chain alkyl group as a substituent does not remove a molecule from the "small molecule" class. Small molecules may also be incorporated into polymers, for example as a pendent group on a polymer backbone or as a part of the backbone. Small molecules may also serve as the core moiety of a dendrimer, which consists of a series of chemical shells built on the core moiety. The core moiety of a dendrimer may be a fluorescent or phosphorescent small molecule emitter. A dendrimer may be a "small molecule," and it is believed that all dendrimers currently used in the field of OLEDs are small molecules.

**[0009]** As used herein, "top" means furthest away from the substrate, while "bottom" means closest to the substrate. Where a first layer is described as "disposed over" a second layer, the first layer is disposed further away from substrate. There may be other layers between the first and second layer, unless it is specified that the first layer is "in contact with" the second layer. For example, a cathode may be described as "disposed over" an anode, even though there are various organic layers in between.

**[0010]** As used herein, "solution processable" means capable of being dissolved, dispersed, or transported in and/or deposited from a liquid medium, either in solution or suspension form.

**[0011]** A ligand may be referred to as "photoactive" when it is believed that the ligand directly contributes to the photoactive properties of an emissive material. A ligand may be referred to as "ancillary" when it is believed that the ligand does not contribute to the photoactive properties of an emissive material, although an ancillary ligand may alter the properties of a photoactive ligand.

**[0012]** As used herein, and as would be generally understood by one skilled in the art, a first "Highest Occupied Molecular Orbital" (HOMO) or "Lowest Unoccupied Molecular Orbital" (LUMO) energy level is "greater than" or "higher than" a second HOMO or LUMO energy level if the first energy level is closer to the vacuum energy level. Since ionization potentials (IP) are measured as a negative energy relative to a vacuum level, a higher HOMO energy level corresponds to an IP having a smaller absolute value (an IP that is less negative). Similarly, a higher LUMO energy level corresponds to an electron affinity (EA) having a smaller

absolute value (an EA that is less negative). On a conventional energy level diagram, with the vacuum level at the top, the LUMO energy level of a material is higher than the HOMO energy level of the same material. A "higher" HOMO or LUMO energy level appears closer to the top of such a diagram than a "lower" HOMO or LUMO energy level.

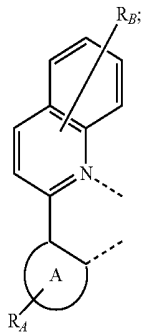
**[0013]** As used herein, and as would be generally understood by one skilled in the art, a first work function is "greater than" or "higher than" a second work function if the first work function has a higher absolute value. Because work functions are generally measured as negative numbers relative to vacuum level, this means that a "higher" work function is more negative. On a conventional energy level diagram, with the vacuum level at the top, a "higher" work function is illustrated as further away from the vacuum level in the downward direction. Thus, the definitions of HOMO and LUMO energy levels follow a different convention than work functions.

**[0014]** More details on OLEDs, and the definitions described above, can be found in U.S. Pat. No. 7,279,704, which is incorporated herein by reference in its entirety.

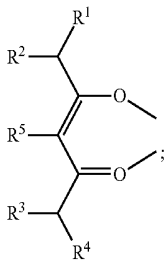
## SUMMARY OF THE INVENTION

**[0015]** According to an embodiment, a compound is provided that has a structure according to formula $M(L_A)_x(L_B)_y(L_C)_z$:

**[0016]** wherein the ligand $L_A$ is

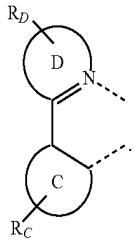


**[0017]** wherein the ligand $L_B$ is



and

**[0018]** wherein the ligand $L_C$ is



In the compounds of formula $M(L_A)_x(L_B)_y(L_C)_z$:

**[0019]** M is a metal having an atomic number greater than 40;

**[0020]** x is 1, or 2;

**[0021]** y is 1, or 2;

**[0022]** z is 0, 1, or 2;

**[0023]** x+y+z is the oxidation state of the metal M;

**[0024]** $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl;

**[0025]** at least one of $R^1$, $R^2$, $R^3$, and $R^4$ has at least two C atoms;

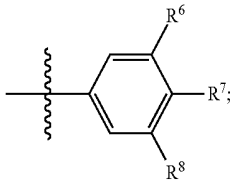
**[0026]** $R^5$ is selected from group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

**[0027]** rings A, C, and D are each independently a 5 or 6-membered carbocyclic or heterocyclic ring;

**[0028]** $R_A$, $R_C$, and $R_D$ each independently represent mono, di, tri, or tetra substitution, or no substitution;

**[0029]** $R_B$ represents mono, di, tri, tetra, penta, or hexa substitution;

**[0030]** at least one $R_B$ has the following structure:



**[0031]** each of $R_A$, $R_B$, $R_C$, and $R_D$ are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

**[0032]** any adjacent substitutents of $R_A$, $R_B$, $R_C$, and $R_D$ are optionally joined to form a ring;

**[0033]** $R^6$, $R^7$, and $R^8$ are independently selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof; and

**[0034]** at least one of $R^6$, $R^7$, and $R^8$ is not hydrogen or deuterium.

**[0035]** According to another embodiment, a first device comprising a first organic light emitting device is also provided. The first organic light emitting device can include an anode, a cathode, and an organic layer, disposed between the anode and the cathode. The organic layer can include a com-

pound of formula $M(L_A)_x(L_B)_y(L_C)_z$. The first device can be a consumer product, an organic light-emitting device, and/or a lighting panel.

**[0036]** Formulations containing a compound of formula $M(L_A)_x(L_B)_y(L_C)_z$ are also provided.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0037]** FIG. **1** shows an organic light emitting device.

**[0038]** FIG. **2** shows an inverted organic light emitting device that does not have a separate electron transport layer.

**[0039]** FIG. **3** shows the structure of the ligands of formula $M(L_A)_x(L_B)_y(L_C)_z$ as disclosed herein.

## DETAILED DESCRIPTION

**[0040]** Generally, an OLED comprises at least one organic layer disposed between and electrically connected to an anode and a cathode. When a current is applied, the anode injects holes and the cathode injects electrons into the organic layer(s). The injected holes and electrons each migrate toward the oppositely charged electrode. When an electron and hole localize on the same molecule, an "exciton," which is a localized electron-hole pair having an excited energy state, is formed. Light is emitted when the exciton relaxes via a photoemissive mechanism. In some cases, the exciton may be localized on an excimer or an exciplex. Non-radiative mechanisms, such as thermal relaxation, may also occur, but are generally considered undesirable.

**[0041]** The initial OLEDs used emissive molecules that emitted light from their singlet states ("fluorescence") as disclosed, for example, in U.S. Pat. No. 4,769,292, which is incorporated by reference in its entirety. Fluorescent emission generally occurs in a time frame of less than 10 nanoseconds.

**[0042]** More recently, OLEDs having emissive materials that emit light from triplet states ("phosphorescence") have been demonstrated. Baldo et al., "Highly Efficient Phosphorescent Emission from Organic Electroluminescent Devices," Nature, vol. 395, 151-154, 1998; ("Baldo-I") and Baldo et al., "Very high-efficiency green organic light-emitting devices based on electrophosphorescence," Appl. Phys. Lett., vol. 75, No. 3, 4-6 (1999) ("Baldo-II"), which are incorporated by reference in their entireties. Phosphorescence is described in more detail in U.S. Pat. No. 7,279,704 at cols. 5-6, which are incorporated by reference.

**[0043]** FIG. **1** shows an organic light emitting device **100**. The figures are not necessarily drawn to scale. Device **100** may include a substrate **110**, an anode **115**, a hole injection layer **120**, a hole transport layer **125**, an electron blocking layer **130**, an emissive layer **135**, a hole blocking layer **140**, an electron transport layer **145**, an electron injection layer **150**, a protective layer **155**, a cathode **160**, and a barrier layer **170**. Cathode **160** is a compound cathode having a first conductive layer **162** and a second conductive layer **164**. Device **100** may be fabricated by depositing the layers described, in order. The properties and functions of these various layers, as well as example materials, are described in more detail in U.S. Pat. No. 7,279,704 at cols. 6-10, which are incorporated by reference.

**[0044]** More examples for each of these layers are available. For example, a flexible and transparent substrate-anode combination is disclosed in U.S. Pat. No. 5,844,363, which is incorporated by reference in its entirety. An example of a p-doped hole transport layer is m-MTDATA doped with $F_4$-TCNQ at a molar ratio of 50:1, as disclosed in U.S. Patent Application Publication No. 2003/0230980, which is incorporated by reference in its entirety. Examples of emissive and host materials are disclosed in U.S. Pat. No. 6,303,238 to Thompson et al., which is incorporated by reference in its entirety. An example of an n-doped electron transport layer is BPhen doped with Li at a molar ratio of 1:1, as disclosed in U.S. Patent Application Publication No. 2003/0230980, which is incorporated by reference in its entirety. U.S. Pat. Nos. 5,703,436 and 5,707,745, which are incorporated by reference in their entireties, disclose examples of cathodes including compound cathodes having a thin layer of metal such as Mg:Ag with an overlying transparent, electrically-conductive, sputter-deposited ITO layer. The theory and use of blocking layers is described in more detail in U.S. Pat. No. 6,097,147 and U.S. Patent Application Publication No. 2003/0230980, which are incorporated by reference in their entireties. Examples of injection layers are provided in U.S. Patent Application Publication No. 2004/0174116, which is incorporated by reference in its entirety. A description of protective layers may be found in U.S. Patent Application Publication No. 2004/0174116, which is incorporated by reference in its entirety.

**[0045]** FIG. **2** shows an inverted OLED **200**. The device includes a substrate **210**, a cathode **215**, an emissive layer **220**, a hole transport layer **225**, and an anode **230**. Device **200** may be fabricated by depositing the layers described, in order. Because the most common OLED configuration has a cathode disposed over the anode, and device **200** has cathode **215** disposed under anode **230**, device **200** may be referred to as an "inverted" OLED. Materials similar to those described with respect to device **100** may be used in the corresponding layers of device **200**. FIG. **2** provides one example of how some layers may be omitted from the structure of device **100**.

**[0046]** The simple layered structure illustrated in FIGS. **1** and **2** is provided by way of non-limiting example, and it is understood that embodiments of the invention may be used in connection with a wide variety of other structures. The specific materials and structures described are exemplary in nature, and other materials and structures may be used. Functional OLEDs may be achieved by combining the various layers described in different ways, or layers may be omitted entirely, based on design, performance, and cost factors. Other layers not specifically described may also be included. Materials other than those specifically described may be used. Although many of the examples provided herein describe various layers as comprising a single material, it is understood that combinations of materials, such as a mixture of host and dopant, or more generally a mixture, may be used. Also, the layers may have various sublayers. The names given to the various layers herein are not intended to be strictly limiting. For example, in device **200**, hole transport layer **225** transports holes and injects holes into emissive layer **220**, and may be described as a hole transport layer or a hole injection layer. In one embodiment, an OLED may be described as having an "organic layer" disposed between a cathode and an anode. This organic layer may comprise a single layer, or may further comprise multiple layers of different organic materials as described, for example, with respect to FIGS. **1** and **2**.

**[0047]** Structures and materials not specifically described may also be used, such as OLEDs comprised of polymeric materials (PLEDs) such as disclosed in U.S. Pat. No. 5,247,190 to Friend et al., which is incorporated by reference in its entirety. By way of further example, OLEDs having a single organic layer may be used. OLEDs may be stacked, for

example as described in U.S. Pat. No. 5,707,745 to Forrest et al, which is incorporated by reference in its entirety. The OLED structure may deviate from the simple layered structure illustrated in FIGS. **1** and **2**. For example, the substrate may include an angled reflective surface to improve outcoupling, such as a mesa structure as described in U.S. Pat. No. 6,091,195 to Forrest et al., and/or a pit structure as described in U.S. Pat. No. 5,834,893 to Bulovic et al., which are incorporated by reference in their entireties.

**[0048]** Unless otherwise specified, any of the layers of the various embodiments may be deposited by any suitable method. For the organic layers, preferred methods include thermal evaporation, ink-jet, such as described in U.S. Pat. Nos. 6,013,982 and 6,087,196, which are incorporated by reference in their entireties, organic vapor phase deposition (OVPD), such as described in U.S. Pat. No. 6,337,102 to Forrest et al., which is incorporated by reference in its entirety, and deposition by organic vapor jet printing (OVJP), such as described in U.S. Pat. No. 7,431,968, which is incorporated by reference in its entirety. Other suitable deposition methods include spin coating and other solution based processes. Solution based processes are preferably carried out in nitrogen or an inert atmosphere. For the other layers, preferred methods include thermal evaporation. Preferred patterning methods include deposition through a mask, cold welding such as described in U.S. Pat. Nos. 6,294,398 and 6,468,819, which are incorporated by reference in their entireties, and patterning associated with some of the deposition methods such as ink-jet and OVJD. Other methods may also be used. The materials to be deposited may be modified to make them compatible with a particular deposition method. For example, substituents such as alkyl and aryl groups, branched or unbranched, and preferably containing at least 3 carbons, may be used in small molecules to enhance their ability to undergo solution processing. Substituents having 20 carbons or more may be used, and 3-20 carbons is a preferred range. Materials with asymmetric structures may have better solution processability than those having symmetric structures, because asymmetric materials may have a lower tendency to recrystallize. Dendrimer substituents may be used to enhance the ability of small molecules to undergo solution processing.

**[0049]** Devices fabricated in accordance with embodiments of the present invention may further optionally comprise a barrier layer. One purpose of the barrier layer is to protect the electrodes and organic layers from damaging exposure to harmful species in the environment including moisture, vapor and/or gases, etc. The barrier layer may be deposited over, under or next to a substrate, an electrode, or over any other parts of a device including an edge. The barrier layer may comprise a single layer, or multiple layers. The barrier layer may be formed by various known chemical vapor deposition techniques and may include compositions having a single phase as well as compositions having multiple phases. Any suitable material or combination of materials may be used for the barrier layer. The barrier layer may incorporate an inorganic or an organic compound or both. The preferred barrier layer comprises a mixture of a polymeric material and a non-polymeric material as described in U.S. Pat. No. 7,968,146, PCT Pat. Application Nos. PCT/US2007/023098 and PCT/US2009/042829, which are herein incorporated by reference in their entireties. To be considered a "mixture", the aforesaid polymeric and non-polymeric materials comprising the barrier layer should be deposited under the same reaction conditions and/or at the same time. The weight ratio of polymeric to non-polymeric material may be in the range of 95:5 to 5:95. The polymeric material and the non-polymeric material may be created from the same precursor material. In one example, the mixture of a polymeric material and a non-polymeric material consists essentially of polymeric silicon and inorganic silicon.

**[0050]** Devices fabricated in accordance with embodiments of the invention may be incorporated into a wide variety of consumer products, including flat panel displays, computer monitors, medical monitors, televisions, billboards, lights for interior or exterior illumination and/or signaling, heads up displays, fully transparent displays, flexible displays, laser printers, telephones, cell phones, personal digital assistants (PDAs), laptop computers, digital cameras, camcorders, viewfinders, micro-displays, 3-D displays, vehicles, a large area wall, theater or stadium screen, or a sign. Various control mechanisms may be used to control devices fabricated in accordance with the present invention, including passive matrix and active matrix. Many of the devices are intended for use in a temperature range comfortable to humans, such as 18 degrees C. to 30 degrees C., and more preferably at room temperature (20-25 degrees C.), but could be used outside this temperature range, for example, from −40 degree C. to +80 degree C.

**[0051]** The materials and structures described herein may have applications in devices other than OLEDs. For example, other optoelectronic devices such as organic solar cells and organic photodetectors may employ the materials and structures. More generally, organic devices, such as organic transistors, may employ the materials and structures.

**[0052]** The term "halo" or "halogen" as used herein includes fluorine, chlorine, bromine, and iodine.

**[0053]** The term "alkyl" as used herein contemplates both straight and branched chain alkyl radicals. Preferred alkyl groups are those containing from one to fifteen carbon atoms and includes methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, and the like. Additionally, the alkyl group may be optionally substituted.

**[0054]** The term "cycloalkyl" as used herein contemplates cyclic alkyl radicals. Preferred cycloalkyl groups are those containing 3 to 7 carbon atoms and includes cyclopropyl, cyclopentyl, cyclohexyl, and the like. Additionally, the cycloalkyl group may be optionally substituted.

**[0055]** The term "alkenyl" as used herein contemplates both straight and branched chain alkene radicals. Preferred alkenyl groups are those containing two to fifteen carbon atoms. Additionally, the alkenyl group may be optionally substituted.

**[0056]** The term "alkynyl" as used herein contemplates both straight and branched chain alkyne radicals. Preferred alkynyl groups are those containing two to fifteen carbon atoms. Additionally, the alkynyl group may be optionally substituted.

**[0057]** The terms "aralkyl" or "arylalkyl" as used herein are used interchangeably and contemplate an alkyl group that has as a substituent an aromatic group. Additionally, the aralkyl group may be optionally substituted.

**[0058]** The term "heterocyclic group" as used herein contemplates aromatic and non-aromatic cyclic radicals. Hetero-aromatic cyclic radicals also means heteroaryl. Preferred hetero-non-aromatic cyclic groups are those containing 3 or 7 ring atoms which includes at least one hetero atom, and includes cyclic amines such as morpholino, piperdino, pyr-

rolidino, and the like, and cyclic ethers, such as tetrahydrofuran, tetrahydropyran, and the like. Additionally, the heterocyclic group may be optionally substituted.

**[0059]** The term "aryl" or "aromatic group" as used herein contemplates single-ring groups and polycyclic ring systems. The polycyclic rings may have two or more rings in which two carbons are common to two adjoining rings (the rings are "fused") wherein at least one of the rings is aromatic, e.g., the other rings can be cycloalkyls, cycloalkenyls, aryl, heterocycles, and/or heteroaryls. Additionally, the aryl group may be optionally substituted.

**[0060]** The term "heteroaryl" as used herein contemplates single-ring hetero-aromatic groups that may include from one to three heteroatoms, for example, pyrrole, furan, thiophene, imidazole, oxazole, thiazole, triazole, pyrazole, pyridine, pyrazine and pyrimidine, and the like. The term heteroaryl also includes polycyclic hetero-aromatic systems having two or more rings in which two atoms are common to two adjoining rings (the rings are "fused") wherein at least one of the rings is a heteroaryl, e.g., the other rings can be cycloalkyls, cycloalkenyls, aryl, heterocycles, and/or heteroaryls. Additionally, the heteroaryl group may be optionally substituted.

**[0061]** The alkyl, cycloalkyl, alkenyl, alkynyl, aralkyl, heterocyclic group, aryl, and heteroaryl may be optionally substituted with one or more substituents selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, cyclic amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

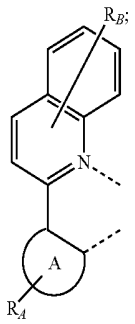
**[0062]** As used herein, "substituted" indicates that a substituent other than H is bonded to the relevant position, such as carbon. Thus, for example, where $R^1$ is mono-substituted, then one $R^1$ must be other than H. Similarly, where $R^1$ is di-substituted, then two of $R^1$ must be other than H. Similarly, where $R^1$ is unsubstituted, $R^1$ is hydrogen for all available positions.

**[0063]** The "aza" designation in the fragments described herein, i.e. aza-dibenzofuran, aza-dibenzothiophene, etc. means that one or more of the C—H groups in the respective fragment can be replaced by a nitrogen atom, for example, and without any limitation, azatriphenylene encompasses both dibenzo[f,h]quinoxaline and dibenzo[f,h]quinoline. One of ordinary skill in the art can readily envision other nitrogen analogs of the aza-derivatives described above, and all such analogs are intended to be encompassed by the terms as set forth herein.

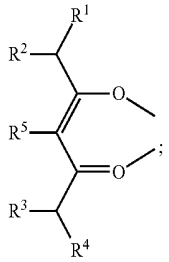
**[0064]** It is to be understood that when a molecular fragment is described as being a substituent or otherwise attached to another moiety, its name may be written as if it were a fragment (e.g. phenyl, phenylene, naphthyl, dibenzofuryl) or as if it were the whole molecule (e.g. benzene, naphthalene, dibenzofuran). As used herein, these different ways of designating a substituent or attached fragment are considered to be equivalent.

**[0065]** According to one embodiment, a compound having a structure according to formula $M(L_A)_x(L_B)_y(L_C)_z$:

**[0066]** wherein the ligand $L_A$ is

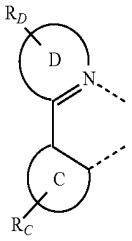



**[0067]** wherein the ligand $L_B$ is




and

**[0068]** wherein the ligand $L_C$ is




is disclosed.

In the compound of formula $M(L_A)_x(L_B)_y(L_C)_z$:

**[0069]** M is a metal having an atomic number greater than 40;

**[0070]** x is 1, or 2;

**[0071]** y is 1, or 2;

**[0072]** z is 0, 1, or 2;

**[0073]** x+y+z is the oxidation state of the metal M;

**[0074]** $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl;

**[0075]** at least one of $R^1$, $R^2$, $R^3$, and $R^4$ has at least two C atoms;

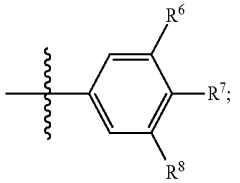
**[0076]** $R^5$ is selected from group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

**[0077]** rings A, C, and D are each independently a 5 or 6-membered carbocyclic or heterocyclic ring;

**[0078]** $R_A$, $R_C$, and $R_D$ each independently represent mono, di, tri, or tetra substitution, or no substitution;

**[0079]** $R_B$ represents mono, di, tri, tetra, penta, or hexa substitution;

**[0080]** at least one $R_B$ has the following structure:




**[0081]** each of $R_A$, $R_B$, $R_C$, and $R_D$ are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

**[0082]** any adjacent substitutents of $R_A$, $R_B$, $R_C$, and $R_D$ are optionally joined to form a ring;

**[0083]** $R^6$, $R^7$, and $R^8$ are independently selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof; and

**[0084]** at least one of $R^6$, $R^7$, and $R^8$ is not hydrogen or deuterium.

**[0085]** In some embodiments, both $R^6$ & $R^8$ are alkyl. In some embodiments, $R^6$ & $R^8$ are the same and are both alkyl. In some embodiments, at least one of $R^6$, $R^7$, and $R^8$ comprises at least 2 C atoms. In some embodiments, at least one of $R^6$, $R^7$, and $R^8$ comprises at least 3 C atoms, while at least one of $R^6$, $R^7$, and $R^8$ comprises at least 4 C atoms in other embodiments.

**[0086]** In some embodiments, $R_B$ is mono substituted. In some embodiments, $R_B$ is at least disubstituted.

**[0087]** In some embodiments, M is selected from the group consisting of Ir, Rh, Re, Ru, Os, Pt, Au, and Cu. In some embodiments, M is Ir.

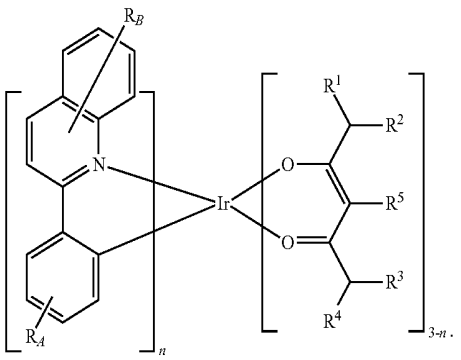
**[0088]** In some embodiments, ring A is benzene. In some embodiments, ring C is benzene and ring D is pyridine.

**[0089]** In some embodiments, $R^5$ is selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, and combinations thereof. In some embodiments, $R^5$ is hydrogen.

**[0090]** In some embodiments, $R^1$, $R^2$, $R^3$, and $R^4$ are alkyl or cycloalkyl. In some such embodiments, $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from the group consisting of methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 2,2-dimethylpropyl, cyclobutyl, cyclopentyl, cyclohexyl, partially or fully deuterated variants thereof, and combinations thereof. In some embodiments, $R^6$, $R^7$, and $R^8$ are independently selected from the group consisting of hydrogen, deuterium, methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 2,2-dimethylpropyl, cyclobutyl, cyclopentyl, cyclohexyl, partially or fully fluorinated variants thereof, fluorine, and combinations thereof.

**[0091]** In some embodiments, the compound has the structure of formula 1:

formula 1

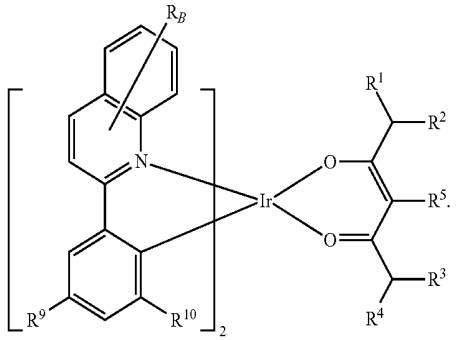



**[0092]** In some embodiments of formula 1, n is 1 or 2. In some embodiments of formula 1, n is 2.

**[0093]** In some embodiments, $R_A$ is selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof.

**[0094]** In some embodiments, the compound has the structure of formula 2:

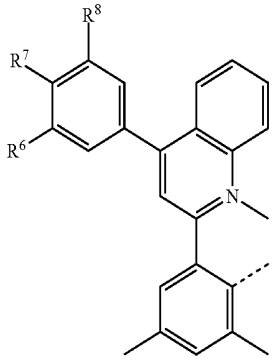
formula 2




**[0095]** In some embodiments of formula 2. $R^9$, and $R^{10}$ are independently selected from the group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof.

**[0096]** In some embodiments, ligand $L_A$ is selected from the group consisting of $L_{A1}$ to $L_{A104}$ listed below:

$L_{A1}$ through $L_{A13}$, each represented by the formula



wherein in $L_{A1}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A2}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A3}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A4}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A5}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A6}$: $R^7$═F, and $R^6$═$R^8$═H,

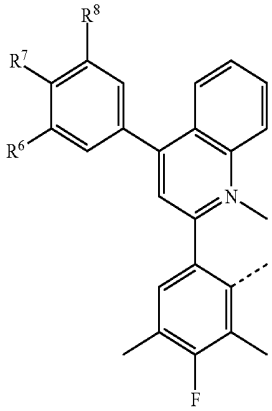
in $L_{A7}$: $R^7$═H, and $R^6$═$R_8$═$CH_3$,

**[0097]** in $L_{A8}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,
in $L_{A9}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,
in $L_{A10}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,
in $L_{A11}$: $R^7$═H, and $R^6$═$R^8$=neopentyl,

in $L_{A12}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A13}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0098]** $L_{A14}$ through $L_{A26}$, each represented by the formula




wherein in $L_{A14}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A14}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A16}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A17}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A18}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A19}$: $R^7$═F, and $R^6$═$R^8$═H,

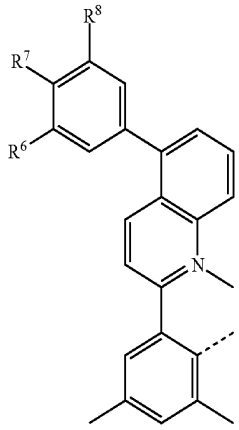
in $L_{A20}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0099]** in $L_{A21}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,
in $L_{A22}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,
in $L_{A23}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,
in $L_{A24}$: $R^7$═H, and $R^6$═$R^8$=neopentyl,

in $L_{A25}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A26}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0100]** $L_{A27}$ through $L_{A39}$, each represented by the formula




wherein in $L_{A27}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A28}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A29}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A30}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A31}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A32}$: $R^7$═F, and $R^6$═$R^8$═H,

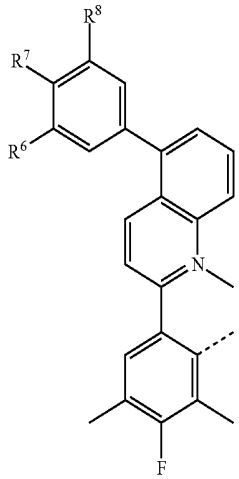
in $L_{A33}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0101]** in $L_{A34}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,
in $L_{A35}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,
in $L_{A36}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,
in $L_{A37}$: $R^7$═H, and $R^6$═$R^8$=neopentyl,

in $L_{A38}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A39}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0102]** $L_{A40}$ through $L_{A52}$, each represented by the formula




wherein in $L_{A40}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A41}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A42}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A43}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A44}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A45}$: $R^7$═F, and $R^6$═$R^8$═H,

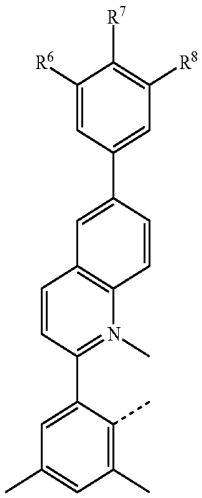
in $L_{A46}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0103]** in $L_{A47}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,
in $L_{A48}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,
in $L_{A49}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,
in $L_{A50}$: $R^7$═H, and $R^6$═$R^8$=neopentyl,

in $L_{A51}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A52}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0104]** $L_{A53}$ through $L_{A65}$, each represented by the formula



wherein in $L_{A53}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A54}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A55}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A56}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A57}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A58}$: $R^7$═F, and $R^6$═$R^8$═H,

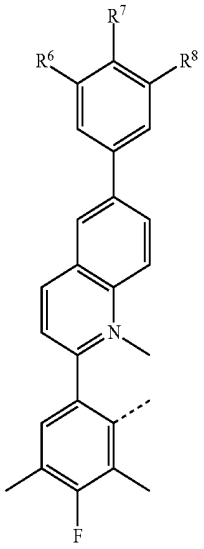
in $L_{A59}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0105]** in $L_{A60}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,
in $L_{A61}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,
in $L_{A62}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,
in $L_{A63}$: $R^7$═H, and $R^6$═$R^8$=neopenty,

in $L_{A64}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A65}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0106]** $L_{A66}$ through $L_{A78}$, each represented by the formula



wherein in $L_{A66}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A67}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A68}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A69}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A70}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A71}$: $R^7$═F, and $R^6$═$R^8$═H,

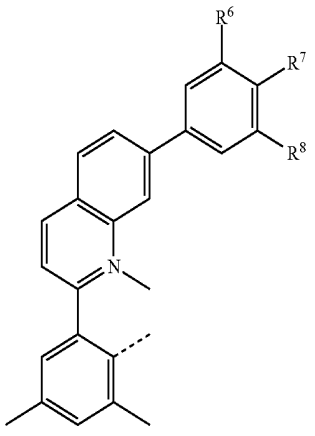
in $L_{A72}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0107]** in $L_{A73}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,
in $L_{A74}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,
in $L_{A75}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,
in $L_{A76}$: $R^7$═H, and $R^6$═$R^8$=neopentyl,

in $L_{A77}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A78}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0108]** $L_{A79}$ through $L_{A91}$, each represented by the formula



wherein in $L_{A79}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,
in $L_{A80}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,
in $L_{A81}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,
in $L_{A82}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,
in $L_{A83}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A84}$: $R^7$═F, and $R^6$═$R^8$═H,

in $L_{A85}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0109]** in $L_{A86}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,

in $L_{A87}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,

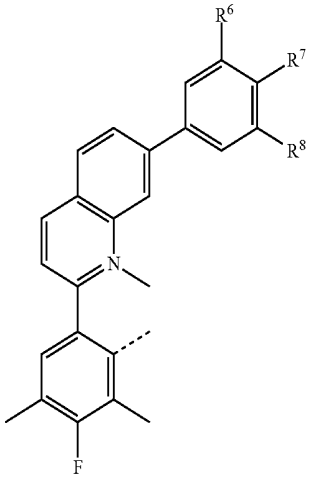
in $L_{A88}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,

in $L_{A89}$: $R^7$═H, and $R^6$═$R^8$ neopentyl,

in $L_{A90}$: $R^7$═H, and $R^6$═$R^8$═F, and

in $L_{A91}$: $R^6$═$R^7$═$R^8$═$CH_3$, and

**[0110]** $L_{A92}$ through $L_{A104}$, each represented by the formula




wherein in $L_{A92}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H,

in $L_{A93}$: $R^7$=isopropyl, and $R^6$═$R^8$═H,

in $L_{A94}$: $R^7$=isobutyl, and $R^6$═$R^8$═H,

in $L_{A95}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H,

in $L_{A96}$: $R^7$=neopentyl, and $R^6$═$R^8$═H,

in $L_{A97}$: $R^7$═F, and $R^6$═$R^8$═H,

in $L_{A98}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$,

**[0111]** in $L_{A99}$: $R^7$═H, and $R^6$═$R^8$=isopropyl,

in $L_{A100}$: $R^7$═H, and $R^6$═$R^8$=isobutyl,

in $L_{A101}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl,

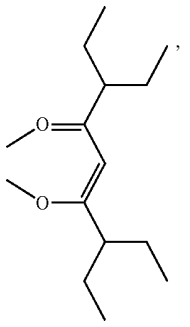
in $L_{A102}$: $R^7$═H, and $R^6$═$R^8$=neopentyl,

in $L_{A103}$: $R^7$═H, and $R^6$═$R^8$═F, and

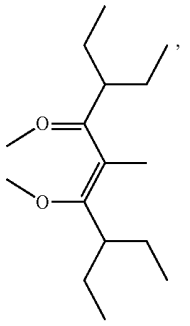
in $L_{A104}$: $R^6$═$R^7$═$R^8$═$CH_3$,

**[0112]** In some embodiments, ligand $L_B$ is selected from the group consisting of $L_{B1}$-$L_{B9}$ listed below:

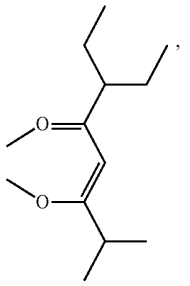
$L_{B1}$



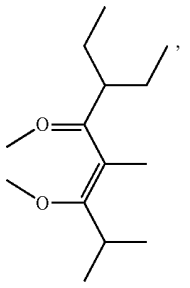

$L_{B2}$



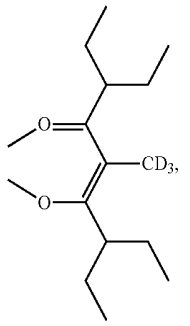

$L_{B3}$




$L_{B4}$

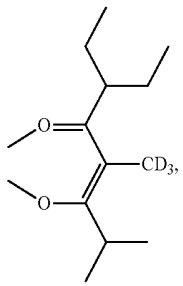



$L_{B5}$

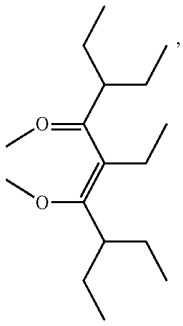


-continued

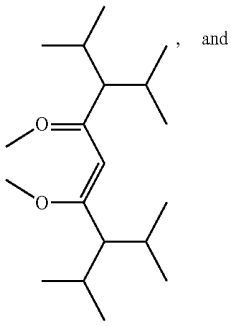
$L_{B6}$



$L_{B7}$

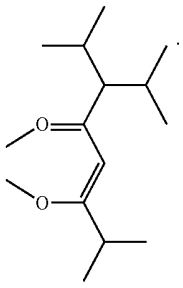


$L_{B8}$



and

$L_{B9}$



**[0113]** In some embodiments, the compound comprises ligand $L_A$ and ligand $L_B$ selected from the group consisting of:

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 1 | $L_{A1}$ | $L_{B1}$ |
| 2 | $L_{A2}$ | $L_{B1}$ |
| 3 | $L_{A3}$ | $L_{B1}$ |
| 4 | $L_{A4}$ | $L_{B1}$ |
| 5 | $L_{A5}$ | $L_{B1}$ |
| 6 | $L_{A6}$ | $L_{B1}$ |
| 7 | $L_{A7}$ | $L_{B1}$ |
| 8 | $L_{A8}$ | $L_{B1}$ |
| 9 | $L_{A9}$ | $L_{B1}$ |
| 10 | $L_{A10}$ | $L_{B1}$ |
| 11 | $L_{A11}$ | $L_{B1}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 12 | $L_{A12}$ | $L_{B1}$ |
| 13 | $L_{A13}$ | $L_{B1}$ |
| 14 | $L_{A14}$ | $L_{B1}$ |
| 15 | $L_{A15}$ | $L_{B1}$ |
| 16 | $L_{A16}$ | $L_{B1}$ |
| 17 | $L_{A17}$ | $L_{B1}$ |
| 18 | $L_{A18}$ | $L_{B1}$ |
| 19 | $L_{A19}$ | $L_{B1}$ |
| 20 | $L_{A20}$ | $L_{B1}$ |
| 21 | $L_{A21}$ | $L_{B1}$ |
| 22 | $L_{A22}$ | $L_{B1}$ |
| 23 | $L_{A23}$ | $L_{B1}$ |
| 24 | $L_{A24}$ | $L_{B1}$ |
| 25 | $L_{A25}$ | $L_{B1}$ |
| 26 | $L_{A26}$ | $L_{B1}$ |
| 27 | $L_{A27}$ | $L_{B1}$ |
| 28 | $L_{A28}$ | $L_{B1}$ |
| 29 | $L_{A29}$ | $L_{B1}$ |
| 30 | $L_{A30}$ | $L_{B1}$ |
| 31 | $L_{A31}$ | $L_{B1}$ |
| 32 | $L_{A32}$ | $L_{B1}$ |
| 33 | $L_{A33}$ | $L_{B1}$ |
| 34 | $L_{A34}$ | $L_{B1}$ |
| 35 | $L_{A35}$ | $L_{B1}$ |
| 36 | $L_{A36}$ | $L_{B1}$ |
| 37 | $L_{A37}$ | $L_{B1}$ |
| 38 | $L_{A38}$ | $L_{B1}$ |
| 39 | $L_{A39}$ | $L_{B1}$ |
| 40 | $L_{A40}$ | $L_{B1}$ |
| 41 | $L_{A41}$ | $L_{B1}$ |
| 42 | $L_{A42}$ | $L_{B1}$ |
| 43 | $L_{A43}$ | $L_{B1}$ |
| 44 | $L_{A44}$ | $L_{B1}$ |
| 45 | $L_{A45}$ | $L_{B1}$ |
| 46 | $L_{A46}$ | $L_{B1}$ |
| 47 | $L_{A47}$ | $L_{B1}$ |
| 48 | $L_{A48}$ | $L_{B1}$ |
| 49 | $L_{A49}$ | $L_{B1}$ |
| 50 | $L_{A50}$ | $L_{B1}$ |
| 51 | $L_{A51}$ | $L_{B1}$ |
| 52 | $L_{A52}$ | $L_{B1}$ |
| 53 | $L_{A53}$ | $L_{B1}$ |
| 54 | $L_{A54}$ | $L_{B1}$ |
| 55 | $L_{A55}$ | $L_{B1}$ |
| 56 | $L_{A56}$ | $L_{B1}$ |
| 57 | $L_{A57}$ | $L_{B1}$ |
| 58 | $L_{A58}$ | $L_{B1}$ |
| 59 | $L_{A59}$ | $L_{B1}$ |
| 60 | $L_{A60}$ | $L_{B1}$ |
| 61 | $L_{A61}$ | $L_{B1}$ |
| 62 | $L_{A62}$ | $L_{B1}$ |
| 63 | $L_{A63}$ | $L_{B1}$ |
| 64 | $L_{A64}$ | $L_{B1}$ |
| 65 | $L_{A65}$ | $L_{B1}$ |
| 66 | $L_{A66}$ | $L_{B1}$ |
| 67 | $L_{A67}$ | $L_{B1}$ |
| 68 | $L_{A68}$ | $L_{B1}$ |
| 69 | $L_{A69}$ | $L_{B1}$ |
| 70 | $L_{A70}$ | $L_{B1}$ |
| 71 | $L_{A71}$ | $L_{B1}$ |
| 72 | $L_{A72}$ | $L_{B1}$ |
| 73 | $L_{A73}$ | $L_{B1}$ |
| 74 | $L_{A74}$ | $L_{B1}$ |
| 75 | $L_{A75}$ | $L_{B1}$ |
| 76 | $L_{A76}$ | $L_{B1}$ |
| 77 | $L_{A77}$ | $L_{B1}$ |
| 78 | $L_{A78}$ | $L_{B1}$ |
| 79 | $L_{A79}$ | $L_{B1}$ |
| 80 | $L_{A80}$ | $L_{B1}$ |
| 81 | $L_{A81}$ | $L_{B1}$ |
| 82 | $L_{A82}$ | $L_{B1}$ |
| 83 | $L_{A83}$ | $L_{B1}$ |
| 84 | $L_{A84}$ | $L_{B1}$ |
| 85 | $L_{A85}$ | $L_{B1}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 86 | $L_{A86}$ | $L_{B1}$ |
| 87 | $L_{A87}$ | $L_{B1}$ |
| 88 | $L_{A88}$ | $L_{B1}$ |
| 89 | $L_{A89}$ | $L_{B1}$ |
| 90 | $L_{A90}$ | $L_{B1}$ |
| 91 | $L_{A91}$ | $L_{B1}$ |
| 92 | $L_{A92}$ | $L_{B1}$ |
| 93 | $L_{A93}$ | $L_{B1}$ |
| 94 | $L_{A94}$ | $L_{B1}$ |
| 95 | $L_{A95}$ | $L_{B1}$ |
| 96 | $L_{A96}$ | $L_{B1}$ |
| 97 | $L_{A97}$ | $L_{B1}$ |
| 98 | $L_{A98}$ | $L_{B1}$ |
| 99 | $L_{A99}$ | $L_{B1}$ |
| 100 | $L_{A100}$ | $L_{B1}$ |
| 101 | $L_{A101}$ | $L_{B1}$ |
| 102 | $L_{A102}$ | $L_{B1}$ |
| 103 | $L_{A103}$ | $L_{B1}$ |
| 104 | $L_{A104}$ | $L_{B1}$ |
| 105 | $L_{A1}$ | $L_{B2}$ |
| 106 | $L_{A2}$ | $L_{B2}$ |
| 107 | $L_{A3}$ | $L_{B2}$ |
| 108 | $L_{A4}$ | $L_{B2}$ |
| 109 | $L_{A5}$ | $L_{B2}$ |
| 110 | $L_{A6}$ | $L_{B2}$ |
| 111 | $L_{A7}$ | $L_{B2}$ |
| 112 | $L_{A8}$ | $L_{B2}$ |
| 113 | $L_{A9}$ | $L_{B2}$ |
| 114 | $L_{A10}$ | $L_{B2}$ |
| 115 | $L_{A11}$ | $L_{B2}$ |
| 116 | $L_{A12}$ | $L_{B2}$ |
| 117 | $L_{A13}$ | $L_{B2}$ |
| 118 | $L_{A14}$ | $L_{B2}$ |
| 119 | $L_{A15}$ | $L_{B2}$ |
| 120 | $L_{A16}$ | $L_{B2}$ |
| 121 | $L_{A17}$ | $L_{B2}$ |
| 122 | $L_{A18}$ | $L_{B2}$ |
| 123 | $L_{A19}$ | $L_{B2}$ |
| 124 | $L_{A20}$ | $L_{B2}$ |
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| 127 | $L_{A23}$ | $L_{B2}$ |
| 128 | $L_{A24}$ | $L_{B2}$ |
| 129 | $L_{A25}$ | $L_{B2}$ |
| 130 | $L_{A26}$ | $L_{B2}$ |
| 131 | $L_{A27}$ | $L_{B2}$ |
| 132 | $L_{A28}$ | $L_{B2}$ |
| 133 | $L_{A29}$ | $L_{B2}$ |
| 134 | $L_{A30}$ | $L_{B2}$ |
| 135 | $L_{A31}$ | $L_{B2}$ |
| 136 | $L_{A32}$ | $L_{B2}$ |
| 137 | $L_{A33}$ | $L_{B2}$ |
| 138 | $L_{A34}$ | $L_{B2}$ |
| 139 | $L_{A35}$ | $L_{B2}$ |
| 140 | $L_{A36}$ | $L_{B2}$ |
| 141 | $L_{A37}$ | $L_{B2}$ |
| 142 | $L_{A38}$ | $L_{B2}$ |
| 143 | $L_{A39}$ | $L_{B2}$ |
| 144 | $L_{A40}$ | $L_{B2}$ |
| 145 | $L_{A41}$ | $L_{B2}$ |
| 146 | $L_{A42}$ | $L_{B2}$ |
| 147 | $L_{A43}$ | $L_{B2}$ |
| 148 | $L_{A44}$ | $L_{B2}$ |
| 149 | $L_{A45}$ | $L_{B2}$ |
| 150 | $L_{A46}$ | $L_{B2}$ |
| 151 | $L_{A47}$ | $L_{B2}$ |
| 152 | $L_{A48}$ | $L_{B2}$ |
| 153 | $L_{A49}$ | $L_{B2}$ |
| 154 | $L_{A50}$ | $L_{B2}$ |
| 155 | $L_{A51}$ | $L_{B2}$ |
| 156 | $L_{A52}$ | $L_{B2}$ |
| 157 | $L_{A53}$ | $L_{B2}$ |
| 158 | $L_{A54}$ | $L_{B2}$ |
| 159 | $L_{A55}$ | $L_{B2}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 160 | $L_{A56}$ | $L_{B2}$ |
| 161 | $L_{A57}$ | $L_{B2}$ |
| 162 | $L_{A58}$ | $L_{B2}$ |
| 163 | $L_{A59}$ | $L_{B2}$ |
| 164 | $L_{A60}$ | $L_{B2}$ |
| 165 | $L_{A61}$ | $L_{B2}$ |
| 166 | $L_{A62}$ | $L_{B2}$ |
| 167 | $L_{A63}$ | $L_{B2}$ |
| 168 | $L_{A64}$ | $L_{B2}$ |
| 169 | $L_{A65}$ | $L_{B2}$ |
| 170 | $L_{A66}$ | $L_{B2}$ |
| 171 | $L_{A67}$ | $L_{B2}$ |
| 172 | $L_{A68}$ | $L_{B2}$ |
| 173 | $L_{A69}$ | $L_{B2}$ |
| 174 | $L_{A70}$ | $L_{B2}$ |
| 175 | $L_{A71}$ | $L_{B2}$ |
| 176 | $L_{A72}$ | $L_{B2}$ |
| 177 | $L_{A73}$ | $L_{B2}$ |
| 178 | $L_{A74}$ | $L_{B2}$ |
| 179 | $L_{A75}$ | $L_{B2}$ |
| 180 | $L_{A76}$ | $L_{B2}$ |
| 181 | $L_{A77}$ | $L_{B2}$ |
| 182 | $L_{A78}$ | $L_{B2}$ |
| 183 | $L_{A79}$ | $L_{B2}$ |
| 184 | $L_{A80}$ | $L_{B2}$ |
| 185 | $L_{A81}$ | $L_{B2}$ |
| 186 | $L_{A82}$ | $L_{B2}$ |
| 187 | $L_{A83}$ | $L_{B2}$ |
| 188 | $L_{A84}$ | $L_{B2}$ |
| 189 | $L_{A85}$ | $L_{B2}$ |
| 190 | $L_{A86}$ | $L_{B2}$ |
| 191 | $L_{A87}$ | $L_{B2}$ |
| 192 | $L_{A88}$ | $L_{B2}$ |
| 193 | $L_{A89}$ | $L_{B2}$ |
| 194 | $L_{A90}$ | $L_{B2}$ |
| 195 | $L_{A91}$ | $L_{B2}$ |
| 196 | $L_{A92}$ | $L_{B2}$ |
| 197 | $L_{A93}$ | $L_{B2}$ |
| 198 | $L_{A94}$ | $L_{B2}$ |
| 199 | $L_{A95}$ | $L_{B2}$ |
| 200 | $L_{A96}$ | $L_{B2}$ |
| 201 | $L_{A97}$ | $L_{B2}$ |
| 202 | $L_{A98}$ | $L_{B2}$ |
| 203 | $L_{A99}$ | $L_{B2}$ |
| 204 | $L_{A100}$ | $L_{B2}$ |
| 205 | $L_{A101}$ | $L_{B2}$ |
| 206 | $L_{A102}$ | $L_{B2}$ |
| 207 | $L_{A103}$ | $L_{B2}$ |
| 208 | $L_{A104}$ | $L_{B2}$ |
| 209 | $L_{A1}$ | $L_{B3}$ |
| 210 | $L_{A2}$ | $L_{B3}$ |
| 211 | $L_{A3}$ | $L_{B3}$ |
| 212 | $L_{A4}$ | $L_{B3}$ |
| 213 | $L_{A5}$ | $L_{B3}$ |
| 214 | $L_{A6}$ | $L_{B3}$ |
| 215 | $L_{A7}$ | $L_{B3}$ |
| 216 | $L_{A8}$ | $L_{B3}$ |
| 217 | $L_{A9}$ | $L_{B3}$ |
| 218 | $L_{A10}$ | $L_{B3}$ |
| 219 | $L_{A11}$ | $L_{B3}$ |
| 220 | $L_{A12}$ | $L_{B3}$ |
| 221 | $L_{A13}$ | $L_{B3}$ |
| 222 | $L_{A14}$ | $L_{B3}$ |
| 223 | $L_{A15}$ | $L_{B3}$ |
| 224 | $L_{A16}$ | $L_{B3}$ |
| 225 | $L_{A17}$ | $L_{B3}$ |
| 226 | $L_{A18}$ | $L_{B3}$ |
| 227 | $L_{A19}$ | $L_{B3}$ |
| 228 | $L_{A20}$ | $L_{B3}$ |
| 229 | $L_{A21}$ | $L_{B3}$ |
| 230 | $L_{A22}$ | $L_{B3}$ |
| 231 | $L_{A23}$ | $L_{B3}$ |
| 232 | $L_{A24}$ | $L_{B3}$ |
| 233 | $L_{A25}$ | $L_{B3}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 234 | $L_{A26}$ | $L_{B3}$ |
| 235 | $L_{A27}$ | $L_{B3}$ |
| 236 | $L_{A28}$ | $L_{B3}$ |
| 237 | $L_{A29}$ | $L_{B3}$ |
| 238 | $L_{A30}$ | $L_{B3}$ |
| 239 | $L_{A31}$ | $L_{B3}$ |
| 240 | $L_{A32}$ | $L_{B3}$ |
| 241 | $L_{A33}$ | $L_{B3}$ |
| 242 | $L_{A34}$ | $L_{B3}$ |
| 243 | $L_{A35}$ | $L_{B3}$ |
| 244 | $L_{A36}$ | $L_{B3}$ |
| 245 | $L_{A37}$ | $L_{B3}$ |
| 246 | $L_{A38}$ | $L_{B3}$ |
| 247 | $L_{A39}$ | $L_{B3}$ |
| 248 | $L_{A40}$ | $L_{B3}$ |
| 249 | $L_{A41}$ | $L_{B3}$ |
| 250 | $L_{A42}$ | $L_{B3}$ |
| 251 | $L_{A43}$ | $L_{B3}$ |
| 252 | $L_{A44}$ | $L_{B3}$ |
| 253 | $L_{A45}$ | $L_{B3}$ |
| 254 | $L_{A46}$ | $L_{B3}$ |
| 255 | $L_{A47}$ | $L_{B3}$ |
| 256 | $L_{A48}$ | $L_{B3}$ |
| 257 | $L_{A49}$ | $L_{B3}$ |
| 258 | $L_{A50}$ | $L_{B3}$ |
| 259 | $L_{A51}$ | $L_{B3}$ |
| 260 | $L_{A52}$ | $L_{B3}$ |
| 261 | $L_{A53}$ | $L_{B3}$ |
| 262 | $L_{A54}$ | $L_{B3}$ |
| 263 | $L_{A55}$ | $L_{B3}$ |
| 264 | $L_{A56}$ | $L_{B3}$ |
| 265 | $L_{A57}$ | $L_{B3}$ |
| 266 | $L_{A58}$ | $L_{B3}$ |
| 267 | $L_{A59}$ | $L_{B3}$ |
| 268 | $L_{A60}$ | $L_{B3}$ |
| 269 | $L_{A61}$ | $L_{B3}$ |
| 270 | $L_{A62}$ | $L_{B3}$ |
| 271 | $L_{A63}$ | $L_{B3}$ |
| 272 | $L_{A64}$ | $L_{B3}$ |
| 273 | $L_{A65}$ | $L_{B3}$ |
| 274 | $L_{A66}$ | $L_{B3}$ |
| 275 | $L_{A67}$ | $L_{B3}$ |
| 276 | $L_{A68}$ | $L_{B3}$ |
| 277 | $L_{A69}$ | $L_{B3}$ |
| 278 | $L_{A70}$ | $L_{B3}$ |
| 279 | $L_{A71}$ | $L_{B3}$ |
| 280 | $L_{A72}$ | $L_{B3}$ |
| 281 | $L_{A73}$ | $L_{B3}$ |
| 282 | $L_{A74}$ | $L_{B3}$ |
| 283 | $L_{A75}$ | $L_{B3}$ |
| 284 | $L_{A76}$ | $L_{B3}$ |
| 285 | $L_{A77}$ | $L_{B3}$ |
| 286 | $L_{A78}$ | $L_{B3}$ |
| 287 | $L_{A79}$ | $L_{B3}$ |
| 288 | $L_{A80}$ | $L_{B3}$ |
| 289 | $L_{A81}$ | $L_{B3}$ |
| 290 | $L_{A82}$ | $L_{B3}$ |
| 291 | $L_{A83}$ | $L_{B3}$ |
| 292 | $L_{A84}$ | $L_{B3}$ |
| 293 | $L_{A85}$ | $L_{B3}$ |
| 294 | $L_{A86}$ | $L_{B3}$ |
| 295 | $L_{A87}$ | $L_{B3}$ |
| 296 | $L_{A88}$ | $L_{B3}$ |
| 297 | $L_{A89}$ | $L_{B3}$ |
| 298 | $L_{A90}$ | $L_{B3}$ |
| 299 | $L_{A91}$ | $L_{B3}$ |
| 300 | $L_{A92}$ | $L_{B3}$ |
| 301 | $L_{A93}$ | $L_{B3}$ |
| 302 | $L_{A94}$ | $L_{B3}$ |
| 303 | $L_{A95}$ | $L_{B3}$ |
| 304 | $L_{A96}$ | $L_{B3}$ |
| 305 | $L_{A97}$ | $L_{B3}$ |
| 306 | $L_{A98}$ | $L_{B3}$ |
| 307 | $L_{A99}$ | $L_{B3}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 308 | $L_{A100}$ | $L_{B3}$ |
| 309 | $L_{A101}$ | $L_{B3}$ |
| 310 | $L_{A102}$ | $L_{B3}$ |
| 311 | $L_{A103}$ | $L_{B3}$ |
| 312 | $L_{A104}$ | $L_{B3}$ |
| 313 | $L_{A1}$ | $L_{B4}$ |
| 314 | $L_{A2}$ | $L_{B4}$ |
| 315 | $L_{A3}$ | $L_{B4}$ |
| 316 | $L_{A4}$ | $L_{B4}$ |
| 317 | $L_{A5}$ | $L_{B4}$ |
| 318 | $L_{A6}$ | $L_{B4}$ |
| 319 | $L_{A7}$ | $L_{B4}$ |
| 320 | $L_{A8}$ | $L_{B4}$ |
| 321 | $L_{A9}$ | $L_{B4}$ |
| 322 | $L_{A10}$ | $L_{B4}$ |
| 323 | $L_{A11}$ | $L_{B4}$ |
| 324 | $L_{A12}$ | $L_{B4}$ |
| 325 | $L_{A13}$ | $L_{B4}$ |
| 326 | $L_{A14}$ | $L_{B4}$ |
| 327 | $L_{A15}$ | $L_{B4}$ |
| 328 | $L_{A16}$ | $L_{B4}$ |
| 329 | $L_{A17}$ | $L_{B4}$ |
| 330 | $L_{A18}$ | $L_{B4}$ |
| 331 | $L_{A19}$ | $L_{B4}$ |
| 332 | $L_{A20}$ | $L_{B4}$ |
| 333 | $L_{A21}$ | $L_{B4}$ |
| 334 | $L_{A22}$ | $L_{B4}$ |
| 335 | $L_{A23}$ | $L_{B4}$ |
| 336 | $L_{A24}$ | $L_{B4}$ |
| 337 | $L_{A25}$ | $L_{B4}$ |
| 338 | $L_{A26}$ | $L_{B4}$ |
| 339 | $L_{A27}$ | $L_{B4}$ |
| 340 | $L_{A28}$ | $L_{B4}$ |
| 341 | $L_{A29}$ | $L_{B4}$ |
| 342 | $L_{A30}$ | $L_{B4}$ |
| 343 | $L_{A31}$ | $L_{B4}$ |
| 344 | $L_{A32}$ | $L_{B4}$ |
| 345 | $L_{A33}$ | $L_{B4}$ |
| 346 | $L_{A34}$ | $L_{B4}$ |
| 347 | $L_{A35}$ | $L_{B4}$ |
| 348 | $L_{A36}$ | $L_{B4}$ |
| 349 | $L_{A37}$ | $L_{B4}$ |
| 350 | $L_{A38}$ | $L_{B4}$ |
| 351 | $L_{A39}$ | $L_{B4}$ |
| 352 | $L_{A40}$ | $L_{B4}$ |
| 353 | $L_{A41}$ | $L_{B4}$ |
| 354 | $L_{A42}$ | $L_{B4}$ |
| 355 | $L_{A43}$ | $L_{B4}$ |
| 356 | $L_{A44}$ | $L_{B4}$ |
| 357 | $L_{A45}$ | $L_{B4}$ |
| 358 | $L_{A46}$ | $L_{B4}$ |
| 359 | $L_{A47}$ | $L_{B4}$ |
| 360 | $L_{A48}$ | $L_{B4}$ |
| 361 | $L_{A49}$ | $L_{B4}$ |
| 362 | $L_{A50}$ | $L_{B4}$ |
| 363 | $L_{A51}$ | $L_{B4}$ |
| 364 | $L_{A52}$ | $L_{B4}$ |
| 365 | $L_{A53}$ | $L_{B4}$ |
| 366 | $L_{A54}$ | $L_{B4}$ |
| 367 | $L_{A55}$ | $L_{B4}$ |
| 368 | $L_{A56}$ | $L_{B4}$ |
| 369 | $L_{A57}$ | $L_{B4}$ |
| 370 | $L_{A58}$ | $L_{B4}$ |
| 371 | $L_{A59}$ | $L_{B4}$ |
| 372 | $L_{A60}$ | $L_{B4}$ |
| 373 | $L_{A61}$ | $L_{B4}$ |
| 374 | $L_{A62}$ | $L_{B4}$ |
| 375 | $L_{A63}$ | $L_{B4}$ |
| 376 | $L_{A64}$ | $L_{B4}$ |
| 377 | $L_{A65}$ | $L_{B4}$ |
| 378 | $L_{A66}$ | $L_{B4}$ |
| 379 | $L_{A67}$ | $L_{B4}$ |
| 380 | $L_{A68}$ | $L_{B4}$ |
| 381 | $L_{A69}$ | $L_{B4}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 382 | $L_{A70}$ | $L_{B4}$ |
| 383 | $L_{A71}$ | $L_{B4}$ |
| 384 | $L_{A72}$ | $L_{B4}$ |
| 385 | $L_{A73}$ | $L_{B4}$ |
| 386 | $L_{A74}$ | $L_{B4}$ |
| 387 | $L_{A75}$ | $L_{B4}$ |
| 388 | $L_{A76}$ | $L_{B4}$ |
| 389 | $L_{A77}$ | $L_{B4}$ |
| 390 | $L_{A78}$ | $L_{B4}$ |
| 391 | $L_{A79}$ | $L_{B4}$ |
| 392 | $L_{A80}$ | $L_{B4}$ |
| 393 | $L_{A81}$ | $L_{B4}$ |
| 394 | $L_{A82}$ | $L_{B4}$ |
| 395 | $L_{A83}$ | $L_{B4}$ |
| 396 | $L_{A84}$ | $L_{B4}$ |
| 397 | $L_{A85}$ | $L_{B4}$ |
| 398 | $L_{A86}$ | $L_{B4}$ |
| 399 | $L_{A87}$ | $L_{B4}$ |
| 400 | $L_{A88}$ | $L_{B4}$ |
| 401 | $L_{A89}$ | $L_{B4}$ |
| 402 | $L_{A90}$ | $L_{B4}$ |
| 403 | $L_{A91}$ | $L_{B4}$ |
| 404 | $L_{A92}$ | $L_{B4}$ |
| 405 | $L_{A93}$ | $L_{B4}$ |
| 406 | $L_{A94}$ | $L_{B4}$ |
| 407 | $L_{A95}$ | $L_{B4}$ |
| 408 | $L_{A96}$ | $L_{B4}$ |
| 409 | $L_{A97}$ | $L_{B4}$ |
| 410 | $L_{A98}$ | $L_{B4}$ |
| 411 | $L_{A99}$ | $L_{B4}$ |
| 412 | $L_{A100}$ | $L_{B4}$ |
| 413 | $L_{A101}$ | $L_{B4}$ |
| 414 | $L_{A102}$ | $L_{B4}$ |
| 415 | $L_{A103}$ | $L_{B4}$ |
| 416 | $L_{A104}$ | $L_{B4}$ |
| 417 | $L_{A1}$ | $L_{B5}$ |
| 418 | $L_{A2}$ | $L_{B5}$ |
| 419 | $L_{A3}$ | $L_{B5}$ |
| 420 | $L_{A4}$ | $L_{B5}$ |
| 421 | $L_{A5}$ | $L_{B5}$ |
| 422 | $L_{A6}$ | $L_{B5}$ |
| 423 | $L_{A7}$ | $L_{B5}$ |
| 424 | $L_{A8}$ | $L_{B5}$ |
| 425 | $L_{A9}$ | $L_{B5}$ |
| 426 | $L_{A10}$ | $L_{B5}$ |
| 427 | $L_{A11}$ | $L_{B5}$ |
| 428 | $L_{A12}$ | $L_{B5}$ |
| 429 | $L_{A13}$ | $L_{B5}$ |
| 430 | $L_{A14}$ | $L_{B5}$ |
| 431 | $L_{A15}$ | $L_{B5}$ |
| 432 | $L_{A16}$ | $L_{B5}$ |
| 433 | $L_{A17}$ | $L_{B5}$ |
| 434 | $L_{A18}$ | $L_{B5}$ |
| 435 | $L_{A19}$ | $L_{B5}$ |
| 436 | $L_{A20}$ | $L_{B5}$ |
| 437 | $L_{A21}$ | $L_{B5}$ |
| 438 | $L_{A22}$ | $L_{B5}$ |
| 439 | $L_{A23}$ | $L_{B5}$ |
| 440 | $L_{A24}$ | $L_{B5}$ |
| 441 | $L_{A25}$ | $L_{B5}$ |
| 442 | $L_{A26}$ | $L_{B5}$ |
| 443 | $L_{A27}$ | $L_{B5}$ |
| 444 | $L_{A28}$ | $L_{B5}$ |
| 445 | $L_{A29}$ | $L_{B5}$ |
| 446 | $L_{A30}$ | $L_{B5}$ |
| 447 | $L_{A31}$ | $L_{B5}$ |
| 448 | $L_{A32}$ | $L_{B5}$ |
| 449 | $L_{A33}$ | $L_{B5}$ |
| 450 | $L_{A34}$ | $L_{B5}$ |
| 451 | $L_{A35}$ | $L_{B5}$ |
| 452 | $L_{A36}$ | $L_{B5}$ |
| 453 | $L_{A37}$ | $L_{B5}$ |
| 454 | $L_{A38}$ | $L_{B5}$ |
| 455 | $L_{A39}$ | $L_{B5}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 456 | $L_{A40}$ | $L_{B5}$ |
| 457 | $L_{A41}$ | $L_{B5}$ |
| 458 | $L_{A42}$ | $L_{B5}$ |
| 459 | $L_{A43}$ | $L_{B5}$ |
| 460 | $L_{A44}$ | $L_{B5}$ |
| 461 | $L_{A45}$ | $L_{B5}$ |
| 462 | $L_{A46}$ | $L_{B5}$ |
| 463 | $L_{A47}$ | $L_{B5}$ |
| 464 | $L_{A48}$ | $L_{B5}$ |
| 465 | $L_{A49}$ | $L_{B5}$ |
| 466 | $L_{A50}$ | $L_{B5}$ |
| 467 | $L_{A51}$ | $L_{B5}$ |
| 468 | $L_{A52}$ | $L_{B5}$ |
| 469 | $L_{A53}$ | $L_{B5}$ |
| 470 | $L_{A54}$ | $L_{B5}$ |
| 471 | $L_{A55}$ | $L_{B5}$ |
| 472 | $L_{A56}$ | $L_{B5}$ |
| 473 | $L_{A57}$ | $L_{B5}$ |
| 474 | $L_{A58}$ | $L_{B5}$ |
| 475 | $L_{A59}$ | $L_{B5}$ |
| 476 | $L_{A60}$ | $L_{B5}$ |
| 477 | $L_{A61}$ | $L_{B5}$ |
| 478 | $L_{A62}$ | $L_{B5}$ |
| 479 | $L_{A63}$ | $L_{B5}$ |
| 480 | $L_{A64}$ | $L_{B5}$ |
| 481 | $L_{A65}$ | $L_{B5}$ |
| 482 | $L_{A66}$ | $L_{B5}$ |
| 483 | $L_{A67}$ | $L_{B5}$ |
| 484 | $L_{A68}$ | $L_{B5}$ |
| 485 | $L_{A69}$ | $L_{B5}$ |
| 486 | $L_{A70}$ | $L_{B5}$ |
| 487 | $L_{A71}$ | $L_{B5}$ |
| 488 | $L_{A72}$ | $L_{B5}$ |
| 489 | $L_{A73}$ | $L_{B5}$ |
| 490 | $L_{A74}$ | $L_{B5}$ |
| 491 | $L_{A75}$ | $L_{B5}$ |
| 492 | $L_{A76}$ | $L_{B5}$ |
| 493 | $L_{A77}$ | $L_{B5}$ |
| 494 | $L_{A78}$ | $L_{B5}$ |
| 495 | $L_{A79}$ | $L_{B5}$ |
| 496 | $L_{A80}$ | $L_{B5}$ |
| 497 | $L_{A81}$ | $L_{B5}$ |
| 498 | $L_{A82}$ | $L_{B5}$ |
| 499 | $L_{A83}$ | $L_{B5}$ |
| 500 | $L_{A84}$ | $L_{B5}$ |
| 501 | $L_{A85}$ | $L_{B5}$ |
| 502 | $L_{A86}$ | $L_{B5}$ |
| 503 | $L_{A87}$ | $L_{B5}$ |
| 504 | $L_{A88}$ | $L_{B5}$ |
| 505 | $L_{A89}$ | $L_{B5}$ |
| 506 | $L_{A90}$ | $L_{B5}$ |
| 507 | $L_{A91}$ | $L_{B5}$ |
| 508 | $L_{A92}$ | $L_{B5}$ |
| 509 | $L_{A93}$ | $L_{B5}$ |
| 510 | $L_{A94}$ | $L_{B5}$ |
| 511 | $L_{A95}$ | $L_{B5}$ |
| 512 | $L_{A96}$ | $L_{B5}$ |
| 513 | $L_{A97}$ | $L_{B5}$ |
| 514 | $L_{A98}$ | $L_{B5}$ |
| 515 | $L_{A99}$ | $L_{B5}$ |
| 516 | $L_{A100}$ | $L_{B5}$ |
| 517 | $L_{A101}$ | $L_{B5}$ |
| 518 | $L_{A102}$ | $L_{B5}$ |
| 519 | $L_{A103}$ | $L_{B5}$ |
| 520 | $L_{A104}$ | $L_{B5}$ |
| 521 | $L_{A1}$ | $L_{B6}$ |
| 522 | $L_{A2}$ | $L_{B6}$ |
| 523 | $L_{A3}$ | $L_{B6}$ |
| 524 | $L_{A4}$ | $L_{B6}$ |
| 525 | $L_{A5}$ | $L_{B6}$ |
| 526 | $L_{A6}$ | $L_{B6}$ |
| 527 | $L_{A7}$ | $L_{B6}$ |
| 528 | $L_{A8}$ | $L_{B6}$ |
| 529 | $L_{A9}$ | $L_{B6}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 530 | $L_{A10}$ | $L_{B6}$ |
| 531 | $L_{A11}$ | $L_{B6}$ |
| 532 | $L_{A12}$ | $L_{B6}$ |
| 533 | $L_{A13}$ | $L_{B6}$ |
| 534 | $L_{A14}$ | $L_{B6}$ |
| 535 | $L_{A15}$ | $L_{B6}$ |
| 536 | $L_{A16}$ | $L_{B6}$ |
| 537 | $L_{A17}$ | $L_{B6}$ |
| 538 | $L_{A18}$ | $L_{B6}$ |
| 539 | $L_{A19}$ | $L_{B6}$ |
| 540 | $L_{A20}$ | $L_{B6}$ |
| 541 | $L_{A21}$ | $L_{B6}$ |
| 542 | $L_{A22}$ | $L_{B6}$ |
| 543 | $L_{A23}$ | $L_{B6}$ |
| 544 | $L_{A24}$ | $L_{B6}$ |
| 545 | $L_{A25}$ | $L_{B6}$ |
| 546 | $L_{A26}$ | $L_{B6}$ |
| 547 | $L_{A27}$ | $L_{B6}$ |
| 548 | $L_{A28}$ | $L_{B6}$ |
| 549 | $L_{A29}$ | $L_{B6}$ |
| 550 | $L_{A30}$ | $L_{B6}$ |
| 551 | $L_{A31}$ | $L_{B6}$ |
| 552 | $L_{A32}$ | $L_{B6}$ |
| 553 | $L_{A33}$ | $L_{B6}$ |
| 554 | $L_{A34}$ | $L_{B6}$ |
| 555 | $L_{A35}$ | $L_{B6}$ |
| 556 | $L_{A36}$ | $L_{B6}$ |
| 557 | $L_{A37}$ | $L_{B6}$ |
| 558 | $L_{A38}$ | $L_{B6}$ |
| 559 | $L_{A39}$ | $L_{B6}$ |
| 560 | $L_{A40}$ | $L_{B6}$ |
| 561 | $L_{A41}$ | $L_{B6}$ |
| 562 | $L_{A42}$ | $L_{B6}$ |
| 563 | $L_{A43}$ | $L_{B6}$ |
| 564 | $L_{A44}$ | $L_{B6}$ |
| 565 | $L_{A45}$ | $L_{B6}$ |
| 566 | $L_{A46}$ | $L_{B6}$ |
| 567 | $L_{A47}$ | $L_{B6}$ |
| 568 | $L_{A48}$ | $L_{B6}$ |
| 569 | $L_{A49}$ | $L_{B6}$ |
| 570 | $L_{A50}$ | $L_{B6}$ |
| 571 | $L_{A51}$ | $L_{B6}$ |
| 572 | $L_{A52}$ | $L_{B6}$ |
| 573 | $L_{A53}$ | $L_{B6}$ |
| 574 | $L_{A54}$ | $L_{B6}$ |
| 575 | $L_{A55}$ | $L_{B6}$ |
| 576 | $L_{A56}$ | $L_{B6}$ |
| 577 | $L_{A57}$ | $L_{B6}$ |
| 578 | $L_{A58}$ | $L_{B6}$ |
| 579 | $L_{A59}$ | $L_{B6}$ |
| 580 | $L_{A60}$ | $L_{B6}$ |
| 581 | $L_{A61}$ | $L_{B6}$ |
| 582 | $L_{A62}$ | $L_{B6}$ |
| 583 | $L_{A63}$ | $L_{B6}$ |
| 584 | $L_{A64}$ | $L_{B6}$ |
| 585 | $L_{A65}$ | $L_{B6}$ |
| 586 | $L_{A66}$ | $L_{B6}$ |
| 587 | $L_{A67}$ | $L_{B6}$ |
| 588 | $L_{A68}$ | $L_{B6}$ |
| 589 | $L_{A69}$ | $L_{B6}$ |
| 590 | $L_{A70}$ | $L_{B6}$ |
| 591 | $L_{A71}$ | $L_{B6}$ |
| 592 | $L_{A72}$ | $L_{B6}$ |
| 593 | $L_{A73}$ | $L_{B6}$ |
| 594 | $L_{A74}$ | $L_{B6}$ |
| 595 | $L_{A75}$ | $L_{B6}$ |
| 596 | $L_{A76}$ | $L_{B6}$ |
| 597 | $L_{A77}$ | $L_{B6}$ |
| 598 | $L_{A78}$ | $L_{B6}$ |
| 599 | $L_{A79}$ | $L_{B6}$ |
| 600 | $L_{A80}$ | $L_{B6}$ |
| 601 | $L_{A81}$ | $L_{B6}$ |
| 602 | $L_{A82}$ | $L_{B6}$ |
| 603 | $L_{A83}$ | $L_{B6}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 604 | $L_{A84}$ | $L_{B6}$ |
| 605 | $L_{A85}$ | $L_{B6}$ |
| 606 | $L_{A86}$ | $L_{B6}$ |
| 607 | $L_{A87}$ | $L_{B6}$ |
| 608 | $L_{A88}$ | $L_{B6}$ |
| 609 | $L_{A89}$ | $L_{B6}$ |
| 610 | $L_{A90}$ | $L_{B6}$ |
| 611 | $L_{A91}$ | $L_{B6}$ |
| 612 | $L_{A92}$ | $L_{B6}$ |
| 613 | $L_{A93}$ | $L_{B6}$ |
| 614 | $L_{A94}$ | $L_{B6}$ |
| 615 | $L_{A95}$ | $L_{B6}$ |
| 616 | $L_{A96}$ | $L_{B6}$ |
| 617 | $L_{A97}$ | $L_{B6}$ |
| 618 | $L_{A98}$ | $L_{B6}$ |
| 619 | $L_{A99}$ | $L_{B6}$ |
| 620 | $L_{A100}$ | $L_{B6}$ |
| 621 | $L_{A101}$ | $L_{B6}$ |
| 622 | $L_{A102}$ | $L_{B6}$ |
| 623 | $L_{A103}$ | $L_{B6}$ |
| 624 | $L_{A104}$ | $L_{B6}$ |
| 625 | $L_{A1}$ | $L_{B7}$ |
| 626 | $L_{A2}$ | $L_{B7}$ |
| 627 | $L_{A3}$ | $L_{B7}$ |
| 628 | $L_{A4}$ | $L_{B7}$ |
| 629 | $L_{A5}$ | $L_{B7}$ |
| 630 | $L_{A6}$ | $L_{B7}$ |
| 631 | $L_{A7}$ | $L_{B7}$ |
| 632 | $L_{A8}$ | $L_{B7}$ |
| 633 | $L_{A9}$ | $L_{B7}$ |
| 634 | $L_{A10}$ | $L_{B7}$ |
| 635 | $L_{A11}$ | $L_{B7}$ |
| 636 | $L_{A12}$ | $L_{B7}$ |
| 637 | $L_{A13}$ | $L_{B7}$ |
| 638 | $L_{A14}$ | $L_{B7}$ |
| 639 | $L_{A15}$ | $L_{B7}$ |
| 640 | $L_{A16}$ | $L_{B7}$ |
| 641 | $L_{A17}$ | $L_{B7}$ |
| 642 | $L_{A18}$ | $L_{B7}$ |
| 643 | $L_{A19}$ | $L_{B7}$ |
| 644 | $L_{A20}$ | $L_{B7}$ |
| 645 | $L_{A21}$ | $L_{B7}$ |
| 646 | $L_{A22}$ | $L_{B7}$ |
| 647 | $L_{A23}$ | $L_{B7}$ |
| 648 | $L_{A24}$ | $L_{B7}$ |
| 649 | $L_{A25}$ | $L_{B7}$ |
| 650 | $L_{A26}$ | $L_{B7}$ |
| 651 | $L_{A27}$ | $L_{B7}$ |
| 652 | $L_{A28}$ | $L_{B7}$ |
| 653 | $L_{A29}$ | $L_{B7}$ |
| 654 | $L_{A30}$ | $L_{B7}$ |
| 655 | $L_{A31}$ | $L_{B7}$ |
| 656 | $L_{A32}$ | $L_{B7}$ |
| 657 | $L_{A33}$ | $L_{B7}$ |
| 658 | $L_{A34}$ | $L_{B7}$ |
| 659 | $L_{A35}$ | $L_{B7}$ |
| 660 | $L_{A36}$ | $L_{B7}$ |
| 661 | $L_{A37}$ | $L_{B7}$ |
| 662 | $L_{A38}$ | $L_{B7}$ |
| 663 | $L_{A39}$ | $L_{B7}$ |
| 664 | $L_{A40}$ | $L_{B7}$ |
| 665 | $L_{A41}$ | $L_{B7}$ |
| 666 | $L_{A42}$ | $L_{B7}$ |
| 667 | $L_{A43}$ | $L_{B7}$ |
| 668 | $L_{A44}$ | $L_{B7}$ |
| 669 | $L_{A45}$ | $L_{B7}$ |
| 670 | $L_{A46}$ | $L_{B7}$ |
| 671 | $L_{A47}$ | $L_{B7}$ |
| 672 | $L_{A48}$ | $L_{B7}$ |
| 673 | $L_{A49}$ | $L_{B7}$ |
| 674 | $L_{A50}$ | $L_{B7}$ |
| 675 | $L_{A51}$ | $L_{B7}$ |
| 676 | $L_{A52}$ | $L_{B7}$ |
| 677 | $L_{A53}$ | $L_{B7}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 678 | $L_{A54}$ | $L_{B7}$ |
| 679 | $L_{A55}$ | $L_{B7}$ |
| 680 | $L_{A56}$ | $L_{B7}$ |
| 681 | $L_{A57}$ | $L_{B7}$ |
| 682 | $L_{A58}$ | $L_{B7}$ |
| 683 | $L_{A59}$ | $L_{B7}$ |
| 684 | $L_{A60}$ | $L_{B7}$ |
| 685 | $L_{A61}$ | $L_{B7}$ |
| 686 | $L_{A62}$ | $L_{B7}$ |
| 687 | $L_{A63}$ | $L_{B7}$ |
| 688 | $L_{A64}$ | $L_{B7}$ |
| 689 | $L_{A65}$ | $L_{B7}$ |
| 690 | $L_{A66}$ | $L_{B7}$ |
| 691 | $L_{A67}$ | $L_{B7}$ |
| 692 | $L_{A68}$ | $L_{B7}$ |
| 693 | $L_{A69}$ | $L_{B7}$ |
| 694 | $L_{A70}$ | $L_{B7}$ |
| 695 | $L_{A71}$ | $L_{B7}$ |
| 696 | $L_{A72}$ | $L_{B7}$ |
| 697 | $L_{A73}$ | $L_{B7}$ |
| 698 | $L_{A74}$ | $L_{B7}$ |
| 699 | $L_{A75}$ | $L_{B7}$ |
| 700 | $L_{A76}$ | $L_{B7}$ |
| 701 | $L_{A77}$ | $L_{B7}$ |
| 702 | $L_{A78}$ | $L_{B7}$ |
| 703 | $L_{A79}$ | $L_{B7}$ |
| 704 | $L_{A80}$ | $L_{B7}$ |
| 705 | $L_{A81}$ | $L_{B7}$ |
| 706 | $L_{A82}$ | $L_{B7}$ |
| 707 | $L_{A83}$ | $L_{B7}$ |
| 708 | $L_{A84}$ | $L_{B7}$ |
| 709 | $L_{A85}$ | $L_{B7}$ |
| 710 | $L_{A86}$ | $L_{B7}$ |
| 711 | $L_{A87}$ | $L_{B7}$ |
| 712 | $L_{A88}$ | $L_{B7}$ |
| 713 | $L_{A89}$ | $L_{B7}$ |
| 714 | $L_{A90}$ | $L_{B7}$ |
| 715 | $L_{A91}$ | $L_{B7}$ |
| 716 | $L_{A92}$ | $L_{B7}$ |
| 717 | $L_{A93}$ | $L_{B7}$ |
| 718 | $L_{A94}$ | $L_{B7}$ |
| 719 | $L_{A95}$ | $L_{B7}$ |
| 720 | $L_{A96}$ | $L_{B7}$ |
| 721 | $L_{A97}$ | $L_{B7}$ |
| 722 | $L_{A98}$ | $L_{B7}$ |
| 723 | $L_{A99}$ | $L_{B7}$ |
| 724 | $L_{A100}$ | $L_{B7}$ |
| 725 | $L_{A101}$ | $L_{B7}$ |
| 726 | $L_{A102}$ | $L_{B7}$ |
| 727 | $L_{A103}$ | $L_{B7}$ |
| 728 | $L_{A104}$ | $L_{B7}$ |
| 729 | $L_{A1}$ | $L_{B8}$ |
| 730 | $L_{A2}$ | $L_{B8}$ |
| 731 | $L_{A3}$ | $L_{B8}$ |
| 732 | $L_{A4}$ | $L_{B8}$ |
| 733 | $L_{A5}$ | $L_{B8}$ |
| 734 | $L_{A6}$ | $L_{B8}$ |
| 735 | $L_{A7}$ | $L_{B8}$ |
| 736 | $L_{A8}$ | $L_{B8}$ |
| 737 | $L_{A9}$ | $L_{B8}$ |
| 738 | $L_{A10}$ | $L_{B8}$ |
| 739 | $L_{A11}$ | $L_{B8}$ |
| 740 | $L_{A12}$ | $L_{B8}$ |
| 741 | $L_{A13}$ | $L_{B8}$ |
| 742 | $L_{A14}$ | $L_{B8}$ |
| 743 | $L_{A15}$ | $L_{B8}$ |
| 744 | $L_{A16}$ | $L_{B8}$ |
| 745 | $L_{A17}$ | $L_{B8}$ |
| 746 | $L_{A18}$ | $L_{B8}$ |
| 747 | $L_{A19}$ | $L_{B8}$ |
| 748 | $L_{A20}$ | $L_{B8}$ |
| 749 | $L_{A21}$ | $L_{B8}$ |
| 750 | $L_{A22}$ | $L_{B8}$ |
| 751 | $L_{A23}$ | $L_{B8}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 752 | $L_{A24}$ | $L_{B8}$ |
| 753 | $L_{A25}$ | $L_{B8}$ |
| 754 | $L_{A26}$ | $L_{B8}$ |
| 755 | $L_{A27}$ | $L_{B8}$ |
| 756 | $L_{A28}$ | $L_{B8}$ |
| 757 | $L_{A29}$ | $L_{B8}$ |
| 758 | $L_{A30}$ | $L_{B8}$ |
| 759 | $L_{A31}$ | $L_{B8}$ |
| 760 | $L_{A32}$ | $L_{B8}$ |
| 761 | $L_{A33}$ | $L_{B8}$ |
| 762 | $L_{A34}$ | $L_{B8}$ |
| 763 | $L_{A35}$ | $L_{B8}$ |
| 764 | $L_{A36}$ | $L_{B8}$ |
| 765 | $L_{A37}$ | $L_{B8}$ |
| 766 | $L_{A38}$ | $L_{B8}$ |
| 767 | $L_{A39}$ | $L_{B8}$ |
| 768 | $L_{A40}$ | $L_{B8}$ |
| 769 | $L_{A41}$ | $L_{B8}$ |
| 770 | $L_{A42}$ | $L_{B8}$ |
| 771 | $L_{A43}$ | $L_{B8}$ |
| 772 | $L_{A44}$ | $L_{B8}$ |
| 773 | $L_{A45}$ | $L_{B8}$ |
| 774 | $L_{A46}$ | $L_{B8}$ |
| 775 | $L_{A47}$ | $L_{B8}$ |
| 776 | $L_{A48}$ | $L_{B8}$ |
| 777 | $L_{A49}$ | $L_{B8}$ |
| 778 | $L_{A50}$ | $L_{B8}$ |
| 779 | $L_{A51}$ | $L_{B8}$ |
| 780 | $L_{A52}$ | $L_{B8}$ |
| 781 | $L_{A53}$ | $L_{B8}$ |
| 782 | $L_{A54}$ | $L_{B8}$ |
| 783 | $L_{A55}$ | $L_{B8}$ |
| 784 | $L_{A56}$ | $L_{B8}$ |
| 785 | $L_{A57}$ | $L_{B8}$ |
| 786 | $L_{A58}$ | $L_{B8}$ |
| 787 | $L_{A59}$ | $L_{B8}$ |
| 788 | $L_{A60}$ | $L_{B8}$ |
| 789 | $L_{A61}$ | $L_{B8}$ |
| 790 | $L_{A62}$ | $L_{B8}$ |
| 791 | $L_{A63}$ | $L_{B8}$ |
| 792 | $L_{A64}$ | $L_{B8}$ |
| 793 | $L_{A65}$ | $L_{B8}$ |
| 794 | $L_{A66}$ | $L_{B8}$ |
| 795 | $L_{A67}$ | $L_{B8}$ |
| 796 | $L_{A68}$ | $L_{B8}$ |
| 797 | $L_{A69}$ | $L_{B8}$ |
| 798 | $L_{A70}$ | $L_{B8}$ |
| 799 | $L_{A71}$ | $L_{B8}$ |
| 800 | $L_{A72}$ | $L_{B8}$ |
| 801 | $L_{A73}$ | $L_{B8}$ |
| 802 | $L_{A74}$ | $L_{B8}$ |
| 803 | $L_{A75}$ | $L_{B8}$ |
| 804 | $L_{A76}$ | $L_{B8}$ |
| 805 | $L_{A77}$ | $L_{B8}$ |
| 806 | $L_{A78}$ | $L_{B8}$ |
| 807 | $L_{A79}$ | $L_{B8}$ |
| 808 | $L_{A80}$ | $L_{B8}$ |
| 809 | $L_{A81}$ | $L_{B8}$ |
| 810 | $L_{A82}$ | $L_{B8}$ |
| 811 | $L_{A83}$ | $L_{B8}$ |
| 812 | $L_{A84}$ | $L_{B8}$ |
| 813 | $L_{A85}$ | $L_{B8}$ |
| 814 | $L_{A86}$ | $L_{B8}$ |
| 815 | $L_{A87}$ | $L_{B8}$ |
| 816 | $L_{A88}$ | $L_{B8}$ |
| 817 | $L_{A89}$ | $L_{B8}$ |
| 818 | $L_{A90}$ | $L_{B8}$ |
| 819 | $L_{A91}$ | $L_{B8}$ |
| 820 | $L_{A92}$ | $L_{B8}$ |
| 821 | $L_{A93}$ | $L_{B8}$ |
| 822 | $L_{A94}$ | $L_{B8}$ |
| 823 | $L_{A95}$ | $L_{B8}$ |
| 824 | $L_{A96}$ | $L_{B8}$ |
| 825 | $L_{A97}$ | $L_{B8}$ |

-continued

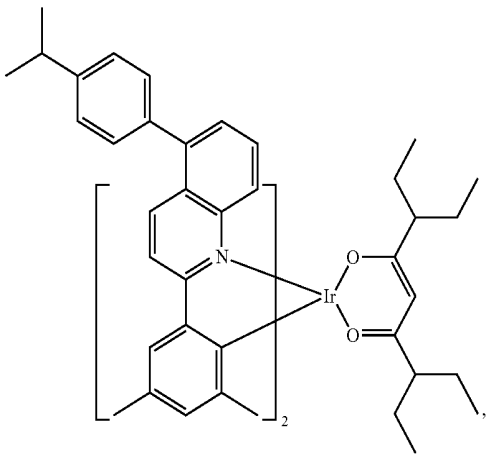
| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 826 | $L_{A98}$ | $L_{B8}$ |
| 827 | $L_{A99}$ | $L_{B8}$ |
| 828 | $L_{A100}$ | $L_{B8}$ |
| 829 | $L_{A101}$ | $L_{B8}$ |
| 830 | $L_{A102}$ | $L_{B8}$ |
| 831 | $L_{A103}$ | $L_{B8}$ |
| 832 | $L_{A104}$ | $L_{B8}$ |
| 833 | $L_{A1}$ | $L_{B9}$ |
| 834 | $L_{A2}$ | $L_{B9}$ |
| 835 | $L_{A3}$ | $L_{B9}$ |
| 836 | $L_{A4}$ | $L_{B9}$ |
| 837 | $L_{A5}$ | $L_{B9}$ |
| 838 | $L_{A6}$ | $L_{B9}$ |
| 839 | $L_{A7}$ | $L_{B9}$ |
| 840 | $L_{A8}$ | $L_{B9}$ |
| 841 | $L_{A9}$ | $L_{B9}$ |
| 842 | $L_{A10}$ | $L_{B9}$ |
| 843 | $L_{A11}$ | $L_{B9}$ |
| 844 | $L_{A12}$ | $L_{B9}$ |
| 845 | $L_{A13}$ | $L_{B9}$ |
| 846 | $L_{A14}$ | $L_{B9}$ |
| 847 | $L_{A15}$ | $L_{B9}$ |
| 848 | $L_{A16}$ | $L_{B9}$ |
| 849 | $L_{A17}$ | $L_{B9}$ |
| 850 | $L_{A18}$ | $L_{B9}$ |
| 851 | $L_{A19}$ | $L_{B9}$ |
| 852 | $L_{A20}$ | $L_{B9}$ |
| 853 | $L_{A21}$ | $L_{B9}$ |
| 854 | $L_{A22}$ | $L_{B9}$ |
| 855 | $L_{A23}$ | $L_{B9}$ |
| 856 | $L_{A24}$ | $L_{B9}$ |
| 857 | $L_{A25}$ | $L_{B9}$ |
| 858 | $L_{A26}$ | $L_{B9}$ |
| 859 | $L_{A27}$ | $L_{B9}$ |
| 860 | $L_{A28}$ | $L_{B9}$ |
| 861 | $L_{A29}$ | $L_{B9}$ |
| 862 | $L_{A30}$ | $L_{B9}$ |
| 863 | $L_{A31}$ | $L_{B9}$ |
| 864 | $L_{A32}$ | $L_{B9}$ |
| 865 | $L_{A33}$ | $L_{B9}$ |
| 866 | $L_{A34}$ | $L_{B9}$ |
| 867 | $L_{A35}$ | $L_{B9}$ |
| 868 | $L_{A36}$ | $L_{B9}$ |
| 869 | $L_{A37}$ | $L_{B9}$ |
| 870 | $L_{A38}$ | $L_{B9}$ |
| 871 | $L_{A39}$ | $L_{B9}$ |
| 872 | $L_{A40}$ | $L_{B9}$ |
| 873 | $L_{A41}$ | $L_{B9}$ |
| 874 | $L_{A42}$ | $L_{B9}$ |
| 875 | $L_{A43}$ | $L_{B9}$ |
| 876 | $L_{A44}$ | $L_{B9}$ |
| 877 | $L_{A45}$ | $L_{B9}$ |
| 878 | $L_{A46}$ | $L_{B9}$ |
| 879 | $L_{A47}$ | $L_{B9}$ |
| 880 | $L_{A48}$ | $L_{B9}$ |
| 881 | $L_{A49}$ | $L_{B9}$ |
| 882 | $L_{A50}$ | $L_{B9}$ |
| 883 | $L_{A51}$ | $L_{B9}$ |
| 884 | $L_{A52}$ | $L_{B9}$ |
| 885 | $L_{A53}$ | $L_{B9}$ |
| 886 | $L_{A54}$ | $L_{B9}$ |
| 887 | $L_{A55}$ | $L_{B9}$ |
| 888 | $L_{A56}$ | $L_{B9}$ |
| 889 | $L_{A57}$ | $L_{B9}$ |
| 890 | $L_{A58}$ | $L_{B9}$ |
| 891 | $L_{A59}$ | $L_{B9}$ |
| 892 | $L_{A60}$ | $L_{B9}$ |
| 893 | $L_{A61}$ | $L_{B9}$ |
| 894 | $L_{A62}$ | $L_{B9}$ |
| 895 | $L_{A63}$ | $L_{B9}$ |
| 896 | $L_{A64}$ | $L_{B9}$ |
| 897 | $L_{A65}$ | $L_{B9}$ |
| 898 | $L_{A66}$ | $L_{B9}$ |
| 899 | $L_{A67}$ | $L_{B9}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 900 | $L_{A68}$ | $L_{B9}$ |
| 901 | $L_{A69}$ | $L_{B9}$ |
| 902 | $L_{A70}$ | $L_{B9}$ |
| 903 | $L_{A71}$ | $L_{B9}$ |
| 904 | $L_{A72}$ | $L_{B9}$ |
| 905 | $L_{A73}$ | $L_{B9}$ |
| 906 | $L_{A74}$ | $L_{B9}$ |
| 907 | $L_{A75}$ | $L_{B9}$ |
| 908 | $L_{A76}$ | $L_{B9}$ |
| 909 | $L_{A77}$ | $L_{B9}$ |
| 910 | $L_{A78}$ | $L_{B9}$ |
| 911 | $L_{A79}$ | $L_{B9}$ |
| 912 | $L_{A80}$ | $L_{B9}$ |
| 913 | $L_{A81}$ | $L_{B9}$ |
| 914 | $L_{A82}$ | $L_{B9}$ |
| 915 | $L_{A83}$ | $L_{B9}$ |
| 916 | $L_{A84}$ | $L_{B9}$ |
| 917 | $L_{A85}$ | $L_{B9}$ |
| 918 | $L_{A86}$ | $L_{B9}$ |
| 919 | $L_{A87}$ | $L_{B9}$ |
| 920 | $L_{A88}$ | $L_{B9}$ |
| 921 | $L_{A89}$ | $L_{B9}$ |
| 922 | $L_{A90}$ | $L_{B9}$ |
| 923 | $L_{A91}$ | $L_{B9}$ |
| 924 | $L_{A92}$ | $L_{B9}$ |
| 925 | $L_{A93}$ | $L_{B9}$ |
| 926 | $L_{A94}$ | $L_{B9}$ |
| 927 | $L_{A95}$ | $L_{B9}$ |
| 928 | $L_{A96}$ | $L_{B9}$ |
| 929 | $L_{A97}$ | $L_{B9}$ |
| 930 | $L_{A98}$ | $L_{B9}$ |
| 931 | $L_{A99}$ | $L_{B9}$ |
| 932 | $L_{A100}$ | $L_{B9}$ |
| 933 | $L_{A101}$ | $L_{B9}$ |
| 934 | $L_{A102}$ | $L_{B9}$ |
| 935 | $L_{A103}$ | $L_{B9}$ |
| 936 | $L_{A104}$ | $L_{B9}$ |

**[0114]** In some embodiments, the compound is selected from the group consisting of:

Compound 28



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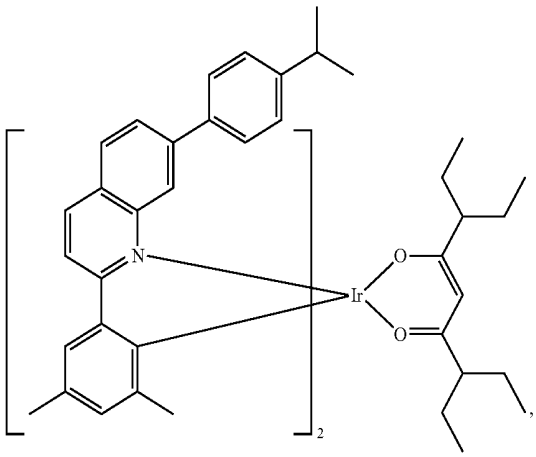
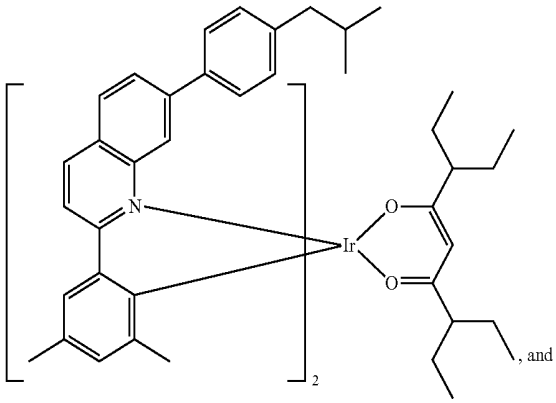
Compound 80

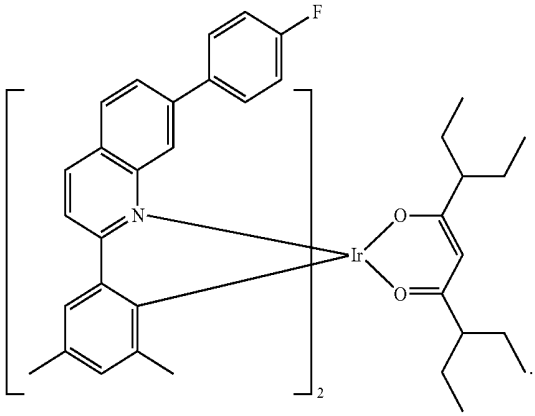


Compound 81



, and

Compound 84

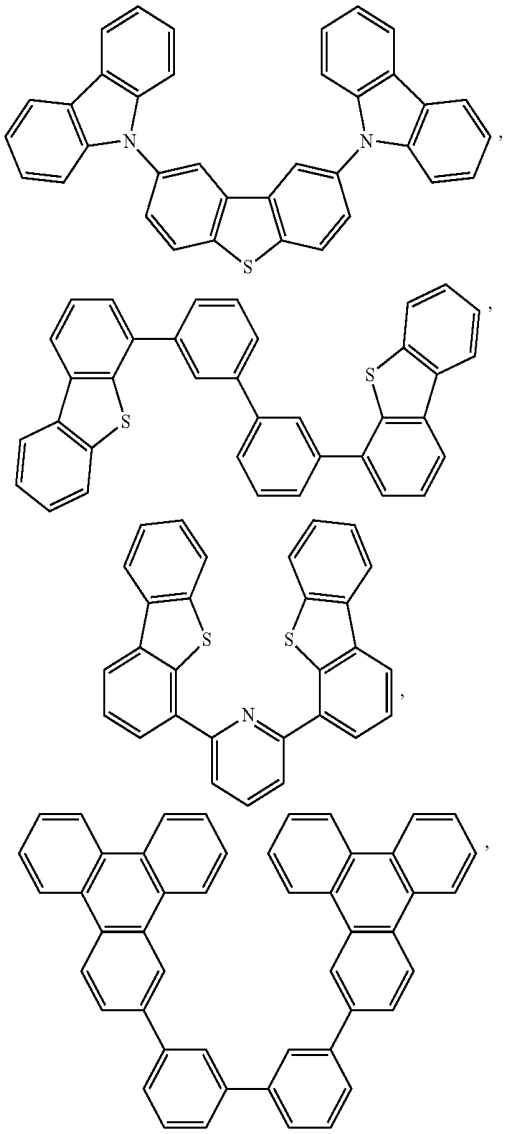


**[0115]** According to another aspect of the present disclosure, a first device is also provided. The first device includes a first organic light emitting device, that includes an anode, a cathode, and an organic layer disposed between the anode and the cathode. The organic layer may include a host and a phosphorescent dopant. The emissive layer can include a compound having a structure according to formula $M(L_A)_x(L_B)_y(L_C)_z$, and its variations as described herein.

**[0116]** The first device can be one or more of a consumer product, an organic light-emitting device and a lighting panel. The organic layer can be an emissive layer and the compound can be an emissive dopant in some embodiments, while the compound can be a non-emissive dopant in other embodiments.

**[0117]** The organic layer can also include a host. In some embodiments, the host can include a metal complex. The host can be a triphenylene containing benzo-fused thiophene or benzo-fused furan. Any substituent in the host can be an unfused substituent independently selected from the group consisting of $C_nH_{2n+1}$, $OC_nH_{2n+1}$, $OAr_1$, $N(C_nH_{2n+1})_2$, $N(Ar_1)(Ar_2)$, $CH{=}CH{-}C_nH_{2n+1}$, $C{\equiv}C{-}C_nH_{2n+1}$, $Ar_1$, $Ar_1{-}Ar_2$, $C_nH_{2n}{-}Ar_1$, or no substitution. In the preceding substituents n can range from 1 to 10; and $Ar_1$ and $Ar_2$ can be independently selected from the group consisting of benzene, biphenyl, naphthalene, triphenylene, carbazole, and heteroaromatic analogs thereof.

**[0118]** The host can be a compound selected from the group consisting of carbazole, dibenzothiophene, dibenzofuran, dibenzoselenophene, azacarbazole, aza-dibenzothiophene, aza-dibenzofuran, and aza-dibenzoselenophene. The host can include a metal complex. The host can be a specific compound selected from the group consisting of:



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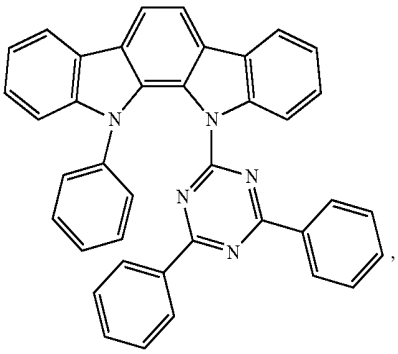

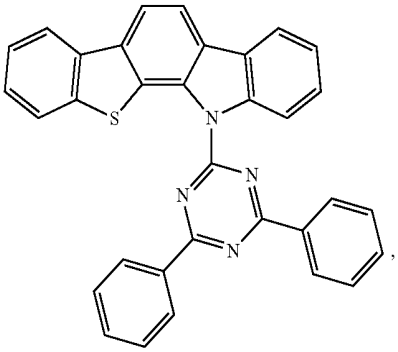

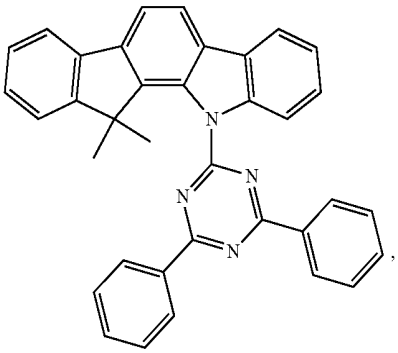

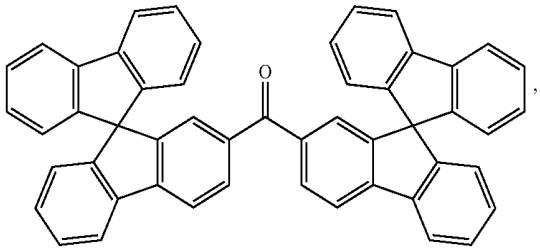

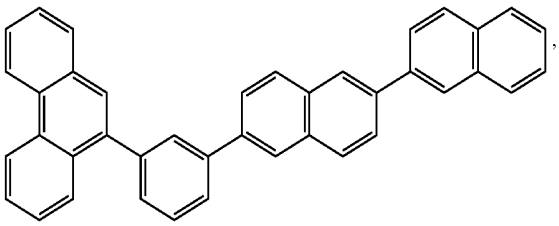

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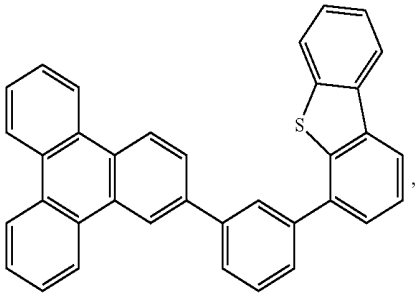
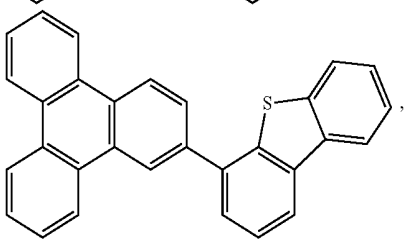




and combinations thereof.

**[0119]** In yet another aspect of the present disclosure, a formulation that comprises a compound having a structure according to formula $M(L_A)_x(L_B)_y(L_C)_z$, and its variations as described herein is disclosed The formulation can include one or more components selected from the group consisting of a solvent, a host, a hole injection material, hole transport material, and an electron transport layer material, disclosed herein.

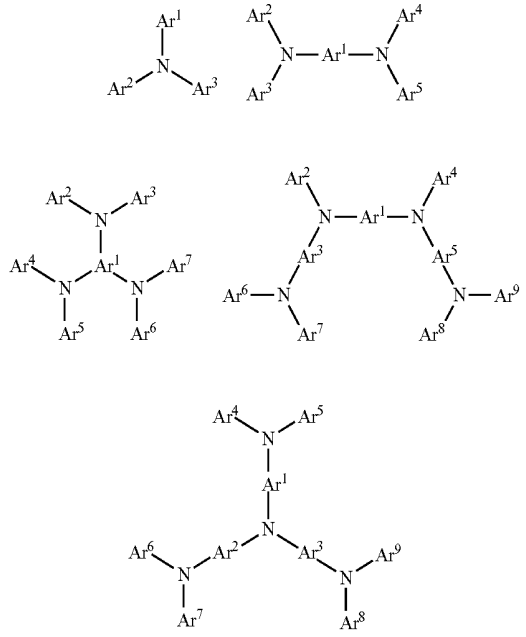
Combination with Other Materials

**[0120]** The materials described herein as useful for a particular layer in an organic light emitting device may be used in combination with a wide variety of other materials present in the device. For example, emissive dopants disclosed herein may be used in conjunction with a wide variety of hosts, transport layers, blocking layers, injection layers, electrodes and other layers that may be present. The materials described or referred to below are non-limiting examples of materials that may be useful in combination with the compounds disclosed herein, and one of skill in the art can readily consult the literature to identify other materials that may be useful in combination.

HIL/HTL:

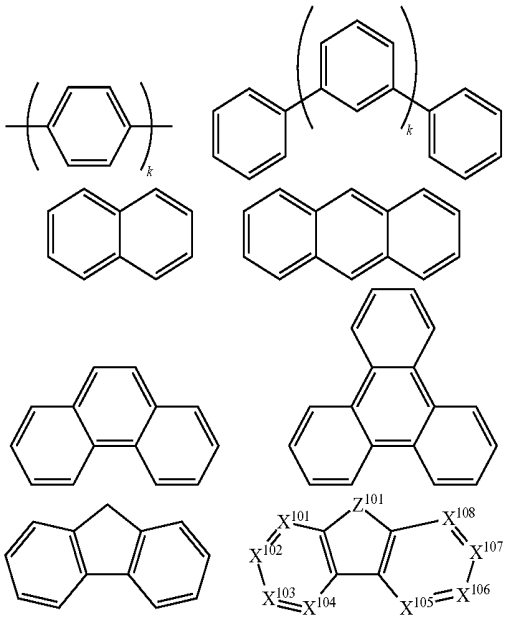
**[0121]** A hole injecting/transporting material to be used in the present invention is not particularly limited, and any compound may be used as long as the compound is typically used as a hole injecting/transporting material. Examples of the material include, but not limit to: a phthalocyanine or porphyrin derivative; an aromatic amine derivative; an indolocarbazole derivative; a polymer containing fluorohydrocarbon; a polymer with conductivity dopants; a conducting polymer, such as PEDOT/PSS; a self-assembly monomer derived from compounds such as phosphonic acid and silane derivatives; a metal oxide derivative, such as $MoO_x$; a p-type semiconducting organic compound, such as 1,4,5,8,9,12-Hexaazatriphenylenehexacarbonitrile; a metal complex, and a cross-linkable compounds.

**[0122]** Examples of aromatic amine derivatives used in HIL or HTL include, but not limit to the following general structures:



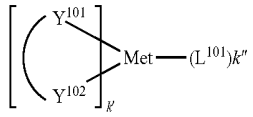
**[0123]** Each of $Ar^1$ to $Ar^9$ is selected from the group consisting aromatic hydrocarbon cyclic compounds such as benzene, biphenyl, triphenyl, triphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, azulene; group consisting aromatic heterocyclic compounds such as dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzoselenophene, carbazole, indolocarbazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuropyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzoselenophenopyridine, and selenophenodipyridine; and group consisting 2 to 10 cyclic structural units which are groups of the same type or different types selected from the aromatic hydrocarbon cyclic group and the aromatic heterocyclic group and are bonded to each other directly or via at least one of oxygen atom, nitrogen atom, sulfur atom, silicon atom, phosphorus atom, boron atom, chain structural unit and the aliphatic cyclic group. Wherein each Ar is further substituted by a substituent selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

**[0124]** In one aspect, $Ar^1$ to $Ar^9$ is independently selected from the group consisting of:



wherein k is an integer from 1 to 20; $X^{101}$ to $X^{108}$ is C (including CH) or N; $Z^{101}$ is $NAr^1$, O, or S; $Ar^1$ has the same group defined above.

**[0125]** Examples of metal complexes used in HIL or HTL include, but not limit to the following general formula:



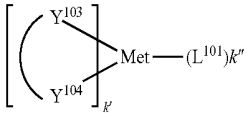
wherein Met is a metal, which can have an atomic weight greater than 40; ($Y^{101}$-$Y^{102}$) is a bidentate ligand, $Y^{101}$ and $Y^{102}$ are independently selected from C, N, O, P, and S; $L^{101}$ is an ancillary ligand; k' is an integer value from 1 to the maximum number of ligands that may be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

**[0126]** In one aspect, ($Y^{101}$-$Y^{102}$) is a 2-phenylpyridine derivative. In another aspect, ($Y^{101}$-$Y^{102}$) is a carbene ligand. In another aspect, Met is selected from Ir, Pt, Os, and Zn. In a further aspect, the metal complex has a smallest oxidation potential in solution vs. $Fc^+/Fc$ couple less than about 0.6 V.

Host:

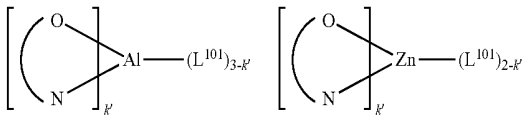
**[0127]** The light emitting layer of the organic EL device of the present invention preferably contains at least a metal complex as light emitting material, and may contain a host material using the metal complex as a dopant material. Examples of the host material are not particularly limited, and any metal complexes or organic compounds may be used as long as the triplet energy of the host is larger than that of the dopant. While the Table below categorizes host materials as preferred for devices that emit various colors, any host material may be used with any dopant so long as the triplet criteria is satisfied.

**[0128]** Examples of metal complexes used as host are preferred to have the following general formula:



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

**[0129]** In one aspect, the metal complexes are:

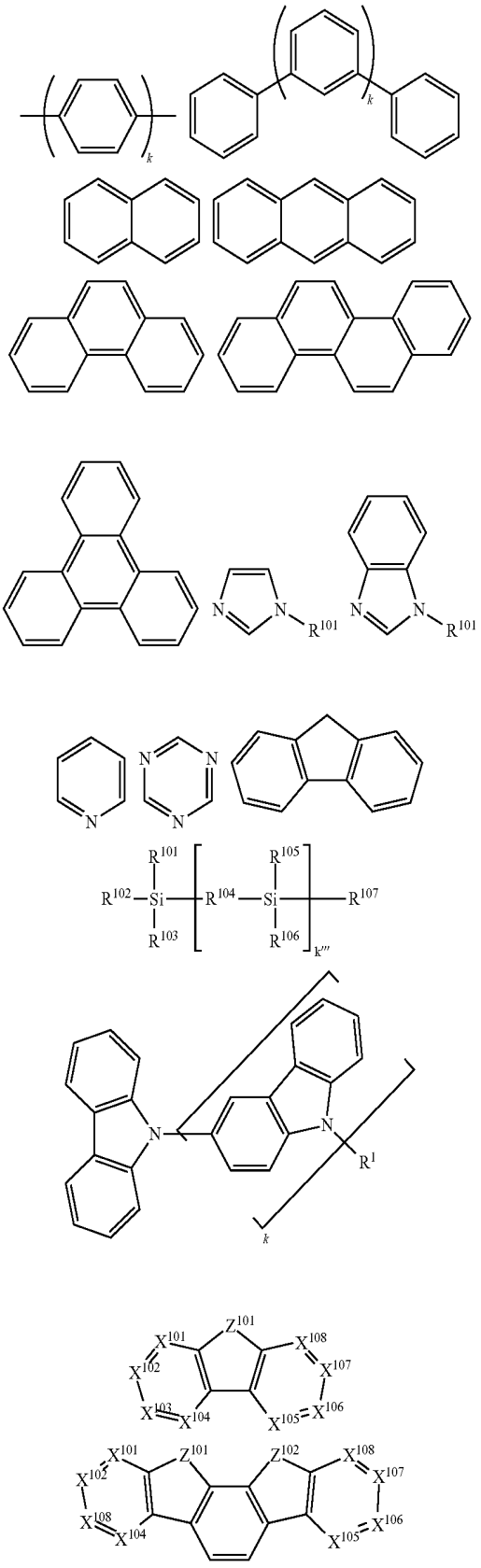


wherein (O—N) is a bidentate ligand, having metal coordinated to atoms O and N.

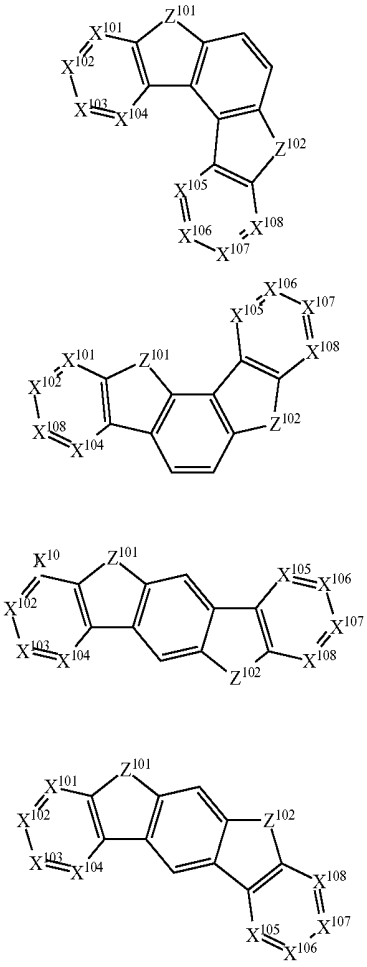
**[0130]** In another aspect, Met is selected from Ir and Pt. In a further aspect, ($Y^{103}$-$Y^{104}$) is a carbene ligand.

**[0131]** Examples of organic compounds used as host are selected from the group consisting aromatic hydrocarbon cyclic compounds such as benzene, biphenyl, triphenyl, triphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, azulene; group consisting aromatic heterocyclic compounds such as dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzoselenophene, carbazole, indolocarbazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuropyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzoselenophenopyridine, and selenophenodipyridine; and group consisting 2 to 10 cyclic structural units which are groups of the same type or different types selected from the aromatic hydrocarbon cyclic group and the aromatic heterocyclic group and are bonded to each other directly or via at least one of oxygen atom, nitrogen atom, sulfur atom, silicon atom, phosphorus atom, boron atom, chain structural unit and the aliphatic cyclic group. Wherein each group is further substituted by a substituent selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

**[0132]** In one aspect, host compound contains at least one of the following groups in the molecule:



-continued



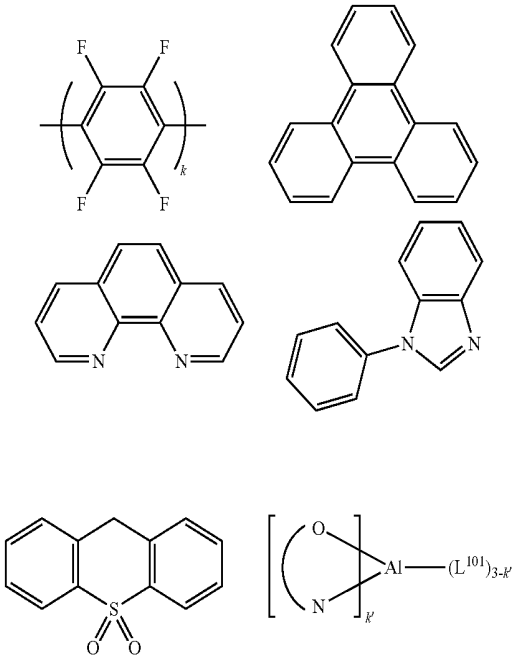
wherein $R^{101}$ to $R^{107}$ independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl heteroalkenyl alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile,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

HBL:

**[0133]** A hole blocking layer (HBL) may be used to reduce the number of holes and/or excitons that leave the emissive layer. The presence of such a blocking layer in a device may result in substantially higher efficiencies as compared to a similar device lacking a blocking layer. Also, a blocking layer may be used to confine emission to a desired region of an OLED.

**[0134]** In one aspect, compound used in HBL contains the same molecule or the same functional groups used as host described above.

**[0135]** In another aspect, compound used in HBL contains at least one of the following groups in the molecule:

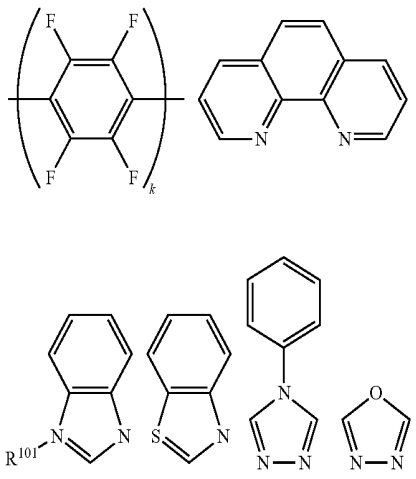


wherein k is an integer from 1 to 20; $L^{101}$ is an another ligand, k' is an integer from 1 to 3.

ETL:

**[0136]** Electron transport layer (ETL) may include a material capable of transporting electrons. Electron transport layer may be intrinsic (undoped), or doped. Doping may be used to enhance conductivity. Examples of the ETL material are not particularly limited, and any metal complexes or organic compounds may be used as long as they are typically used to transport electrons.

**[0137]** In one aspect, compound used in ETL contains at least one of the following groups in the molecule:



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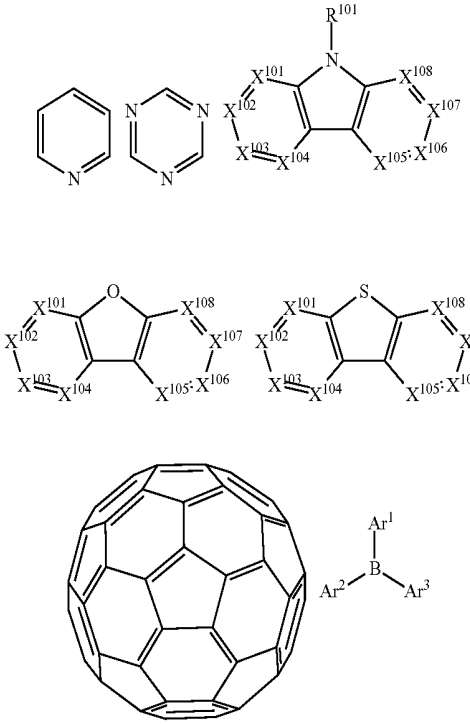
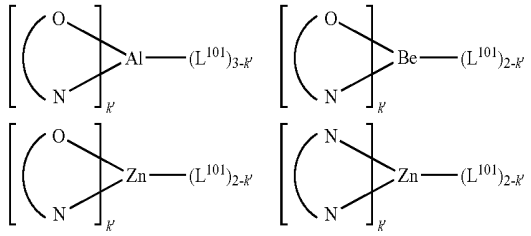


wherein $R^{101}$ is selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl,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

**[0138]** In another aspect, the metal complexes used in ETL contains, but not limit to the following general formula:



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

**[0139]** In any above-mentioned compounds used in each layer of the OLED device, the hydrogen atoms can be partially or fully deuterated. Thus, any specifically listed substituent, such as, without limitation, methyl, phenyl, pyridyl, etc. encompasses undeuterated, partially deuterated, and fully deuterated versions thereof. Similarly, classes of substituents such as, without limitation, alkyl, aryl, cycloalkyl, heteroaryl, etc. also encompass undeuterated, partially deuterated, and fully deuterated versions thereof.

**[0140]** In addition to and/or in combination with the materials disclosed herein, many hole injection materials, hole transporting materials, host materials, dopant materials, exiton/hole blocking layer materials, electron transporting and electron injecting materials may be used in an OLED. Non-limiting examples of the materials that may be used in an OLED in combination with materials disclosed herein are listed in Table A below. Table A lists non-limiting classes of materials, non-limiting examples of compounds for each class, and references that disclose the materials.

TABLE A

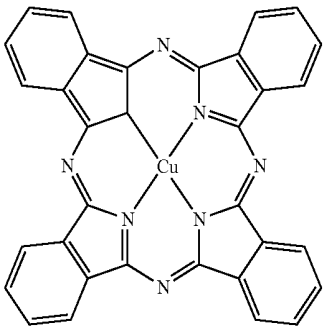
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Hole injection materials | | |
| Phthalocyanine and porphyrin compounds |  | Appl, Phys. Lett. 69, 2160 (1996) |

TABLE A-continued

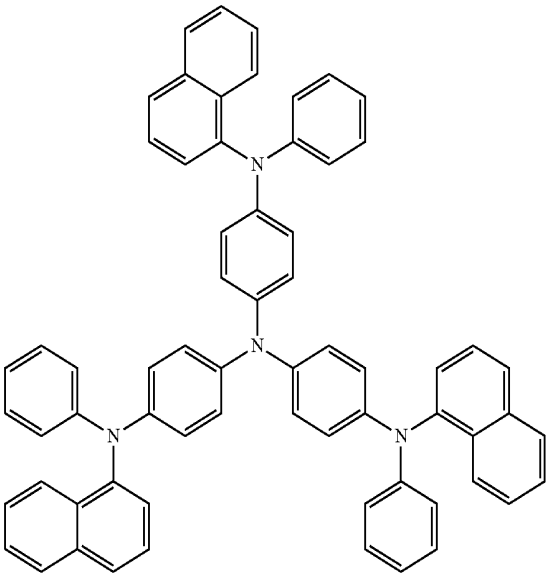
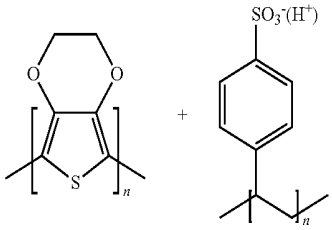
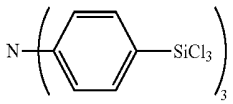
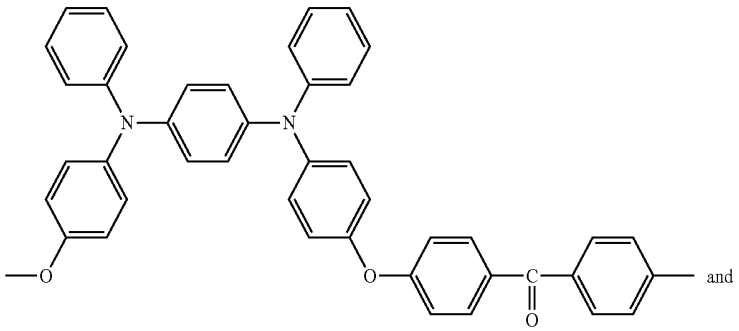
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Starburst triaryiamines |  | J. Lumin, 72-74, 985 (1997) |
| $CF_x$ Fluorohydrocarbon polymer |  | Appl. Phys. Lett. 78, 673 (2001) |
| Conducting polymers (e.g., PEDOT:PSS, polyaniline, polythiophene) |  | Synth. Met. 87, 171 (1997) WO2007002683 |
| Phosphonic acid and silane SAMs |  | US20030162053 |
| Triarylamine or polythiophene polymers with conductivity dopants |  and | EP1725079A1 |

TABLE A-continued

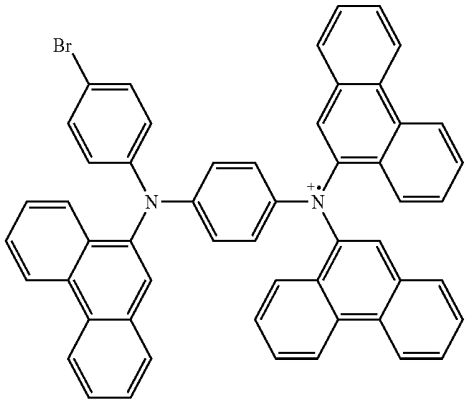
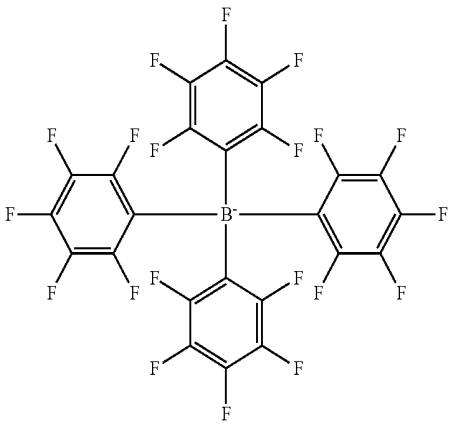
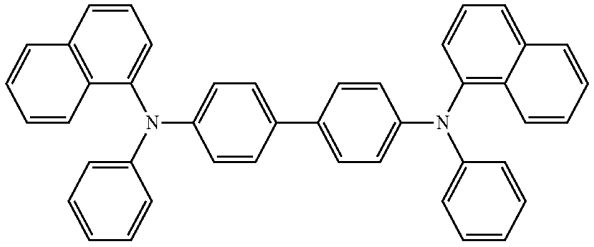
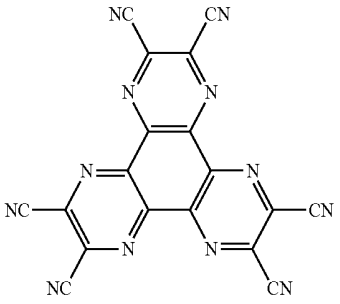
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | |
| |  | |
| Organic compounds with conductive inorganic compounds, such as molybdenum and tungsten oxides |  | US20050123751<br>SID Symposium Digest, 37, 923 (2006)<br>WO2009018009 |
| n-type semiconducting organic complexes |  | US20020158242 |

TABLE A-continued

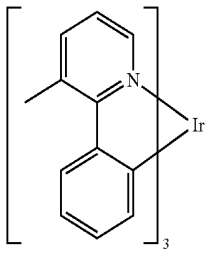
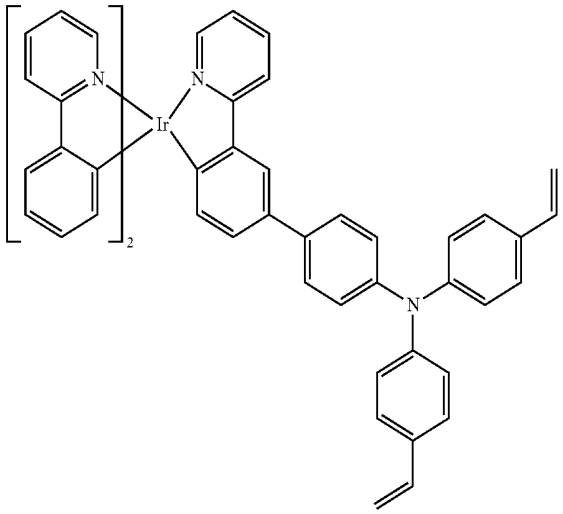
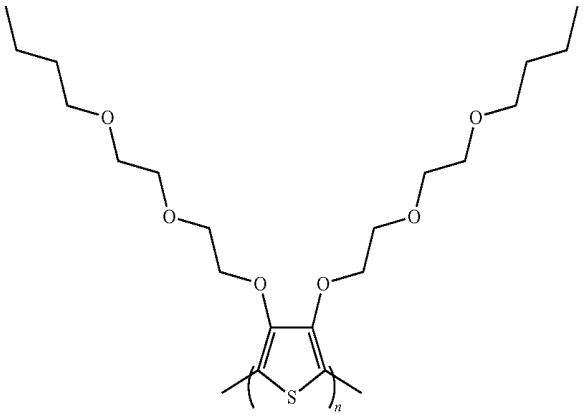
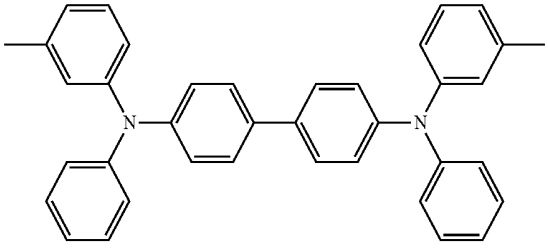
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Metal organometallic complexes |  | US20060240279 |
| Cross-linkable compounds |  | US20080220265 |
| Polythiophene based polymers and copolymers |  | WO 2011075644 EP2350216 |
| Hole transporting materials | | |
| Triarylamines (e.g., TPD, α-NPD) |  | Appl. Phys. Lett. 51, 913 (1987) |

TABLE A-continued

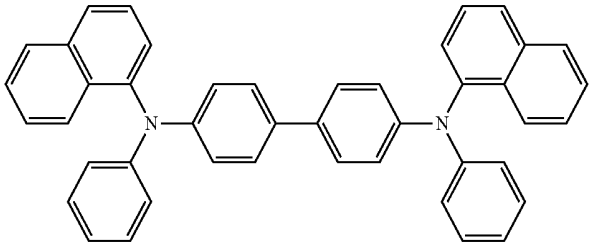
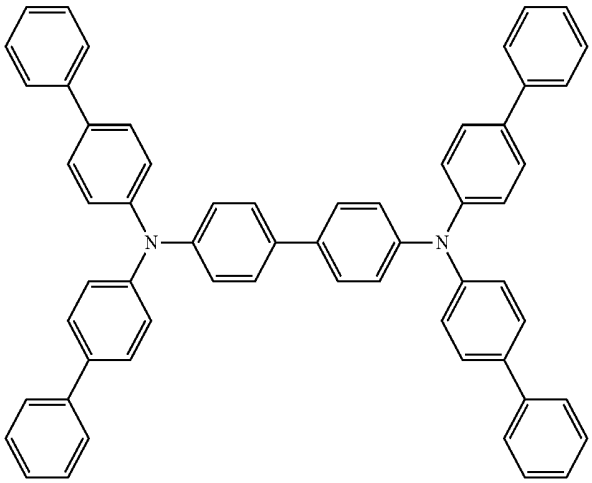
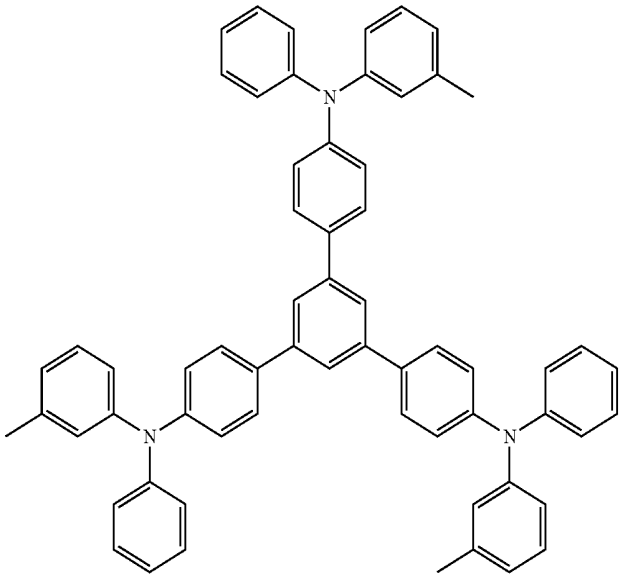
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | U.S. Pat. No. 5,061,569 |
| |  | EP650955 |
| |  | J. Mater. Chem. 3, 319 (1993) |

TABLE A-continued

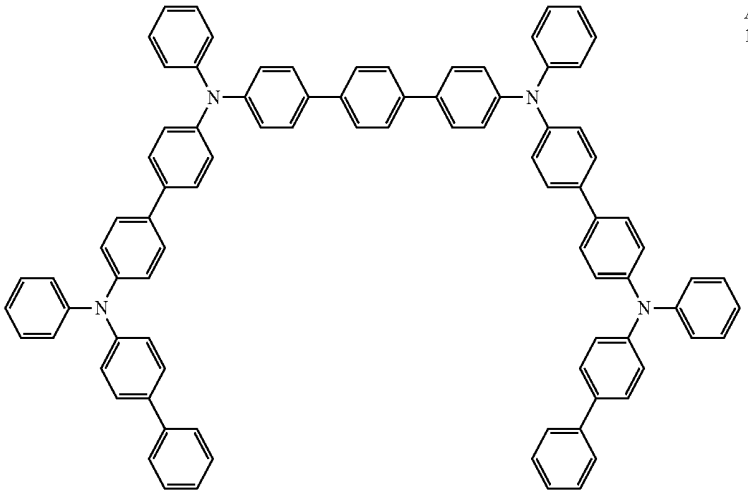
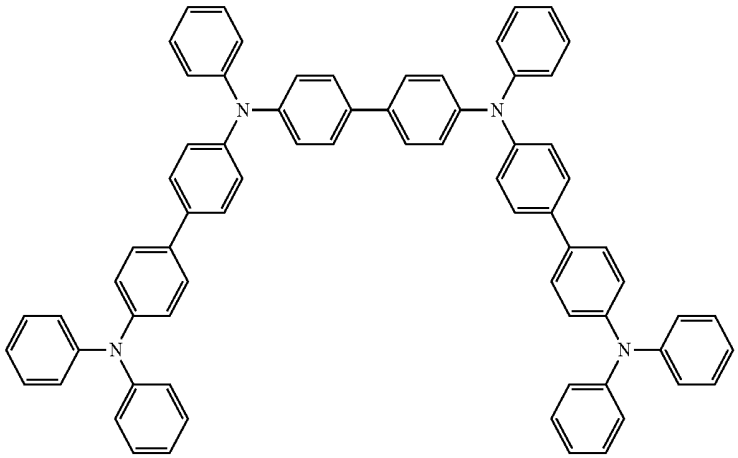
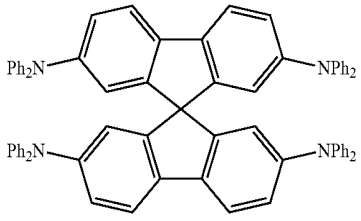
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | Appl. Phys. Lett. 90, 183503 (2007) |
| |  | Appl. Phys. Lett. 90, 183503 (2007) |
| Triarylamine on spirofluorene core |  | Synth. Met. 91, 209 (1997) |

TABLE A-continued

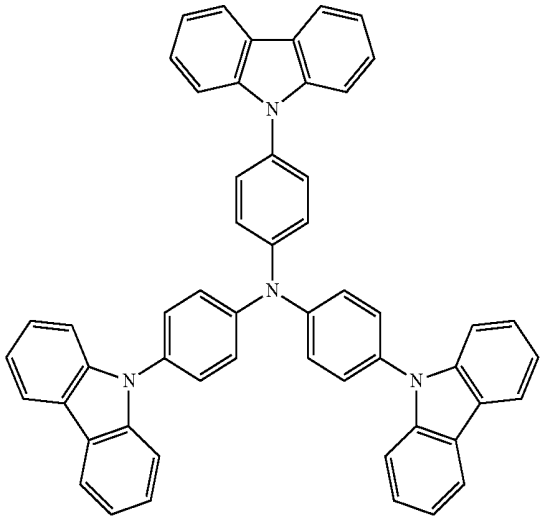
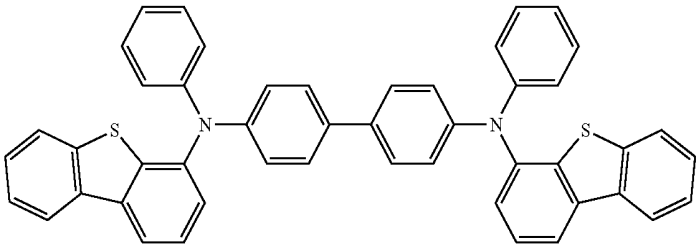
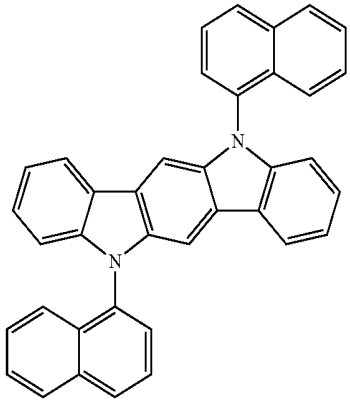
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Arylamine carbazole compounds |  | Adv. Mater. 6, 677 (1994), US20080124572 |
| Triarylamine with (di)benzothiophene/ (di)benzofuran |  | US20070278938, US20080106190 US20110163302 |
| Indolocarbazoles |  | Synth. Met. 111, 421 (2000) |

TABLE A-continued

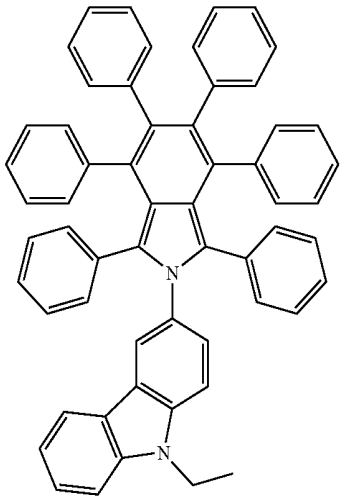
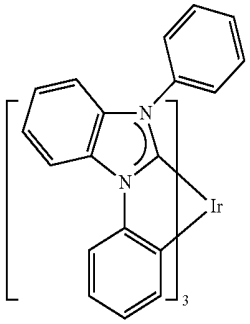
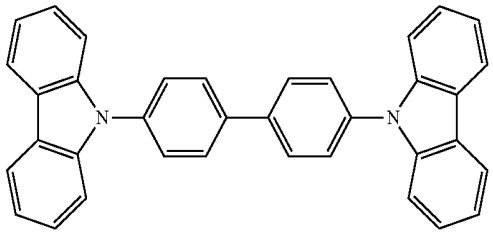
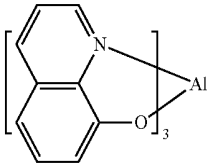
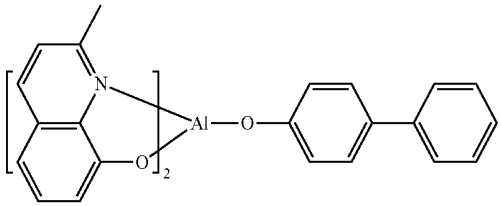
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Isoindole compounds |  | Chem. Mater. 15, 3148 (2003) |
| Metal carbene complexes |  | US20080018221 |
| Phosphorescent OLED host materials<br>Red hosts | | |
| Arylcarbazoles |  | Appl. Phys. Lett. 78, 1622 (2001) |
| Metal 8-hydroxyquinolates (e.g., $Alq_3$, BAlq) |  | Nature 395, 151 (1998) |
| |  | US20060202194 |

TABLE A-continued

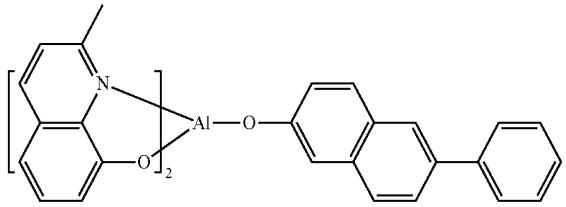
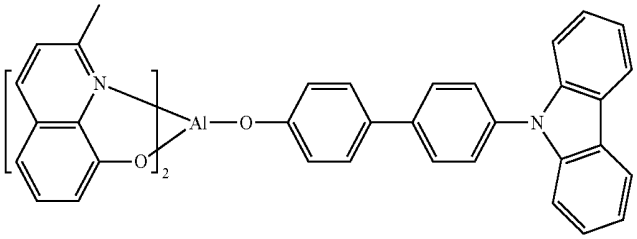
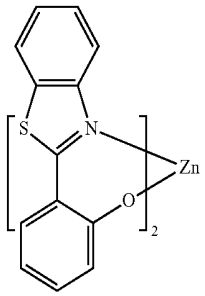
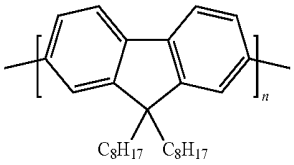
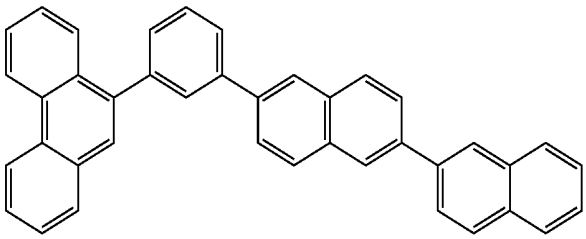
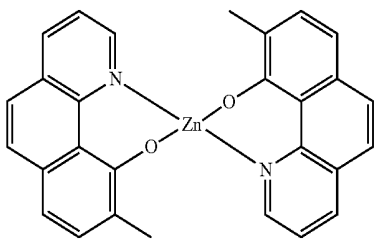
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | WO2005014551 |
| |  | WO2006072002 |
| Metal phenoxybenzothiazole compounds |  | Appl. Phys. Lett. 90, 123509 (2007) |
| Conjugated oligomers and polymers (e.g., polyfluorene) |  | Org. Electron. 1, 15 (2000) |
| Aromatic fused rings |  | WO2009066779, WO2009066778, WO2009063833, US20090045731, US20090045730, WO2009008311, US20090008605, US20090009065 |
| Zinc complexes |  | WO2010056066 |

TABLE A-continued

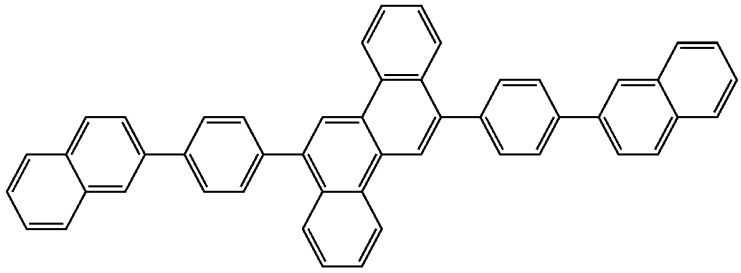
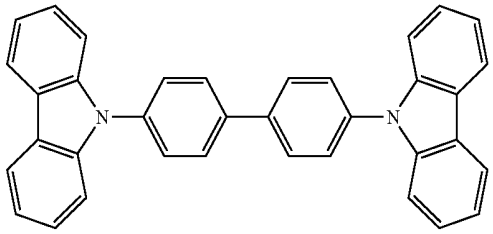
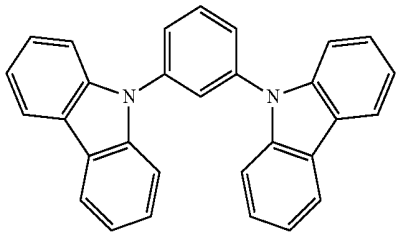
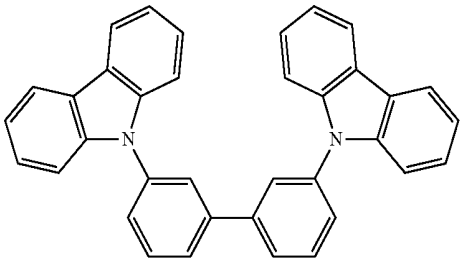
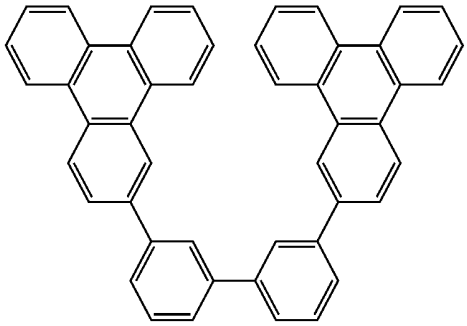
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Chrysene based compounds |  | WO2011086863 |
| | Green hosts | |
| Arylcarbazoles |  | Appl. Phys. Lett. 78, 1622 (2001) |
| |  | US20030175553 |
| |  | WO2001039234 |
| Aryltriphenylene compounds |  | US20060280965 |

TABLE A-continued

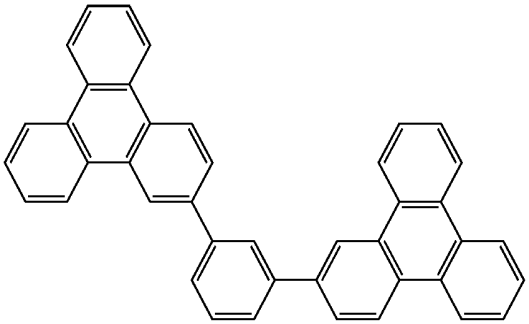
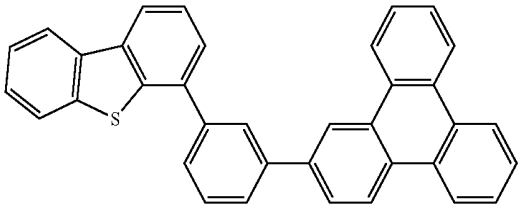
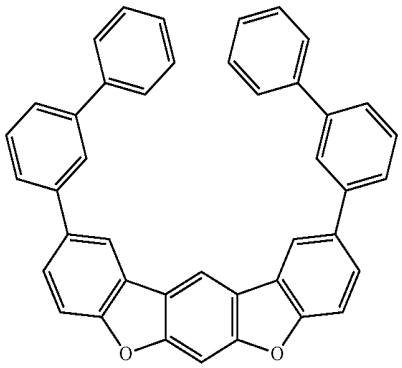
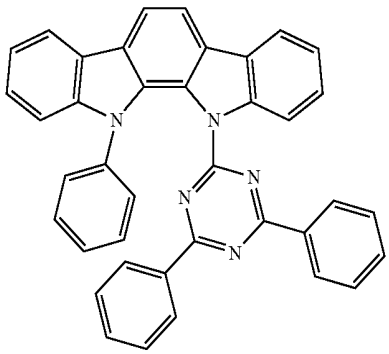
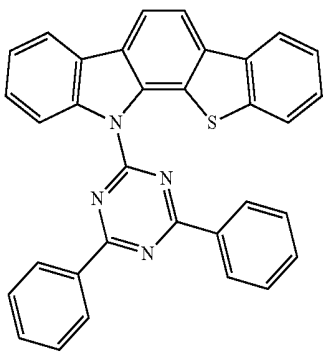
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | US20060280965 |
| |  | WO2009021126 |
| Poly-fused heteroaryl compounds |  | US20090309488<br>US20090302743<br>US20100012931 |
| Donor acceptor type molecules |  | WO2008056746 |
| |  | WO2010107244 |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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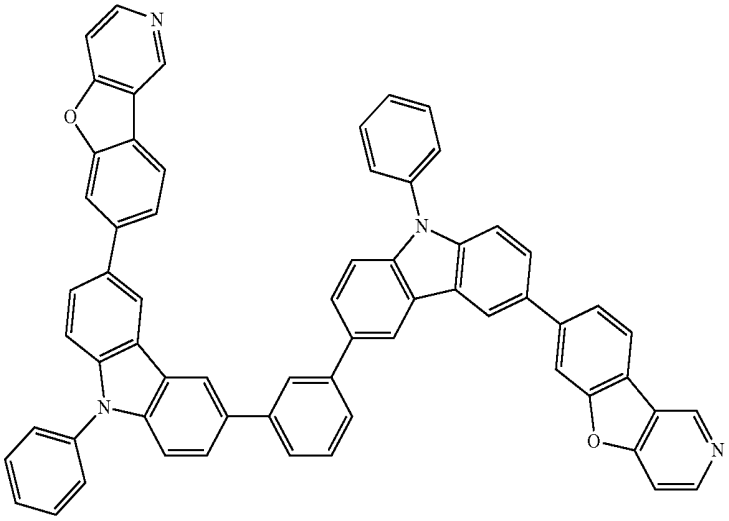
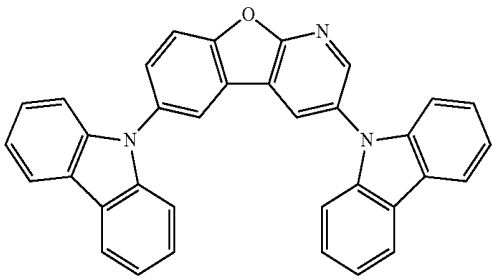
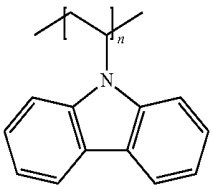
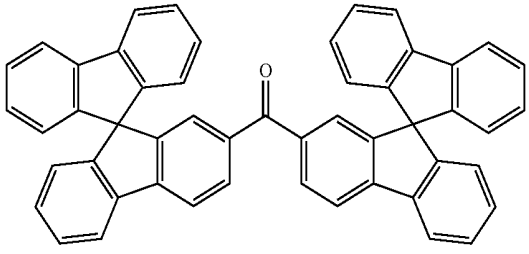
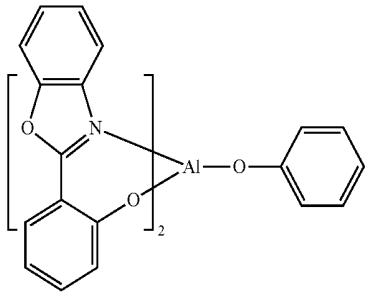
| Aza-carbazole/DBT/DBF |  | JP2008074939 |
| |  | US2010187984 |
| Polymers (e.g., PVK) |  | Appl. Phys. Lett. 77, 2280 (2000) |
| Spirofluorene compounds |  | WO2004093207 |
| Metal phenoxybenzooxazole compounds |  | WO2005089025 |

TABLE A-continued

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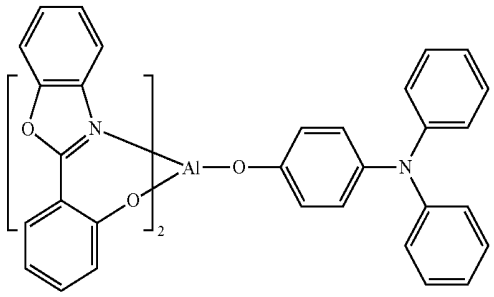
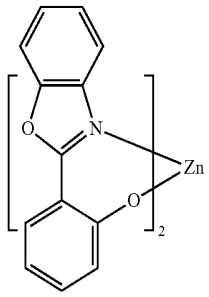
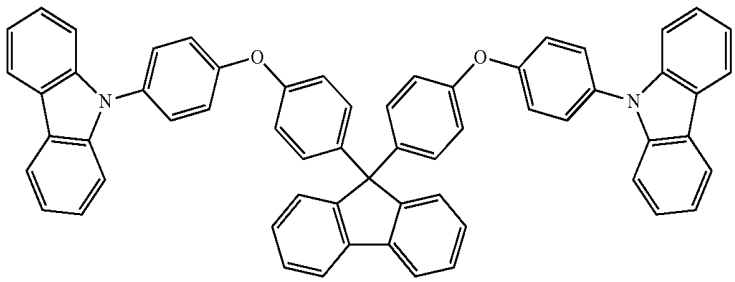
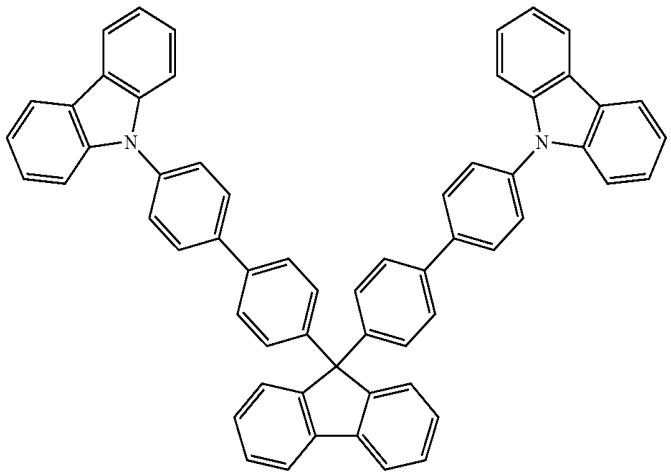
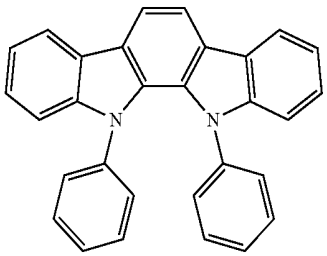
| |  | WO2006132173 |
| |  | JP200511610 |
| Spirofluorene-carbazole compounds |  | JP2007254297 |
| |  | JP2007254297 |
| Indolocarbazoles |  | WO2007063796 |

TABLE A-continued

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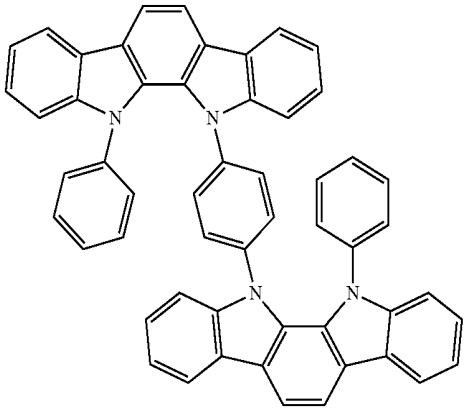
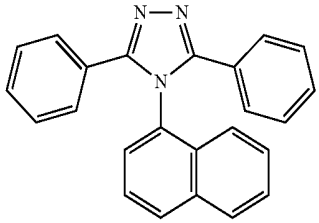
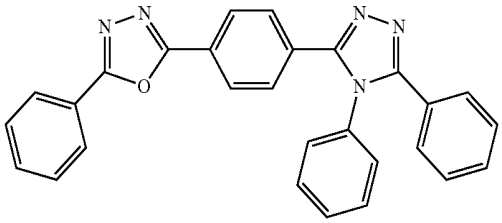
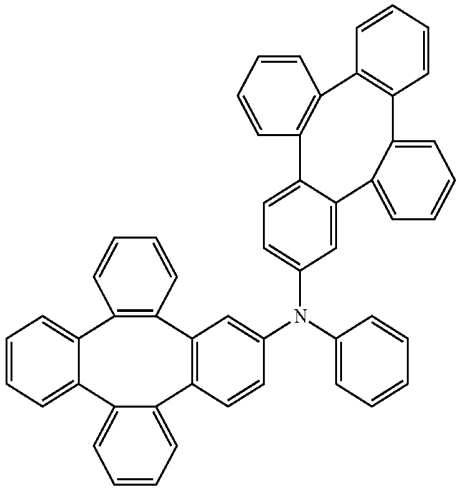
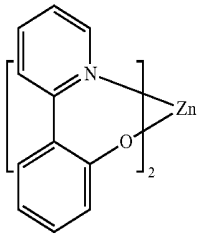
| |  | WO2007063754 |
| 5-member ring electron deficient heterocycles (e.g., triazole, oxadiazole) |  | J. Appl. Phys. 90, 5048 (2001) |
| |  | WO2004107822 |
| Tetraphenylene complexes |  | US20050112407 |
| Metal phenoxypyridine compounds |  | WO2005030900 |

TABLE A-continued

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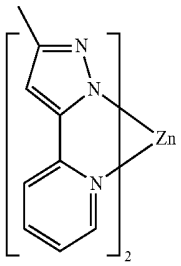
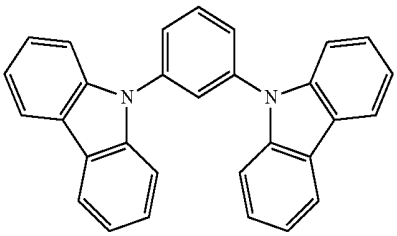
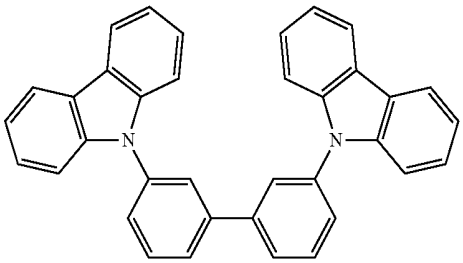
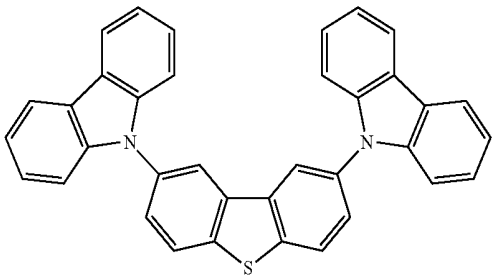
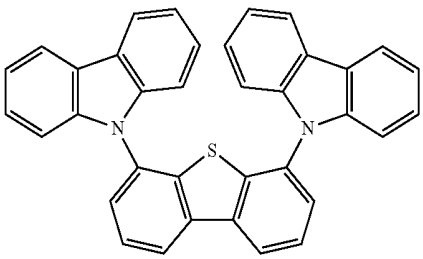
| Metal coordination complexes (e.g., Zn, Al with N^N ligands) |  | US20040137268, US20040137267 |
| | Blue hosts | |
| Arylcarbazoles |  | Appl. Phys. Lett, 82, 2422 (2003) |
| |  | US20070190359 |
| Dibenzothiophene/ Dibenzofuran-carbazole compounds |  | WO2006114966, US20090167162 |
| |  | US20090167162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

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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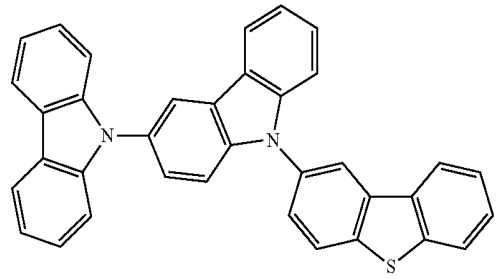
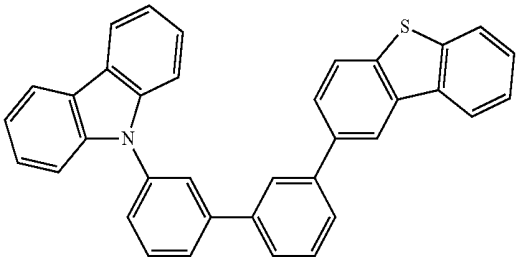
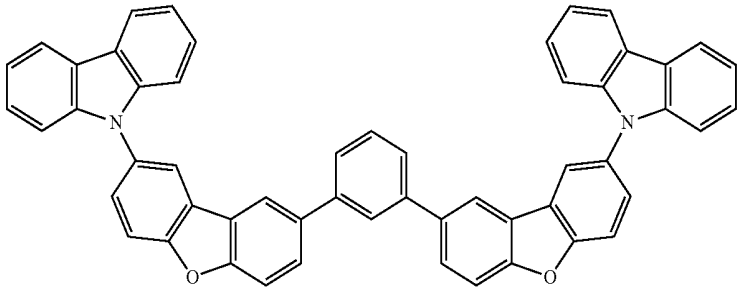
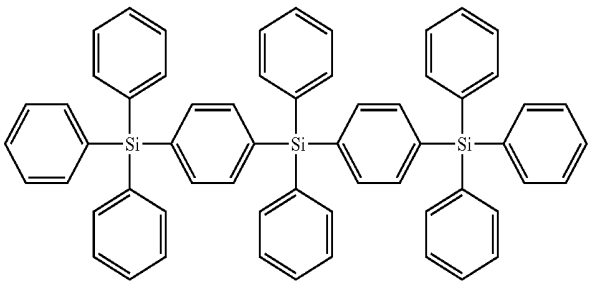
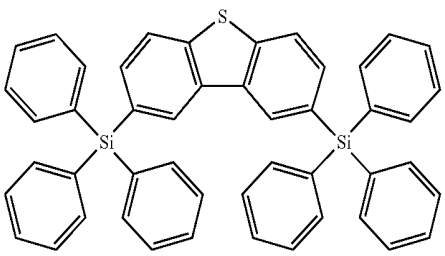
| |  | WO2009086028 |
| |  | US20090030202, US20090017330 |
| |  | US20100084966 |
| Silicon aryl compounds |  | US20050238919 |
| |  | WO2009003898 |

TABLE A-continued

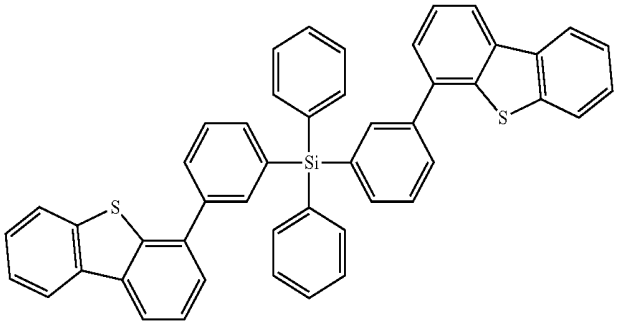
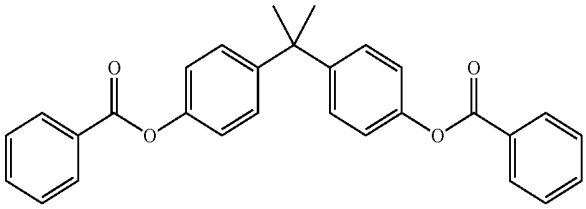
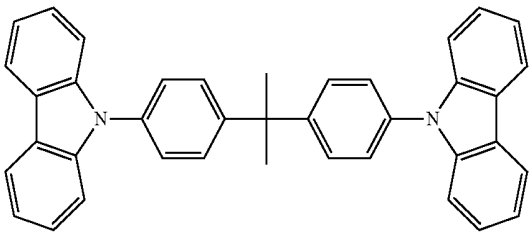
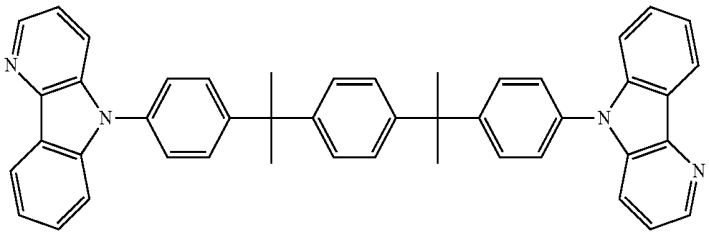
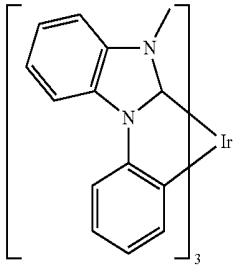
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Silicon/Germanium aryl compounds |  | EP2034538A |
| Aryl benzol ester |  | WO2006100298 |
| Carbazole linked by non-conjugated groups |  | US20040115476 |
| Aza-carbazoles |  | US20060121308 |
| High triplet metal organometallic complex |  | U.S. Pat. No. 7,154,114 |

TABLE A-continued

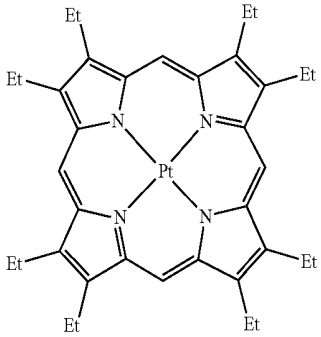
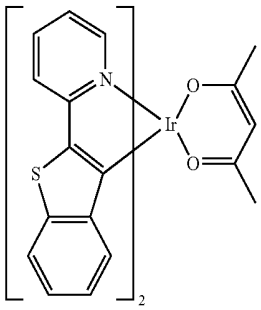
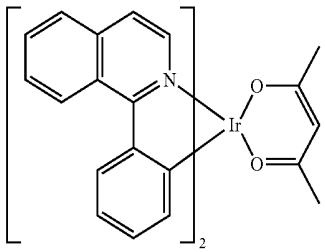
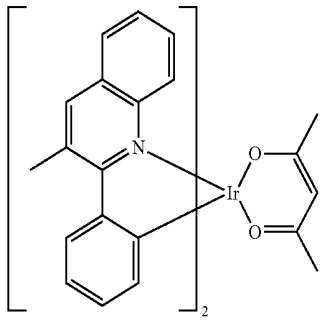
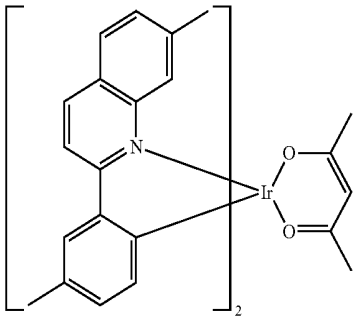
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| | Phosphorescent dopants<br>Red dopants | |
| Heavy metal porphyrins (e.g., PtOEP) |  | Nature 395, 151 (1998) |
| Iridium(III) organometallic complexes |  | Appl. Phys. Lett. 78, 1622 (2001) |
| |  | US20030072964 |
| |  | US20030072964 |
| |  | US20060202194 |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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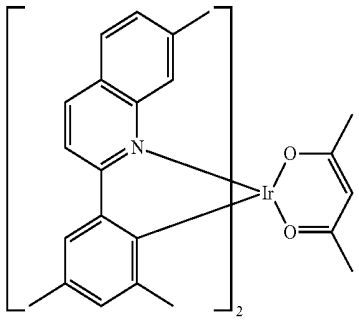
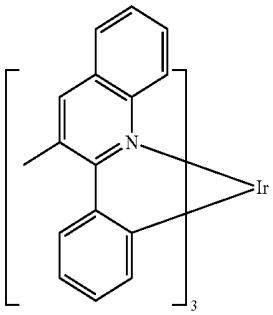
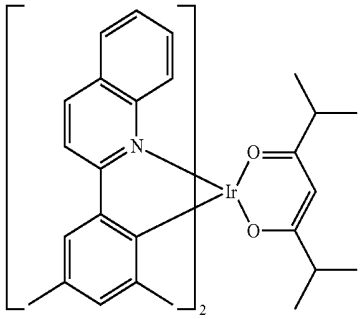
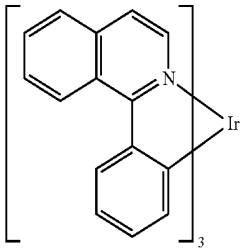
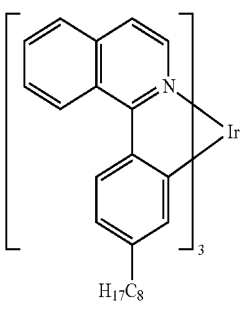
| |  | US20060202194 |
| |  | US20070087321 |
| |  | US20080261076<br>US20100090591 |
| |  | US20070087321 |
| |  | Adv. Mater. 19, 739 (2007) |

TABLE A-continued

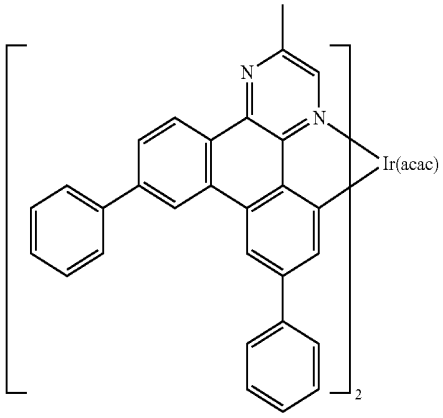
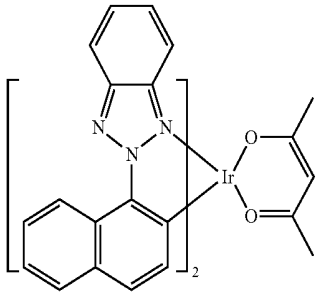
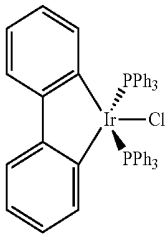
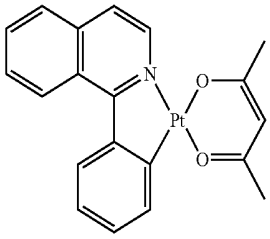
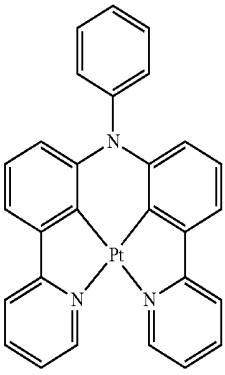
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | WO2009100991 |
| |  | WO2008101842 |
| |  | U.S. Pat. No. 7,232,618 |
| Platinum( I I ) organometallic complexes |  | WO2003040257 |
| |  | US20070103060 |

TABLE A-continued

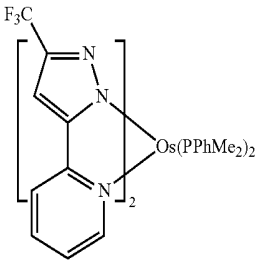
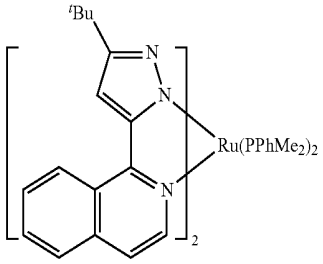
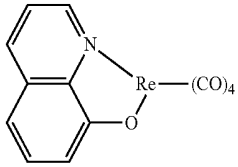
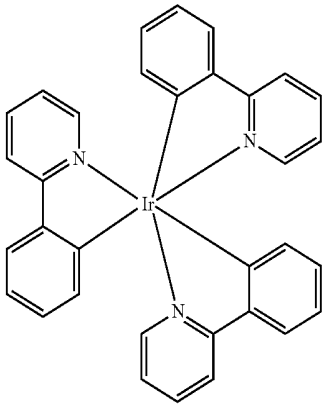
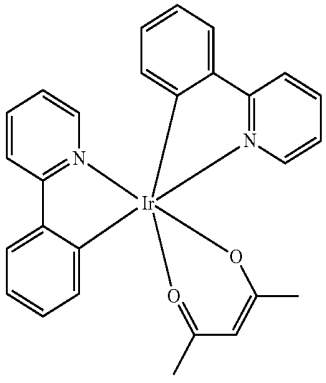
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Osmium(III) complexes |  | Chem. Mater. 17, 3532 (2005) |
| Ruthenium (II) complexes |  | Adv. Mater. 17, 1059 (2005) |
| Rhenium (I), (II), and (III) complexes |  | US20050244673 |
| | Green dopants | |
| Iridium(III) organometallic complexes |  | Inorg. Chem. 40, 1704 (2001) |
| | and its derivatives | |
| |  | US20020034656 |

TABLE A-continued

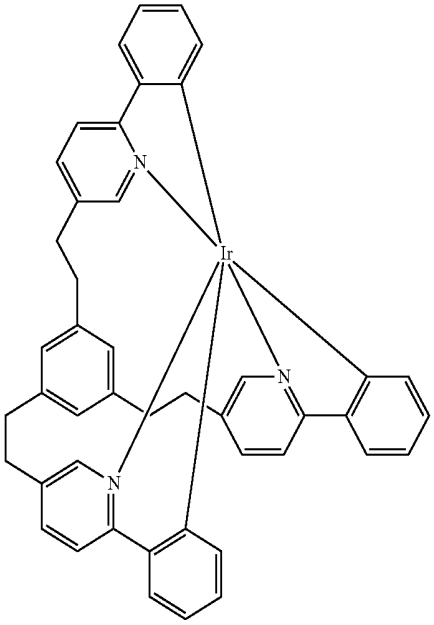
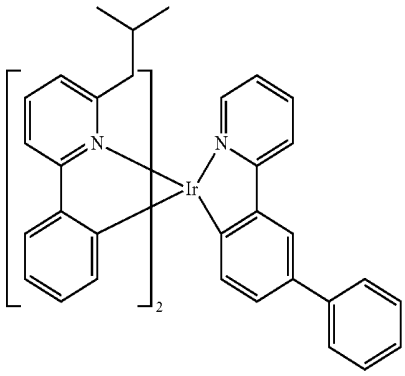
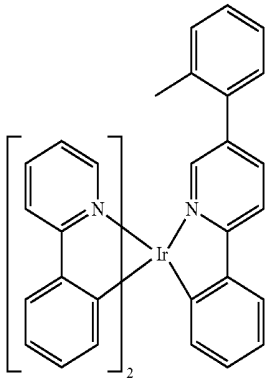
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | U.S. Pat. No. 7,332,232 |
| |  | US20090108737 |
| |  | WO2010028151 |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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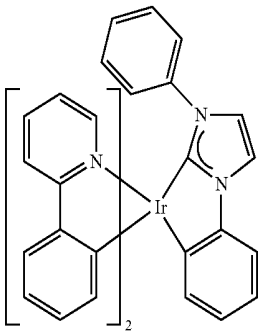
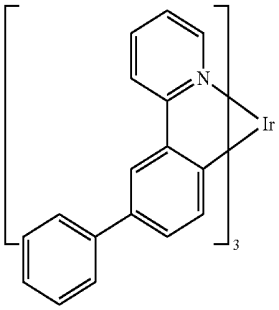
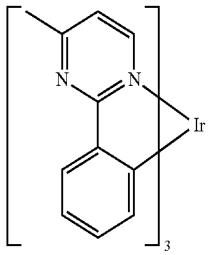
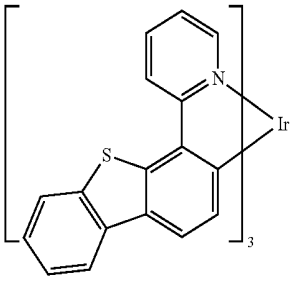
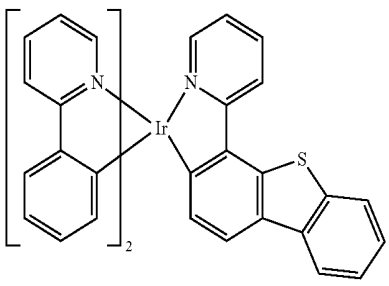
| |  | EP1841834B |
| |  | US20060127696 |
| |  | US20090039776 |
| |  | U.S. Pat. No. 6,921,915 |
| |  | US20100244004 |

TABLE A-continued

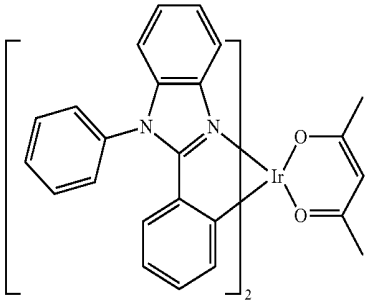
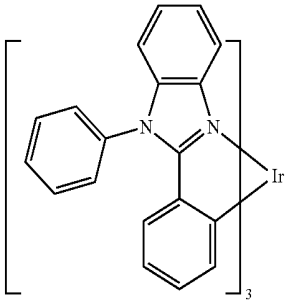
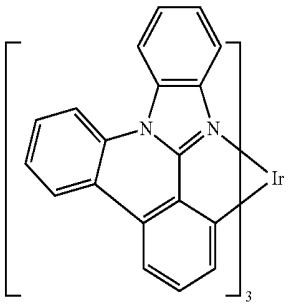
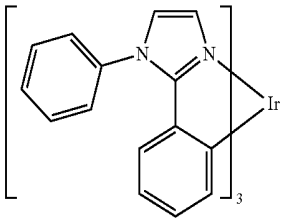
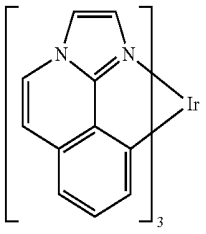
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | U.S. Pat. No. 6,687,266 |
| |  | Chem. Mater. 16, 2480 (2004) |
| |  | US20070190359 |
| |  | US 20060008670 JP2007123392 |
| |  | WO2010086089, WO2011044988 |

TABLE A-continued

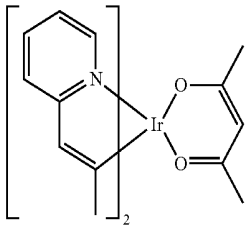
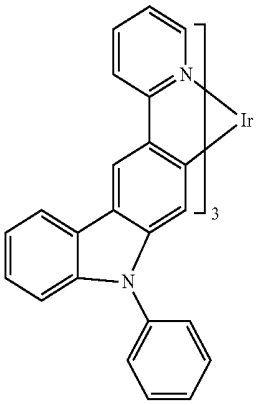
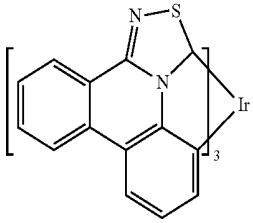
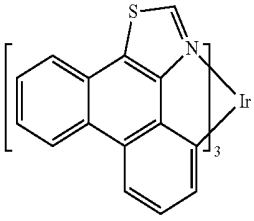
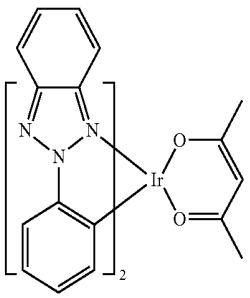
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | Adv. Mater. 16, 2003 (2004) |
| |  | Angew. Chem. Int . Ed. 2006, 45, 7800 |
| |  | WO2009050290 |
| |  | US20090165846 |
| |  | US20080015355 |

TABLE A-continued

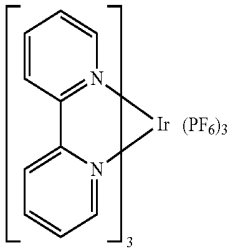
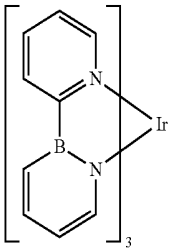
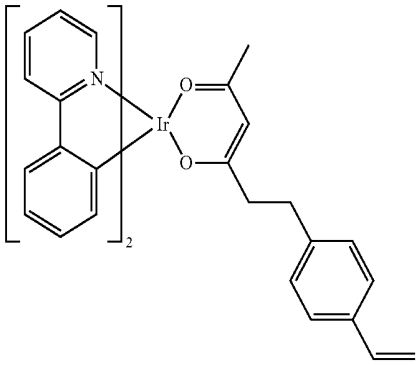
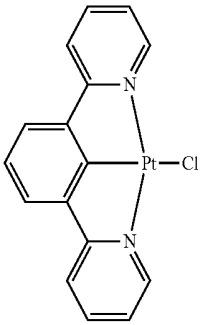
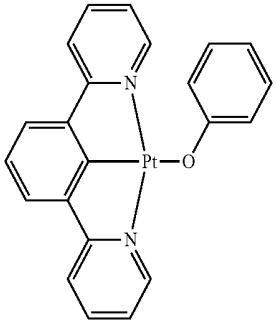
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | US20010015432 |
| |  | US20100295032 |
| Monomer for polymeric metal organometallic compounds |  | U.S. Pat. No. 7,250,226, U.S. Pat. No. 7,396,598 |
| Pt(II) organometallic complexes, including polydentated ligands |  | Appl. Phys. Lett. 86, 153505 (2005) |
| |  | Appl. Phys. Lett 86, 153505 (2005) |

TABLE A-continued

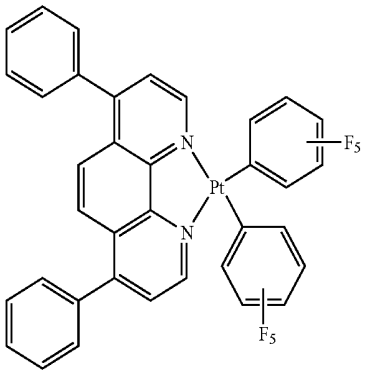
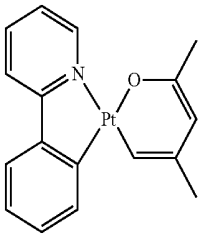
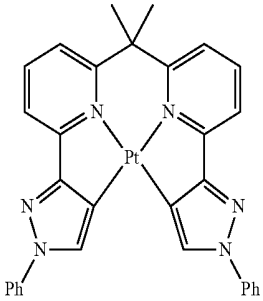
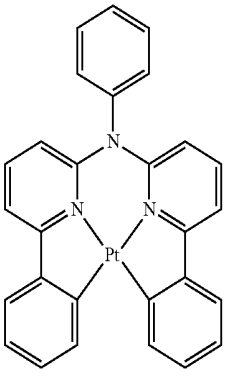
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | Chem. Lett. 34, 592 (2005) |
| |  | WO2002015645 |
| |  | US20060263635 |
| |  | US20060182992 US20070103060 |

TABLE A-continued

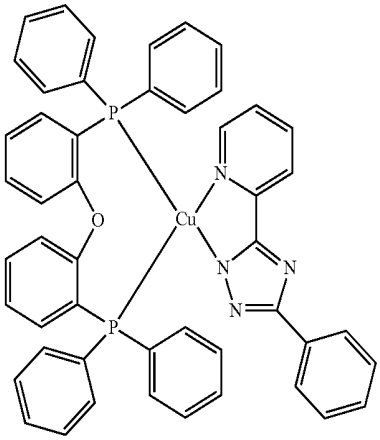
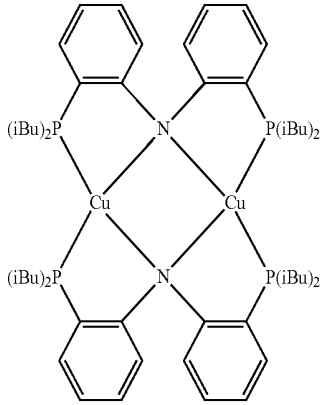
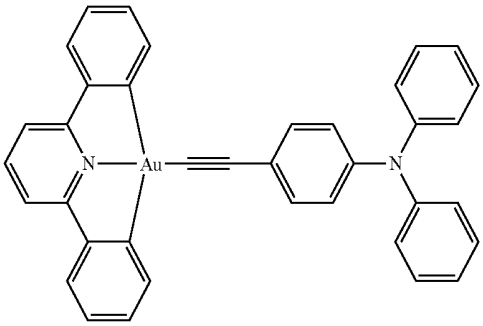
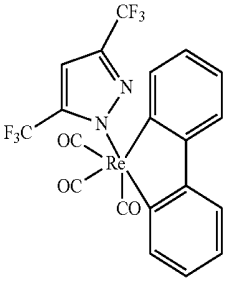
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Cu complexes |  | WO2009000673 |
| |  | US20070111026 |
| Gold complexes |  | Chem. Commun. 2906 (2005) |
| Rhenium(III) complexes |  | Inorg. Chem. 42, 1248 (2003) |

TABLE A-continued

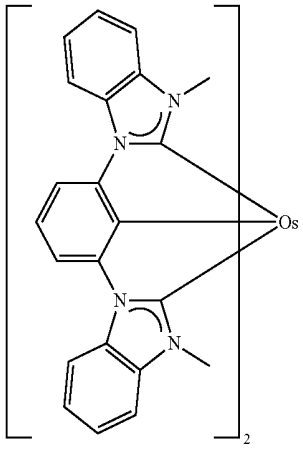
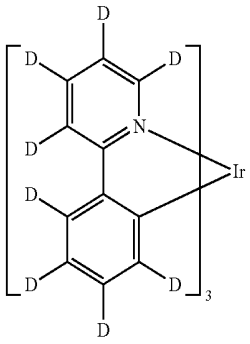
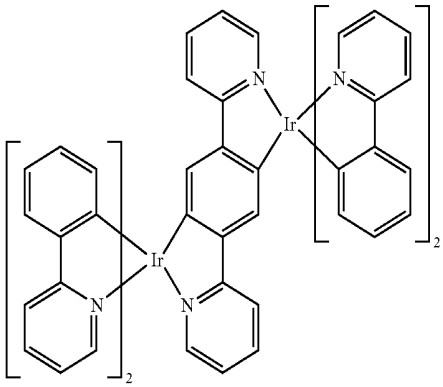
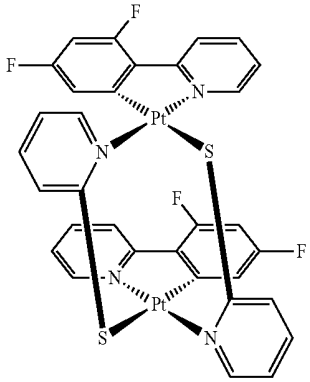
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Osmium(II) complexes |  | U.S. Pat. No. 7,279,704 |
| Deuterated organometallic complexes |  | US20030138657 |
| Organometallic complexes with two or more metal centers |  | US20030152802 |
| |  | U.S. Pat. No. 7,090,928 |

TABLE A-continued

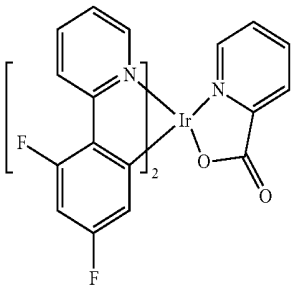
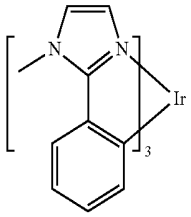
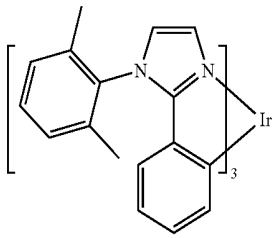
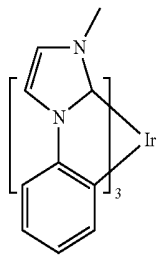
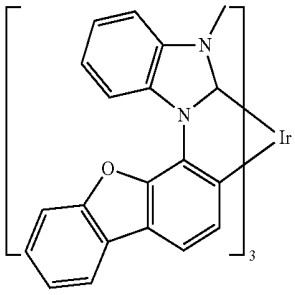
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| | Blue dopants | |
| Iridiam(III) organometallic complexes |  | WO2002002714 |
| |  | WO2006009024 |
| |  | US20060251923<br>US20110057559<br>US20110204333 |
| |  | U.S. Pat. No. 7,393,599,<br>WO2006056418,<br>US20050260441,<br>WO2005019373 |
| |  | U.S. Pat. No. 7,534,505 |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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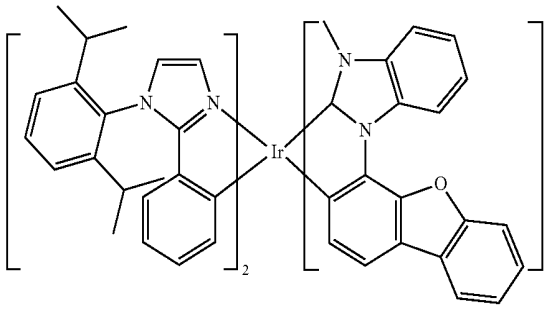
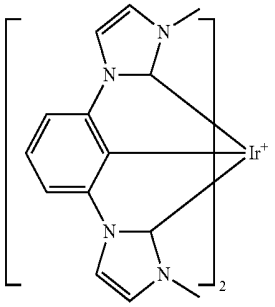
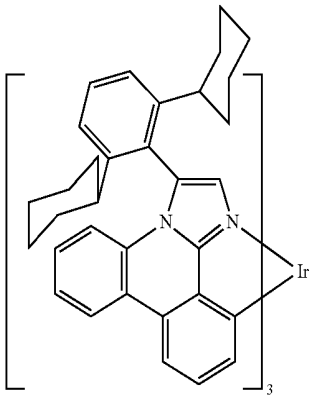
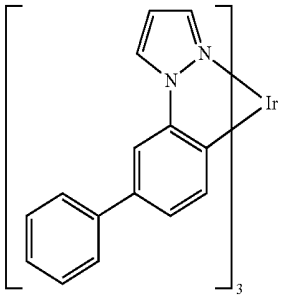
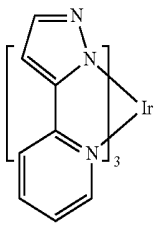
| |  | WO2011051404 |
| |  | U.S. Pat. No. 7,445,855 |
| |  | US20070190359, US20080297033 US20100148663 |
| |  | U.S. Pat. No. 7,338,722 |
| |  | US20020134984 |

TABLE A-continued

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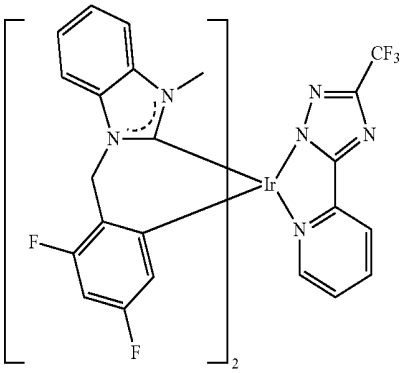
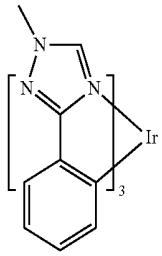
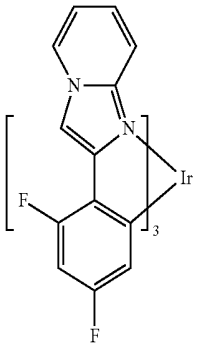
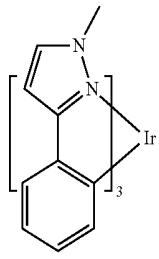
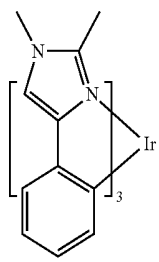
| |  | Angew. Chem. Int. Ed. 47, 4542 (2008) |
| |  | Chem. Mater. 18, 5119 (2006) |
| |  | Chem. 46, 4308 (2007) |
| |  | WO2005123873 |
| |  | WO2005123873 |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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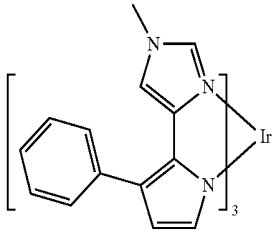
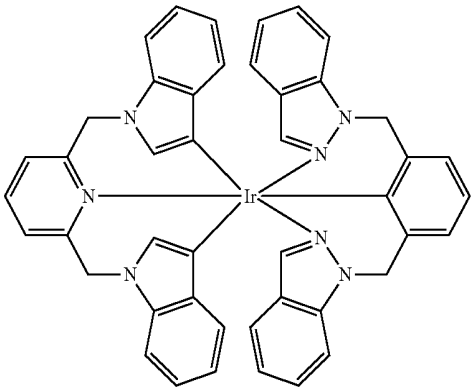
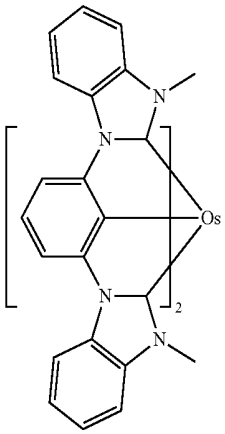
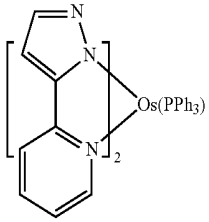
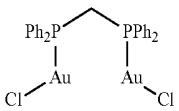
| |  | WO2007004380 |
| |  | WO2006082742 |
| Ostnium(II) complexes |  | U.S. Pat. No. 7,279,704 |
| |  | Organometallics 23, 3745 (2004) |
| Gold complexes |  | Appl. Phys. Lett. 74, 1361 (1999) |

TABLE A-continued

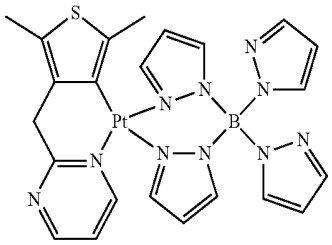
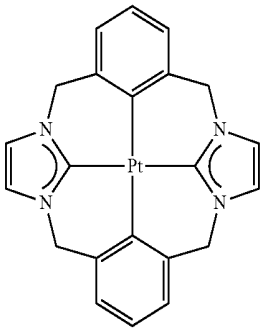
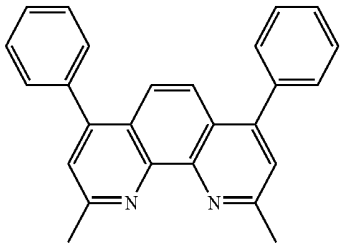
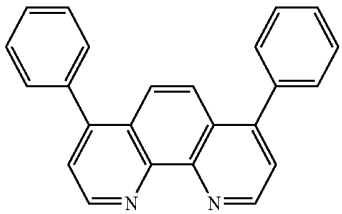
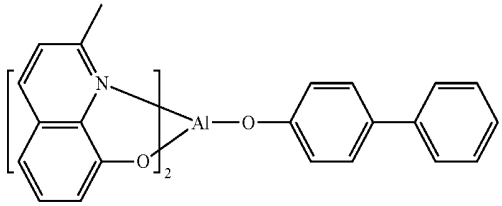
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Platinum(II) complexes |  | WO2006098120, WO2006103874 |
| Pt tetradentate complexes with at least one metal-carbene bond |  | U.S. Pat. No. 7,655,323 |
| Exciton/hole blocking layer materials | | |
| Bathocuprine compounds (e.g., BCP, BPhen) |  | Appl. Phys. Lett. 75, 4 (1999) |
| |  | Appl. Phys. Lett. 79, 449 (2001) |
| Metal 8-hydroxyquinolates (e.g., BAlq) |  | Appl. Phys. Lett. 81, 162 (2002) |

TABLE A-continued

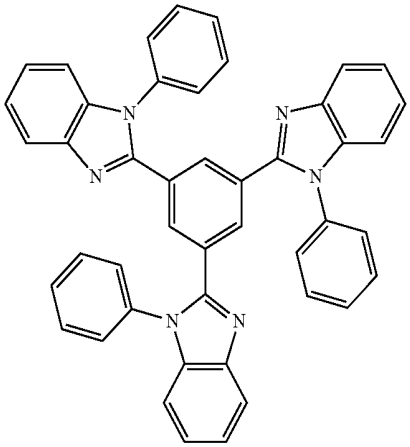
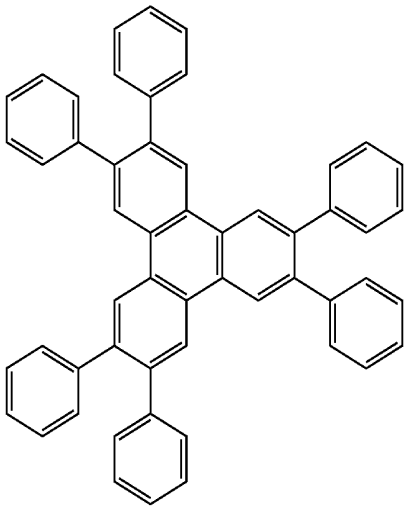
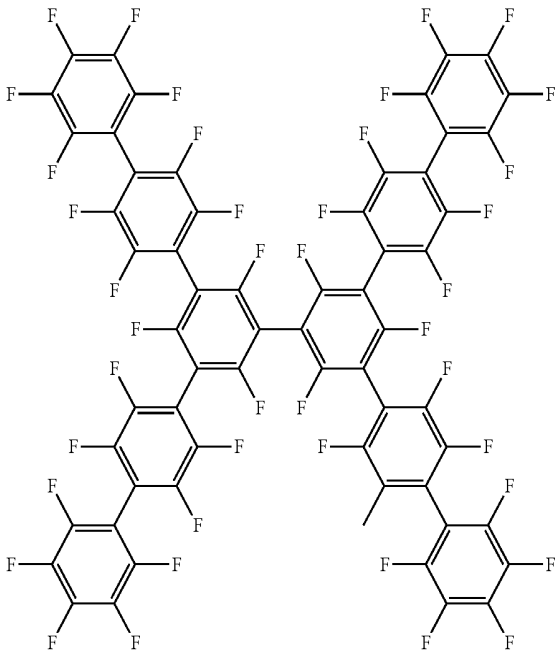
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| 5-member ring electron deficient heterocycles such as triazole, oxadiazole, imidazole, benzoimidazole |  | Appl. Phys. Lett. 81, 162 (2002) |
| Triphenylene compounds |  | US20050025993 |
| Fluorinated aromatic compounds |  | Appl. Phys. Lett. 79, 156 (2001) |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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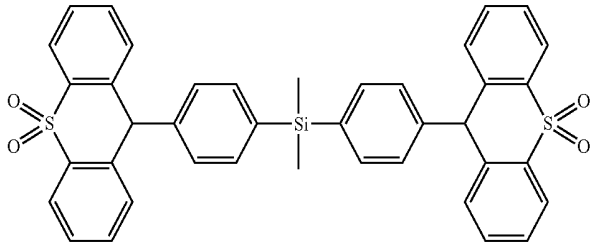
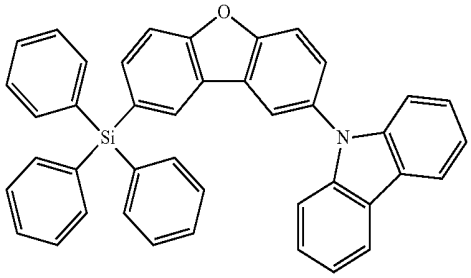
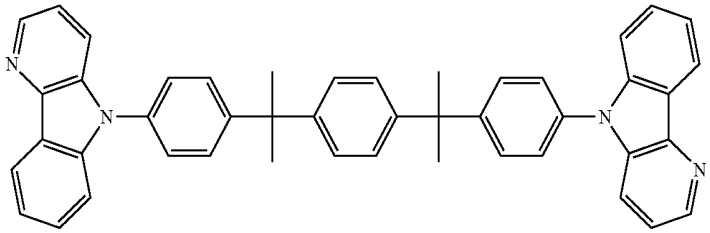
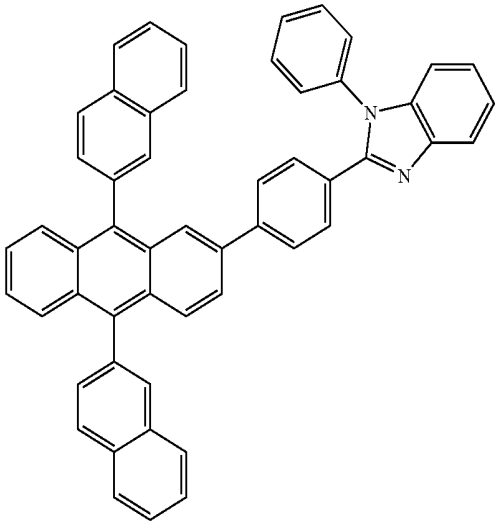
| Phenothiazine-S-oxide |  | WO2008132085 |
| Silylated five-membered nitrogen, oxygen, sulfur or phosphorus dibenzoheterocycles |  | WO2010079051 |
| Aza-carbazoles |  | US20060121308 |
| Electron transporting materials | | |
| Anthracene-benzoimidazole compounds |  | WO2003060956 |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
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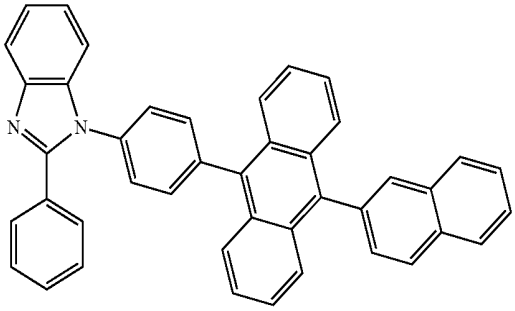
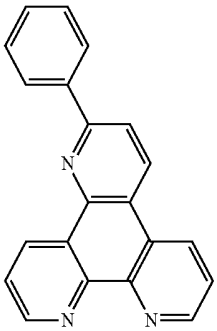
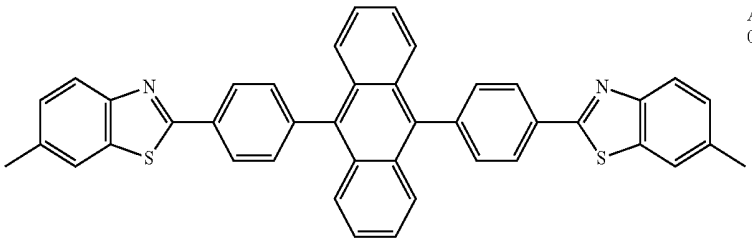
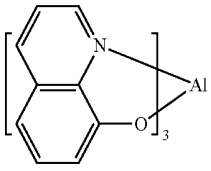
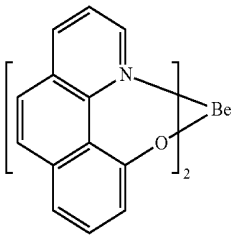
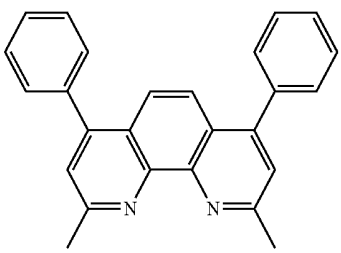
| |  | US20090179554 |
| Aza triphenylene derivatives |  | US20090115316 |
| Anthracene-benzothiazole compounds |  | Appl. Phys. Lett. 89, 063504 (2006) |
| Metal 8-hydroxyquinolates (e.g., $Alq_3$, $Zrq_4$) |  | Appl. Phys. Lett. 51, 913 (1987)<br>U.S. Pat. No. 7,230,107 |
| Metal hydroxybenzoquinolates |  | Chem. Lett. 5, 905 (1993) |
| Bathocuprine compounds such as BCP, E3Phen, etc |  | Appl. Phys. Lett. 91, 263503 (2007) |

TABLE A-continued

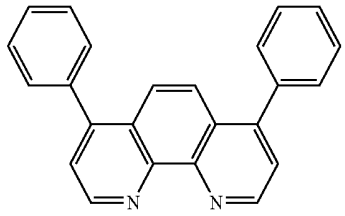
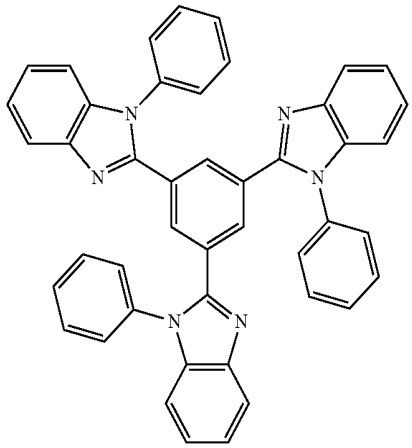
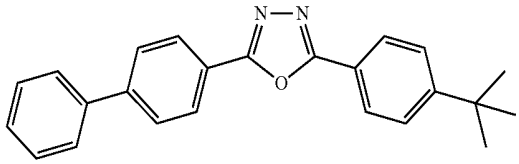
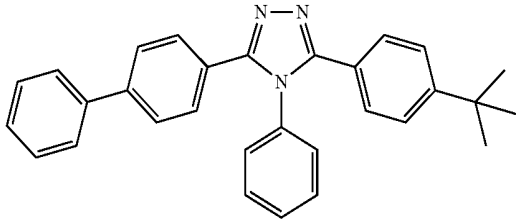
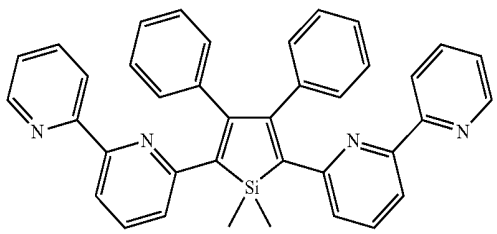
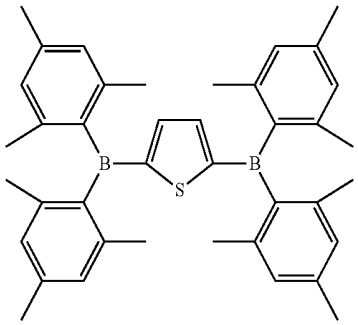
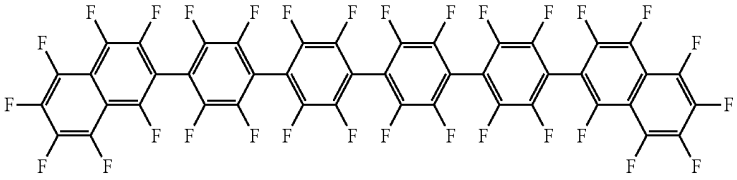
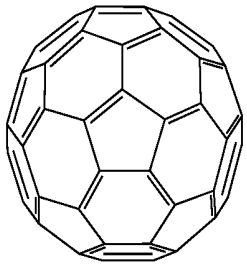
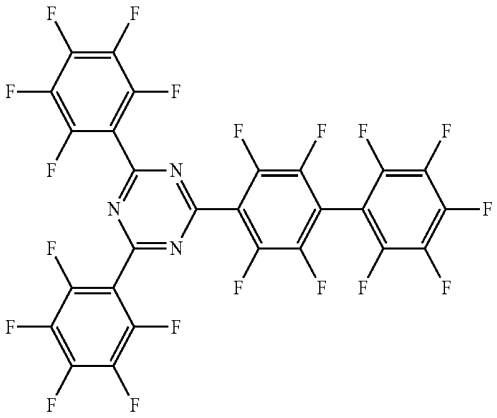
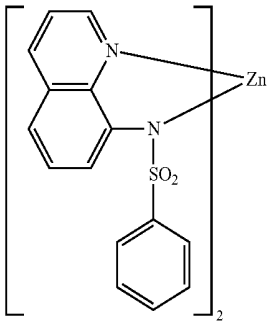
| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| |  | Appl. Phys. Lett. 79, 449 (2001) |
| 5-member ring electron deficient heterocycles (e.g., triazole, oxadiazole, imidazole, benzoimidazole) |  | Appl. Phys. Lett. 74, 865 (1999) |
| |  | Appl. Phys. Lett. 55, 1489 (1989) |
| |  | Jpn. J. Apply. Phys. 32, L917 (1993) |
| Silole compounds |  | Org. Electron. 4, 113 (2003) |

TABLE A-continued

| MATERIAL | EXAMPLES OF MATERIAL | PUBLICATIONS |
|---|---|---|
| Arylborane compounds |  | J. Am. Chem. Soc. 120, 9714 (1998) |
| Fluorinated aromatic compounds |  | J. Am. Chem. Soc. 122, 1832 (2000) |
| Fullerene (e.g., C60) |  | US20090101870 |
| Triazine complexes |  | US20040036077 |
| Zn (N^N) complexes |  | U.S. Pat. No. 6,528,187 |

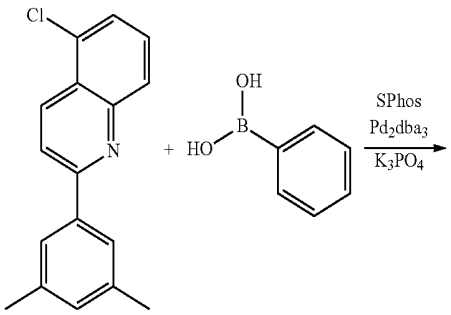
EXPERIMENTAL

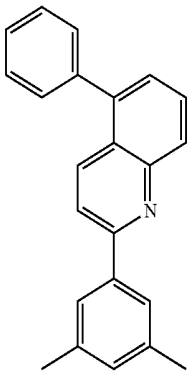
Materials Synthesis

**[0141]** All reactions were carried out under nitrogen protections unless specified otherwise. All solvents for reactions are anhydrous and used as received from commercial sources.

Synthesis of Comparative Compound 1

**[0142]** Step 1:

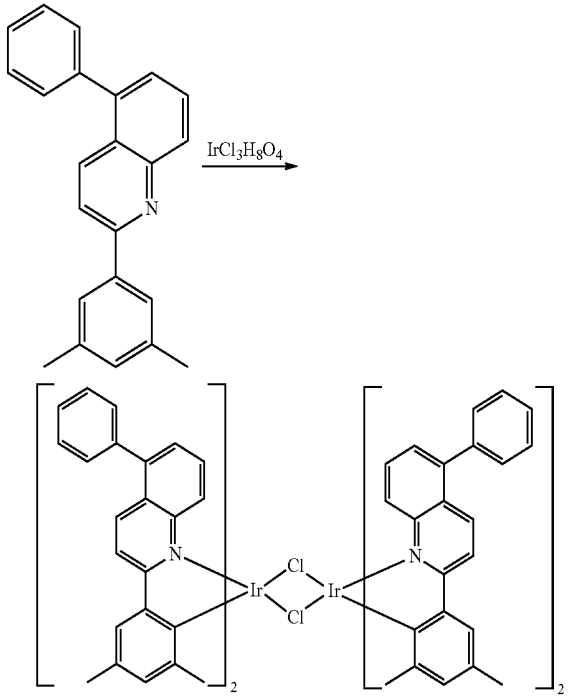



Synthesis of
2-(3,5-dimethylphenyl)-5-phenylquinoline

**[0143]** $Pd_2dba_3$ (0.24 g, 0.26 mmol) dicyclohexyl(2',6'-dimethoxy-[1,1'-biphenyl]-2-yl)phosphine (SHOS) (0.43 g, 1.05 mmol), 5-chloro-2-(3,5-dimethylphenyl)quinoline (3.50 g, 13.1 mmol), phenylboronic acid (2.39 g, 19.6 mmol), and potassium phosphate ($K_3PO_4$) (5.55 g, 26.1 mmol) were diluted with 110 mL of dimethoxyethane (DME) and 22 mL of water. The solution was bubbled with nitrogen gas for 20 minutes and the reaction mixture was maintained at reflux for 12 hours. Upon completion, 100 mL of toluene was added and the mixture was extracted 3 times with 100 mL of dichloromethane (DCM), then dried over sodium sulfate, and evaporated. The crude product was purified via column chromatography using Heptanes/ethyl acetate (EA) (100/0 to 90/10) solvent system. The yellowish oil was solidified in heptanes. The filtered solids were triturated from methanol to afford the pure 2-(3,5-dimethylphenyl)-5-phenylquinoline (2.6 g, 65% yield).

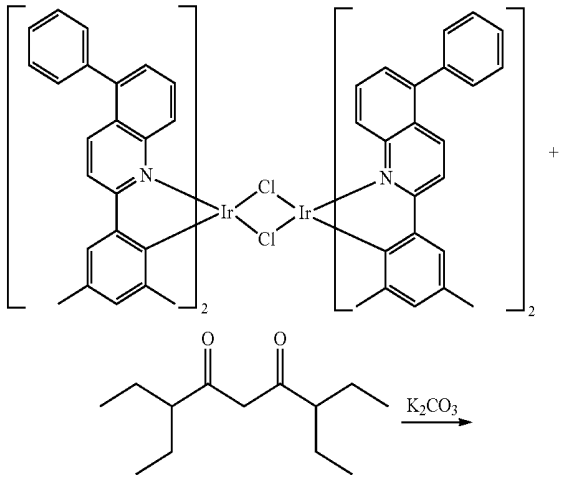
**[0144]** Step 2:




Synthesis of Ir(III) Dimer

**[0145]** Iridium chloride hydrate (0.78 g, 2.10 mmol) and 2-(3,5-dimethylphenyl)-5-phenylquinoline (2.6 g, 8.40 mmol) were diluted in 24 ml 2-ethoxyethanol and 8 mL of water. The mixture was degassed by bubbling nitrogen for 20 minutes and the reaction was maintained at 105° C. for 24 hours. The reaction mixture was then cooled to 0° C. and filtered. The solid was washed with cold ethanol and dried to afford 1.6 g (85% yield) of the dimer.

**[0146]** Step 3:



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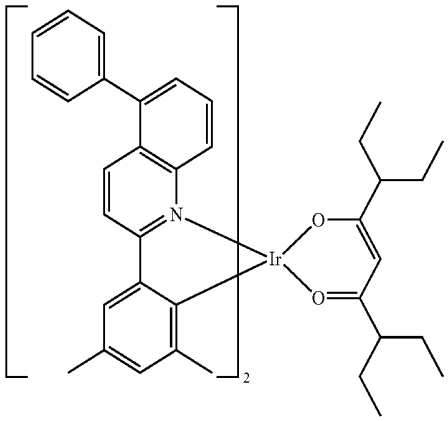
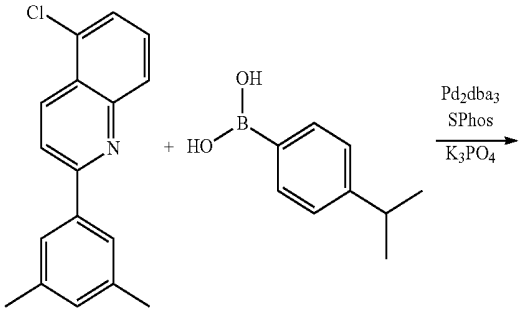


Synthesis of Comparative Compound 1

**[0147]** A mixture of the Ir(III) dimer of step 2 (1.60 g, 0.95 mmol) from step 2, and 3,7-diethylnonane-4,6-dione (2.01 g, 9.47 mmol) were diluted in 20 mL 2-ethoxyethanol, and the mixture was degassed by bubbling nitrogen gas for 20 minutes. Potassium carbonate (1.31 g, 9.47 mmol) was then added and the reaction mixture was stirred at room temperature overnight. Upon completion, the reaction was diluted with dichloromethane (DCM), filtered through a pad of Celite and washed with more DCM. The crude material was purified via column chromatography (silica pre-treated with triethylamine) using a Heptanes/DCM (100/0 to 97/3) solvent system. The evaporated pure fractions were triturated in methanol which afforded 1.3 g (68% yield) of pure comparative compound 1.

Synthesis of Comparative Compound 2

**[0148]** Step 1:

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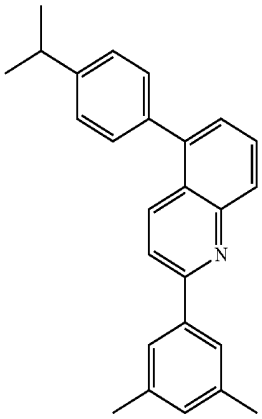
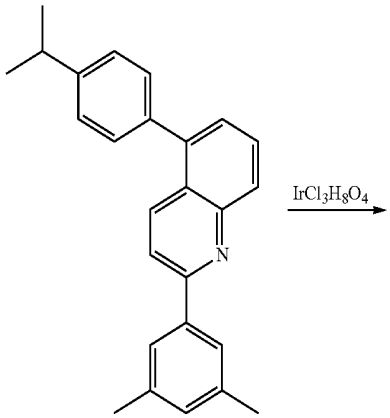


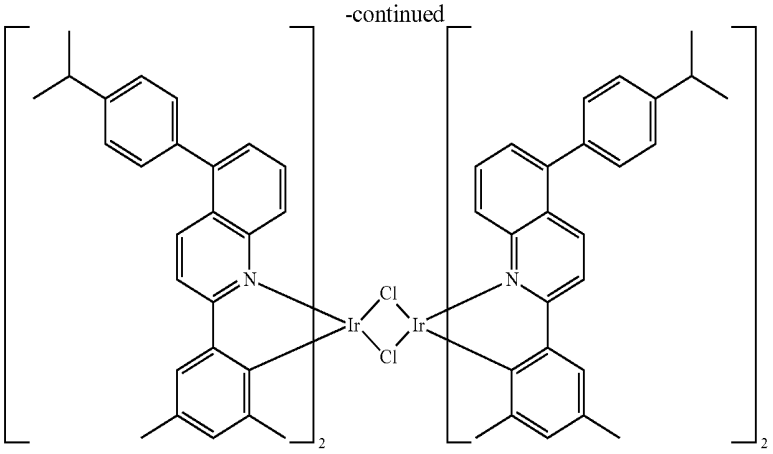
Synthesis of 2-(3,5-dimethylphenyl)-5-(4-isopropylphenyl)quinoline

**[0149]** 5-chloro-2-(3,5-dimethylphenyl)quinoline (3.75 g, 14.0 mmol), (4-isopropylphenyl)boronic acid (2.76 g, 16.8 mmol), $Pd_2dba_3$ (0.26 g, 0.28 mmol), dicyclohexyl(2',6'-dimethoxy-[1,1'-biphenyl]-2-yl)phosphine (SPhos) (0.46 g, 1.12 mmol), and $K_3PO_4$ (5.95 g, 28.0 mmol) were diluted in toluene (120 mL) and water (25 mL). The mixture was degassed by bubbling nitrogen gas for 15 minutes and then the reaction mixture was refluxed overnight. Upon completion, the reaction mixture was cooled to room temperature, then extracted with toluene, and washed with water and brine. The crude product was purified via column chromatography using a heptanes/ethyl acetate (95/5) solvent system. The white powder was recrystallized from heptanes to isolate 2-(3,5-dimethylphenyl)-5-(4-isopropylphenyl)quinoline (3.0 g, 61% yield) as white crystals.

**[0150]** Step 2:



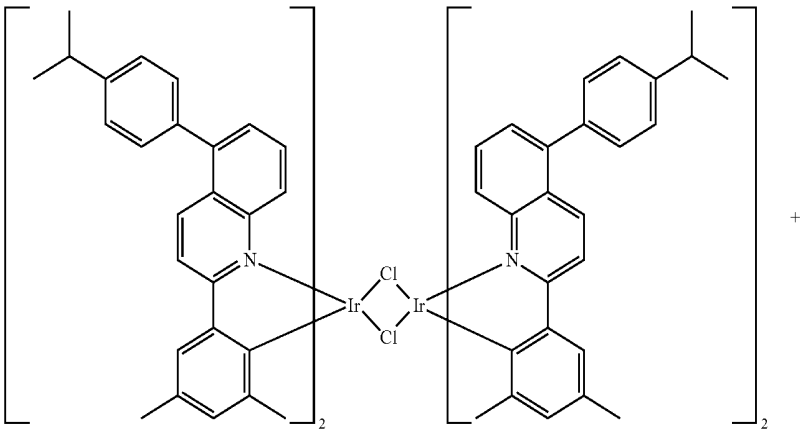
-continued

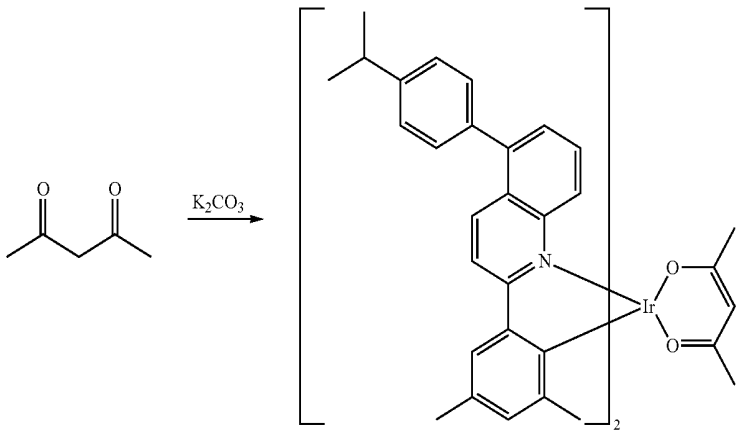


Synthesis of Ir(III) Dimer

**[0151]** 2-(3,5-dimethylphenyl)-5-(4-isopropylphenyl) quinoline (1.10 g, 3.13 mmol) was solubilized in 2-ethoxyethanol (12 mL) and water (4 mL). The mixture was degassed with nitrogen for 30 minutes. Iridium chloride hydrate (0.36 g, 0.96 mmol) was then added to the solution (some ligand precipitated) and the reaction was refluxed under nitrogen for 24 h. After cooling, the solid was filtered, washed with methanol, and dried to yielded the Ir(III) dimer (0.65 g, 73% yield) as a dark red powder.

**[0152]** Step 3:



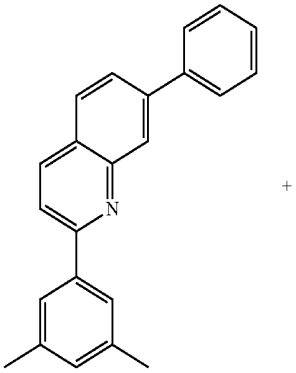


Synthesis of Comparative Compound 2

**[0153]** Ir(III) dimer of step 2 (0.65 g, 0.35 mmol) and pentane-2,4-dione (0.35 g, 3.50 mmol) were diluted in 2-Ethoxyethanol (12 mL). The mixture was then degassed by bubbling nitrogen gas through it. $K_2CO_3$ (0.48 g, 3.50 mmol) was then added and the reaction mixture was stirred at room temperature overnight. The reaction mixture was diluted with DCM, filtered through a pad of Celite, and washed with DCM. The crude material was purified by column chromatography (silica pre-treated with TEA) using a heptanes/DCM (95/5 to 90/10)) solvent system. The combined fractions were triturated from methanol and the solids were recrystallized from DCM/methanol two times. Comparative compound 2 was isolated as a red powder. (0.4 g, 58% yield).

Synthesis of Comparative Compound 3

**[0154]** Step 1:



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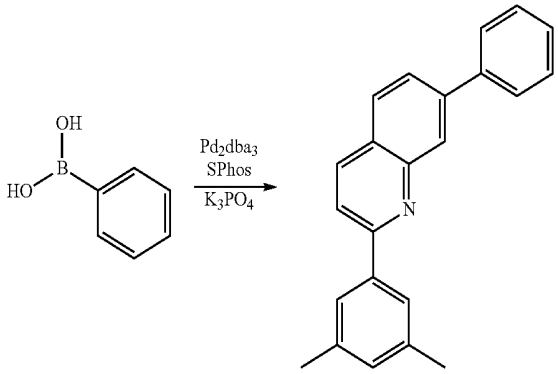
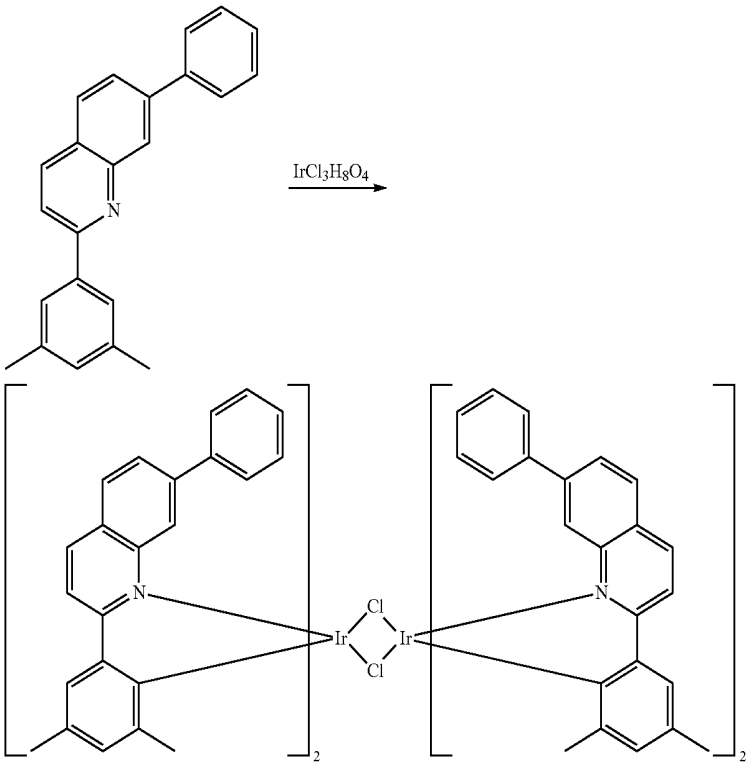



Synthesis of 2-(3,5-dimethylphenyl)-7-phenylquinoline

**[0155]** 7-chloro-2-(3,5-dimethylphenyl)quinoline (3.5 g, 13.1 mmol), phenylboronic acid (2.39 g, 19.6 mmol), $Pd_2dba_3$ (0.24 g, 0.26 mmol), dicyclohexyl(2',6'-dimethoxy-[1,1'-biphenyl]-2-yl)phosphine (0.43 g, 1.05 mmol), and $K_3PO_4$ (5.55 g, 26.1 mmol) were inserted in a round bottom flask (RBF) and diluted with DME (110 mL) and Water (22 mL). The reaction was degassed by bubbling nitrogen gas for 15 minutes and then heated to reflux overnight. The mixture was then cooled to room temperature and extracted with ethyl alcohol (EA). The crude material was purified by column chromatography using a heptanes/EA (95/5) solvent system. The collected fractions were triturated with MeOH to afford 2-(3,5-dimethylphenyl)-5-phenylquinoline (3.4 g, 85% yield) as a white powder.

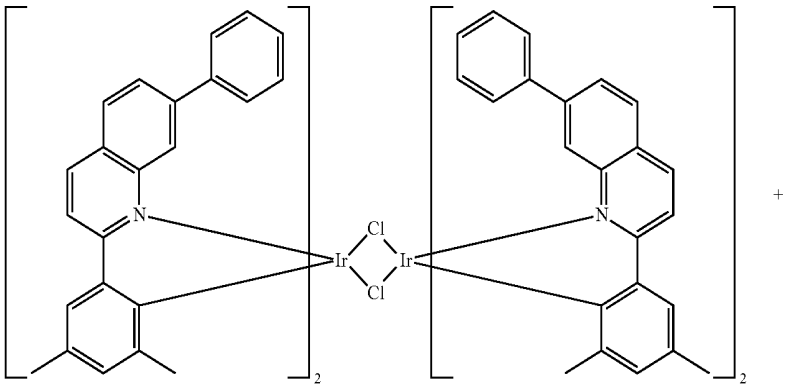
**[0156]** Step 2:

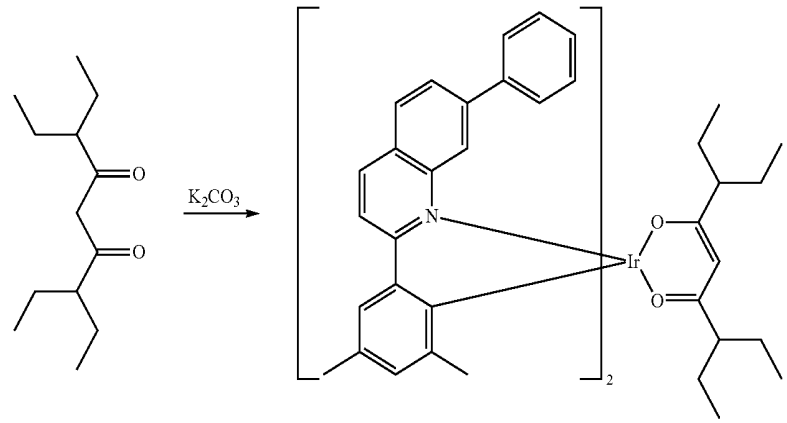


Synthesis of Ir(III) Dimer

**[0157]** 2-(3,5-dimethylphenyl)-7-phenylquinoline (3.35 g, 10.8 mmol) was solubilized in ethoxyethanol (25 mL) and water (8 mL) and degassed by bubbling nitrogen gas for 30 minutes. Iridium chloride hydrate (1.00 g, 2.71 mmol) was then added to the mixture, which was then heated to reflux under nitrogen for 24 h. After cooling the mixture to room temperature, the solid was filtered, washed with methanol, and dried to give the Ir(III) Dimer (1.8 g 79% yield) as a red powder.

**[0158]** Step 3:



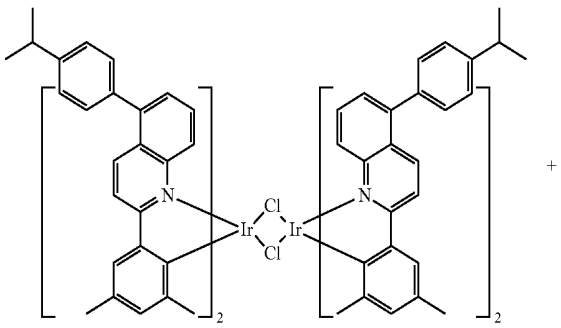



Synthesis of Comparative Compound 3

**[0159]** The Ir(III) dimer of step 2 (1.9 g, 1.13 mmol) and 3,7-diethylnonane-4,6-dione (2.39 g, 11.3 mmol) were diluted in 2-ethoxyethanol (40 mL), and the mixture was degassed by bubbling nitrogen gas for 15 minutes. Potassium carbonate (1.56 g, 11.3 mmol) was then added and the reaction was stirred at room temperature overnight. Upon completion of the reaction, the mixture was diluted with DCM, filtered through a plug of Celite, and washed with DCM. The crude material was purified by column chromatography (silica gel pre-treated with triethylamine) using a heptanes/DCM (95/5) solvent system. The collected fractions were titurated with MeOH. A red powder was recrystallized from a MeOH/DCM solvent system to afford 1.5 g (63% yield) of comparative compound 3 as red crystals.

Synthesis of Compound 28

**[0160]** Step 1:



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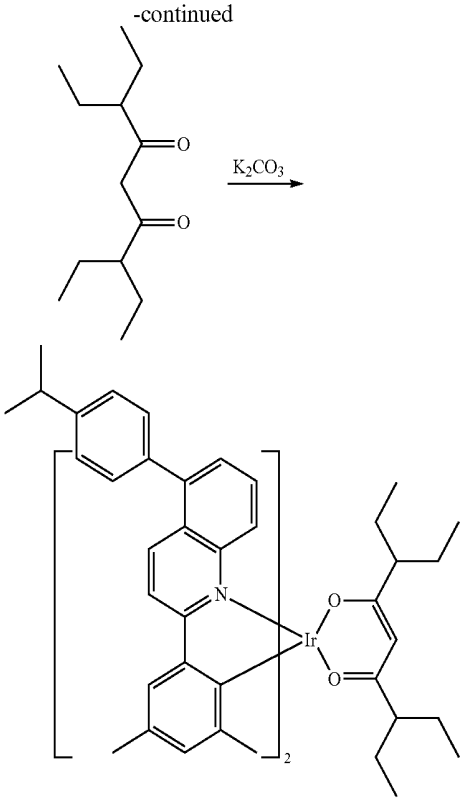
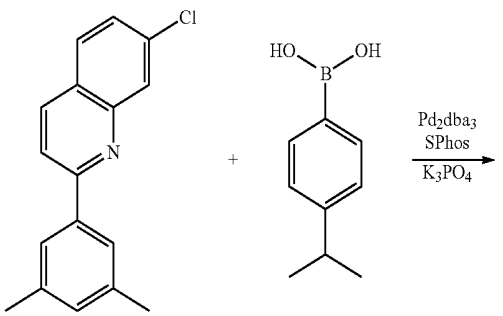



Synthesis of Compound 28

**[0161]** Ir(III) dimer of step 2 of the synthesis of comparative compound 2 (1.50 g, 0.81 mmol), above, and 3,7-diethylnonane-4,6-dione (1.72 g, 8.1 mmol) were diluted in ethoxyethanol (27 mL). The mixture was then degassed by bubbling nitrogen gas. $K_2CO$ (1.12 g, 8.1 mmol) was then added, and the reaction mixture was stirred at room temperature overnight. The mixture was diluted with DCM, filtered through a pad of Celite, and washed with DCM. The crude material was purified via column chromatography (silica pretreated with triethylamine) using a heptanes/DCM 80/20 solvent system. The collected pure fractions were triturated from methanol, and the solids were recrystallized from DCM/methanol two times to yield compound 28 as dark red crystals (1.3 g, 73% yield).

Synthesis of Compound 80

**[0162]** Step 1:

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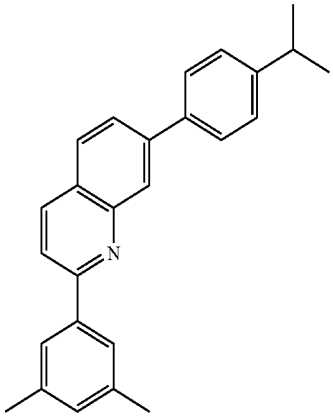
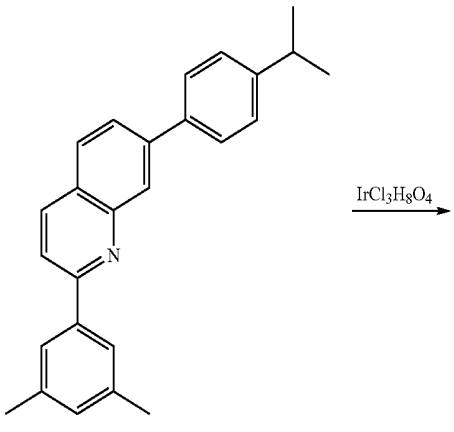



Synthesis of 2-(3,5-dimethylphenyl)-7-(4-Isopropylphenyl)quinoline

**[0163]** 7-chloro-2-(3,5-dimethylphenyl)quinoline (4.25 g, 15.9 mmol), (4-isopropylphenyl)boronic acid (3.12 g, 19.1 mmol), $Pd_2dba_3$ (0.29 g, 0.32 mmol), dicyclohexyl(2',6'-dimethoxy-[1,1'-biphenyl]-2-yl)phosphine (SPhos) (0.52 g, 1.27 mmol), and $K_3PO_4$ (6.74 g, 31.7 mmol) were solubilized in toluene (130 mL) and water (27 mL). The reaction mixture was degassed by bubbling nitrogen gas through it for 15 minutes, then the reaction mixture was heated to reflux overnight. Upon completion, the reaction mixture was cooled to room temperature, extracted with ethyl acetate, and washed with brine and water. The crude product was purified via column chromatography using a heptanes/ethyl acetate (97/3 to 95/5) solvent system. The product was then recrystallized from heptanes/DCM to isolate 2-(3,5-dimethylphenyl)-7-(4-isopropylphenyl)quinoline (2.5 g, 45% yield) of pure ligand.

**[0164]** Step 2:



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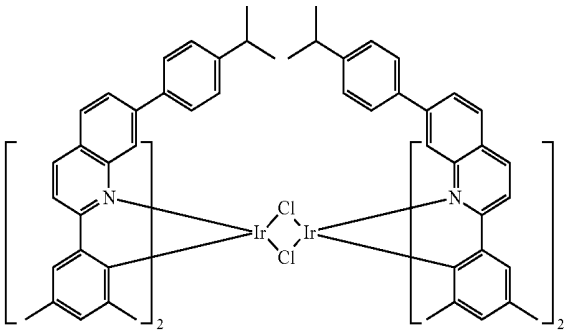
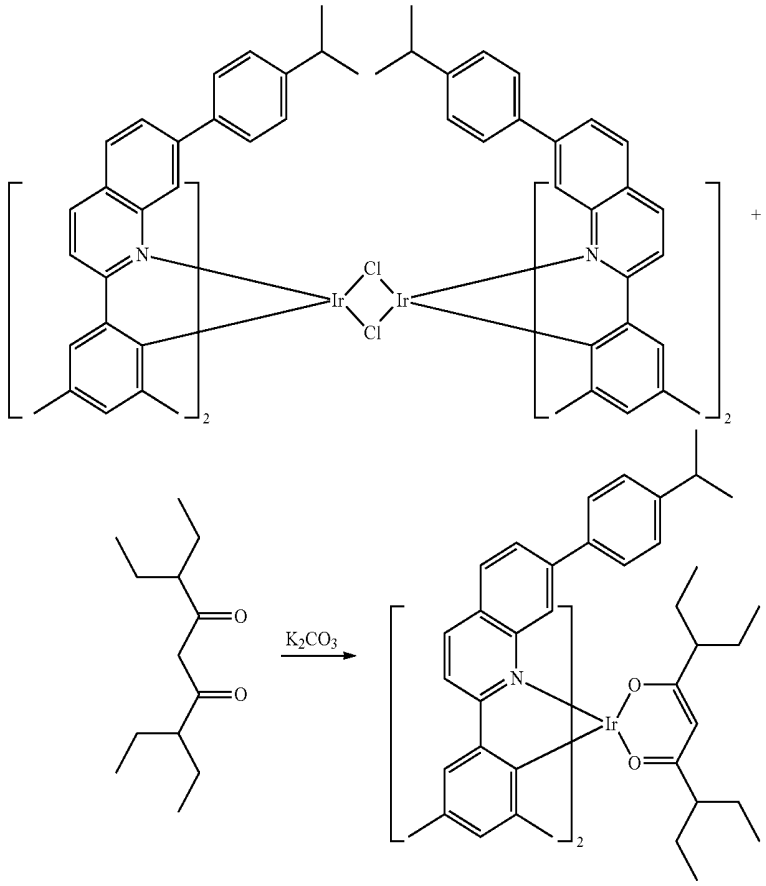


Synthesis of Ir(III) Dimer

**[0165]** 2-(3,5-dimethylphenyl)-7-(4-isopropylphenyl) quinoline (2.25 g, 6.40 mmol) was solubilized in ethoxyethanol (23 mL) and water (8 mL), then the mixture was degassed with nitrogen gas for 30 minutes. Iridium chloride hydrate (0.68 g, 1.83 mmol) was then added to the reaction mixture, and the reaction mixture was refluxed under nitrogen for 24 h. After cooling to room temperature, the solid was filtered, washed with methanol and dried to give Ir(III) dimer (1.2 g, 71% yield) as a brown powder.

**[0166]** Step 3:

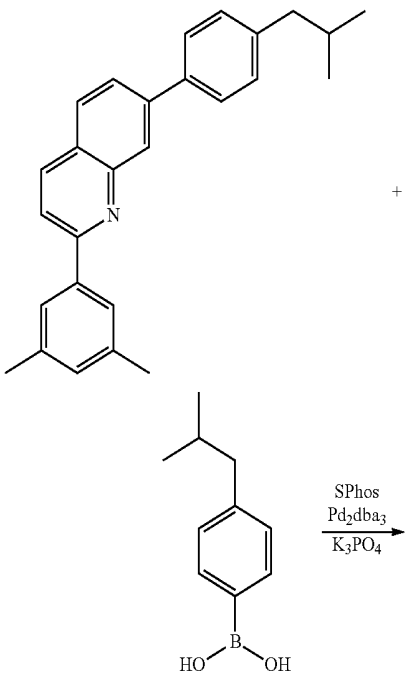


Synthesis of Compound 80

**[0167]** The Ir(III) dimer of step 2 (1.1 g, 0.59 mmol) and 3,7-diethylnonane-4,6-dione (1.26 g, 5.92 mmol) were diluted in ethoxyethanol (20 mL), then the reaction mixture was degassed by bubbling nitrogen gas through it. $K_2CO$ (0.82 g, 5.92 mmol) was then added to the reaction mixture, and the reaction mixture was stirred at room temperature overnight. The reaction mixture was diluted with DCM, filtered through a pad of Celite, and washed with DCM. The crude material was purified by column chromatography (silica pre-treated with TEA) using a heptanes/DCM (95/5) solvent system. The collected pure fractions were triturated from methanol and the solids were recrystallized from DCM/MeOH. Compound 80 was isolate as a dark red solid (1.0 g, 76% yield).

Synthesis of Compound 81

**[0168]** Step 1:

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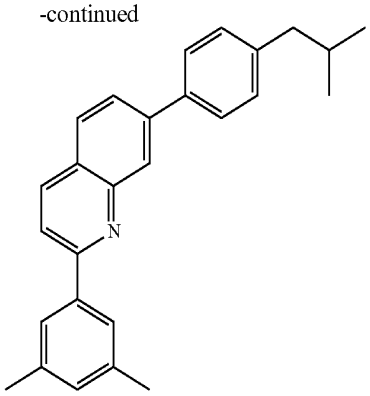
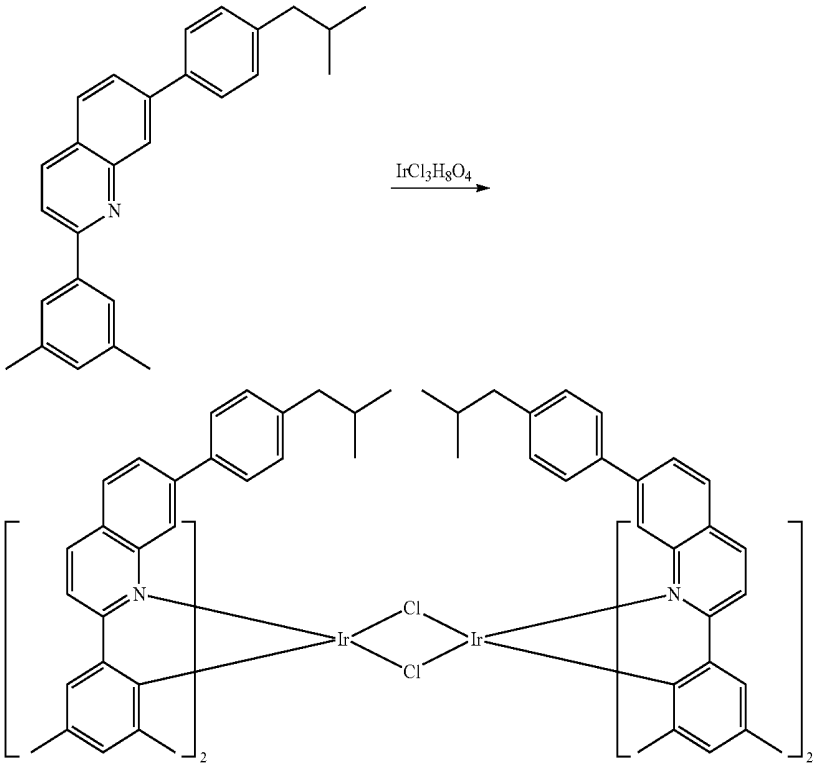



Synthesis of 2-(3,5-dimethylphenyl)-7-(4-isobutylphenyl)quinoline

**[0169]** 7-chloro-2-(3,5-dimethylphenyl)quinoline (3.5 g, 13.1 mmol), (4-isobutylphenyl)boronic acid (3.49 g, 19.6 mmol), $Pd_2dba_3$ (0.24 g, 0.26 mmol), dicyclohexyl(2',6'-dimethoxy-[1,1'-biphenyl]-2-yl)phosphine (SPhos) (0.43 g, 1.05 mmol), and $K_3PO_4$ (5.55 g, 26.1 mmol) were diluted in toluene (110 mL) and water (20 mL). The reaction mixture was degassed by bubbling nitrogen through it for 15 minutes. The reaction mixture was then heated to reflux overnight. Upon completion, the mixture was cooled, extracted with EA and washed with water. The crude product was purified by column chromatography using a heptanes/EA (95/5) solvent system. The collected product was triturated from heptanes to isolate pure 2-(3,5-dimethylphenyl)-7-(4-isobutylphenyl) quinoline (3.10 g, 65% yield) as a white powder.

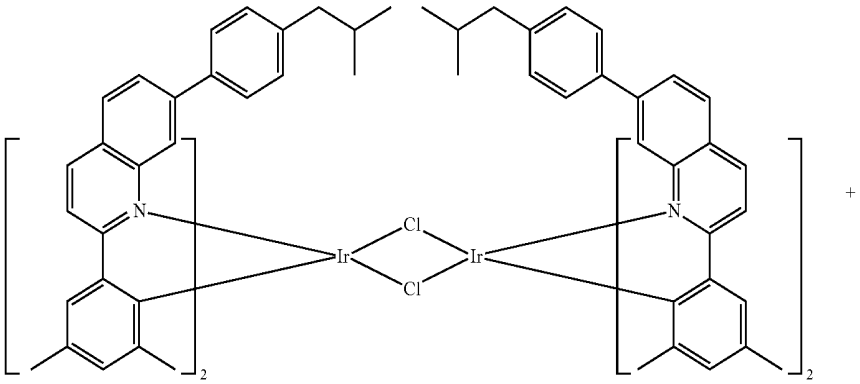
**[0170]** Step 2:

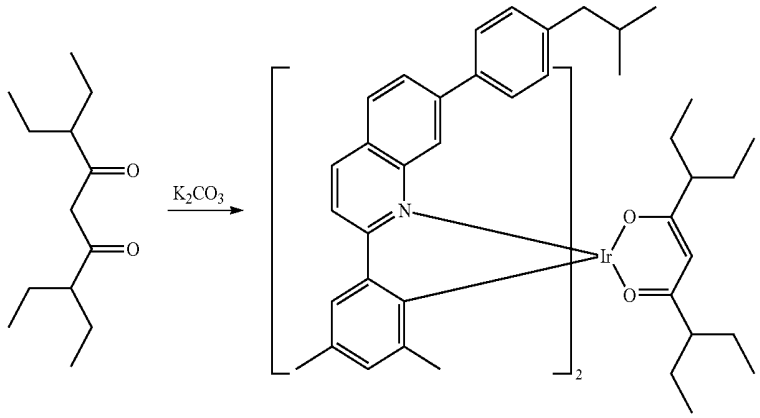


Synthesis of Ir(III) Dimer

**[0171]** 2-(3,5-dimethylphenyl)-7-(4-isobutylphenyl) quinoline (3.2 g, 8.75 mmol) was solubilized in ethoxyethanol (27 mL) and water (9 mL), then degassed with nitrogen for 30 minutes. Iridium chloride hydrate (0.81 g, 2.19 mmol) was then added to the reaction mixture, and the reaction mixture was refluxed under nitrogen for 24 h. After cooling to room temperature, the solid was filtered, washed with methanol, and dried to give Ir(III) dimer (1.55 g, 74% yield) as a red powder. There was still ligand left, but the product was used without further purification.

**[0172]** Step 3:



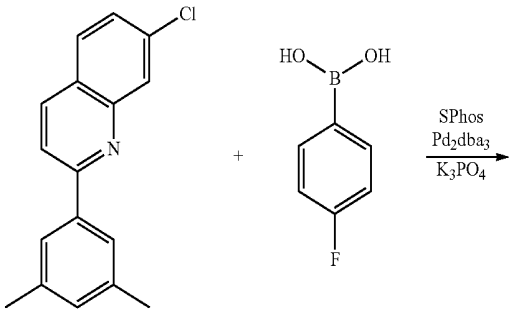




Synthesis of Compound 81

**[0173]** The Ir(III) dimer of step 2 (1.50 g, 0.78 mmol) and 3,7-diethylnonane-4,6-dione (1.67 g, 7.84 mmol) were diluted in ethoxyethanol (26 mL), then the mixture was degassed by bubbling nitrogen gas through it. $K_2CO_3$ (1.08 g, 7.84 mmol) was then added and the reaction mixture was stirred at room temperature overnight. The reaction mixture was diluted with DCM, filtered through a pad of Celite, and washed with DCM. The crude material was purified by column chromatography (silica pre-treated with TEA) using a heptanes/DCM (90/10) solvent system. The collected pure fractions were triturated from methanol and the solids were recrystallized from DCM/methanol. Compound 81 was isolated as a red powder (1.25 g, 70% yield).

Synthesis of Compound 84

**[0174]** Step 1:



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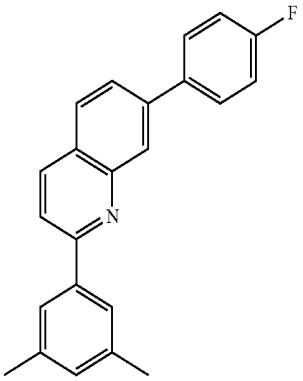
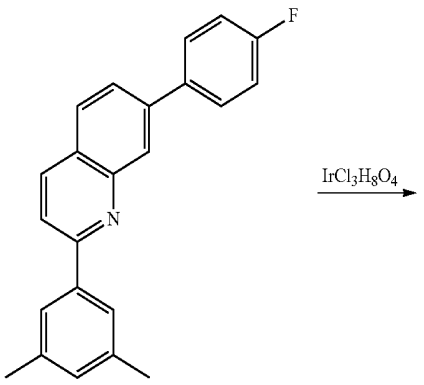


Synthesis of
2-(3,5-dimethylphenyl)-7-(4-fluorophenyl)quinoline

**[0175]** 7-chloro-2-(3,5-dimethylphenyl)quinoline (4 g, 14.94 mmol), (4-fluorophenyl)boronic acid (2.508 g, 17.93 mmol), Pd2(dba)3 (0.274 g, 0.299 mmol), dicyclohexyl(2', 6'-dimethoxy-[1,1'-biphenyl]-2-yl)phosphine (0.491 g, 1.195 mmol), potassium phosphate (7.93 g, 37.3 mmol), toluene (100 mL) and water (20 mL) were combined in a flask. A condenser was attached then the system, which was evacuated and purged with nitrogen three times. The reaction mixture was heated to reflux overnight. After cooling, the reaction mixture was filtered through celite using ethyl acetate. After the aqueous was partitioned off, the organic portion was washed with brine once, dried with sodium sulfate, filtered, and concentrated down to 5.8 g of a brown solid. The sample was purified with silica gel using a heptane/DCM (50/50) solvent system to get 4.5 g of a white solid. HPLC indicated it was 99.7% pure. 125 ml heptane was added to the 4.5 g sample, then DCM until the solids dissolved. The solution was heated to reflux to remove the DCM. A white precipitate formed immediately upon cooling. The sample was allowed to stand for two hours, then the precipitate was filtered off to get 3.88 g of a white solid for a 79% yield of 2-(3,5-dimethylphenyl)-7-(4-fluorophenyl)quinoline.

**[0176]** Step 2:



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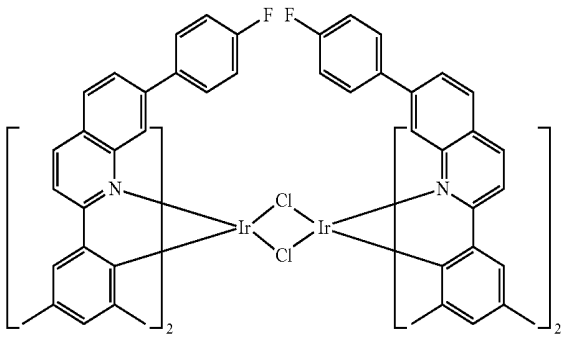
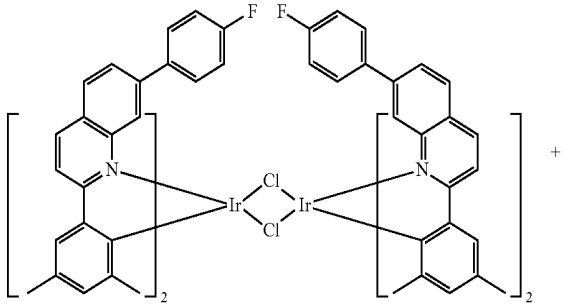
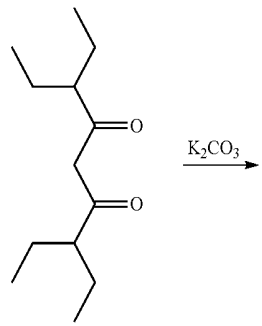


Synthesis of Ir(III) Dimer

**[0177]** 2-(3,5-dimethylphenyl)-7-(4-fluorophenyl)quinoline (3.00 g, 9.16 mmol) was solubilized in ethoxyethanol (29 mL) and water (10 mL), then the mixture was degassed with nitrogen for 30 minutes. Iridium chloride hydrate (0.85 g, 2.29 mmol) was then added to the reaction mixture, and the reaction mixture was refluxed under nitrogen for 24 h. After cooling to room temperature, the solid was filtered, washed with methanol, and dried to yield the Ir(III) dimer (2.70 g, 134% yield) as a red powder. There was still ligand left but the product was used without further purification. The true yield of the reaction is believed to be around 50-60%.

**[0178]** Step 3:





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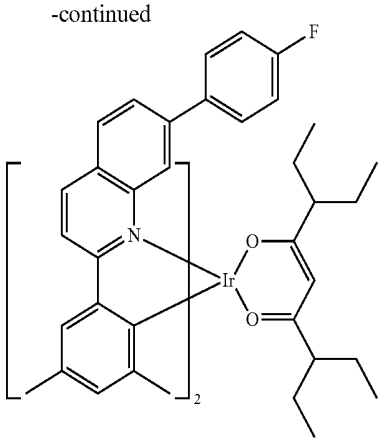


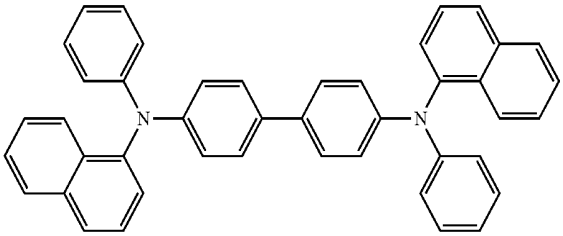
Synthesis of Compound 84

**[0179]** The Ir(III) dimer of step 2 (2.70 g, 1.53 mmol), 3,7-diethylnonane-4,6-dione (3.26 g, 15.3 mmol), and 2-ethoxyethanol (40 mL) were combined in a 100 ml single neck round bottom flask. Nitrogen was bubbled directly into the solution for 15 min. Potassium carbonate (2.12 g, 15.3 mmol) was added, then the system was placed under nitrogen and stirred at room temperature overnight. Next morning, TLC indicated a product had formed. The reaction was filtered through celite using DCM until the red color came off. The solution was concentrated down to a dark red oil. The sample was purified with silica gel, preconditioned with heptane/triethyl amine; DCM (60/20/20), then heptane/DCM (90/10), using a heptanes/DCM (90/10) solvent system. Fractions containing the dark red color were combined and concentrated down to 2.70 g of a dark red solid. To remove the ligand, the sample was triturated in 100 ml refluxing methanol, then the insoluble red precipitate was filtered off while the methanol was still hot to get 0.88 g of a red solid. The trituration was repeated with 75 ml hot methanol and the filtered red solid was dried in a vacuum oven overnight to get 0.80 g of a red solid for a 49.4% yield of compound 84.

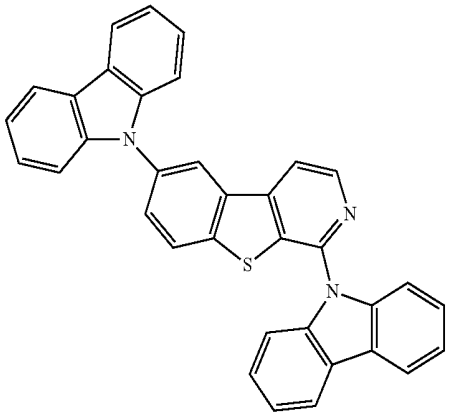
Device Examples

**[0180]** All example devices were fabricated by high vacuum ($<10^{-7}$ Torr) thermal evaporation. The anode electrode was 1200 Å of indium tin oxide (ITO). The cathode consisted of 10 Å of LiF followed by 1,000 Å of Al. All devices were encapsulated with a glass lid sealed with an epoxy resin in a nitrogen glove box (<1 ppm of $H_2O$ and $O_2$) immediately after fabrication, and a moisture getter was incorporated inside the package. The organic stack of the device examples consisted of sequentially, from the ITO surface, 100 Å of LG101 (purchased from LG chem) as the hole injection layer (HIL); 400 Å of 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPD) as the hole transporting layer (HTL); 300 Å of an emissive layer (EML) containing Compound H as a host (79%), a stability dopant (SD) (18%), and Compound 28, Compound 80, Compound 81, or Compound 84 as an emitter; 100 Å of Compound H as a blocking layer; and 450 Å of $Alq_3$ (tris-8-hydroxyquinoline aluminum) as the ETL. The emitter was selected to provide the desired color and the stability dopant (SD) was mixed with the electron-transporting host and the emitter to help transport positive charge in the emissive layer. The Comparative Example devices were fabricated similarly to the device examples except that Comparative Compounds 1, 2, and 3 were used as the emitter in the EML. Table 1 shows the composition of the EML in the device, while the device results and data are summarized in Table 2 and Table 3. As used herein, NPD, compound H, SD, and $AlQ_3$ have the following structures:

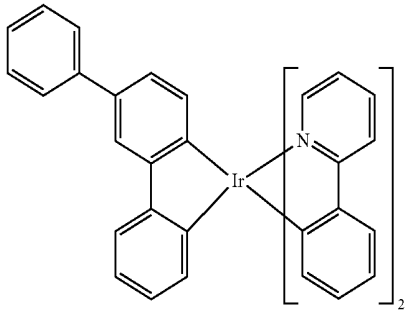
NPD



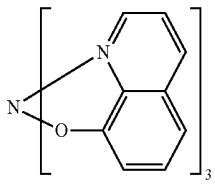
Compound H



SD



AlQ3



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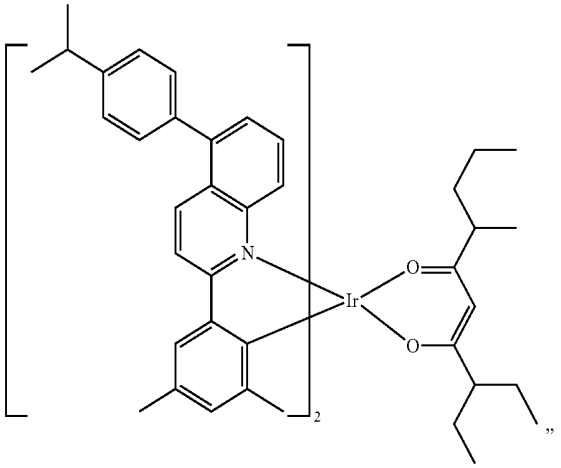
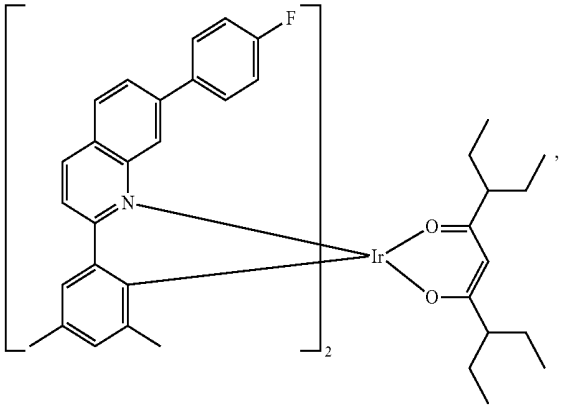
Compound 28

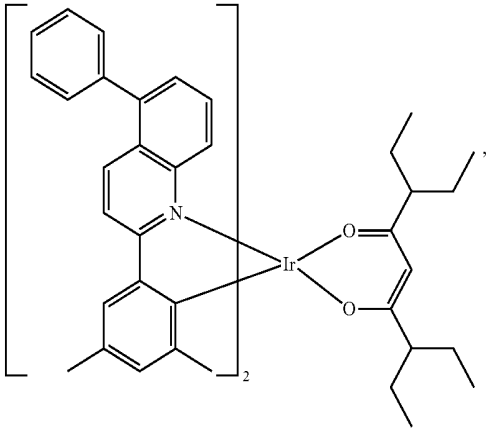


-continued

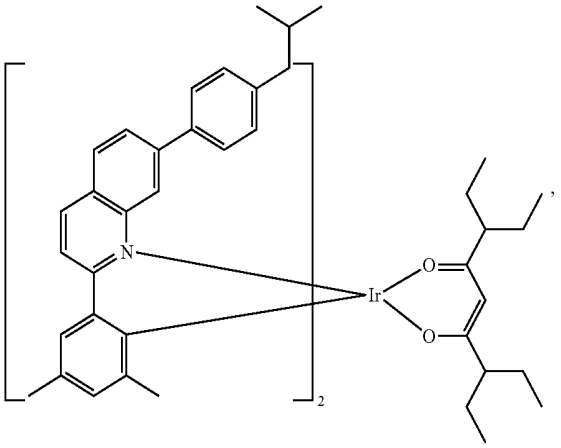
Compound 84



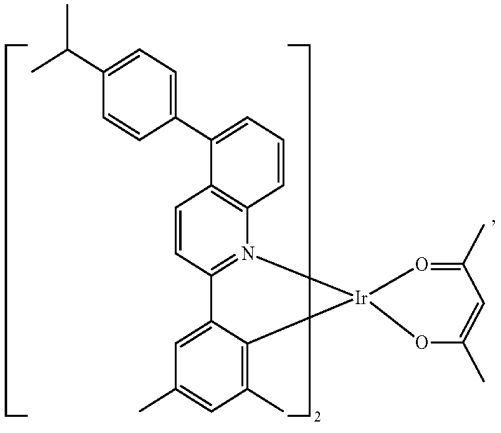
Comparative Compound 1



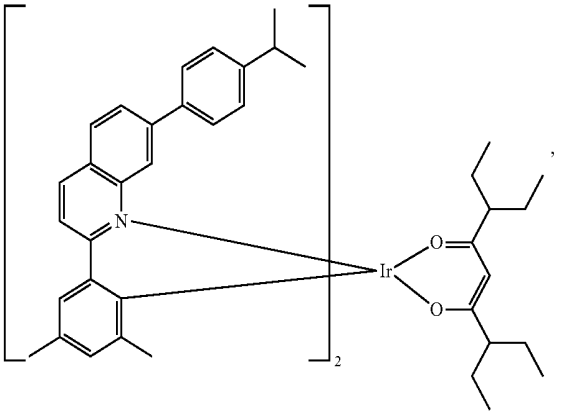
Compound 80



Comparative Compound 2



Compound 81



and

-continued

Comparative Compound 3

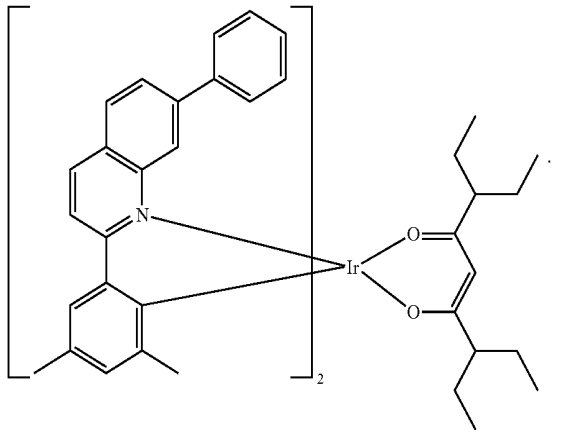


TABLE 1

Compounds of EML in the devices

| Example | Emitter |
|---|---|
| Device Example 1 | Compound 28 |
| Device Example 2 | Compound 80 |
| Device Example 3 | Compound 81 |
| Device Example 4 | Compound 84 |
| Comparative example 1 | Comparative compound 1 |
| Comparative example 2 | Comparative compound 2 |
| Comparative example 3 | Comparative compound 3 |

TABLE 2

Device results of Device examples 1 and comparative device example 1.

| | 1931 CIE | | λ max | FWHM | LE at 1,000 nits |
|---|---|---|---|---|---|
| | x | y | [nm] | [nm] | [cd/A] |
| Device Example 1 | 0.66 | 0.34 | 620 | 52 | 26.2 |
| Comparative example 1 | 0.65 | 0.35 | 620 | 55 | 25.7 |
| Comparative example 2 | 0.65 | 0.35 | 622 | 61 | 21.8 |

TABLE 3

Device results of Device examples 2-4 and comparative device example 3

| | 1931 CIE | | λ max | FWHM | LE at 1,000 nits |
|---|---|---|---|---|---|
| | x | y | [nm] | [nm] | [cd/A] |
| Device Example 2 | 0.66 | 0.34 | 621 | 55 | 23.0 |

TABLE 3-continued

Device results of Device examples 2-4 and comparative device example 3

| | 1931 CIE | | λ max | FWHM | LE at 1,000 nits |
|---|---|---|---|---|---|
| | x | y | [nm] | [nm] | [cd/A] |
| Device Example 3 | 0.66 | 0.34 | 622 | 54 | 20.9 |
| Device Example 4 | 0.65 | 0.35 | 622 | 52 | 19.7 |
| Comparative example 3 | 0.66 | 0.34 | 625 | 56 | 19.0 |

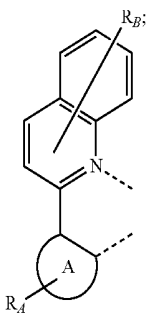
**[0181]** Tables 2 and 3 summarize the performance of the devices. The 1931 CIE values were measured at 10 mA/cm$^2$. The luminous efficiency was measured at 1000 cd/m$^2$. The device examples have a full width at half maximum (FWHM) that is narrower than the comparative examples. In addition, the devices with inventive compounds have higher luminous efficiency than the devices with comparative compounds. When compared against devices using comparative compounds 1 and 2 as emitter, device with inventive compound 28 as emitter showed narrow FWHM (52 nm vs. 55 nm and 61 nm) and higher efficiency. (26.2 cd/A vs. 25.7 cd/A and 21.8 cd/A). Device examples 2, 3, and 4 also show superior characteristics compared to comparative example 3.

**[0182]** It is understood that the various embodiments described herein are by way of example only, and are not intended to limit the scope of the invention. For example, many of the materials and structures described herein may be substituted with other materials and structures without deviating from the spirit of the invention. The present invention as claimed may therefore include variations from the particular examples and preferred embodiments described herein, as will be apparent to one of skill in the art. It is understood that various theories as to why the invention works are not intended to be limiting.

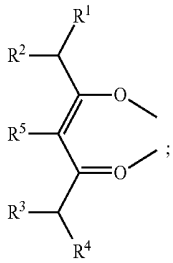
We claim:

**1**. A compound having a formula $M(L_A)_x(L_B)(L_C)_z$:

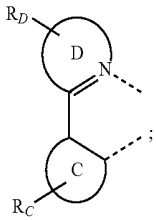
wherein the ligand $L_A$ is



wherein the ligand $L_B$ is



wherein the ligand $L_C$ is



wherein M is a metal having an atomic number greater than 40;

wherein x is 1, or 2;

wherein y is 1, or 2;

wherein z is 0, 1, or 2;

wherein x+y+z is the oxidation state of the metal M;

wherein $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl;

wherein at least one of $R^1$, $R^2$, $R^3$, and $R^4$ has at least two C atoms;

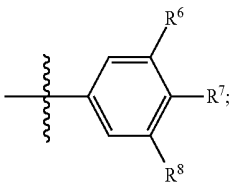
wherein $R^5$ is selected from group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

wherein rings A, C, and D are each independently a 5 or 6-membered carbocyclic or heterocyclic ring;

wherein $R_A$, $R_C$, and $R_D$ each independently represent mono, di, tri, or tetra substitution, or no substitution;

wherein $R_B$ represents mono, di, tri, tetra, penta, or hexa substitution;

wherein at least one $R_B$ has the following structure:



wherein each of $R_A$, $R_B$, $R_C$, and $R_D$ are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

wherein any adjacent substitutents of $R_A$, $R_B$, $R_C$, and $R_D$ are optionally joined to form a ring;

wherein $R^6$, $R^7$, and $R^8$ are independently selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof; and

wherein at least one of $R^6$, $R^7$, and $R^8$ is not hydrogen or deuterium.

**2**. The compound of claim **1**, wherein M is selected from the group consisting of Ir, Rh, Re, Ru, Os, Pt, Au, and Cu.

**3**. The compound of claim **1**, wherein M is Ir.

**4**. The compound of claim **1**, wherein ring A is benzene.

**5**. The compound of claim **1**, wherein ring C is benzene, and ring D is pyridine.

**6**. The compound of claim **1**, wherein $R^5$ is selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, and combinations thereof.

**7**. The compound of claim **1**, wherein $R^5$ is hydrogen.

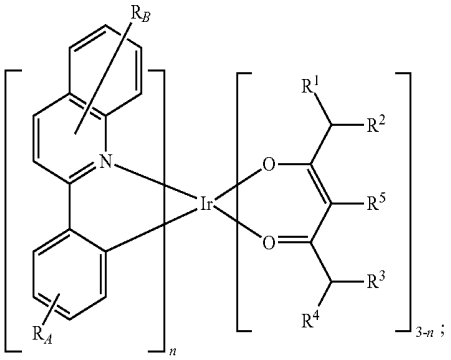
**8**. The compound of claim **1**, wherein $R^1$, $R^2$, $R^3$, and $R^4$ are alkyl or cycloalkyl.

**9**. The compound of claim **1**, wherein $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from the group consisting of methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 2,2-dimethylpropyl, cyclobutyl, cyclopentyl, cyclohexyl, partially or fully deuterated variants thereof, and combinations thereof.

**10**. The compound of claim **1**, wherein $R^6$, $R^7$, and $R^8$ are independently selected from the group consisting of hydrogen, deuterium, methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 2,2-dimethylpropyl, cyclobutyl, cyclopentyl, cyclohexyl, partially or fully fluorinated variants thereof, fluorine, and combinations thereof.

**11**. The compound of claim **1**, wherein $R_B$ is mono substitution.

**12**. The compound of claim **1**, wherein the compound has the following formula:

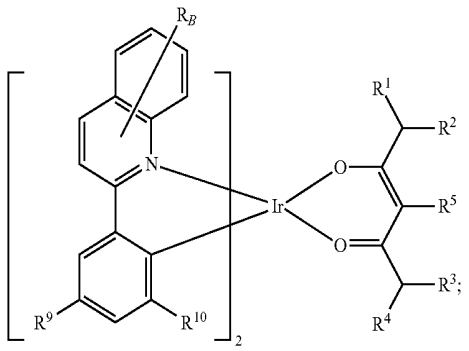


wherein n is 1 or 2.

**13**. The compound of claim **12**, wherein n is 2.

**14**. The compound of claim **12**, wherein $R_A$ is selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof.

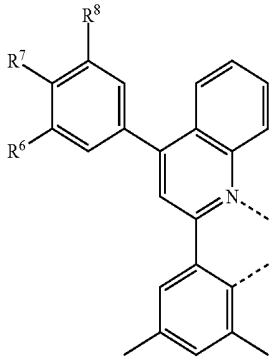
**15**. The compound of claim **12**, wherein the compound has the following formula:



wherein $R^9$, and $R^{10}$ are independently selected from the group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof.

**16**. The compound of claim **1**, wherein $L_A$ is selected from the group consisting of $L_{A1}$ to $L_{A104}$ listed below:

$L_{A1}$ through $L_{A13}$, each represented by the formula



wherein in $L_{A1}$: $R^7$=$CH_3$, and $R^6$=$R^8$=H;

in $L_{A2}$: $R^7$=isopropyl, and $R^6$=$R^8$=H;

in $L_{A3}$: $R^7$=isobutyl, and $R^6$=$R^8$=H;

in $L_{A4}$: $R^7$=cyclopentyl, and $R^6$=$R^8$=H;

in $L_{A5}$: $R^7$=neopentyl, and $R^6$=$R^8$=H;

in $L_{A6}$: $R^7$=F, and $R^6$=$R^8$=H;

in $L_{A7}$: $R^7$=H, and $R^6$=$R_8$=$CH_3$;

in $L_{A8}$: $R^7$=H, and $R^6$=$R^8$=isopropyl;

in $L_{A9}$: $R^7$=H, and $R^6$=$R^8$=isobutyl;

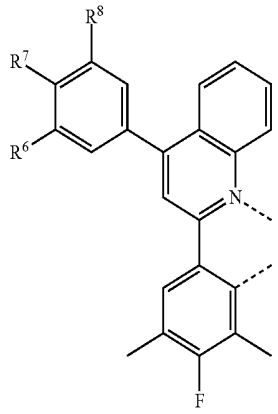
in $L_{A10}$: $R^7$=H, and $R^6$=$R^8$=cyclopentyl;

in $L_{A11}$: $R^7$=H, and $R^6$=$R^8$=neopentyl;

in $L_{A12}$: $R^7$=H, and $R^6$=$R^8$=F; and

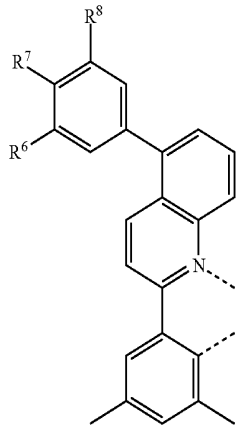
in $L_{A13}$: $R^6$=$R^7$=$R^8$=$CH_3$;

$L_{A14}$ through $L_{A26}$, each represented by the formula



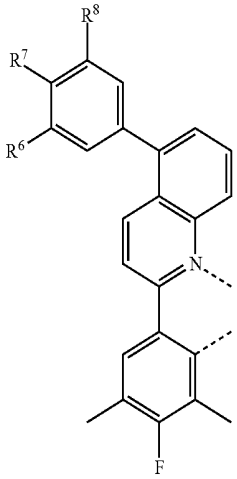
wherein in $L_{A14}$: $R^7$=$CH_3$, and $R^6$=$R^8$=H;
in $L_{A14}$: $R^7$=isopropyl, and $R^6$=$R^8$=H;
in $L_{A16}$: $R^7$=isobutyl, and $R^6$=$R^8$=H;
in $L_{A17}$: $R^7$=cyclopentyl, and $R^6$=$R^8$=H;
in $L_{A18}$: $R^7$=neopentyl, and $R^6$=$R^8$=H;
in $L_{A19}$: $R^7$=F, and $R^6$=$R^8$=H;
in $L_{A20}$: $R^7$=H, and $R^6$=$R^8$=$CH_3$;
in $L_{A21}$: $R^7$=H, and $R^6$=$R^8$=isopropyl;
in $L_{A22}$: $R^7$=H, and $R^6$=$R^8$=isobutyl;
in $L_{A23}$: $R^7$=H, and $R^6$=$R^8$=cyclopentyl;
in $L_{A24}$: $R^7$=H, and $R^6$=$R^8$=neopentyl;
in $L_{A25}$: $R^7$=H, and $R^6$=$R^8$=F; and
in $L_{A26}$: $R^6$=$R^7$=$R^8$=$CH_3$;

$L_{A27}$ through $L_{A39}$, each represented by the formula

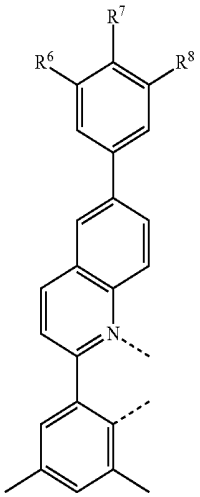


wherein in $L_{A27}$: $R^7$=$CH_3$, and $R^6$=$R^8$=H;
in $L_{A28}$: $R^7$=isopropyl, and $R^6$=$R^8$=H;
in $L_{A29}$: $R^7$=isobutyl, and $R^6$=$R^8$=H;
in $L_{A30}$: $R^7$=cyclopentyl, and $R^6$=$R^8$=H;
in $L_{A31}$: $R^7$=neopentyl, and $R^6$=$R^8$=H;
in $L_{A32}$: $R^7$=F, and $R^6$=$R^8$=H;
in $L_{A33}$: $R^7$=H, and $R^6$=$R^8$=$CH_3$;
in $L_{A34}$: $R^7$=H, and $R^6$=$R^8$=isopropyl;
in $L_{A35}$: $R^7$=H, and $R^6$=$R^8$=isobutyl;
in $L_{A36}$: $R^7$=H, and $R^6$=$R^8$=cyclopentyl;
in $L_{A37}$: $R^7$=H, and $R^6$=$R^8$=neopentyl;
in $L_{A38}$: $R^7$=H, and $R^6$=$R^8$=F; and
in $L_{A39}$: $R^6$=$R^7$=$R^8$=$CH_3$;

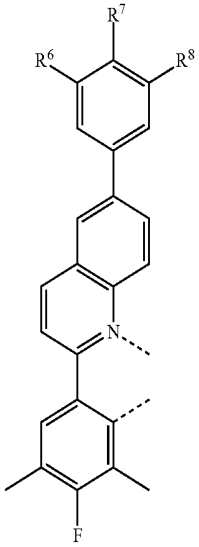
$L_{A440}$ through $L_{A452}$, each represented by the formula



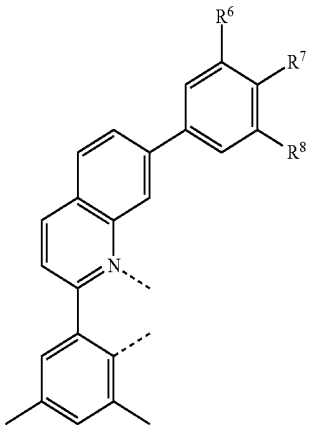
wherein in $L_{A440}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H;
in $L_{A441}$: $R^7$=isopropyl, and $R^6$═$R^8$═H;
in $L_{A442}$: $R^7$=isobutyl, and $R^6$═$R^8$═H;
in $L_{A443}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H;
in $L_{A444}$: $R^7$=neopentyl, and $R^6$═$R^8$═H;
in $L_{A445}$: $R^7$═F, and $R^6$═$R^8$═H;
in $L_{A446}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$;
in $L_{A447}$: $R^7$═H, and $R^6$═$R^8$=isopropyl;
in $L_{A448}$: $R^7$═H, and $R^6$═$R^8$=isobutyl;
in $L_{A449}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl;
in $L_{A450}$: $R^7$═H, and $R^6$═$R^8$=neopentyl;
in $L_{A451}$: $R^7$═H, and $R^6$═$R^8$═F; and
in $L_{A452}$: $R^6$═$R^7$═$R^8$═$CH_3$;
$L_{A453}$ through $L_{A465}$, each represented by the formula



wherein in $L_{A453}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H;
in $L_{A454}$: $R^7$=isopropyl, and $R^6$═$R^8$═H;
in $L_{A455}$: $R^7$=isobutyl, and $R^6$═$R^8$═H;
in $L_{A456}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H;
in $L_{A457}$: $R^7$=neopentyl, and $R^6$═$R^8$═H;
in $L_{A458}$: $R^7$═F, and $R^6$═$R^8$═H;
in $L_{A459}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$;
in $L_{A460}$: $R^7$═H, and $R^6$═$R^8$=isopropyl;
in $L_{A461}$: $R^7$═H, and $R^6$═$R^8$=isobutyl;
in $L_{A462}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl;
in $L_{A463}$: $R^7$═H, and $R^6$═$R^8$=neopentyl;
in $L_{A464}$: $R^7$═H, and $R^6$═$R^8$═F; and
in $L_{A465}$: $R^6$═$R^7$═$R^8$═$CH_3$;
$L_{A466}$ through $L_{A478}$, each represented by the formula

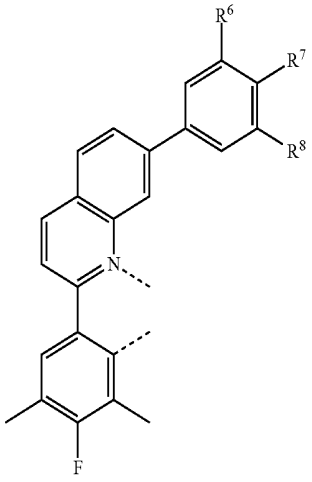


wherein in $L_{A466}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H;
in $L_{A467}$: $R^7$=isopropyl, and $R^6$═$R^8$═H;
in $L_{A468}$: $R^7$=isobutyl, and $R^6$═$R^8$═H;
in $L_{A469}$: $R^7$=cyclopentyl, and $R^6$═$R^8$═H;
in $L_{A470}$: $R^7$=neopentyl, and $R^6$═$R^8$═H;
in $L_{A471}$: $R^7$═F, and $R^6$═$R^8$═H;
in $L_{A472}$: $R^7$═H, and $R^6$═$R^8$═$CH_3$;
in $L_{A473}$: $R^7$═H, and $R^6$═$R^8$=isopropyl;
in $L_{A474}$: $R^7$═H, and $R^6$═$R^8$=isobutyl;
in $L_{A475}$: $R^7$═H, and $R^6$═$R^8$=cyclopentyl;
in $L_{A476}$: $R^7$═H, and $R^6$═$R^8$=neopentyl;
in $L_{A477}$: $R^7$═H, and $R^6$═$R^8$═F; and
in $L_{A478}$: $R^6$═$R^7$═$R^8$═$CH_3$;
$L_{A479}$ through $L_{A491}$, each represented by the formula



wherein in $L_{A479}$: $R^7$═$CH_3$, and $R^6$═$R^8$═H;
in $L_{A480}$: $R^7$=isopropyl, and $R^6$═$R^8$═H;
in $L_{A481}$: $R^7$=isobutyl, and $R^6$═$R^8$═H;

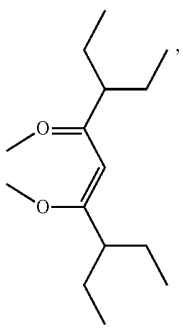
in $L_{A82}$: $R^7$=cyclopentyl, and $R^6$=$R^8$=H;
in $L_{A83}$: $R^7$=neopentyl, and $R^6$=$R^8$=H;
in $L_{A84}$: $R^7$=F, and $R^6$=$R^8$=H;
in $L_{A85}$: $R^7$=H, and $R^6$=$R^8$=$CH_3$;
in $L_{A86}$: $R^7$=H, and $R^6$=$R^8$=isopropyl;
in $L_{A87}$: $R^7$=H, and $R^6$=$R^8$=isobutyl;
in $L_{A88}$: $R^7$=H, and $R^6$=$R^8$=cyclopentyl;
in $L_{A89}$: $R^7$=H, and $R^6$=$R^8$ neopentyl;
in $L_{A90}$: $R^7$=H, and $R^6$=$R^8$=F; and
in $L_{A91}$: $R^6$=$R^7$=$R^8$=$CH_3$; and
$L_{A92}$ through $L_{A104}$, each represented by the formula




wherein in $L_{A92}$: $R^7$=$CH_3$, and $R^6$=$R^8$=H;
in $L_{A93}$: $R^7$=isopropyl, and $R^6$=$R^8$=H;
in $L_{A94}$: $R^7$=isobutyl, and $R^6$=$R^8$=H;
in $L_{A95}$: $R^7$=cyclopentyl, and $R^6$=$R^8$=H;
in $L_{A96}$: $R^7$=neopentyl, and $R^6$=$R^8$=H;
in $L_{A97}$: $R^7$=F, and $R^6$=$R^8$=H;
in $L_{A98}$: $R^7$=H, and $R^6$=$R^8$=$CH_3$;
in $L_{A99}$: $R^7$=H, and $R^6$=$R^8$=isopropyl;
in $L_{A100}$: $R^7$=H, and $R^6$=$R^8$=isobutyl;
in $L_{A101}$: $R^7$=H, and $R^6$=$R^8$=cyclopentyl;
in $L_{A102}$: $R^7$=H, and $R^6$=$R^8$=neopentyl;
in $L_{A103}$: $R^7$=H, and $R^6$=$R^8$=F; and
in $L_{A104}$: $R^6$=$R^7$=$R^8$=$CH_3$.

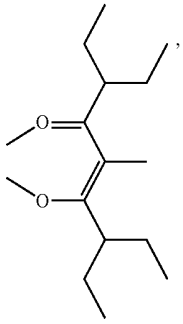
**17**. The compound of claim **1**, wherein $L_B$ is selected from the group consisting of $L_{B1}$-$L_{B9}$ listed below:

$L_{B1}$

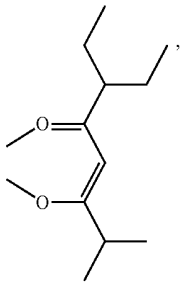



-continued

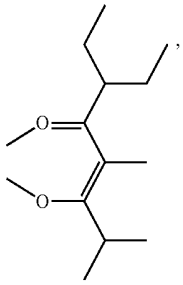
$L_{B2}$



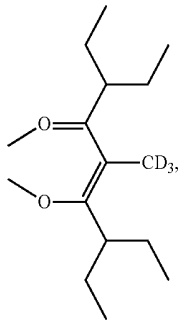

$L_{B3}$



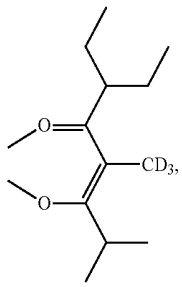

$L_{B4}$




$L_{B5}$

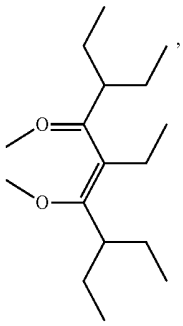



$L_{B6}$

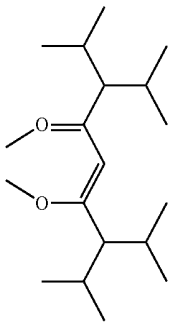


-continued

$L_{B7}$

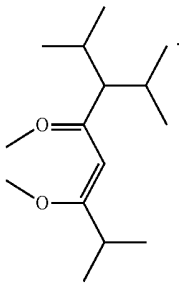


$L_{B8}$



and

$L_{B9}$



**18**. The compound of claim **1**, wherein the compound comprises ligand $L_A$ and ligand $L_B$ selected from the group consisting of:

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 1 | $L_{A1}$ | $L_{B1}$ |
| 2 | $L_{A2}$ | $L_{B1}$ |
| 3 | $L_{A3}$ | $L_{B1}$ |
| 4 | $L_{A4}$ | $L_{B1}$ |
| 5 | $L_{A5}$ | $L_{B1}$ |
| 6 | $L_{A6}$ | $L_{B1}$ |
| 7 | $L_{A7}$ | $L_{B1}$ |
| 8 | $L_{A8}$ | $L_{B1}$ |
| 9 | $L_{A9}$ | $L_{B1}$ |
| 10 | $L_{A10}$ | $L_{B1}$ |
| 11 | $L_{A11}$ | $L_{B1}$ |
| 12 | $L_{A12}$ | $L_{B1}$ |
| 13 | $L_{A13}$ | $L_{B1}$ |
| 14 | $L_{A14}$ | $L_{B1}$ |
| 15 | $L_{A15}$ | $L_{B1}$ |
| 16 | $L_{A16}$ | $L_{B1}$ |
| 17 | $L_{A17}$ | $L_{B1}$ |
| 18 | $L_{A18}$ | $L_{B1}$ |
| 19 | $L_{A19}$ | $L_{B1}$ |
| 20 | $L_{A20}$ | $L_{B1}$ |
| 21 | $L_{A21}$ | $L_{B1}$ |
| 22 | $L_{A22}$ | $L_{B1}$ |
| 23 | $L_{A23}$ | $L_{B1}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 24 | $L_{A24}$ | $L_{B1}$ |
| 25 | $L_{A25}$ | $L_{B1}$ |
| 26 | $L_{A26}$ | $L_{B1}$ |
| 27 | $L_{A27}$ | $L_{B1}$ |
| 28 | $L_{A28}$ | $L_{B1}$ |
| 29 | $L_{A29}$ | $L_{B1}$ |
| 30 | $L_{A30}$ | $L_{B1}$ |
| 31 | $L_{A31}$ | $L_{B1}$ |
| 32 | $L_{A32}$ | $L_{B1}$ |
| 33 | $L_{A33}$ | $L_{B1}$ |
| 34 | $L_{A34}$ | $L_{B1}$ |
| 35 | $L_{A35}$ | $L_{B1}$ |
| 36 | $L_{A36}$ | $L_{B1}$ |
| 37 | $L_{A37}$ | $L_{B1}$ |
| 38 | $L_{A38}$ | $L_{B1}$ |
| 39 | $L_{A39}$ | $L_{B1}$ |
| 40 | $L_{A40}$ | $L_{B1}$ |
| 41 | $L_{A41}$ | $L_{B1}$ |
| 42 | $L_{A42}$ | $L_{B1}$ |
| 43 | $L_{A43}$ | $L_{B1}$ |
| 44 | $L_{A44}$ | $L_{B1}$ |
| 45 | $L_{A45}$ | $L_{B1}$ |
| 46 | $L_{A46}$ | $L_{B1}$ |
| 47 | $L_{A47}$ | $L_{B1}$ |
| 48 | $L_{A48}$ | $L_{B1}$ |
| 49 | $L_{A49}$ | $L_{B1}$ |
| 50 | $L_{A50}$ | $L_{B1}$ |
| 51 | $L_{A51}$ | $L_{B1}$ |
| 52 | $L_{A52}$ | $L_{B1}$ |
| 53 | $L_{A53}$ | $L_{B1}$ |
| 54 | $L_{A54}$ | $L_{B1}$ |
| 55 | $L_{A55}$ | $L_{B1}$ |
| 56 | $L_{A56}$ | $L_{B1}$ |
| 57 | $L_{A57}$ | $L_{B1}$ |
| 58 | $L_{A58}$ | $L_{B1}$ |
| 59 | $L_{A59}$ | $L_{B1}$ |
| 60 | $L_{A60}$ | $L_{B1}$ |
| 61 | $L_{A61}$ | $L_{B1}$ |
| 62 | $L_{A62}$ | $L_{B1}$ |
| 63 | $L_{A63}$ | $L_{B1}$ |
| 64 | $L_{A64}$ | $L_{B1}$ |
| 65 | $L_{A65}$ | $L_{B1}$ |
| 66 | $L_{A66}$ | $L_{B1}$ |
| 67 | $L_{A67}$ | $L_{B1}$ |
| 68 | $L_{A68}$ | $L_{B1}$ |
| 69 | $L_{A69}$ | $L_{B1}$ |
| 70 | $L_{A70}$ | $L_{B1}$ |
| 71 | $L_{A71}$ | $L_{B1}$ |
| 72 | $L_{A72}$ | $L_{B1}$ |
| 73 | $L_{A73}$ | $L_{B1}$ |
| 74 | $L_{A74}$ | $L_{B1}$ |
| 75 | $L_{A75}$ | $L_{B1}$ |
| 76 | $L_{A76}$ | $L_{B1}$ |
| 77 | $L_{A77}$ | $L_{B1}$ |
| 78 | $L_{A78}$ | $L_{B1}$ |
| 79 | $L_{A79}$ | $L_{B1}$ |
| 80 | $L_{A80}$ | $L_{B1}$ |
| 81 | $L_{A81}$ | $L_{B1}$ |
| 82 | $L_{A82}$ | $L_{B1}$ |
| 83 | $L_{A83}$ | $L_{B1}$ |
| 84 | $L_{A84}$ | $L_{B1}$ |
| 85 | $L_{A85}$ | $L_{B1}$ |
| 86 | $L_{A86}$ | $L_{B1}$ |
| 87 | $L_{A87}$ | $L_{B1}$ |
| 88 | $L_{A88}$ | $L_{B1}$ |
| 89 | $L_{A89}$ | $L_{B1}$ |
| 90 | $L_{A90}$ | $L_{B1}$ |
| 91 | $L_{A91}$ | $L_{B1}$ |
| 92 | $L_{A92}$ | $L_{B1}$ |
| 93 | $L_{A93}$ | $L_{B1}$ |
| 94 | $L_{A94}$ | $L_{B1}$ |
| 95 | $L_{A95}$ | $L_{B1}$ |
| 96 | $L_{A96}$ | $L_{B1}$ |
| 97 | $L_{A97}$ | $L_{B1}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 98 | $L_{A98}$ | $L_{B1}$ |
| 99 | $L_{A99}$ | $L_{B1}$ |
| 100 | $L_{A100}$ | $L_{B1}$ |
| 101 | $L_{A101}$ | $L_{B1}$ |
| 102 | $L_{A102}$ | $L_{B1}$ |
| 103 | $L_{A103}$ | $L_{B1}$ |
| 104 | $L_{A104}$ | $L_{B1}$ |
| 105 | $L_{A1}$ | $L_{B2}$ |
| 106 | $L_{A2}$ | $L_{B2}$ |
| 107 | $L_{A3}$ | $L_{B2}$ |
| 108 | $L_{A4}$ | $L_{B2}$ |
| 109 | $L_{A5}$ | $L_{B2}$ |
| 110 | $L_{A6}$ | $L_{B2}$ |
| 111 | $L_{A7}$ | $L_{B2}$ |
| 112 | $L_{A8}$ | $L_{B2}$ |
| 113 | $L_{A9}$ | $L_{B2}$ |
| 114 | $L_{A10}$ | $L_{B2}$ |
| 115 | $L_{A11}$ | $L_{B2}$ |
| 116 | $L_{A12}$ | $L_{B2}$ |
| 117 | $L_{A13}$ | $L_{B2}$ |
| 118 | $L_{A14}$ | $L_{B2}$ |
| 119 | $L_{A15}$ | $L_{B2}$ |
| 120 | $L_{A16}$ | $L_{B2}$ |
| 121 | $L_{A17}$ | $L_{B2}$ |
| 122 | $L_{A18}$ | $L_{B2}$ |
| 123 | $L_{A19}$ | $L_{B2}$ |
| 124 | $L_{A20}$ | $L_{B2}$ |
| 125 | $L_{A21}$ | $L_{B2}$ |
| 126 | $L_{A22}$ | $L_{B2}$ |
| 127 | $L_{A23}$ | $L_{B2}$ |
| 128 | $L_{A24}$ | $L_{B2}$ |
| 129 | $L_{A25}$ | $L_{B2}$ |
| 130 | $L_{A26}$ | $L_{B2}$ |
| 131 | $L_{A27}$ | $L_{B2}$ |
| 132 | $L_{A28}$ | $L_{B2}$ |
| 133 | $L_{A29}$ | $L_{B2}$ |
| 134 | $L_{A30}$ | $L_{B2}$ |
| 135 | $L_{A31}$ | $L_{B2}$ |
| 136 | $L_{A32}$ | $L_{B2}$ |
| 137 | $L_{A33}$ | $L_{B2}$ |
| 138 | $L_{A34}$ | $L_{B2}$ |
| 139 | $L_{A35}$ | $L_{B2}$ |
| 140 | $L_{A36}$ | $L_{B2}$ |
| 141 | $L_{A37}$ | $L_{B2}$ |
| 142 | $L_{A38}$ | $L_{B2}$ |
| 143 | $L_{A39}$ | $L_{B2}$ |
| 144 | $L_{A40}$ | $L_{B2}$ |
| 145 | $L_{A41}$ | $L_{B2}$ |
| 146 | $L_{A42}$ | $L_{B2}$ |
| 147 | $L_{A43}$ | $L_{B2}$ |
| 148 | $L_{A44}$ | $L_{B2}$ |
| 149 | $L_{A45}$ | $L_{B2}$ |
| 150 | $L_{A46}$ | $L_{B2}$ |
| 151 | $L_{A47}$ | $L_{B2}$ |
| 152 | $L_{A48}$ | $L_{B2}$ |
| 153 | $L_{A49}$ | $L_{B2}$ |
| 154 | $L_{A50}$ | $L_{B2}$ |
| 155 | $L_{A51}$ | $L_{B2}$ |
| 156 | $L_{A52}$ | $L_{B2}$ |
| 157 | $L_{A53}$ | $L_{B2}$ |
| 158 | $L_{A54}$ | $L_{B2}$ |
| 159 | $L_{A55}$ | $L_{B2}$ |
| 160 | $L_{A56}$ | $L_{B2}$ |
| 161 | $L_{A57}$ | $L_{B2}$ |
| 162 | $L_{A58}$ | $L_{B2}$ |
| 163 | $L_{A59}$ | $L_{B2}$ |
| 164 | $L_{A60}$ | $L_{B2}$ |
| 165 | $L_{A61}$ | $L_{B2}$ |
| 166 | $L_{A62}$ | $L_{B2}$ |
| 167 | $L_{A63}$ | $L_{B2}$ |
| 168 | $L_{A64}$ | $L_{B2}$ |
| 169 | $L_{A65}$ | $L_{B2}$ |
| 170 | $L_{A66}$ | $L_{B2}$ |
| 171 | $L_{A67}$ | $L_{B2}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 172 | $L_{A68}$ | $L_{B2}$ |
| 173 | $L_{A69}$ | $L_{B2}$ |
| 174 | $L_{A70}$ | $L_{B2}$ |
| 175 | $L_{A71}$ | $L_{B2}$ |
| 176 | $L_{A72}$ | $L_{B2}$ |
| 177 | $L_{A73}$ | $L_{B2}$ |
| 178 | $L_{A74}$ | $L_{B2}$ |
| 179 | $L_{A75}$ | $L_{B2}$ |
| 180 | $L_{A76}$ | $L_{B2}$ |
| 181 | $L_{A77}$ | $L_{B2}$ |
| 182 | $L_{A78}$ | $L_{B2}$ |
| 183 | $L_{A79}$ | $L_{B2}$ |
| 184 | $L_{A80}$ | $L_{B2}$ |
| 185 | $L_{A81}$ | $L_{B2}$ |
| 186 | $L_{A82}$ | $L_{B2}$ |
| 187 | $L_{A83}$ | $L_{B2}$ |
| 188 | $L_{A84}$ | $L_{B2}$ |
| 189 | $L_{A85}$ | $L_{B2}$ |
| 190 | $L_{A86}$ | $L_{B2}$ |
| 191 | $L_{A87}$ | $L_{B2}$ |
| 192 | $L_{A88}$ | $L_{B2}$ |
| 193 | $L_{A89}$ | $L_{B2}$ |
| 194 | $L_{A90}$ | $L_{B2}$ |
| 195 | $L_{A91}$ | $L_{B2}$ |
| 196 | $L_{A92}$ | $L_{B2}$ |
| 197 | $L_{A93}$ | $L_{B2}$ |
| 198 | $L_{A94}$ | $L_{B2}$ |
| 199 | $L_{A95}$ | $L_{B2}$ |
| 200 | $L_{A96}$ | $L_{B2}$ |
| 201 | $L_{A97}$ | $L_{B2}$ |
| 202 | $L_{A98}$ | $L_{B2}$ |
| 203 | $L_{A99}$ | $L_{B2}$ |
| 204 | $L_{A100}$ | $L_{B2}$ |
| 205 | $L_{A101}$ | $L_{B2}$ |
| 206 | $L_{A102}$ | $L_{B2}$ |
| 207 | $L_{A103}$ | $L_{B2}$ |
| 208 | $L_{A104}$ | $L_{B2}$ |
| 209 | $L_{A1}$ | $L_{B3}$ |
| 210 | $L_{A2}$ | $L_{B3}$ |
| 211 | $L_{A3}$ | $L_{B3}$ |
| 212 | $L_{A4}$ | $L_{B3}$ |
| 213 | $L_{A5}$ | $L_{B3}$ |
| 214 | $L_{A6}$ | $L_{B3}$ |
| 215 | $L_{A7}$ | $L_{B3}$ |
| 216 | $L_{A8}$ | $L_{B3}$ |
| 217 | $L_{A9}$ | $L_{B3}$ |
| 218 | $L_{A10}$ | $L_{B3}$ |
| 219 | $L_{A11}$ | $L_{B3}$ |
| 220 | $L_{A12}$ | $L_{B3}$ |
| 221 | $L_{A13}$ | $L_{B3}$ |
| 222 | $L_{A14}$ | $L_{B3}$ |
| 223 | $L_{A15}$ | $L_{B3}$ |
| 224 | $L_{A16}$ | $L_{B3}$ |
| 225 | $L_{A17}$ | $L_{B3}$ |
| 226 | $L_{A18}$ | $L_{B3}$ |
| 227 | $L_{A19}$ | $L_{B3}$ |
| 228 | $L_{A20}$ | $L_{B3}$ |
| 229 | $L_{A21}$ | $L_{B3}$ |
| 230 | $L_{A22}$ | $L_{B3}$ |
| 231 | $L_{A23}$ | $L_{B3}$ |
| 232 | $L_{A24}$ | $L_{B3}$ |
| 233 | $L_{A25}$ | $L_{B3}$ |
| 234 | $L_{A26}$ | $L_{B3}$ |
| 235 | $L_{A27}$ | $L_{B3}$ |
| 236 | $L_{A28}$ | $L_{B3}$ |
| 237 | $L_{A29}$ | $L_{B3}$ |
| 238 | $L_{A30}$ | $L_{B3}$ |
| 239 | $L_{A31}$ | $L_{B3}$ |
| 240 | $L_{A32}$ | $L_{B3}$ |
| 241 | $L_{A33}$ | $L_{B3}$ |
| 242 | $L_{A34}$ | $L_{B3}$ |
| 243 | $L_{A35}$ | $L_{B3}$ |
| 244 | $L_{A36}$ | $L_{B3}$ |
| 245 | $L_{A37}$ | $L_{B3}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 246 | $L_{A38}$ | $L_{B3}$ |
| 247 | $L_{A39}$ | $L_{B3}$ |
| 248 | $L_{A40}$ | $L_{B3}$ |
| 249 | $L_{A41}$ | $L_{B3}$ |
| 250 | $L_{A42}$ | $L_{B3}$ |
| 251 | $L_{A43}$ | $L_{B3}$ |
| 252 | $L_{A44}$ | $L_{B3}$ |
| 253 | $L_{A45}$ | $L_{B3}$ |
| 254 | $L_{A46}$ | $L_{B3}$ |
| 255 | $L_{A47}$ | $L_{B3}$ |
| 256 | $L_{A48}$ | $L_{B3}$ |
| 257 | $L_{A49}$ | $L_{B3}$ |
| 258 | $L_{A50}$ | $L_{B3}$ |
| 259 | $L_{A51}$ | $L_{B3}$ |
| 260 | $L_{A52}$ | $L_{B3}$ |
| 261 | $L_{A53}$ | $L_{B3}$ |
| 262 | $L_{A54}$ | $L_{B3}$ |
| 263 | $L_{A55}$ | $L_{B3}$ |
| 264 | $L_{A56}$ | $L_{B3}$ |
| 265 | $L_{A57}$ | $L_{B3}$ |
| 266 | $L_{A58}$ | $L_{B3}$ |
| 267 | $L_{A59}$ | $L_{B3}$ |
| 268 | $L_{A60}$ | $L_{B3}$ |
| 269 | $L_{A61}$ | $L_{B3}$ |
| 270 | $L_{A62}$ | $L_{B3}$ |
| 271 | $L_{A63}$ | $L_{B3}$ |
| 272 | $L_{A64}$ | $L_{B3}$ |
| 273 | $L_{A65}$ | $L_{B3}$ |
| 274 | $L_{A66}$ | $L_{B3}$ |
| 275 | $L_{A67}$ | $L_{B3}$ |
| 276 | $L_{A68}$ | $L_{B3}$ |
| 277 | $L_{A69}$ | $L_{B3}$ |
| 278 | $L_{A70}$ | $L_{B3}$ |
| 279 | $L_{A71}$ | $L_{B3}$ |
| 280 | $L_{A72}$ | $L_{B3}$ |
| 281 | $L_{A73}$ | $L_{B3}$ |
| 282 | $L_{A74}$ | $L_{B3}$ |
| 283 | $L_{A75}$ | $L_{B3}$ |
| 284 | $L_{A76}$ | $L_{B3}$ |
| 285 | $L_{A77}$ | $L_{B3}$ |
| 286 | $L_{A78}$ | $L_{B3}$ |
| 287 | $L_{A79}$ | $L_{B3}$ |
| 288 | $L_{A80}$ | $L_{B3}$ |
| 289 | $L_{A81}$ | $L_{B3}$ |
| 290 | $L_{A82}$ | $L_{B3}$ |
| 291 | $L_{A83}$ | $L_{B3}$ |
| 292 | $L_{A84}$ | $L_{B3}$ |
| 293 | $L_{A85}$ | $L_{B3}$ |
| 294 | $L_{A86}$ | $L_{B3}$ |
| 295 | $L_{A87}$ | $L_{B3}$ |
| 296 | $L_{A88}$ | $L_{B3}$ |
| 297 | $L_{A89}$ | $L_{B3}$ |
| 298 | $L_{A90}$ | $L_{B3}$ |
| 299 | $L_{A91}$ | $L_{B3}$ |
| 300 | $L_{A92}$ | $L_{B3}$ |
| 301 | $L_{A93}$ | $L_{B3}$ |
| 302 | $L_{A94}$ | $L_{B3}$ |
| 303 | $L_{A95}$ | $L_{B3}$ |
| 304 | $L_{A96}$ | $L_{B3}$ |
| 305 | $L_{A97}$ | $L_{B3}$ |
| 306 | $L_{A98}$ | $L_{B3}$ |
| 307 | $L_{A99}$ | $L_{B3}$ |
| 308 | $L_{A100}$ | $L_{B3}$ |
| 309 | $L_{A101}$ | $L_{B3}$ |
| 310 | $L_{A102}$ | $L_{B3}$ |
| 311 | $L_{A103}$ | $L_{B3}$ |
| 312 | $L_{A104}$ | $L_{B3}$ |
| 313 | $L_{A1}$ | $L_{B4}$ |
| 314 | $L_{A2}$ | $L_{B4}$ |
| 315 | $L_{A3}$ | $L_{B4}$ |
| 316 | $L_{A4}$ | $L_{B4}$ |
| 317 | $L_{A5}$ | $L_{B4}$ |
| 318 | $L_{A6}$ | $L_{B4}$ |
| 319 | $L_{A7}$ | $L_{B4}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 320 | $L_{A8}$ | $L_{B4}$ |
| 321 | $L_{A9}$ | $L_{B4}$ |
| 322 | $L_{A10}$ | $L_{B4}$ |
| 323 | $L_{A11}$ | $L_{B4}$ |
| 324 | $L_{A12}$ | $L_{B4}$ |
| 325 | $L_{A13}$ | $L_{B4}$ |
| 326 | $L_{A14}$ | $L_{B4}$ |
| 327 | $L_{A15}$ | $L_{B4}$ |
| 328 | $L_{A16}$ | $L_{B4}$ |
| 329 | $L_{A17}$ | $L_{B4}$ |
| 330 | $L_{A18}$ | $L_{B4}$ |
| 331 | $L_{A19}$ | $L_{B4}$ |
| 332 | $L_{A20}$ | $L_{B4}$ |
| 333 | $L_{A21}$ | $L_{B4}$ |
| 334 | $L_{A22}$ | $L_{B4}$ |
| 335 | $L_{A23}$ | $L_{B4}$ |
| 336 | $L_{A24}$ | $L_{B4}$ |
| 337 | $L_{A25}$ | $L_{B4}$ |
| 338 | $L_{A26}$ | $L_{B4}$ |
| 339 | $L_{A27}$ | $L_{B4}$ |
| 340 | $L_{A28}$ | $L_{B4}$ |
| 341 | $L_{A29}$ | $L_{B4}$ |
| 342 | $L_{A30}$ | $L_{B4}$ |
| 343 | $L_{A31}$ | $L_{B4}$ |
| 344 | $L_{A32}$ | $L_{B4}$ |
| 345 | $L_{A33}$ | $L_{B4}$ |
| 346 | $L_{A34}$ | $L_{B4}$ |
| 347 | $L_{A35}$ | $L_{B4}$ |
| 348 | $L_{A36}$ | $L_{B4}$ |
| 349 | $L_{A37}$ | $L_{B4}$ |
| 350 | $L_{A38}$ | $L_{B4}$ |
| 351 | $L_{A39}$ | $L_{B4}$ |
| 352 | $L_{A40}$ | $L_{B4}$ |
| 353 | $L_{A41}$ | $L_{B4}$ |
| 354 | $L_{A42}$ | $L_{B4}$ |
| 355 | $L_{A43}$ | $L_{B4}$ |
| 356 | $L_{A44}$ | $L_{B4}$ |
| 357 | $L_{A45}$ | $L_{B4}$ |
| 358 | $L_{A46}$ | $L_{B4}$ |
| 359 | $L_{A47}$ | $L_{B4}$ |
| 360 | $L_{A48}$ | $L_{B4}$ |
| 361 | $L_{A49}$ | $L_{B4}$ |
| 362 | $L_{A50}$ | $L_{B4}$ |
| 363 | $L_{A51}$ | $L_{B4}$ |
| 364 | $L_{A52}$ | $L_{B4}$ |
| 365 | $L_{A53}$ | $L_{B4}$ |
| 366 | $L_{A54}$ | $L_{B4}$ |
| 367 | $L_{A55}$ | $L_{B4}$ |
| 368 | $L_{A56}$ | $L_{B4}$ |
| 369 | $L_{A57}$ | $L_{B4}$ |
| 370 | $L_{A58}$ | $L_{B4}$ |
| 371 | $L_{A59}$ | $L_{B4}$ |
| 372 | $L_{A60}$ | $L_{B4}$ |
| 373 | $L_{A61}$ | $L_{B4}$ |
| 374 | $L_{A62}$ | $L_{B4}$ |
| 375 | $L_{A63}$ | $L_{B4}$ |
| 376 | $L_{A64}$ | $L_{B4}$ |
| 377 | $L_{A65}$ | $L_{B4}$ |
| 378 | $L_{A66}$ | $L_{B4}$ |
| 379 | $L_{A67}$ | $L_{B4}$ |
| 380 | $L_{A68}$ | $L_{B4}$ |
| 381 | $L_{A69}$ | $L_{B4}$ |
| 382 | $L_{A70}$ | $L_{B4}$ |
| 383 | $L_{A71}$ | $L_{B4}$ |
| 384 | $L_{A72}$ | $L_{B4}$ |
| 385 | $L_{A73}$ | $L_{B4}$ |
| 386 | $L_{A74}$ | $L_{B4}$ |
| 387 | $L_{A75}$ | $L_{B4}$ |
| 388 | $L_{A76}$ | $L_{B4}$ |
| 389 | $L_{A77}$ | $L_{B4}$ |
| 390 | $L_{A78}$ | $L_{B4}$ |
| 391 | $L_{A79}$ | $L_{B4}$ |
| 392 | $L_{A80}$ | $L_{B4}$ |
| 393 | $L_{A81}$ | $L_{B4}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 394 | $L_{A82}$ | $L_{B4}$ |
| 395 | $L_{A83}$ | $L_{B4}$ |
| 396 | $L_{A84}$ | $L_{B4}$ |
| 397 | $L_{A85}$ | $L_{B4}$ |
| 398 | $L_{A86}$ | $L_{B4}$ |
| 399 | $L_{A87}$ | $L_{B4}$ |
| 400 | $L_{A88}$ | $L_{B4}$ |
| 401 | $L_{A89}$ | $L_{B4}$ |
| 402 | $L_{A90}$ | $L_{B4}$ |
| 403 | $L_{A91}$ | $L_{B4}$ |
| 404 | $L_{A92}$ | $L_{B4}$ |
| 405 | $L_{A93}$ | $L_{B4}$ |
| 406 | $L_{A94}$ | $L_{B4}$ |
| 407 | $L_{A95}$ | $L_{B4}$ |
| 408 | $L_{A96}$ | $L_{B4}$ |
| 409 | $L_{A97}$ | $L_{B4}$ |
| 410 | $L_{A98}$ | $L_{B4}$ |
| 411 | $L_{A99}$ | $L_{B4}$ |
| 412 | $L_{A100}$ | $L_{B4}$ |
| 413 | $L_{A101}$ | $L_{B4}$ |
| 414 | $L_{A102}$ | $L_{B4}$ |
| 415 | $L_{A103}$ | $L_{B4}$ |
| 416 | $L_{A104}$ | $L_{B4}$ |
| 417 | $L_{A1}$ | $L_{B5}$ |
| 418 | $L_{A2}$ | $L_{B5}$ |
| 419 | $L_{A3}$ | $L_{B5}$ |
| 420 | $L_{A4}$ | $L_{B5}$ |
| 421 | $L_{A5}$ | $L_{B5}$ |
| 422 | $L_{A6}$ | $L_{B5}$ |
| 423 | $L_{A7}$ | $L_{B5}$ |
| 424 | $L_{A8}$ | $L_{B5}$ |
| 425 | $L_{A9}$ | $L_{B5}$ |
| 426 | $L_{A10}$ | $L_{B5}$ |
| 427 | $L_{A11}$ | $L_{B5}$ |
| 428 | $L_{A12}$ | $L_{B5}$ |
| 429 | $L_{A13}$ | $L_{B5}$ |
| 430 | $L_{A14}$ | $L_{B5}$ |
| 431 | $L_{A15}$ | $L_{B5}$ |
| 432 | $L_{A16}$ | $L_{B5}$ |
| 433 | $L_{A17}$ | $L_{B5}$ |
| 434 | $L_{A18}$ | $L_{B5}$ |
| 435 | $L_{A19}$ | $L_{B5}$ |
| 436 | $L_{A20}$ | $L_{B5}$ |
| 437 | $L_{A21}$ | $L_{B5}$ |
| 438 | $L_{A22}$ | $L_{B5}$ |
| 439 | $L_{A23}$ | $L_{B5}$ |
| 440 | $L_{A24}$ | $L_{B5}$ |
| 441 | $L_{A25}$ | $L_{B5}$ |
| 442 | $L_{A26}$ | $L_{B5}$ |
| 443 | $L_{A27}$ | $L_{B5}$ |
| 444 | $L_{A28}$ | $L_{B5}$ |
| 445 | $L_{A29}$ | $L_{B5}$ |
| 446 | $L_{A30}$ | $L_{B5}$ |
| 447 | $L_{A31}$ | $L_{B5}$ |
| 448 | $L_{A32}$ | $L_{B5}$ |
| 449 | $L_{A33}$ | $L_{B5}$ |
| 450 | $L_{A34}$ | $L_{B5}$ |
| 451 | $L_{A35}$ | $L_{B5}$ |
| 452 | $L_{A36}$ | $L_{B5}$ |
| 453 | $L_{A37}$ | $L_{B5}$ |
| 454 | $L_{A38}$ | $L_{B5}$ |
| 455 | $L_{A39}$ | $L_{B5}$ |
| 456 | $L_{A40}$ | $L_{B5}$ |
| 457 | $L_{A41}$ | $L_{B5}$ |
| 458 | $L_{A42}$ | $L_{B5}$ |
| 459 | $L_{A43}$ | $L_{B5}$ |
| 460 | $L_{A44}$ | $L_{B5}$ |
| 461 | $L_{A45}$ | $L_{B5}$ |
| 462 | $L_{A46}$ | $L_{B5}$ |
| 463 | $L_{A47}$ | $L_{B5}$ |
| 464 | $L_{A48}$ | $L_{B5}$ |
| 465 | $L_{A49}$ | $L_{B5}$ |
| 466 | $L_{A50}$ | $L_{B5}$ |
| 467 | $L_{A51}$ | $L_{B5}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 468 | $L_{A52}$ | $L_{B5}$ |
| 469 | $L_{A53}$ | $L_{B5}$ |
| 470 | $L_{A54}$ | $L_{B5}$ |
| 471 | $L_{A55}$ | $L_{B5}$ |
| 472 | $L_{A56}$ | $L_{B5}$ |
| 473 | $L_{A57}$ | $L_{B5}$ |
| 474 | $L_{A58}$ | $L_{B5}$ |
| 475 | $L_{A59}$ | $L_{B5}$ |
| 476 | $L_{A60}$ | $L_{B5}$ |
| 477 | $L_{A61}$ | $L_{B5}$ |
| 478 | $L_{A62}$ | $L_{B5}$ |
| 479 | $L_{A63}$ | $L_{B5}$ |
| 480 | $L_{A64}$ | $L_{B5}$ |
| 481 | $L_{A65}$ | $L_{B5}$ |
| 482 | $L_{A66}$ | $L_{B5}$ |
| 483 | $L_{A67}$ | $L_{B5}$ |
| 484 | $L_{A68}$ | $L_{B5}$ |
| 485 | $L_{A69}$ | $L_{B5}$ |
| 486 | $L_{A70}$ | $L_{B5}$ |
| 487 | $L_{A71}$ | $L_{B5}$ |
| 488 | $L_{A72}$ | $L_{B5}$ |
| 489 | $L_{A73}$ | $L_{B5}$ |
| 490 | $L_{A74}$ | $L_{B5}$ |
| 491 | $L_{A75}$ | $L_{B5}$ |
| 492 | $L_{A76}$ | $L_{B5}$ |
| 493 | $L_{A77}$ | $L_{B5}$ |
| 494 | $L_{A78}$ | $L_{B5}$ |
| 495 | $L_{A79}$ | $L_{B5}$ |
| 496 | $L_{A80}$ | $L_{B5}$ |
| 497 | $L_{A81}$ | $L_{B5}$ |
| 498 | $L_{A82}$ | $L_{B5}$ |
| 499 | $L_{A83}$ | $L_{B5}$ |
| 500 | $L_{A84}$ | $L_{B5}$ |
| 501 | $L_{A85}$ | $L_{B5}$ |
| 502 | $L_{A86}$ | $L_{B5}$ |
| 503 | $L_{A87}$ | $L_{B5}$ |
| 504 | $L_{A88}$ | $L_{B5}$ |
| 505 | $L_{A89}$ | $L_{B5}$ |
| 506 | $L_{A90}$ | $L_{B5}$ |
| 507 | $L_{A91}$ | $L_{B5}$ |
| 508 | $L_{A92}$ | $L_{B5}$ |
| 509 | $L_{A93}$ | $L_{B5}$ |
| 510 | $L_{A94}$ | $L_{B5}$ |
| 511 | $L_{A95}$ | $L_{B5}$ |
| 512 | $L_{A96}$ | $L_{B5}$ |
| 513 | $L_{A97}$ | $L_{B5}$ |
| 514 | $L_{A98}$ | $L_{B5}$ |
| 515 | $L_{A99}$ | $L_{B5}$ |
| 516 | $L_{A100}$ | $L_{B5}$ |
| 517 | $L_{A101}$ | $L_{B5}$ |
| 518 | $L_{A102}$ | $L_{B5}$ |
| 519 | $L_{A103}$ | $L_{B5}$ |
| 520 | $L_{A104}$ | $L_{B5}$ |
| 521 | $L_{A1}$ | $L_{B6}$ |
| 522 | $L_{A2}$ | $L_{B6}$ |
| 523 | $L_{A3}$ | $L_{B6}$ |
| 524 | $L_{A4}$ | $L_{B6}$ |
| 525 | $L_{A5}$ | $L_{B6}$ |
| 526 | $L_{A6}$ | $L_{B6}$ |
| 527 | $L_{A7}$ | $L_{B6}$ |
| 528 | $L_{A8}$ | $L_{B6}$ |
| 529 | $L_{A9}$ | $L_{B6}$ |
| 530 | $L_{A10}$ | $L_{B6}$ |
| 531 | $L_{A11}$ | $L_{B6}$ |
| 532 | $L_{A12}$ | $L_{B6}$ |
| 533 | $L_{A13}$ | $L_{B6}$ |
| 534 | $L_{A14}$ | $L_{B6}$ |
| 535 | $L_{A15}$ | $L_{B6}$ |
| 536 | $L_{A16}$ | $L_{B6}$ |
| 537 | $L_{A17}$ | $L_{B6}$ |
| 538 | $L_{A18}$ | $L_{B6}$ |
| 539 | $L_{A19}$ | $L_{B6}$ |
| 540 | $L_{A20}$ | $L_{B6}$ |
| 541 | $L_{A21}$ | $L_{B6}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 542 | $L_{A22}$ | $L_{B6}$ |
| 543 | $L_{A23}$ | $L_{B6}$ |
| 544 | $L_{A24}$ | $L_{B6}$ |
| 545 | $L_{A25}$ | $L_{B6}$ |
| 546 | $L_{A26}$ | $L_{B6}$ |
| 547 | $L_{A27}$ | $L_{B6}$ |
| 548 | $L_{A28}$ | $L_{B6}$ |
| 549 | $L_{A29}$ | $L_{B6}$ |
| 550 | $L_{A30}$ | $L_{B6}$ |
| 551 | $L_{A31}$ | $L_{B6}$ |
| 552 | $L_{A32}$ | $L_{B6}$ |
| 553 | $L_{A33}$ | $L_{B6}$ |
| 554 | $L_{A34}$ | $L_{B6}$ |
| 555 | $L_{A35}$ | $L_{B6}$ |
| 556 | $L_{A36}$ | $L_{B6}$ |
| 557 | $L_{A37}$ | $L_{B6}$ |
| 558 | $L_{A38}$ | $L_{B6}$ |
| 559 | $L_{A39}$ | $L_{B6}$ |
| 560 | $L_{A40}$ | $L_{B6}$ |
| 561 | $L_{A41}$ | $L_{B6}$ |
| 562 | $L_{A42}$ | $L_{B6}$ |
| 563 | $L_{A43}$ | $L_{B6}$ |
| 564 | $L_{A44}$ | $L_{B6}$ |
| 565 | $L_{A45}$ | $L_{B6}$ |
| 566 | $L_{A46}$ | $L_{B6}$ |
| 567 | $L_{A47}$ | $L_{B6}$ |
| 568 | $L_{A48}$ | $L_{B6}$ |
| 569 | $L_{A49}$ | $L_{B6}$ |
| 570 | $L_{A50}$ | $L_{B6}$ |
| 571 | $L_{A51}$ | $L_{B6}$ |
| 572 | $L_{A52}$ | $L_{B6}$ |
| 573 | $L_{A53}$ | $L_{B6}$ |
| 574 | $L_{A54}$ | $L_{B6}$ |
| 575 | $L_{A55}$ | $L_{B6}$ |
| 576 | $L_{A56}$ | $L_{B6}$ |
| 577 | $L_{A57}$ | $L_{B6}$ |
| 578 | $L_{A58}$ | $L_{B6}$ |
| 579 | $L_{A59}$ | $L_{B6}$ |
| 580 | $L_{A60}$ | $L_{B6}$ |
| 581 | $L_{A61}$ | $L_{B6}$ |
| 582 | $L_{A62}$ | $L_{B6}$ |
| 583 | $L_{A63}$ | $L_{B6}$ |
| 584 | $L_{A64}$ | $L_{B6}$ |
| 585 | $L_{A65}$ | $L_{B6}$ |
| 586 | $L_{A66}$ | $L_{B6}$ |
| 587 | $L_{A67}$ | $L_{B6}$ |
| 588 | $L_{A68}$ | $L_{B6}$ |
| 589 | $L_{A69}$ | $L_{B6}$ |
| 590 | $L_{A70}$ | $L_{B6}$ |
| 591 | $L_{A71}$ | $L_{B6}$ |
| 592 | $L_{A72}$ | $L_{B6}$ |
| 593 | $L_{A73}$ | $L_{B6}$ |
| 594 | $L_{A74}$ | $L_{B6}$ |
| 595 | $L_{A75}$ | $L_{B6}$ |
| 596 | $L_{A76}$ | $L_{B6}$ |
| 597 | $L_{A77}$ | $L_{B6}$ |
| 598 | $L_{A78}$ | $L_{B6}$ |
| 599 | $L_{A79}$ | $L_{B6}$ |
| 600 | $L_{A80}$ | $L_{B6}$ |
| 601 | $L_{A81}$ | $L_{B6}$ |
| 602 | $L_{A82}$ | $L_{B6}$ |
| 603 | $L_{A83}$ | $L_{B6}$ |
| 604 | $L_{A84}$ | $L_{B6}$ |
| 605 | $L_{A85}$ | $L_{B6}$ |
| 606 | $L_{A86}$ | $L_{B6}$ |
| 607 | $L_{A87}$ | $L_{B6}$ |
| 608 | $L_{A88}$ | $L_{B6}$ |
| 609 | $L_{A89}$ | $L_{B6}$ |
| 610 | $L_{A90}$ | $L_{B6}$ |
| 611 | $L_{A91}$ | $L_{B6}$ |
| 612 | $L_{A92}$ | $L_{B6}$ |
| 613 | $L_{A93}$ | $L_{B6}$ |
| 614 | $L_{A94}$ | $L_{B6}$ |
| 615 | $L_{A95}$ | $L_{B6}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 616 | $L_{A96}$ | $L_{B6}$ |
| 617 | $L_{A97}$ | $L_{B6}$ |
| 618 | $L_{A98}$ | $L_{B6}$ |
| 619 | $L_{A99}$ | $L_{B6}$ |
| 620 | $L_{A100}$ | $L_{B6}$ |
| 621 | $L_{A101}$ | $L_{B6}$ |
| 622 | $L_{A102}$ | $L_{B6}$ |
| 623 | $L_{A103}$ | $L_{B6}$ |
| 624 | $L_{A104}$ | $L_{B6}$ |
| 625 | $L_{A1}$ | $L_{B7}$ |
| 626 | $L_{A2}$ | $L_{B7}$ |
| 627 | $L_{A3}$ | $L_{B7}$ |
| 628 | $L_{A4}$ | $L_{B7}$ |
| 629 | $L_{A5}$ | $L_{B7}$ |
| 630 | $L_{A6}$ | $L_{B7}$ |
| 631 | $L_{A7}$ | $L_{B7}$ |
| 632 | $L_{A8}$ | $L_{B7}$ |
| 633 | $L_{A9}$ | $L_{B7}$ |
| 634 | $L_{A10}$ | $L_{B7}$ |
| 635 | $L_{A11}$ | $L_{B7}$ |
| 636 | $L_{A12}$ | $L_{B7}$ |
| 637 | $L_{A13}$ | $L_{B7}$ |
| 638 | $L_{A14}$ | $L_{B7}$ |
| 639 | $L_{A15}$ | $L_{B7}$ |
| 640 | $L_{A16}$ | $L_{B7}$ |
| 641 | $L_{A17}$ | $L_{B7}$ |
| 642 | $L_{A18}$ | $L_{B7}$ |
| 643 | $L_{A19}$ | $L_{B7}$ |
| 644 | $L_{A20}$ | $L_{B7}$ |
| 645 | $L_{A21}$ | $L_{B7}$ |
| 646 | $L_{A22}$ | $L_{B7}$ |
| 647 | $L_{A23}$ | $L_{B7}$ |
| 648 | $L_{A24}$ | $L_{B7}$ |
| 649 | $L_{A25}$ | $L_{B7}$ |
| 650 | $L_{A26}$ | $L_{B7}$ |
| 651 | $L_{A27}$ | $L_{B7}$ |
| 652 | $L_{A28}$ | $L_{B7}$ |
| 653 | $L_{A29}$ | $L_{B7}$ |
| 654 | $L_{A30}$ | $L_{B7}$ |
| 655 | $L_{A31}$ | $L_{B7}$ |
| 656 | $L_{A32}$ | $L_{B7}$ |
| 657 | $L_{A33}$ | $L_{B7}$ |
| 658 | $L_{A34}$ | $L_{B7}$ |
| 659 | $L_{A35}$ | $L_{B7}$ |
| 660 | $L_{A36}$ | $L_{B7}$ |
| 661 | $L_{A37}$ | $L_{B7}$ |
| 662 | $L_{A38}$ | $L_{B7}$ |
| 663 | $L_{A39}$ | $L_{B7}$ |
| 664 | $L_{A40}$ | $L_{B7}$ |
| 665 | $L_{A41}$ | $L_{B7}$ |
| 666 | $L_{A42}$ | $L_{B7}$ |
| 667 | $L_{A43}$ | $L_{B7}$ |
| 668 | $L_{A44}$ | $L_{B7}$ |
| 669 | $L_{A45}$ | $L_{B7}$ |
| 670 | $L_{A46}$ | $L_{B7}$ |
| 671 | $L_{A47}$ | $L_{B7}$ |
| 672 | $L_{A48}$ | $L_{B7}$ |
| 673 | $L_{A49}$ | $L_{B7}$ |
| 674 | $L_{A50}$ | $L_{B7}$ |
| 675 | $L_{A51}$ | $L_{B7}$ |
| 676 | $L_{A52}$ | $L_{B7}$ |
| 677 | $L_{A53}$ | $L_{B7}$ |
| 678 | $L_{A54}$ | $L_{B7}$ |
| 679 | $L_{A55}$ | $L_{B7}$ |
| 680 | $L_{A56}$ | $L_{B7}$ |
| 681 | $L_{A57}$ | $L_{B7}$ |
| 682 | $L_{A58}$ | $L_{B7}$ |
| 683 | $L_{A59}$ | $L_{B7}$ |
| 684 | $L_{A60}$ | $L_{B7}$ |
| 685 | $L_{A61}$ | $L_{B7}$ |
| 686 | $L_{A62}$ | $L_{B7}$ |
| 687 | $L_{A63}$ | $L_{B7}$ |
| 688 | $L_{A64}$ | $L_{B7}$ |
| 689 | $L_{A65}$ | $L_{B7}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 690 | $L_{A66}$ | $L_{B7}$ |
| 691 | $L_{A67}$ | $L_{B7}$ |
| 692 | $L_{A68}$ | $L_{B7}$ |
| 693 | $L_{A69}$ | $L_{B7}$ |
| 694 | $L_{A70}$ | $L_{B7}$ |
| 695 | $L_{A71}$ | $L_{B7}$ |
| 696 | $L_{A72}$ | $L_{B7}$ |
| 697 | $L_{A73}$ | $L_{B7}$ |
| 698 | $L_{A74}$ | $L_{B7}$ |
| 699 | $L_{A75}$ | $L_{B7}$ |
| 700 | $L_{A76}$ | $L_{B7}$ |
| 701 | $L_{A77}$ | $L_{B7}$ |
| 702 | $L_{A78}$ | $L_{B7}$ |
| 703 | $L_{A79}$ | $L_{B7}$ |
| 704 | $L_{A80}$ | $L_{B7}$ |
| 705 | $L_{A81}$ | $L_{B7}$ |
| 706 | $L_{A82}$ | $L_{B7}$ |
| 707 | $L_{A83}$ | $L_{B7}$ |
| 708 | $L_{A84}$ | $L_{B7}$ |
| 709 | $L_{A85}$ | $L_{B7}$ |
| 710 | $L_{A86}$ | $L_{B7}$ |
| 711 | $L_{A87}$ | $L_{B7}$ |
| 712 | $L_{A88}$ | $L_{B7}$ |
| 713 | $L_{A89}$ | $L_{B7}$ |
| 714 | $L_{A90}$ | $L_{B7}$ |
| 715 | $L_{A91}$ | $L_{B7}$ |
| 716 | $L_{A92}$ | $L_{B7}$ |
| 717 | $L_{A93}$ | $L_{B7}$ |
| 718 | $L_{A94}$ | $L_{B7}$ |
| 719 | $L_{A95}$ | $L_{B7}$ |
| 720 | $L_{A96}$ | $L_{B7}$ |
| 721 | $L_{A97}$ | $L_{B7}$ |
| 722 | $L_{A98}$ | $L_{B7}$ |
| 723 | $L_{A99}$ | $L_{B7}$ |
| 724 | $L_{A100}$ | $L_{B7}$ |
| 725 | $L_{A101}$ | $L_{B7}$ |
| 726 | $L_{A102}$ | $L_{B7}$ |
| 727 | $L_{A103}$ | $L_{B7}$ |
| 728 | $L_{A104}$ | $L_{B7}$ |
| 729 | $L_{A1}$ | $L_{B8}$ |
| 730 | $L_{A2}$ | $L_{B8}$ |
| 731 | $L_{A3}$ | $L_{B8}$ |
| 732 | $L_{A4}$ | $L_{B8}$ |
| 733 | $L_{A5}$ | $L_{B8}$ |
| 734 | $L_{A6}$ | $L_{B8}$ |
| 735 | $L_{A7}$ | $L_{B8}$ |
| 736 | $L_{A8}$ | $L_{B8}$ |
| 737 | $L_{A9}$ | $L_{B8}$ |
| 738 | $L_{A10}$ | $L_{B8}$ |
| 739 | $L_{A11}$ | $L_{B8}$ |
| 740 | $L_{A12}$ | $L_{B8}$ |
| 741 | $L_{A13}$ | $L_{B8}$ |
| 742 | $L_{A14}$ | $L_{B8}$ |
| 743 | $L_{A15}$ | $L_{B8}$ |
| 744 | $L_{A16}$ | $L_{B8}$ |
| 745 | $L_{A17}$ | $L_{B8}$ |
| 746 | $L_{A18}$ | $L_{B8}$ |
| 747 | $L_{A19}$ | $L_{B8}$ |
| 748 | $L_{A20}$ | $L_{B8}$ |
| 749 | $L_{A21}$ | $L_{B8}$ |
| 750 | $L_{A22}$ | $L_{B8}$ |
| 751 | $L_{A23}$ | $L_{B8}$ |
| 752 | $L_{A24}$ | $L_{B8}$ |
| 753 | $L_{A25}$ | $L_{B8}$ |
| 754 | $L_{A26}$ | $L_{B8}$ |
| 755 | $L_{A27}$ | $L_{B8}$ |
| 756 | $L_{A28}$ | $L_{B8}$ |
| 757 | $L_{A29}$ | $L_{B8}$ |
| 758 | $L_{A30}$ | $L_{B8}$ |
| 759 | $L_{A31}$ | $L_{B8}$ |
| 760 | $L_{A32}$ | $L_{B8}$ |
| 761 | $L_{A33}$ | $L_{B8}$ |
| 762 | $L_{A34}$ | $L_{B8}$ |
| 763 | $L_{A35}$ | $L_{B8}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 764 | $L_{A36}$ | $L_{B8}$ |
| 765 | $L_{A37}$ | $L_{B8}$ |
| 766 | $L_{A38}$ | $L_{B8}$ |
| 767 | $L_{A39}$ | $L_{B8}$ |
| 768 | $L_{A40}$ | $L_{B8}$ |
| 769 | $L_{A41}$ | $L_{B8}$ |
| 770 | $L_{A42}$ | $L_{B8}$ |
| 771 | $L_{A43}$ | $L_{B8}$ |
| 772 | $L_{A44}$ | $L_{B8}$ |
| 773 | $L_{A45}$ | $L_{B8}$ |
| 774 | $L_{A46}$ | $L_{B8}$ |
| 775 | $L_{A47}$ | $L_{B8}$ |
| 776 | $L_{A48}$ | $L_{B8}$ |
| 777 | $L_{A49}$ | $L_{B8}$ |
| 778 | $L_{A50}$ | $L_{B8}$ |
| 779 | $L_{A51}$ | $L_{B8}$ |
| 780 | $L_{A52}$ | $L_{B8}$ |
| 781 | $L_{A53}$ | $L_{B8}$ |
| 782 | $L_{A54}$ | $L_{B8}$ |
| 783 | $L_{A55}$ | $L_{B8}$ |
| 784 | $L_{A56}$ | $L_{B8}$ |
| 785 | $L_{A57}$ | $L_{B8}$ |
| 786 | $L_{A58}$ | $L_{B8}$ |
| 787 | $L_{A59}$ | $L_{B8}$ |
| 788 | $L_{A60}$ | $L_{B8}$ |
| 789 | $L_{A61}$ | $L_{B8}$ |
| 790 | $L_{A62}$ | $L_{B8}$ |
| 791 | $L_{A63}$ | $L_{B8}$ |
| 792 | $L_{A64}$ | $L_{B8}$ |
| 793 | $L_{A65}$ | $L_{B8}$ |
| 794 | $L_{A66}$ | $L_{B8}$ |
| 795 | $L_{A67}$ | $L_{B8}$ |
| 796 | $L_{A68}$ | $L_{B8}$ |
| 797 | $L_{A69}$ | $L_{B8}$ |
| 798 | $L_{A70}$ | $L_{B8}$ |
| 799 | $L_{A71}$ | $L_{B8}$ |
| 800 | $L_{A72}$ | $L_{B8}$ |
| 801 | $L_{A73}$ | $L_{B8}$ |
| 802 | $L_{A74}$ | $L_{B8}$ |
| 803 | $L_{A75}$ | $L_{B8}$ |
| 804 | $L_{A76}$ | $L_{B8}$ |
| 805 | $L_{A77}$ | $L_{B8}$ |
| 806 | $L_{A78}$ | $L_{B8}$ |
| 807 | $L_{A79}$ | $L_{B8}$ |
| 808 | $L_{A80}$ | $L_{B8}$ |
| 809 | $L_{A81}$ | $L_{B8}$ |
| 810 | $L_{A82}$ | $L_{B8}$ |
| 811 | $L_{A83}$ | $L_{B8}$ |
| 812 | $L_{A84}$ | $L_{B8}$ |
| 813 | $L_{A85}$ | $L_{B8}$ |
| 814 | $L_{A86}$ | $L_{B8}$ |
| 815 | $L_{A87}$ | $L_{B8}$ |
| 816 | $L_{A88}$ | $L_{B8}$ |
| 817 | $L_{A89}$ | $L_{B8}$ |
| 818 | $L_{A90}$ | $L_{B8}$ |
| 819 | $L_{A91}$ | $L_{B8}$ |
| 820 | $L_{A92}$ | $L_{B8}$ |
| 821 | $L_{A93}$ | $L_{B8}$ |
| 822 | $L_{A94}$ | $L_{B8}$ |
| 823 | $L_{A95}$ | $L_{B8}$ |
| 824 | $L_{A96}$ | $L_{B8}$ |
| 825 | $L_{A97}$ | $L_{B8}$ |
| 826 | $L_{A98}$ | $L_{B8}$ |
| 827 | $L_{A99}$ | $L_{B8}$ |
| 828 | $L_{A100}$ | $L_{B8}$ |
| 829 | $L_{A101}$ | $L_{B8}$ |
| 830 | $L_{A102}$ | $L_{B8}$ |
| 831 | $L_{A103}$ | $L_{B8}$ |
| 832 | $L_{A104}$ | $L_{B8}$ |
| 833 | $L_{A1}$ | $L_{B9}$ |
| 834 | $L_{A2}$ | $L_{B9}$ |
| 835 | $L_{A3}$ | $L_{B9}$ |
| 836 | $L_{A4}$ | $L_{B9}$ |
| 837 | $L_{A5}$ | $L_{B9}$ |

-continued

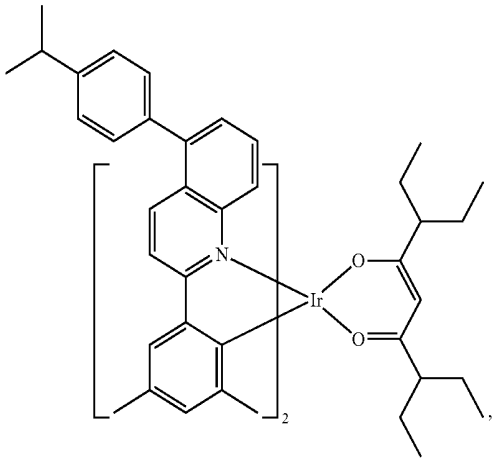
| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 838 | $L_{A6}$ | $L_{B9}$ |
| 839 | $L_{A7}$ | $L_{B9}$ |
| 840 | $L_{A8}$ | $L_{B9}$ |
| 841 | $L_{A9}$ | $L_{B9}$ |
| 842 | $L_{A10}$ | $L_{B9}$ |
| 843 | $L_{A11}$ | $L_{B9}$ |
| 844 | $L_{A12}$ | $L_{B9}$ |
| 845 | $L_{A13}$ | $L_{B9}$ |
| 846 | $L_{A14}$ | $L_{B9}$ |
| 847 | $L_{A15}$ | $L_{B9}$ |
| 848 | $L_{A16}$ | $L_{B9}$ |
| 849 | $L_{A17}$ | $L_{B9}$ |
| 850 | $L_{A18}$ | $L_{B9}$ |
| 851 | $L_{A19}$ | $L_{B9}$ |
| 852 | $L_{A20}$ | $L_{B9}$ |
| 853 | $L_{A21}$ | $L_{B9}$ |
| 854 | $L_{A22}$ | $L_{B9}$ |
| 855 | $L_{A23}$ | $L_{B9}$ |
| 856 | $L_{A24}$ | $L_{B9}$ |
| 857 | $L_{A25}$ | $L_{B9}$ |
| 858 | $L_{A26}$ | $L_{B9}$ |
| 859 | $L_{A27}$ | $L_{B9}$ |
| 860 | $L_{A28}$ | $L_{B9}$ |
| 861 | $L_{A29}$ | $L_{B9}$ |
| 862 | $L_{A30}$ | $L_{B9}$ |
| 863 | $L_{A31}$ | $L_{B9}$ |
| 864 | $L_{A32}$ | $L_{B9}$ |
| 865 | $L_{A33}$ | $L_{B9}$ |
| 866 | $L_{A34}$ | $L_{B9}$ |
| 867 | $L_{A35}$ | $L_{B9}$ |
| 868 | $L_{A36}$ | $L_{B9}$ |
| 869 | $L_{A37}$ | $L_{B9}$ |
| 870 | $L_{A38}$ | $L_{B9}$ |
| 871 | $L_{A39}$ | $L_{B9}$ |
| 872 | $L_{A40}$ | $L_{B9}$ |
| 873 | $L_{A41}$ | $L_{B9}$ |
| 874 | $L_{A42}$ | $L_{B9}$ |
| 875 | $L_{A43}$ | $L_{B9}$ |
| 876 | $L_{A44}$ | $L_{B9}$ |
| 877 | $L_{A45}$ | $L_{B9}$ |
| 878 | $L_{A46}$ | $L_{B9}$ |
| 879 | $L_{A47}$ | $L_{B9}$ |
| 880 | $L_{A48}$ | $L_{B9}$ |
| 881 | $L_{A49}$ | $L_{B9}$ |
| 882 | $L_{A50}$ | $L_{B9}$ |
| 883 | $L_{A51}$ | $L_{B9}$ |
| 884 | $L_{A52}$ | $L_{B9}$ |
| 885 | $L_{A53}$ | $L_{B9}$ |
| 886 | $L_{A54}$ | $L_{B9}$ |
| 887 | $L_{A55}$ | $L_{B9}$ |
| 888 | $L_{A56}$ | $L_{B9}$ |
| 889 | $L_{A57}$ | $L_{B9}$ |
| 890 | $L_{A58}$ | $L_{B9}$ |
| 891 | $L_{A59}$ | $L_{B9}$ |
| 892 | $L_{A60}$ | $L_{B9}$ |
| 893 | $L_{A61}$ | $L_{B9}$ |
| 894 | $L_{A62}$ | $L_{B9}$ |
| 895 | $L_{A63}$ | $L_{B9}$ |
| 896 | $L_{A64}$ | $L_{B9}$ |
| 897 | $L_{A65}$ | $L_{B9}$ |
| 898 | $L_{A66}$ | $L_{B9}$ |
| 899 | $L_{A67}$ | $L_{B9}$ |
| 900 | $L_{A68}$ | $L_{B9}$ |
| 901 | $L_{A69}$ | $L_{B9}$ |
| 902 | $L_{A70}$ | $L_{B9}$ |
| 903 | $L_{A71}$ | $L_{B9}$ |
| 904 | $L_{A72}$ | $L_{B9}$ |
| 905 | $L_{A73}$ | $L_{B9}$ |
| 906 | $L_{A74}$ | $L_{B9}$ |
| 907 | $L_{A75}$ | $L_{B9}$ |
| 908 | $L_{A76}$ | $L_{B9}$ |

-continued

| Compound Number | $L_A$ | $L_B$ |
|---|---|---|
| 909 | $L_{A77}$ | $L_{B9}$ |
| 910 | $L_{A78}$ | $L_{B9}$ |
| 911 | $L_{A79}$ | $L_{B9}$ |
| 912 | $L_{A80}$ | $L_{B9}$ |
| 913 | $L_{A81}$ | $L_{B9}$ |
| 914 | $L_{A82}$ | $L_{B9}$ |
| 915 | $L_{A83}$ | $L_{B9}$ |
| 916 | $L_{A84}$ | $L_{B9}$ |
| 917 | $L_{A85}$ | $L_{B9}$ |
| 918 | $L_{A86}$ | $L_{B9}$ |
| 919 | $L_{A87}$ | $L_{B9}$ |
| 920 | $L_{A88}$ | $L_{B9}$ |
| 921 | $L_{A89}$ | $L_{B9}$ |
| 922 | $L_{A90}$ | $L_{B9}$ |
| 923 | $L_{A91}$ | $L_{B9}$ |
| 924 | $L_{A92}$ | $L_{B9}$ |
| 925 | $L_{A93}$ | $L_{B9}$ |
| 926 | $L_{A94}$ | $L_{B9}$ |
| 927 | $L_{A95}$ | $L_{B9}$ |
| 928 | $L_{A96}$ | $L_{B9}$ |
| 929 | $L_{A97}$ | $L_{B9}$ |
| 930 | $L_{A98}$ | $L_{B9}$ |
| 931 | $L_{A99}$ | $L_{B9}$ |
| 932 | $L_{A100}$ | $L_{B9}$ |
| 933 | $L_{A101}$ | $L_{B9}$ |
| 934 | $L_{A102}$ | $L_{B9}$ |
| 935 | $L_{A103}$ | $L_{B9}$ |
| 936 | $L_{A104}$ | $L_{B9}$ |

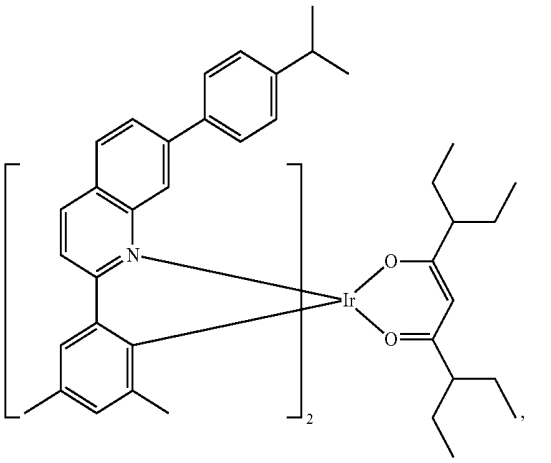
**19**. The compound of claim **1**, wherein the compound is selected from the group consisting of

Compound 28

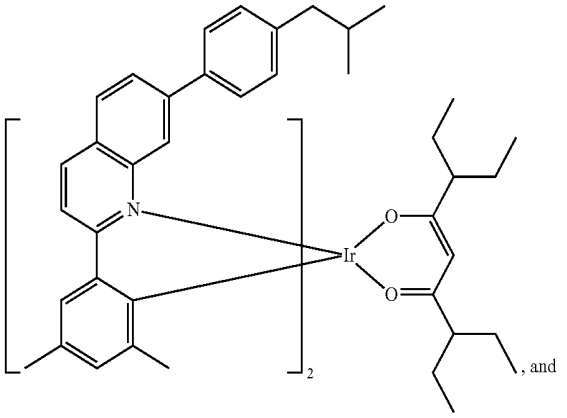


-continued

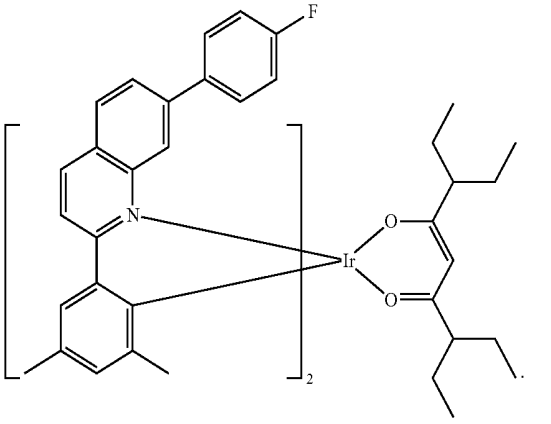
Compound 80



Compound 81



Compound 84



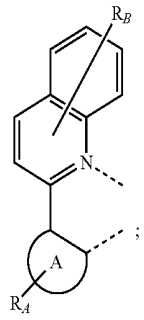
**20**. A first device comprising a first organic light emitting device, the first organic light emitting device comprising:

an anode;

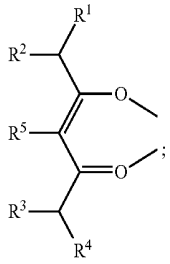
a cathode; and

an organic layer, disposed between the anode and the cathode, comprising a compound having a formula $M(L_A)_x(L_B)_y(L_C)_z$:

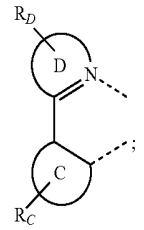
wherein the ligand $L_A$ is



wherein the ligand $L_B$ is



wherein the ligand $L_C$ is



wherein M is a metal having an atomic number greater than 40;

wherein x is 1, or 2;

wherein y is 1, or 2;

wherein z is 0, 1, or 2;

wherein x+y+z is the oxidation state of the metal M;

wherein $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl;

wherein at least one of $R^1$, $R^2$, $R^3$, and $R^4$ has at least two C atoms;

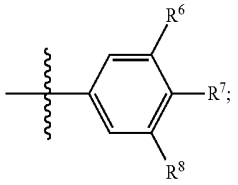
wherein $R^5$ is selected from group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

wherein rings A, C, and D are each independently a 5 or 6-membered carbocyclic or heterocyclic ring;

wherein $R_A$, $R_C$, and $R_D$ each independently represent mono, di, tri, or tetra substitution, or no substitution;

wherein $R_B$ represents mono, di, tri, tetra, penta, or hexa substitution;

wherein at least one $R_B$ has the following structure:



wherein each of $R_A$, $R_B$, $R_C$, and $R_D$ are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

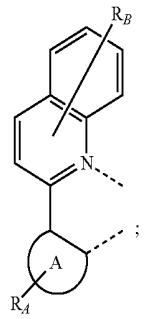
wherein any adjacent substitutents of $R_A$, $R_B$, $R_C$, and $R_D$ are optionally joined to form a ring;

wherein $R^6$, $R^7$, and $R^8$ are independently selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof; and

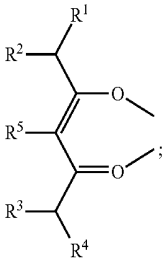
wherein at least one of $R^6$, $R^7$, and $R^8$ is not hydrogen or deuterium.

**21**. A formulation comprising a compound having a formula $M(L_A)_x(L_B)_y(L_C)_z$:

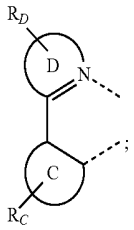
wherein the ligand $L_A$ is



wherein the ligand $L_B$ is



wherein the ligand $L_C$ is



wherein M is a metal having an atomic number greater than 40;

wherein x is 1, or 2;

wherein y is 1, or 2;

wherein z is 0, 1, or 2;

wherein x+y+z is the oxidation state of the metal M;

wherein $R^1$, $R^2$, $R^3$, and $R^4$ are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl;

wherein at least one of $R^1$, $R^2$, $R^3$, and $R^4$ has at least two C atoms;

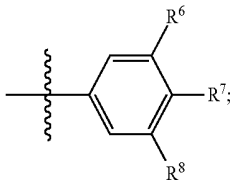
wherein $R^5$ is selected from group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

wherein rings A, C, and D are each independently a 5 or 6-membered carbocyclic or heterocyclic ring;

wherein $R_A$, $R_C$, and $R_D$ each independently represent mono, di, tri, or tetra substitution, or no substitution;

wherein $R_B$ represents mono, di, tri, tetra, penta, or hexa substitution;

wherein at least one $R_B$ has the following structure:



wherein each of $R_A$, $R_B$, $R_C$, and $R_D$ are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof;

wherein any adjacent substitutents of $R_A$, $R_B$, $R_C$, and $R_D$ are optionally joined to form a ring;

wherein $R^6$, $R^7$, and $R^8$ are independently selected from group consisting of hydrogen, deuterium, alkyl, cycloalkyl, halide, and combinations thereof; and

wherein at least one of $R^6$, $R^7$, and $R^8$ is not hydrogen or deuterium.

* * * * *

| | | | |
|---|---|---|---|
| 专利名称(译) | 有机电致发光材料和器件 | | |
| 公开(公告)号 | US20160028023A1 | 公开(公告)日 | 2016-01-28 |
| 申请号 | US14/337983 | 申请日 | 2014-07-22 |
| [标]申请(专利权)人(译) | 环球展览公司 | | |
| 申请(专利权)人(译) | 通用显示器公司 | | |
| 当前申请(专利权)人(译) | 通用显示器公司 | | |
| [标]发明人 | BOUDREAULT PIERRE LUC T<br>WENDT HARVEY<br>ELSHENAWY ZEINAB<br>XIA CHUANJUN | | |
| 发明人 | BOUDREAULT, PIERRE-LUC T.<br>WENDT, HARVEY<br>ELSHENAWY, ZEINAB<br>XIA, CHUANJUN | | |
| IPC分类号 | H01L51/00 H01L51/50 | | |
| CPC分类号 | H01L51/5012 H01L51/0085 C07F15/0033 C09K11/06 H01L51/0081 H01L51/5016 H01L2251/308 | | |
| 其他公开文献 | US9929357 | | |
| 外部链接 | Espacenet USPTO | | |


摘要(译)

具有式M（L A ）x（L B ）y 的化合物（L C ）其中配体L A 配体L B 和配体L C 被披露。在该式中，M是重金属，x和y是1或2，z是0,1或2，其中x + y + z是金属M的氧化态.R 1 ，R 2 ，R 3 和R 4 独立地选自烷基，环烷基，芳基和杂芳基，和R 1 ，R 2 ，R 3 和R 4 中的至少一个具有至少两个C原子。环A，C和D各自独立地为5或6元碳环或杂环;至少一个R B 具有以下结构 R 6 ，R 7 和R 8 中的至少一个是烷基，环烷基，卤化物及其组合。任何相邻的R A ，R B ，R C 和R D 的取代基任选地连接形成环。