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(54) **Organic electroluminescent materials**

Organic electroluminescent materials

Matériaux électroluminescents organiques

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(73) Proprietor: **Universal Display Corporation**
Ewing, NJ 08618 (US)

(72) Inventors:
- **Adamovich, Vadim**
  Ewing, NJ 08618 (US)
- **Yamamoto, Hitoshi**
  Ewing, NJ 08618 (US)
- **Wang, Ting-Chih**
  Ewing, NJ 08618 (US)
- **Weaver, Michael S.**
  Ewing, NJ 08618 (US)
- **Xia, Chuanjun**
  Ewing, NJ 08618 (US)
- **Alleyene, Bert**
  Ewing, NJ 08618 (US)
- **Boudreault, Pierre-Luc T.**
  Ewing, NJ 08618 (US)
- **Dyatkin, Alexey Borisovich**
  Ewing, NJ 08618 (US)
- **Joseph, Scott**
  Ewing, NJ 08618 (US)

(74) Representative: **Maiwald Patent- und Rechtsanwaltsgesellschaft mbH**
Elisenhof
Elisenstraße 3
80335 München (DE)

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to organic light emitting devices (OLEDs), and more specifically to organic materials used in such devices. More specifically, the present invention relates to novel premixed host systems for phosphorescent OLEDs. At least one emitter and at least another material can be mixed and co-evaporated from one sublimation crucible in a vacuum thermal evaporation (VTE) process and achieve stable evaporation.

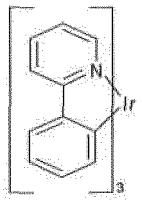
BACKGROUND

[0002] 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.

[0003] 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.

[0004] 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.

[0005] One example of a green emissive molecule is tris(2-phenylpyridine) iridium, denoted $Ir(ppy)_3$, which has the following structure:



[0006] In this, and later figures herein, we depict the dative bond from nitrogen to metal (here, Ir) as a straight line.

[0007] 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.

[0008] 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.

[0009] As used herein, "solution processible" means capable of being dissolved, dispersed, or transported in and/or deposited from a liquid medium, either in solution or suspension form.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] More details on OLEDs, and the definitions described above, can be found in US Pat. No. 7,279,704.

[0014] WO 2012/0053263 A1 describes an organic electroluminescent element comprising a first compound having a carbazole moiety and a nitrogen-containing 6-membered aromatic heterocyclic moiety and a second compound having an anthracene moiety and a benzimidazole moiety; WO 2011/013843 A1 describes an organic electroluminescence device with a light emitting layer comprising a first compound having a carbazole moiety and a nitrogen-containing 6-membered aromatic heterocyclic moiety and a second compound being an organometallic iridium complex; WO 2011/136755 A1 describes an organic electroluminescence comprising a first compound with a dibenzofuran, dibenzothiophen or dibenzoselenophen moiety and a triphenylene moiety and a second compound being a carbazole derivative; US 2011/0177641 A1 describes a method of fabricating an organic light emitting device comprising solution depositing of a first organic layer comprising an organic host material and an organic emitting material and a second organic layer comprising an organic emitting material deposited over and in direct contact with the first organic layer; WO 2012/166101 A1 describes an organic light emitting device comprising an organic electroluminescent layer with an electrontransporting host material, a hole transporting host material, and a wide band gap host material.

SUMMARY OF THE INVENTION

[0015] The invention is described in the independent claim. Preferred embodiments are described in the dependent claims.

[0016] The present disclosure provides a novel composition comprising a mixture of a first compound and a second compound, according to the claims wherein the first compound has different chemical structure than the second compound; wherein the first compound is capable of functioning as a phosphorescent emitter in an organic light emitting device at room temperature. The first compound can have an evaporation temperature T1 of 150 to 350 °C. The second compound can have an evaporation temperature T2 of 150 to 350 °C. In order to form the composition comprising a mixture of the first compound and the second compound described, the absolute value of T1-T2, the difference between T1 and T2, should be less than 20 °C. The first compound has a concentration C1 in the mixture and a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between $1x10^{-6}$ Torr (1 Torr equals 133.322 Pascals) to $1x10^{-9}$ Torr, at a 2Å/sec (1 Angstrom equals 0.1 nm) deposition rate on a surface positioned at a predetermined distance away from the mixture being evaporated, and wherein the absolute value of (C1-C2)/C1 is less than 5%.

[0017] According to an embodiment of the present disclosure, 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 first composition further comprising a mixture of a first compound and a second compound, wherein the first compound has a different chemical structure than the second compound;

wherein the first compound is capable of functioning as a phosphorescent emitter in an organic light emitting device at room temperature;

wherein the first compound has an evaporation temperature T1 of 150 to 350 °C;

wherein the second compound has an evaporation temperature T2 of 150 to 350 °C;

wherein the absolute value of T1-T2 is less than 20 °C;

wherein the first compound has a concentration C1 in said mixture, a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between $1x10^{-6}$ Torr to $1x10^{-9}$ Torr, at a 2Å/sec deposition rate on a surface positioned at a predetermined distance away from the mixture being evaporated; and wherein the absolute value of (C1-C2)/C1 is less than 5%.

[0018] According to an embodiment of the present disclosure, a method of fabricating an organic light emitting device comprising a first electrode, a second electrode, and a first organic layer disposed between the first electrode and the second electrode, wherein the first organic layer comprises a first organic composition further comprising a mixture of a first compound and a second compound, is disclosed. The method comprises:

providing a substrate having the first electrode disposed thereon;
depositing the first composition over the first electrode; and
depositing the second electrode over the first organic layer, wherein the first compound has different chemical structure than the second compound;

wherein the first compound is capable of functioning as a phosphorescent emitter in an organic light emitting device at room temperature;
wherein the first compound has an evaporation temperature T1 of 150 to 350 °C;
wherein the second compound has an evaporation temperature T2 of 150 to 350 °C;
wherein the absolute value of T1-T2 is less than 20 °C;
wherein the first compound has a concentration C1 in said mixture, and a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between $1x10^{-6}$ Torr to $1x10^{-9}$ Torr, at a 2Å/sec deposition rate on a surface positioned at a predefined distance away from the mixture being evaporate; and wherein the absolute value of (C1-C2)/C1 is less than 5%.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 shows an organic light emitting device that can incorporate the inventive host material disclosed herein.

FIG. 2 shows an inverted organic light emitting device that can incorporate the inventive host material disclosed herein.

FIGS. 3(a)-3(c) show examples of white OLEDs in top emission, bottom emission and transparent OLEDs (TOLED) configurations.

FIGS. 4(a)-4(d) show examples of blue -yellow white OLED structures.

FIGS. 5(a)-5(g) show examples of two-unit white stacked OLED structures.

FIGS. 6(a)-6(c) show examples of white stacked OLED structures having three or more units.

DETAILED DESCRIPTION

[0020] 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.

[0021] 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. Fluorescent emission generally occurs in a time frame of less than 10 nanoseconds.

[0022] 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"). Phosphorescence is described in more detail in US Pat. No. 7,279,704 at cols. 5-6.

[0023] 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 US 7,279,704 at cols. 6-10.

[0024] 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. 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. Examples of host materials are disclosed in U.S. Pat. No. 6,303,238 to Thompson et al. 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. U.S. Pat. Nos. 5,703,436 and 5,707,745, 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. Examples of injection layers are provided in U.S. Patent Application Publication No. 2004/0174116. A description of protective layers may be found in U.S. Patent Application Publication No. 2004/0174116.

[0025] 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**.

[0026] 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.

[0027] 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. 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. The OLED structure may deviate from the simple layered structure illustrated in FIGS. 1 and 2. For example, the substrate may include an angled reflective surface to improve out-coupling, such as a mesa structure as described in U.S. Pat. No. 6,091,195 to Forrest et al., and/or a pit structure as described in U.S. Pat. No. 5,834,893 to Bulovic et al.

[0028] 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, organic vapor phase deposition (OVPD), such as described in U.S. Pat. No. 6,337,102 to Forrest et al., and deposition by organic vapor jet printing (OVJP), such as described in U.S. Pat. No. 7,431,968. 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, 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 processibility 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.

[0029] 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. 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.

[0030] 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.

[0031] 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.

[0032] The term "halo" or "halogen" as used herein includes fluorine, chlorine, bromine, and iodine.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] The term "alkynyl" as used herein contemplates both straight and branched chain alkyne radicals. Preferred alkyl groups are those containing two to fifteen carbon atoms. Additionally, the alkynyl group may be optionally substituted.

[0037] 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.

[0038] The term "heterocyclic group" as used herein contemplates aromatic and non-aromatic cyclic radicals. Hetero-aromatic cyclic radicals also refer to heteroaryl. Preferred hetero-non-aromatic cyclic groups are those containing 3 or 7 ring atoms which includes at least one hetero atom, and includes cyclic amines such as morpholino, piperdino, pyrrolidino, and the like, and cyclic ethers, such as tetrahydrofuran, tetrahydropyran, and the like. Additionally, the heterocyclic group may be optionally substituted.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] The "aza" designation in the fragments described herein, i.e. aza-dibenzofuran, aza-dibenzonethiophene, 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.

[0044] 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. naphthyl, dibenzofuryl) or as if it were the whole molecule (e.g. naphthalene, dibenzofuran). As used herein, these different ways of designating a substituent or attached fragment are considered to be equivalent.

[0045] Often, the emissive layer (EML) of OLED devices exhibiting good lifetime and efficiency requires more than two components (e.g. 3 or 4 components). Fabricating such EMLs using vacuum thermal evaporation (VTE) process then requires evaporating 3 or 4 evaporation source materials in separate VTE sublimation crucibles, which is very complicated and costly compared to a standard two-component EML with a single host and an emitter, which requires only two evaporation sources.

[0046] Premixing two or more materials and evaporating them from one VTE sublimation crucible can reduce the complexity of the fabrication process. However, the co-evaporation must be stable and produce an evaporated film having a composition that remains constant through the evaporation process. Variations in the film's composition may adversely affect the device performance. In order to obtain a stable co-evaporation from a mixture of compounds under vacuum, one would assume that the materials must have the same evaporation temperature under the same condition. However, this may not be the only parameter one has to consider. When two compounds are mixed together, they may interact with each other and the evaporation property of the mixture may differ from their individual properties. On the other hand, materials with slightly different evaporation temperatures may form a stable co-evaporation mixture. Therefore, it is extremely difficult to achieve a stable co-evaporation mixture. So far, there have been very few stable co-evaporation mixture examples. "Evaporation temperature" of a material is measured in a vacuum deposition tool at a constant pressure, normally between $1x10^{-7}$ Torr to $1x10^{-8}$ Torr, at a 2Å/sec deposition rate on a surface positioned at a set distance away from the evaporation source of the material being evaporated, e.g. sublimation crucible in a VTE tool. The various measured values such as temperature, pressure, deposition rate, etc. disclosed herein are expected to have nominal variations because of the expected tolerances in the measurements that produced these quantitative values as understood by one of ordinary skill in the art.

[0047] Many factors other than temperature can contribute to the ability to achieve stable co-evaporation, such as the miscibility of the different materials and the phase transition temperatures of the different materials. The inventors found that when two materials have similar evaporation temperatures, and similar mass loss rate or similar vapor pressures, the two materials can co-evaporate consistently. "Mass loss rate" of a material is defined as the percentage of mass lost over time ("percentage/minute" or "%/min") and is determined by measuring the time it takes to lose the first 10% of the mass of a sample of the material as measured by thermal gravity analysis (TGA) under a given experimental condition at a given constant temperature for a given material after the a steady evaporation state is reached. The given constant temperature is one temperature point that is chosen so that the value of mass loss rate is between about 0.05 to 0.50 %/min. A skilled person in this field should appreciate that in order to compare two parameters, the experimental condition should be consistent. The method of measuring mass loss rate and vapor pressure is well known in the art and can be found, for example, in Bull. et al. Mater. Sci. 2011, 34, 7.

[0048] In the state of the art phosphorescent OLED devices, the EML may consist of three or more components. In one example, the EML can consist of two host-type compounds and an emitter combination (e.g. a hole transporting cohost (h-host), an electron transporting cohost (e-host), and a compound capable of functioning as a phosphorescent emitter in an OLED at room temperature). In another example, the EML can consist of one host-type compound and two emitter-type compounds (e.g., a host compound and two compounds each capable of functioning as a phosphorescent emitter in an OLED at room temperature). Conventionally, in order to fabricate such EMLs having three or more components using VTE process, three or more evaporation sources are required, one for each of the components. Because the concentration of the components are important for the device performance, typically, the rate of deposition of each component is measured individually during the deposition process. This makes the VTE process complicated and costly. Thus, it is desired to premix at least two of the components of such EMLs to reduce the number of VTE evaporation sources.

[0049] As used herein, an "emitter-type compound" refers to a compound that is capable of functioning as a phosphorescent emitter in the EML of an OLED at room temperature. A "host-type compound" refers to a compound that is capable of functioning as a host material in the EML of an OLED at room temperature.

[0050] If any two of the three or more components of the EMLs can be premixed and form a stable mixture of co-

evaporation source, then the number of evaporation sources required for EML layer fabrication would be reduced. In order for materials to be premixable into an evaporation source, they should co-evaporate and deposit uniformly without changing the ratio. The ratio of the components in the mixture should be the same as the ratio of the components in the evaporation deposited films from these premixed materials. Therefore, the concentration of the two components in the deposited film is controlled by their concentration in the premixed evaporation source.

[0051] The present disclosure describes a new class of emitters and another class of materials (such as host-type materials) which can be premixed to provide a VTE co-evaporation source that can be used for a stable co-evaporation of the two materials.

[0052] Maximizing the efficiency of a phosphorescent emitter in an OLED may involve narrowing the emission spectrum. This side effect of narrowed emission is not desirable in some applications, such as, when the emitter is used as part of a white emitting OLED. In applications such as for white emitting OLEDs, often a broad full width half maximum (FWHM) spectrum is preferred.

[0053] One possible approach to achieving both high efficiency and a broad FWHM spectrum is to incorporate two emitters within a device. This can be done by incorporating the emitters in separate EMLs or depositing two emitters into one layer. The inventors have discovered that by premixing two emitters that have similar thermal evaporation properties in a desired ratio and depositing the material by evaporation using a VTE process from one evaporation sublimation crucible containing the mixed composition source material, the manufacuring of OLEDs having an EML comprising the two emitters can be simplified.

[0054] The combination of premixed compounds described in this disclosure, where at least one of the compounds is an emitter-type compound, can be used for fine tuning device emission spectra for a specific spectral width without compromising the device efficiency. Premixing allows for a greater control of the ratio of the components of the EML layer thereby more accurately enabling the desired/resultant spectral shape than when evaporating the components of the EML layer from separate evaporation sources. This provides a more robust manufacturing process for OLEDs.

[0055] According to the present disclosure, the composition of the film deposited by VTE from a premixed emitter evaporation source material is determined in advance at the mixing stage. The composition of the premixed emitter evaporation source material is determined by the desired contribution of the two emitter-type compounds used. The ratio of the two emitter-type compounds in the composition of the premix may be between 1:1 to 200:1. Preferably, the ratio is between 1:1 to 50:1, more preferably between 1:1 and 20:1, more preferably between 1:1 to 5:1, and most preferably between 1:1 to 2:1.

EXAMPLES AND REFERENCE EXAMPLES NOT CLAIMED

[0056] In a first reference example, a combination of two emitter-type compounds, Compound 20 and Compound 145, having very similar sublimation properties are premixed together, placed in a single deposition source and evaporated into a device EML with a variable ratio. For example, a mixture of these two emitters was deposited at 0.2Å/s for a film 2000 Å thick. Material was then deposited onto a substrate at a deposition rate of 1 Å/s to yield a film of 70nm thick. The ratio of the two emitters in the premixture, as measured by weight prior to mixing, was 85% (Compoun 20) to 15% (Compoun 145). The composition of the premixture, as measured by high pressure liquid chromatography (HPLC), was 84.5% (Compound 20) to 15.5% (Compound 145). Because mixing can lead to non-uniformities within the total premixture, an error bar of 1% is given for the measured % of the premixture components when a small sample is analyzed by HPLC. The composition of the deposited film, as measured by HPLC, was 85.3% (Compound 20) to 14.7% (Compound 145). Therefore, the compositions of the premixture and deposited material are equivalent.

[0057] The two-compound mixture combinations disclosed herein can be used in making various white OLED configurations. For example, the two-compound mixture combinations disclosed herein can be used to make premixed emitter evaporation source materials that can be used in depositing broad yellow EML layers in blue-yellow white OLEDs.

[0058] Examples of the various configurations for such blue-yellow white OLEDs are illustrated in FIGS. 3(a) through 6(c). The layers "Y EML," "Y1 EML," and "Y2 EML" in the figures are the broad yellow EMLs and as well known in the art, the broad yellow EML layers often consist of two emitter-type compounds in order to achieve the desired emission spectrum required for producing white light in conjunction with the blue EML layers. The layers "Ph B EML," "F1 B EML," "B EML," "B1 EML," and "B2 EML" in the figures are the blue EMLs.

[0059] In these examples, the broad yellow EML layers are made of two emitter-type compounds to produce light in desired red-green, red-yellow, or yellow spectrum that when combined with the blue emission from the blue EML to produce white light emitting OLEDs. The premixed emitter evaporation source materials disclosed herein is useful for depositing these broad yellow EML layers by VTE process.

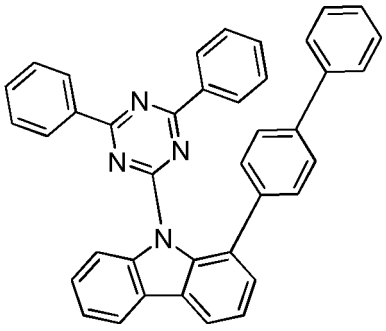
[0060] FIGS. 3(a) - 3(c) show basic configurations for blue-yellow white OLEDs. FIG. 3(a) shows an example of blue-yellow white OLEDs in a bottom emission configuration (anode is transparent). FIG. 3(b) shows an example of a blue-yellow white OLED in a transparent OLED configuration (both anode and cathode are transparent). FIG. 3(c) shows an example of a blue-yellow white OLED in a top emission configuration (cathode is transparent). The examples shown in

FIGS. 4(a) - 6(c) are all shown in the bottom emission configuration but one skilled in the art would readily understand that the examples shown in FIGS. 4(a) - 6(c) are equally applicable to the top emission configuration and transparent OLED configurations.

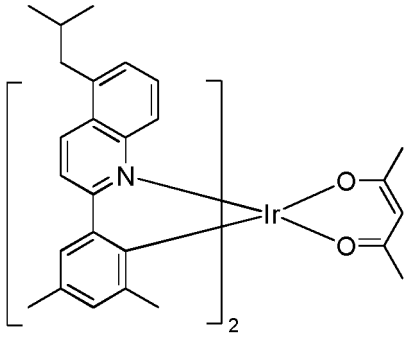
[0061] FIGS. 4(a)-4(d) show examples of single-unit blue-yellow white OLED structures. FIGS. 5(a)-5(g) show examples of two-unit blue-yellow white stacked OLED structures. FIGS. 6(a)-6(c) show examples of three-unit blue-yellow white stacked OLED structures. One skilled in the art would readily understand that these stacked OLED configurations can be applied to embodiments having more than three light emitting units. In these figures, the following abbreviations are used: HIL - hole injection layer, HTL - hole transporter layer, EML - emissive layer, ETL - , electron transporter layer, EIL - electron injection layer, SL - separation layer, CGL - charge generation layer, Ph - phosphorescent, F1- fluorescent. In these configurations, HIL2 can be the same material as HIL1 or a different material, HTL3 can be the same material as HTL1 or a different material, HTL4 can be the same material as HTL2 or a different material, ETL3 can be the same material as ETL1 or a different material, and ETL4 can be the same material as ETL2 or a different material. B EML, B1 EML and B2 EML are blue EMLs and they can be either fluorescent or phosphorescent. B2 EML can be the same material as B1 EML or a different material. Y EML, Y1 EML, and Y2 EML are yellow EMLs and they can be either fluorescent or phosphorescent. Y2 EML can be the same material as Y1 EML or a different material.

[0062] In the white stacked OLED structures of FIGS. 6(a)-6(c), HIL2 can be the same material as HIL1 or a different material, HTL3 can be the same material as HTL1 or a different material, HTL4 can be the same material as HTL2 or a different material, ETL3 can be the same material as ETL1 or a different material, and ETL4 can be the same material as ETL2 or a different material. B EML1 and B EML2 represent blue EMLs and can be either fluorescent or phosphorescent. B EML1 can be the same material as B EML2 or a different material. Y EML represent yellow EML. The number of stacked units can be any number greater than or equal to 3. The number of blue and yellow EML units can be any number. The stacked units can be in any order, e.g. B/Y/B/Y or B/B/Y/Y, or B/Y/B/Y/B, etc., where B denotes blue and Y denotes broad yellow.

[0063] According to an aspect of the present disclosure, a second example of premixed emitter evaporation source is disclosed. The premixed mixture according to this example, comprises one emitter-type compound, Compound E5, and one host compound, Compound H1. Compound H1 and Compound E5 demonstrated premixability, which means they can be premixed and codeposited from one evaporation source without changing the composition. Uniform coevaporation of host: emitter pair is desired for the consistency of the device performance fabricated from this premixed precursor. The structures of Compound H1 and Compoun E5 are shown below:



Compound H1



Compound E5

[0064] The premixability of Compound H1 and Compound E5 was tested by HPLC analysis of evaporated films. For this purpose the host Compound H1 (0.485 g) and emitter Compound E5 (0.015 g) were mixed and grinded to form 0.5 g of the mixture. The mixture was loaded into the evaporation source of the vacuum VTE chamber. The chamber was pumped down to 10^{-7} Torr pressure. The premixed components were deposited at rate 2 Å/s onto glass substrates. The substrates were replaced continuously after deposition of 1100 Å of film without stopping the deposition and cooling the source. The premixed material was evaporated until depletion.

[0065] The deposite films were analyzed by HPLC (HPLC Conditions C18, 80-100 (CH_3CN concentration in CH_3CN and H_2O), 30 min, detected wavelength 254 nm) and results are shown in Table 1 below. The composition of the host Compound H1 and emitter Compound E5 did not change significantly from Plate 1 to Plate 3. Each of the sample substrates are labeled Plate 1, Plate 2, and Plate 3. Some fluctuations in the concentration do not reveal any trend and can be explained by the accuracy of HPLC analysis.

Table 1: HPLC composition (%) of sequentially deposited films from a premixed host: emitter pair (host Compound H1 and emitter Compound E5) evaporation source.

Films (1100Å)	H1	E5
Plate #	[%]	[%]
1	98.0	2.0
2	98.1	1.9
3	97.8	2.2

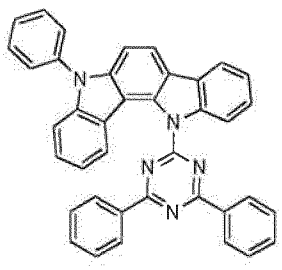
This data shows that host Compound H1 and emitter Compound E5 and potentially the other hosts and emitters from these families can be premixed to be used as single evaporation sources for an EML or part of the EML for PHOLEDs.

[0066] Examples of other possible premixed host:emitter pairs are provided in Table 2 below.

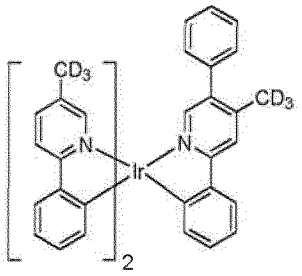
Table 2. Examples of possible premix pairs

Mixture number	Electron transporting host	Emitter Metal complex
1	Compound H1	Compound E5
2	Compound H14	Compound E1
3	Compound H21	Compound E4
4	Compound H30	Compound E9
5	Compound H21	Compound E17
6	Compound H33	Compound E13

In the reference example not claimed host
Compound EH40 and emitter Compound 97 show premixability also. It means that they can be premixed and codeposited from one source without changing the composition. Uniform coevaporation of host: emitter is critical for the consistency of the devices performance fabricated from this premixed precursor. The structures of host Compound EH40 and emitter Compound 97 are shown below.



Compound EH40



Compound 97

[0067] The premixability of Compound EH40 and Compound 97 was tested by HPLC analysis of evaporated films. For this purpose the host Compound EH40 and emitter Compound 97 were mixed in the ratio ~ 7:1 and grinded to form 0.2 g of the mixture. The mixture was loaded into the evaporation source of the vacuum VTE chamber. The chamber was pumped down to 10^{-7} Torr pressure. The premixed components were deposited at rate 2 Å/s onto glass substrates. The substrates were replaced continuously after deposition of 500 Å of film without stopping the deposition and cooling the source. The premixed material was evaporated until depletion.

[0068] The films were analyzed by HPLC (HPLC Conditions C18, 100% CH_3CN, 30 min, detected wavelength 254 nm) and results are shown in Table 3. The composition of the host Compound EH40 and emitter Compound 97 did not change significantly from Plate 1 to Plate 5. Each of the sample substrates are labeled Plate 1, Plate 2, and Plate 3. Some fluctuations in the concentration do not reveal any trend and can be explained by the accuracy of HPLC analysis.

Table 3: HPLC composition (%) of sequentially deposited films from premixed host: emitter (Host Compound EH40: Emitter Compound 97 in ratio of ~7:1) evaporation source.

Films (500Å)	Host Compound EH40 (%)	Emitter Compound 97 (%)
Plate1	87.2	12.8
Plate2	87.1	12.9
Plate3	87.5	12.5
Plate4	87.6	12.4
Plate5	87.9	12.1

[0069] This is the evidence that host Compound EH40 and emitter Compound 97, and potentially the other hosts and emitters from these families can be premixed to be used as single evaporation sources for an EML or part of the EML for PHOLEDs. Reference examples
of other possible
premixed host:emitter pairs not claimed are provided in Table 4 below.

Table 4. Reference examples of possible premix pairs of host:emitter.

Mixture number	Electron transporting host	Emitter Metal complex
1	Compound EH1	Compound 4
2	Compound EH2	Compound 7
3	Compound EH4	Compound 3
4	Compound EH5	Compound 11
5	Compound EH8	Compound 1
6	Compound EH8	Compound 67
7	Compound EH16	Compound 21
8	Compound EH28	Compound 29
9	Compound EH40	Compound 34
10	Compound EH40	Compound 97

[0070] According to an aspect of the present disclosure, a composition comprising a mixture of a first compound and a second compound is now described. In the mixture, the first compound has a different chemical structure than the second compound. The first compound is capable of functioning as a phosphorescent emitter in an OLED at room temperature. The first compound has an evaporation temperature T1 of 150 to 350 °C and the second compound has an evaporation temperature T2 of 150 to 350 °C, wherein the absolute value of T1-T2, *i.e.* the difference between T1 and T2, is less than 20 °C. Preferably, the absolute value of T1-T2 is less than 10 °C and more preferably less than 5 °C.

[0071] The first compound has a concentration C1 in the mixture and a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between $1x10^{-6}$ Torr to $1x10^{-9}$ Torr, at a 2Å/sec deposition rate on a surface positioned at a predefined distance away from the evaporation source of the mixture being evaporated, and wherein the absolute value of (C1-C2)/C1 is less than 5%. Preferably, the absolute value of (C1-C2)/C1 is less than 3%.

[0072] The concentrations C1 and C2 are relative concentrations of the first compound. Therefore, the conditional requirement for the two compounds forming the mixture described above means that the relative concentration of the first compound in the as-deposited film (C2) should be as close to the original relative concentration of the first compound (C1) in the evaporation source mixture. One of ordinary skill in this field should realize that the concentration of each component in the mixture is expressed as relative percentage. The concentration of each component in the mixture can be measured by a suitable analytical methods well known to those skilled in the art. Examples of such methods are high pressure liquid chromatography (HPLC) and nuclear magnetic resonance spectroscopy (NMR). The percentage was calculated by deviding the integration area under the HPLC trace of each component by the total integration area. HPLC can use different detectors such as UV-vis, photo diode array detector, refractive index detector, fluorescence detector,

and light scattering detector. Due to different materials properties, each component in the mixture may respond differently. Therefore, the measured concerntration may differ from their real concentration in the mixture, however the relative ratio value of (C1-C2)/C1 is independent of these variables as long as the experimental condition keeps consistent, for example, all concentrations should be calculated under the exact same HPLC parameters for each component. It is sometimes preferred to select a measurement condition that gives calculated concentration close to the real concentration. However, it is not necessary. It is important to select a detecting condition that accurately detects each component. For example, fluorescence detector should not be used if one of the components does not fluoresce.

[0073] In one embodiment, the first compound has evaporation temperature T1 of 200 to 350 °C and the second compound has evaporation temperature T2 of 200 to 350 °C.

[0074] In one embodiment, the first compound has a vapor pressure of PI at T1 at 1 atm, (1 atm equals 101325 Pa) and the second compound has a vapor pressure of P2 at T2 at 1 atm. The ratio of P1/P2 is desirably within the range of 0.90 to 1.10.

[0075] The first compound has a first mass loss rate and the second compound has a second mass loss rate, wherein the ratio between the first mass loss rate and the second mass loss rate is desirably within the range of 0.90 to 1.10. Preferably, the ratio between the first mass loss rate and the second mass loss rate is within the range of 0.95 to 1.05. More prefeably, the ratio between the first mass loss rate and the second mass loss rate is within the range of 0.97 to 1.03.

[0076] The phosphorescent emitter component in the composition is capable of emitting light from a triplet excited state to a ground singlet state at room temperature. In one embodiment of the composition, the first compound is a metal coordination complex having a metal-carbon bond. The metal in the metal-carbon bond is Ir (iridium).

[0077] In one embodiment of the composition, the second compound is also capable of functioning as a phosphorescent emitter in an OLED at room temperature.

[0078] In another embodiment, the second compound is capable of functioning as a host in the EML of an OLED at room temperature. In one embodiment, the host is a hole transporting host. In another embodiment, the host is an electron transporting host.

[0079] According to an aspect of the present disclosure, the lowest triplet energy TE1 of the first compound is lower than that of the second compound. Triplet energy is determined by phosphorescence in an organic solvent glass at 77 °K.

[0080] In one embodiment of the composition, the second compound comprises at least one chemical group selected from the group consisting of triphenylene, or carbazole.

[0081] In one embodiment of the composition, the first compound and the second compound each has a purity in excess of 99 % as determined by HPLC.

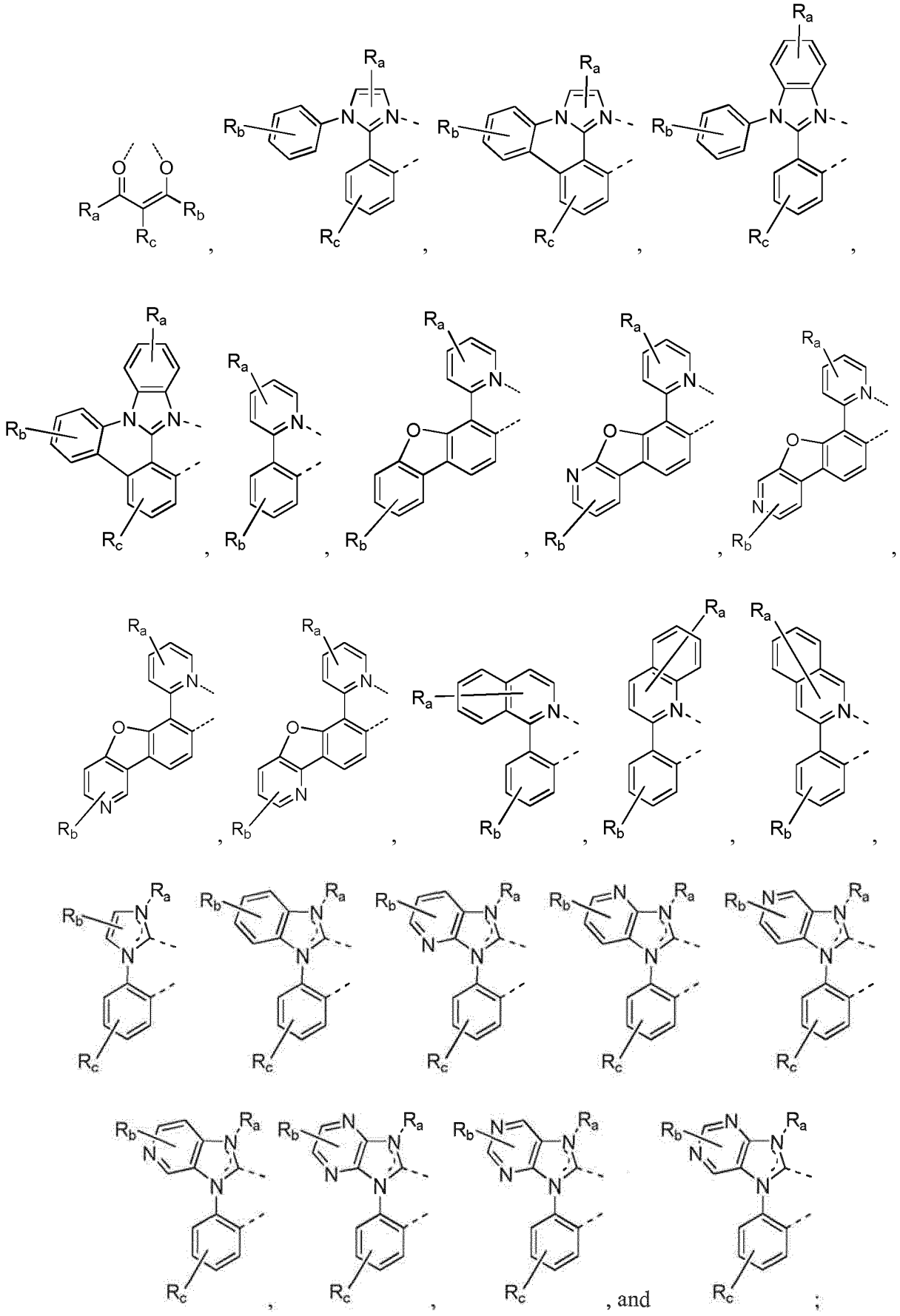
[0082] Accoding to another aspect, the mixture in the composition further comprises a third compound. The third compound has a different chemical structure than the first compound and the second compound, wherein the third compound has an evaporation temperature T3 of 150 to 350 °C; and wherein the absolute value of T1-T3 is less than 20 °C. Preferably, the absolute value of T1-T3 is less than 10 °C, and more preferably less than 5 °C.

[0083] In one embodiment, the composition is in a liquid form at a temperature less than T1 (the evaporation temperature of the first compound) and T2 (the evaporation temperature of the second compound).

[0084] In an aspect of the composition, the first compound has the formula of

$$M(L^1)_x(L^2)_y(L^3)_z;$$

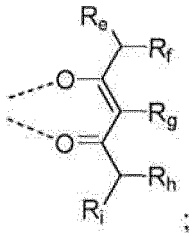
wherein L^1, L^2 and L^3 can be the same or different;
wherein x is 1, 2, or 3;
wherein y is 0, 1, or 2;
wherein z is 0, 1, or 2;
wherein x+y+z is the oxidation state of the metal M;
wherein L^1, L^2, and L^3 are independently selected from the group consisting of:



wherein R_a, R_b, R_c, and R_d may represent mono, di, tri, or tetra substitution, or no substitution; wherein R_a, R_b, R_c, and R_d are independently selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; and wherein two adjacent substituents of R_a, R_b, R_c, and R_d are optionally joined to form a fused ring or form a multidentate ligand.

[0085] According to another aspect , where the first compound has the formula of $M(L^1)_x(L^2)_y(L^3)_z$ as defined above, the first compound has the formula of $Ir(L^1)_2(L^2)$.

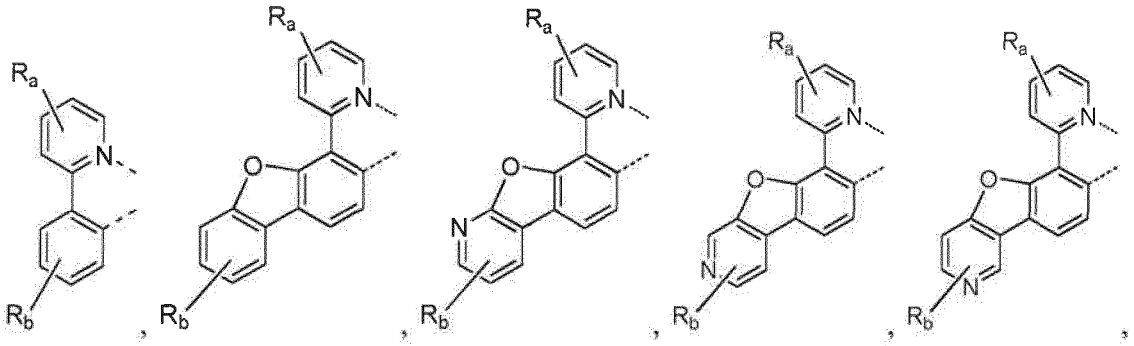
[0086] In the aspect , where the first compound has the formula of $Ir(L^1)_2(L^2)$, L^2 has the formula:



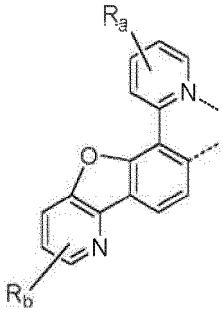
;

wherein R_e, R_f, R_h, and R_i are independently selected from group consisting of alkyl, cycloalkyl, aryl, and heteroaryl; wherein at least one of R_e, R_f, R_h, and R_i has at least two carbon atoms;
wherein R_g is selected from group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

[0087] In the aspect , where the first compound has the formula of $Ir(L^1)_2(L^2)$, L^2 has the formula selected from the group consisting of:



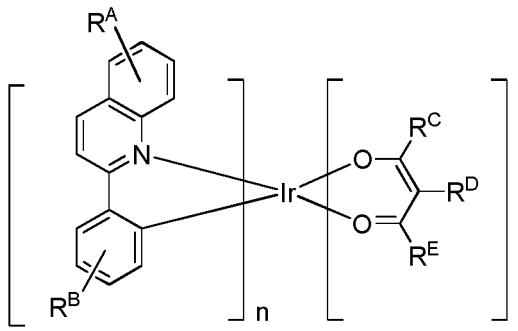
and



[0088] In another aspect , where the first compound has the formula of $M(L^1)_x(L^2)_y(L^3)_z$

as defined above, the first compound has the formula of $Pt(L^1)_2$ or $Pt(L^1)(L^2)$. L^1 can be connected to the other L^1 or L^2 to form a tetradentate ligand.

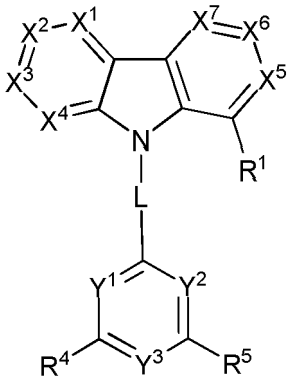
[0089] In the composition of the present invention, the first compound has the Formula I:



, Formula I;

wherein R^A represents mono, di, tri, tetra, penta, hexa substitutions, or no substitution;
R^B represents mono, di, tri, tetra substitutions, or no substitution;
R^A, R^B, R^C, R^D, and R^E are each independently 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;
wherein n is 1 or 2;

wherein the second compound has the Formula II, and is selected from the structures according to the claims:



Formula II,

wherein R^1, R^4, and R^5 are independently selected from 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; wherein L is selected from the group consisting of a direct bond, aryl, substituted aryl, heteroaryl, substituted heteroaryl, and combinations thereof;
wherein X^1 , X^2, X^3 , X^4, X^5, X^6, X^7 , Y^1, Y^2, and Y^3 are each independently selected from the group consisting of CR and N;
wherein at least two of Y^1, Y^2, and Y^3 are N; and
wherein each R can be same or different, and is independently 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.

[0090] In another embodiment, R^1, R^4, and R^5 in Formula II are independently selected from group consisting of non-fused aryl, non-fused heteroaryl, and combinations thereof; wherein L is selected from the group consisting of a direct bond, non-fused aryl, non-fused heteroaryl, and combinations thereof; and wherein each of R is independently selected from the group consisting of hydrogen, deuterium, non-fused aryl, non-fused heteroaryl and combinations thereof.

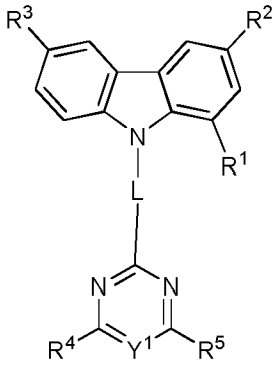
[0091] In another embodiment, R^1 in Formula II is selected from the group consisting of phenyl, biphenyl, terphenyl,

tetraphenyl, pentaphenyl, pyridine, phenyl pyridine and pyridyl phenyl.

[0092] In another embodiment, L in Formula II is selected from the group consisting of phenyl, pyridyl, biphenyl, terphenyl and a direct bond.

[0093] In another embodiment, R^4 and R^5 in Formula II are each independently selected from the group consisting of phenyl, pyridyl, biphenyl, and terphenyl.

[0094] In another embodiment of the composition, where the first compound has the structure according to Forumula I as defined above, the second compound has a structure according to Formula III, and is selected from one of the structures according to the claims:

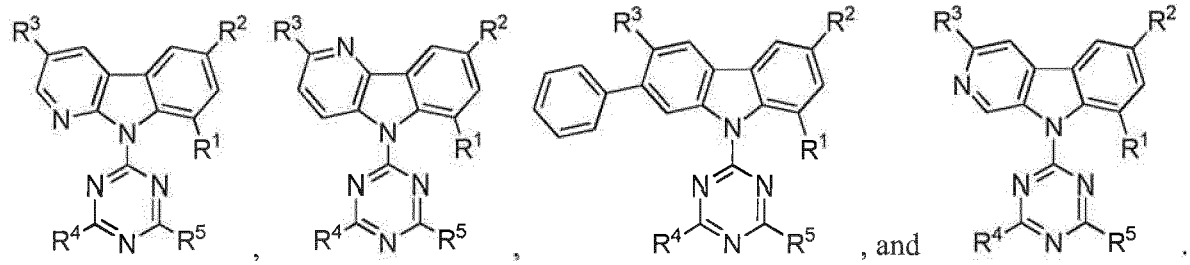


Formula III;

wherein R^2 and R^3 are each independently 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.

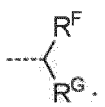
[0095] In an aspect
, R^2 and R^3 of Formula III are each independently selected from the
group consisting of hydrogen, deuterium, non-fused aryl, non-fused heteroaryl and combinations thereof.

[0096] In an aspect
, where the second compound has the structure of Forumula III, the
second compound can have a structure selected from the group consisting of:



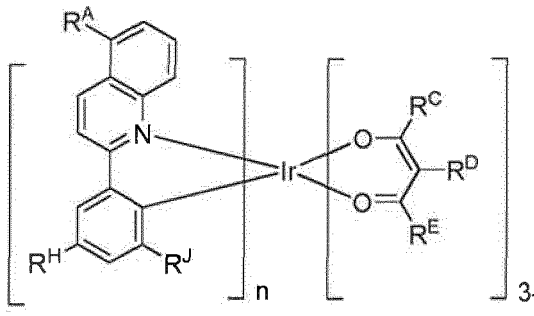
[0097] In one embodiment of the composition where the first compound has the structure of Formula I, n is 1. In another embodiment, R^A, R^B, R^C, R^D, and R^E are each independently selected from the group consisting of hydrogen, deuterium, alkyl, cycloalkyl, and combinations thereof. In another embodiment, at least one of R^C and R^E contains a branched alkyl moiety with branching at a position further than the α position to the carbonyl group. In another embodiment, R^D is hydrogen.

[0098] In one embodiment of the composition where the first compound has the structure of Formula I, at least one of R^C and R^E has the following structure:



wherein R^F, and R^G are independently selected from group consisting of alkyl and cycloalkyl; and wherein at least one of R^F, and R^G has at least two C.

[0099] In the composition of the present invention
where the second compound has the structure
according to the claims, the first compound has a structure according to Formula IV:



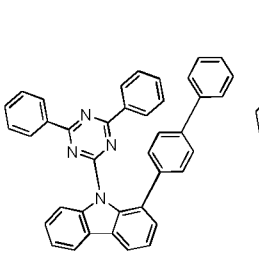
, Formula IV;

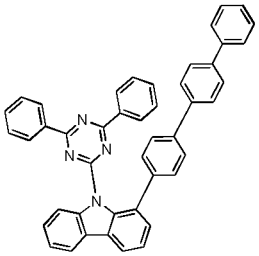
wherein R^H and R^J are each independently selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, cyclic amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

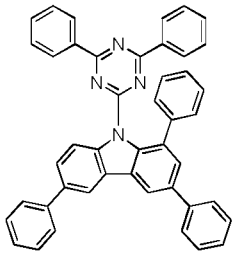
[0100] In another embodiment of the composition where the first compound has a structure according to Formula IV as defined above, R^H and R^J are each independently selected from the group consisting of hydrogen, deuterium, alkyl, cycloalkyl, and combinations thereof.

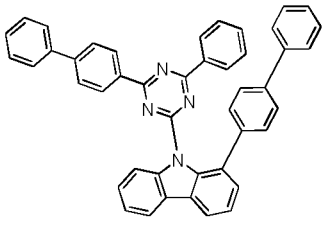
[0101] In another embodiment of the composition where the first compound has a structure according to Formula IV as defined above, R^H and R^J are methyl.

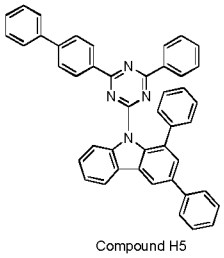
[0102] In an embodiment of the composition where the second compound has a structure according to Formula II, the second compound is selected from the group consisting of:

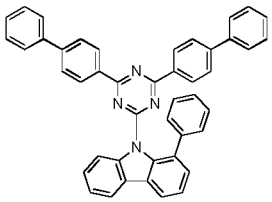

Compound H1 ,

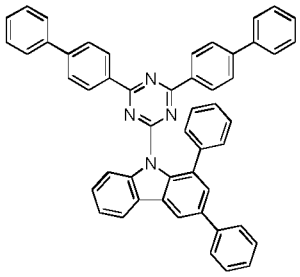

Compound H2 ,

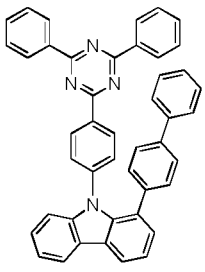

Compound H3 ,

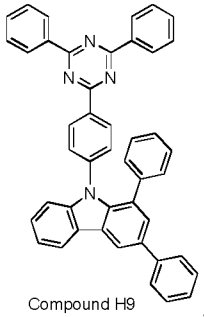

Compound H4 ,


Compound H5 ,

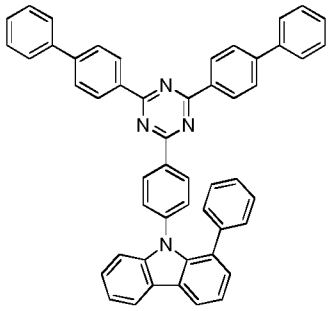

Compound H6 ,


Compound H7 ,

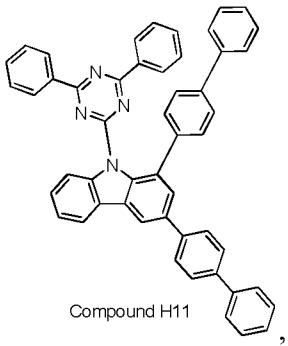

Compound H8 ,



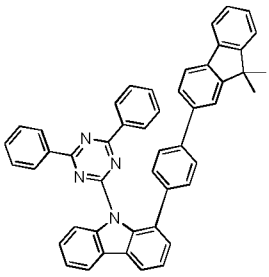
Compound H9 ,



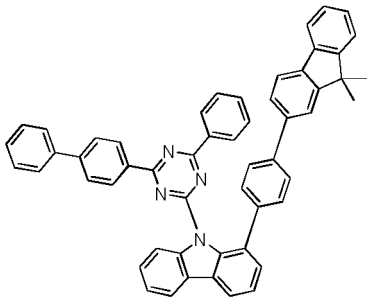
Compound H10 ,



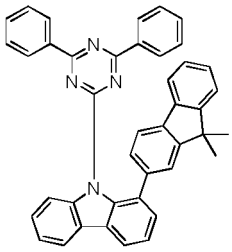
Compound H11 ,



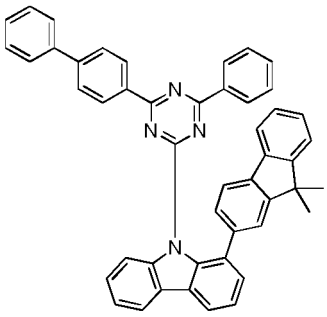
Compound H12 ,



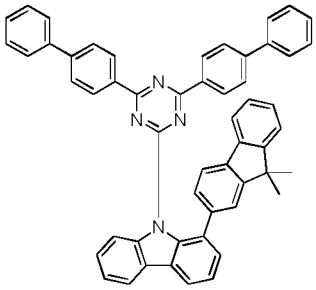
Compound H13 ,



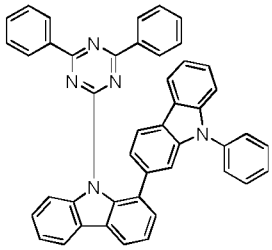
Compound H14 ,



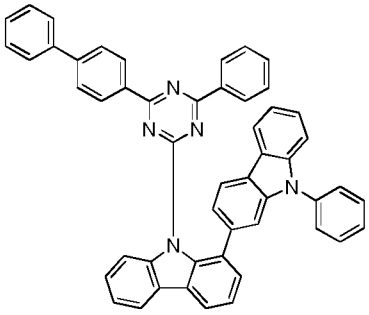
Compound H15 ,



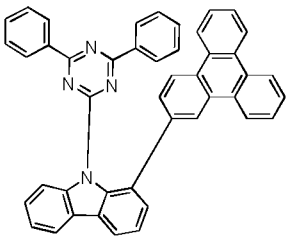
Compound H16 ,



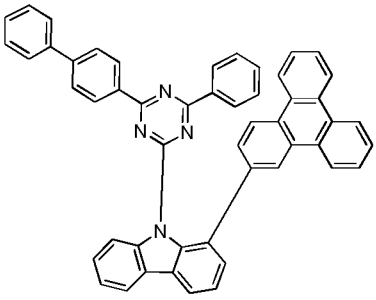
Compound H17 ,



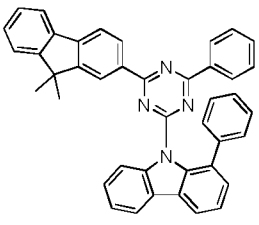
Compound H18 ,



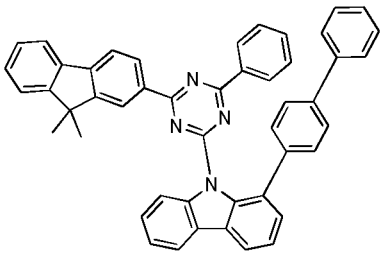
Compound H19 ,



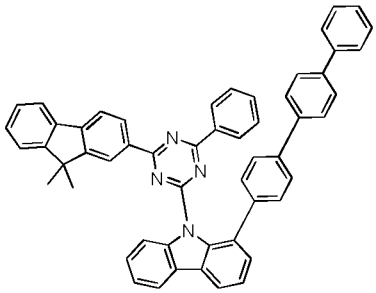
Compound H20 ,



Compound H21 ,



Compound H22 ,



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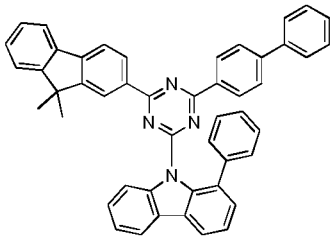
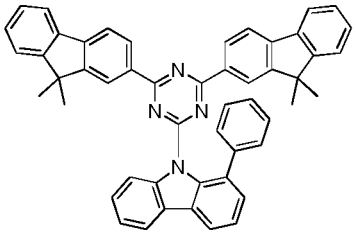
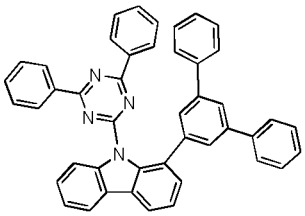


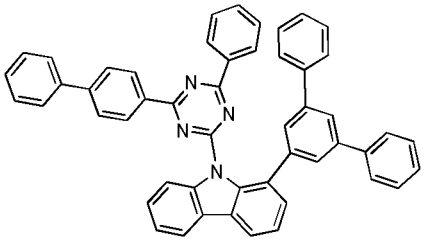
Compound H24 ,



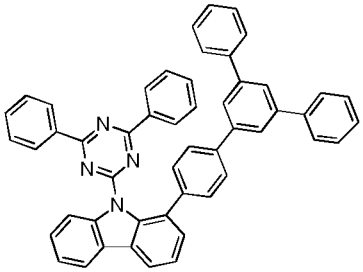
Compound H25 ,



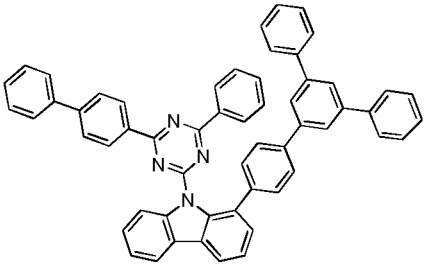
Compound H26 ,



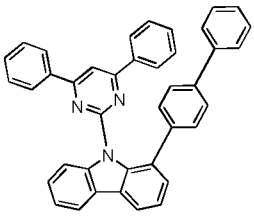
Compound H27 ,



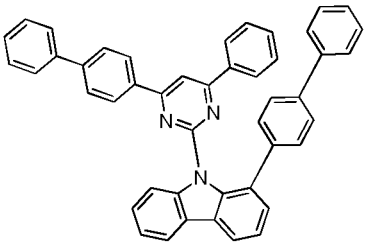
Compound H28 ,



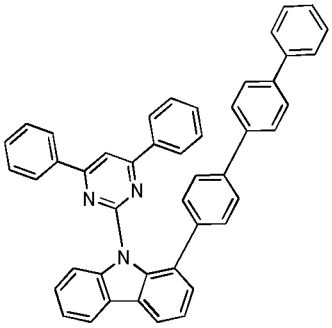
Compound H29 ,



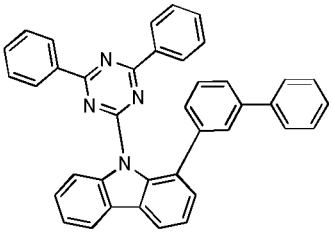
Compound H30 ,



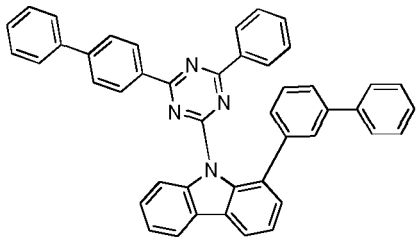
Compound H31 ,



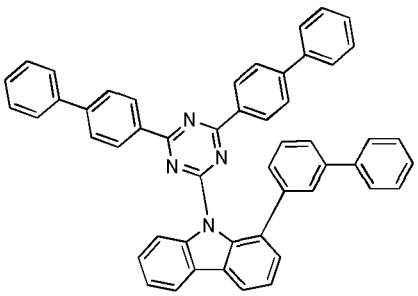
Compound H32 ,



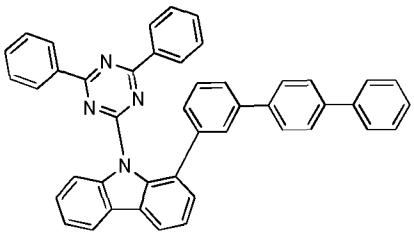
Compound H33 ,



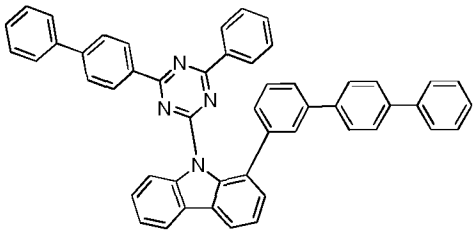
Compound H34 ,



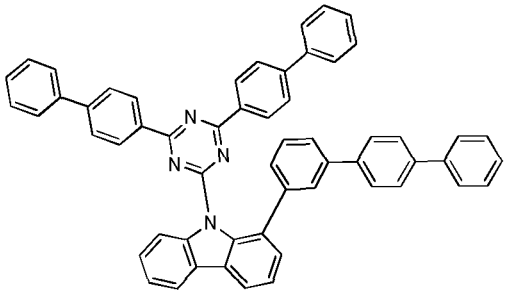
Compound H35 ,



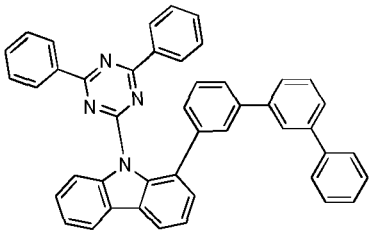
Compound H36 ,



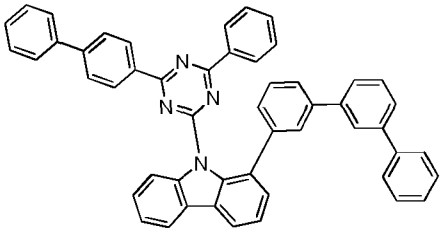
Compound H37 ,



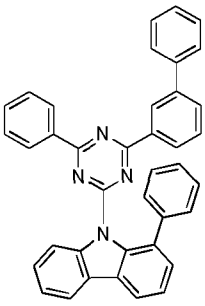
Compound H38 ,



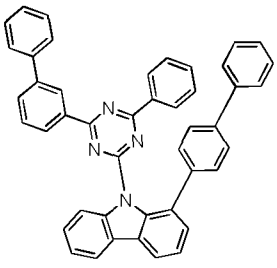
Compound H39 ,



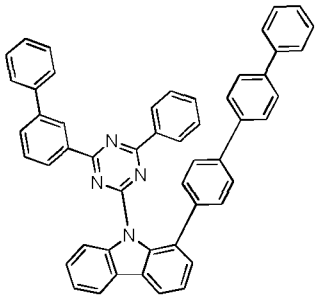
Compound H40 ,



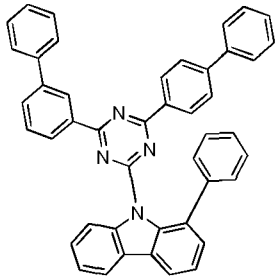
Compound H41 ,



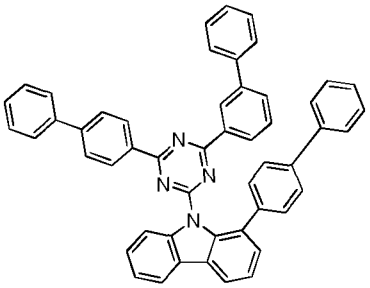
Compound H42 ,



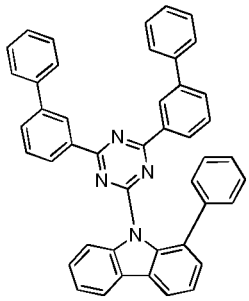
Compound H43 ,



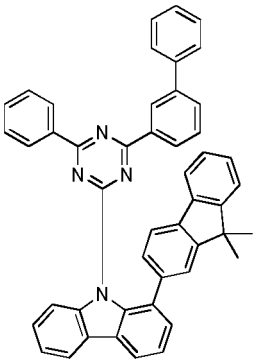
Compound H44 ,



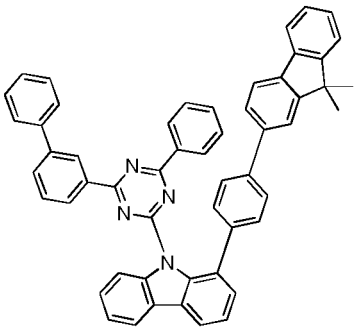
Compound H45 ,



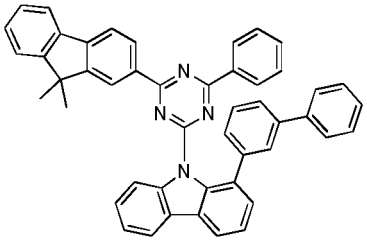
Compound H46 ,



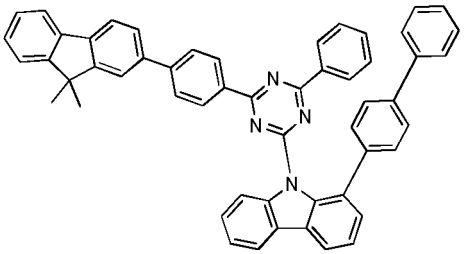
Compound H47 ,



Compound H48 ,

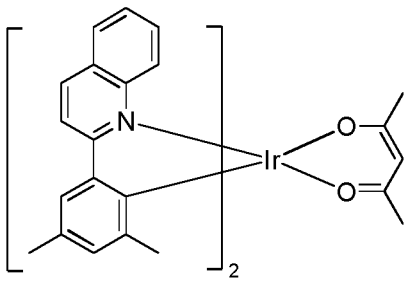


Compound H49 , and

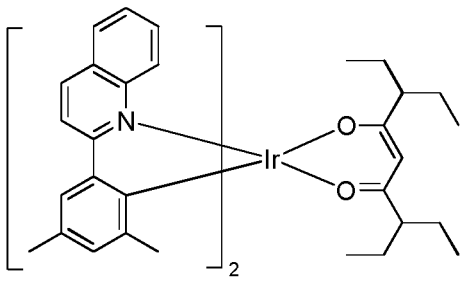


Compound H50 .

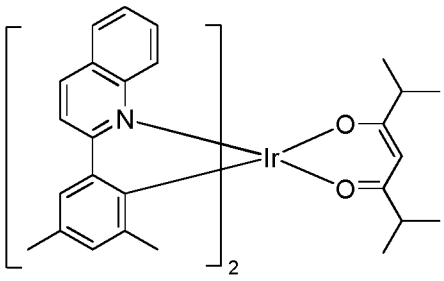
[0103] In another embodiment of the composition where the first compound has a structure according to Formula I as defined above, the first compound can be selected from the group consisting of:



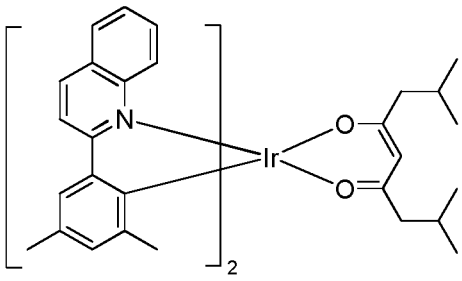
Compound E1 ,



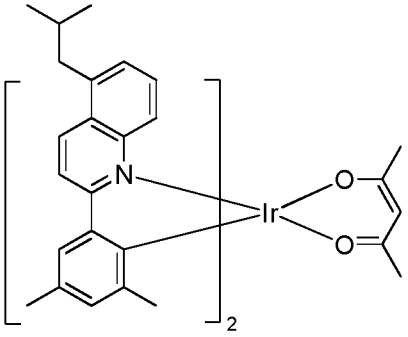
Compound E2 ,



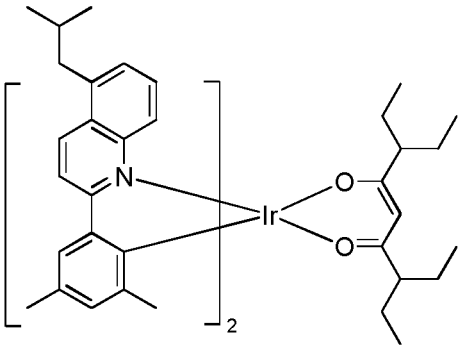
Compound E3 ,



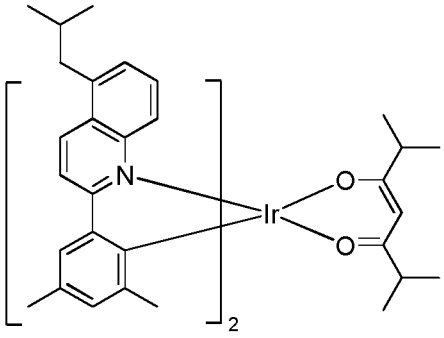
Compound E4 ,



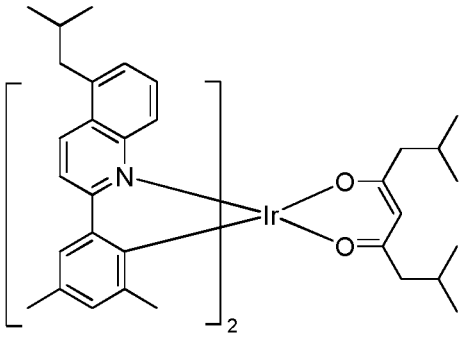
Compound E5 ,



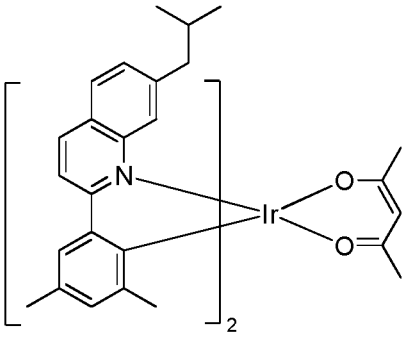
Compound E6 ,



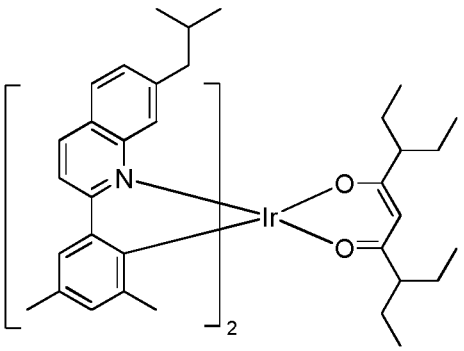
Compound E7 ,



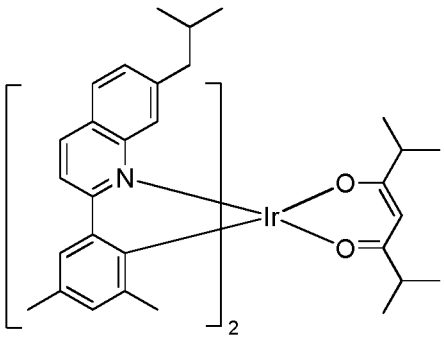
Compound E8 ,



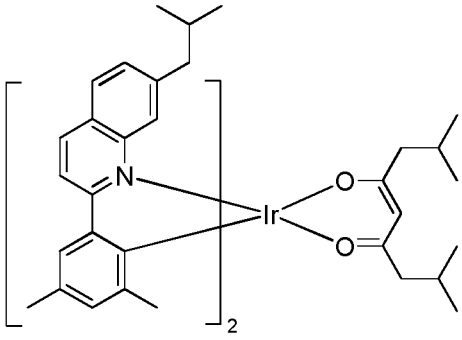
Compound E9 ,



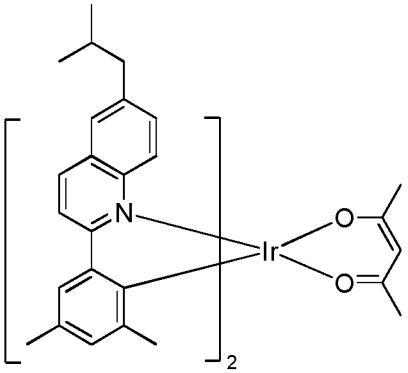
Compound E10 ,



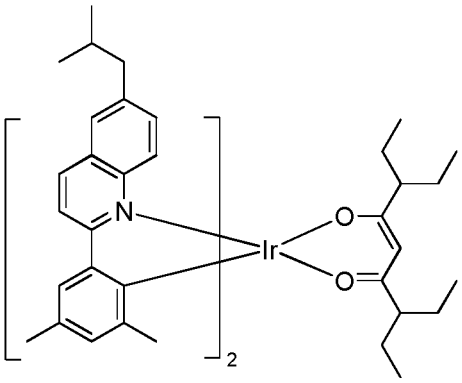
Compound E11 ,



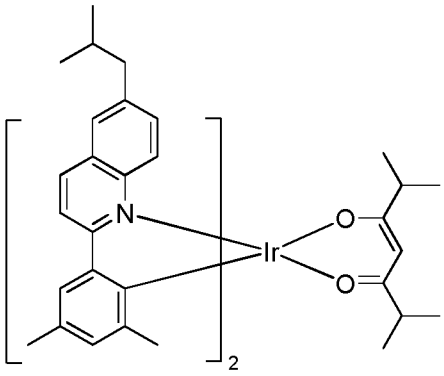
Compound E12 ,



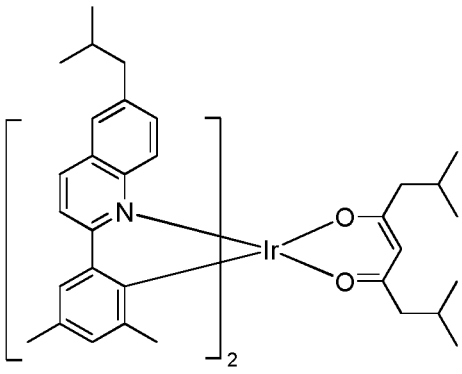
Compound E13 ,



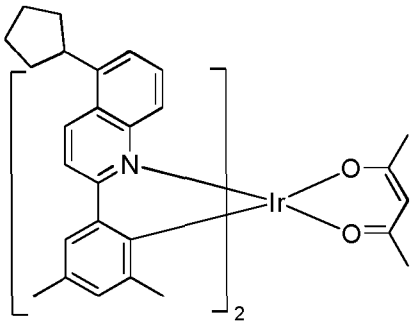
Compound E14 ,



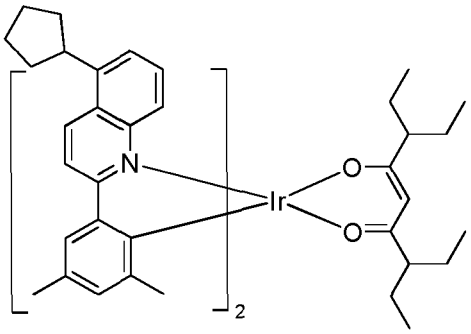
Compound E15 ,



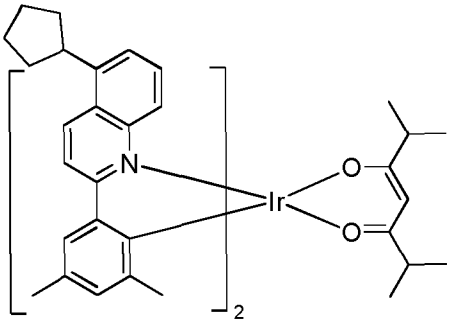
Compound E16 ,



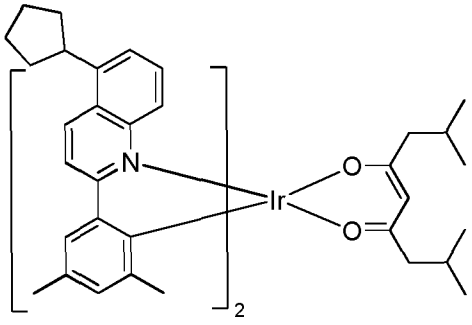
Compound E17 ,



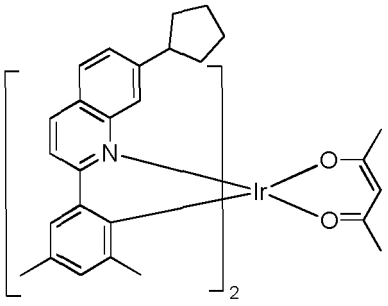
Compound E18 ,



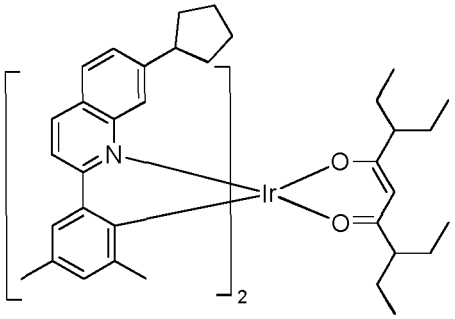
Compound E19 ,



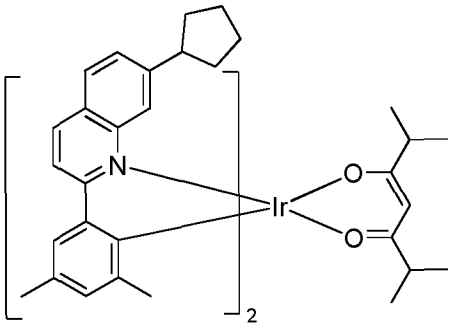
Compound E20 ,



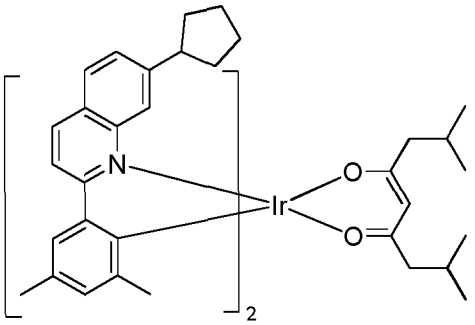
Compound E21 ,



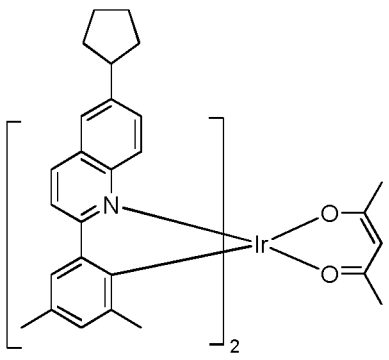
Compound E22 ,



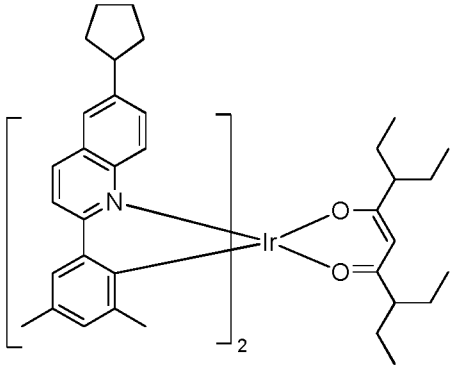
Compound E23



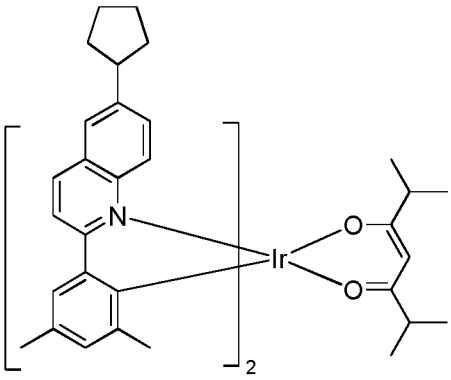
Compound E24 ,



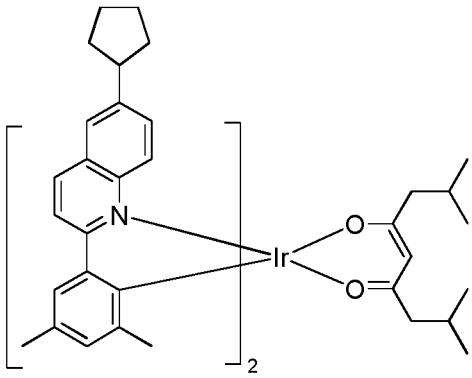
Compound E25 ,



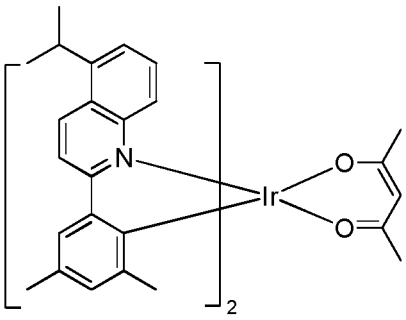
Compound E26 ,



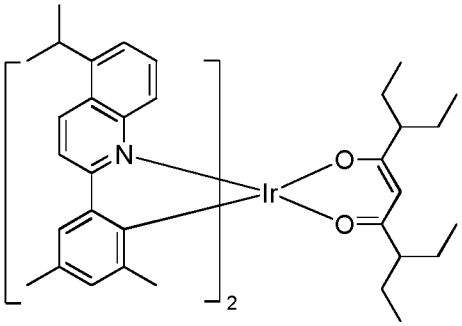
Compound E27



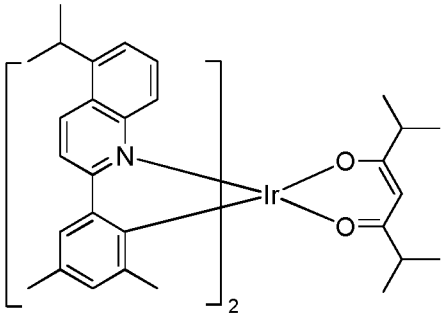
Compound E28 ,



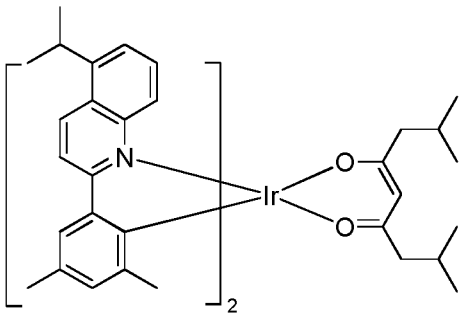
Compound E29 ,



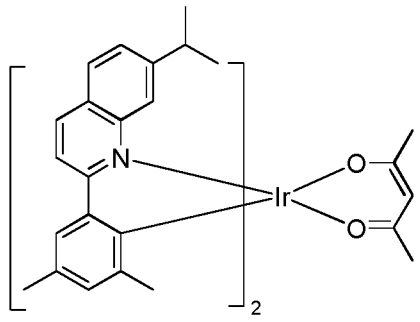
Compound E30 ,



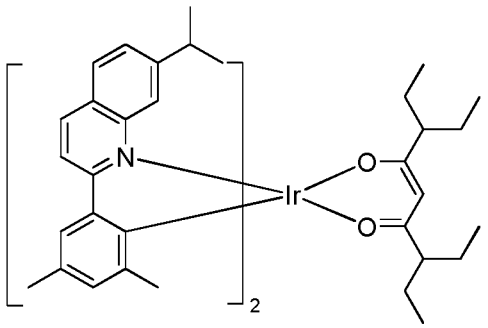
Compound E31 ,



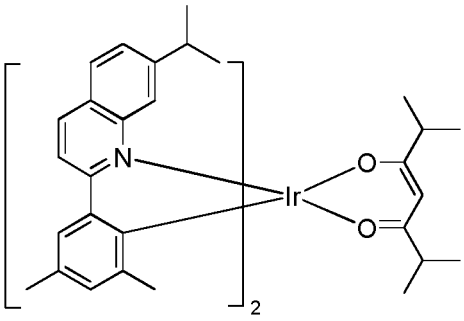
Compound E32 ,



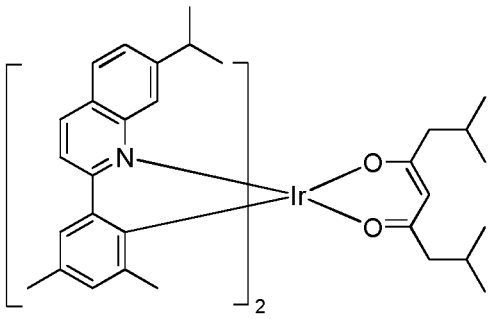
Compound E33 ,



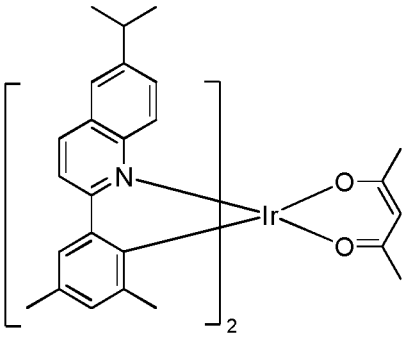
Compound E34 ,



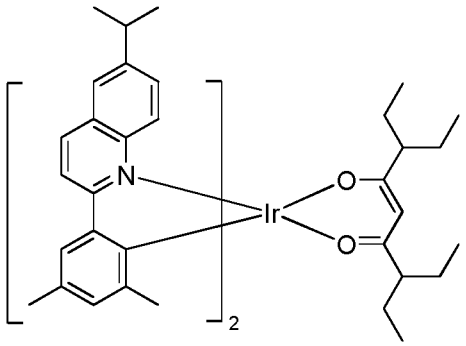
Compound E35 ,



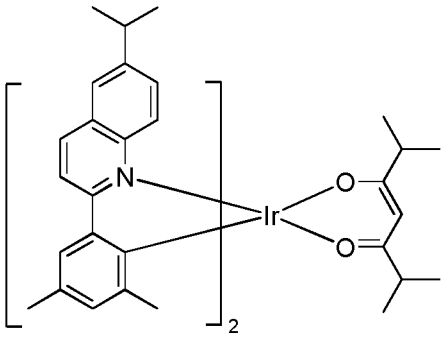
Compound E36 ,



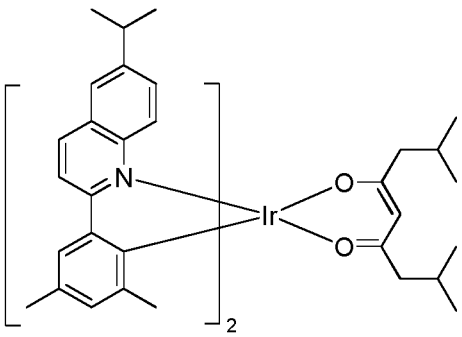
Compound E37 ,



Compound E38 ,



Compound E39 , and



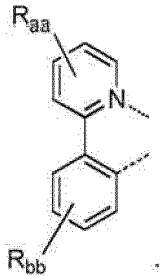
Compound E40 .

[0104] In another embodiment of the composition where the first compound has a structure according to Formula I and the second compound has a structure according to Formula II as defined above, the mixture of the first compound

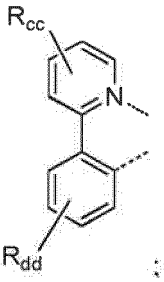
and the second compound is selected from the group consisting of: (Compound E5 and Compound H1), (Compound E1 and Compound HI4), (Compound E4 and Compound H21), (Compound E9 and Compound H30), (Compound E17 and Compound H21), and (Compound E13 and Compound H33).

[0105] In another embodiment of the composition where the first compound has a structure according to Formula I and the second compound has a structure according to Formula II as defined above, the mixture of the first compound and the second compound is (Compound E5 and Compound HI).

[0106] In an aspect the composition comprises
a mixture of a first compound and a
second compound, wherein the first compound has a difference chemical structure than the second compound, wherein the first compound is capable of functioning as a phosphorescent emitter in an OLED at room temperature, the first compound and the second compound each independently has the formula of $Ir(L^1)_2(L^2)$, wherein L^1 has the formula:



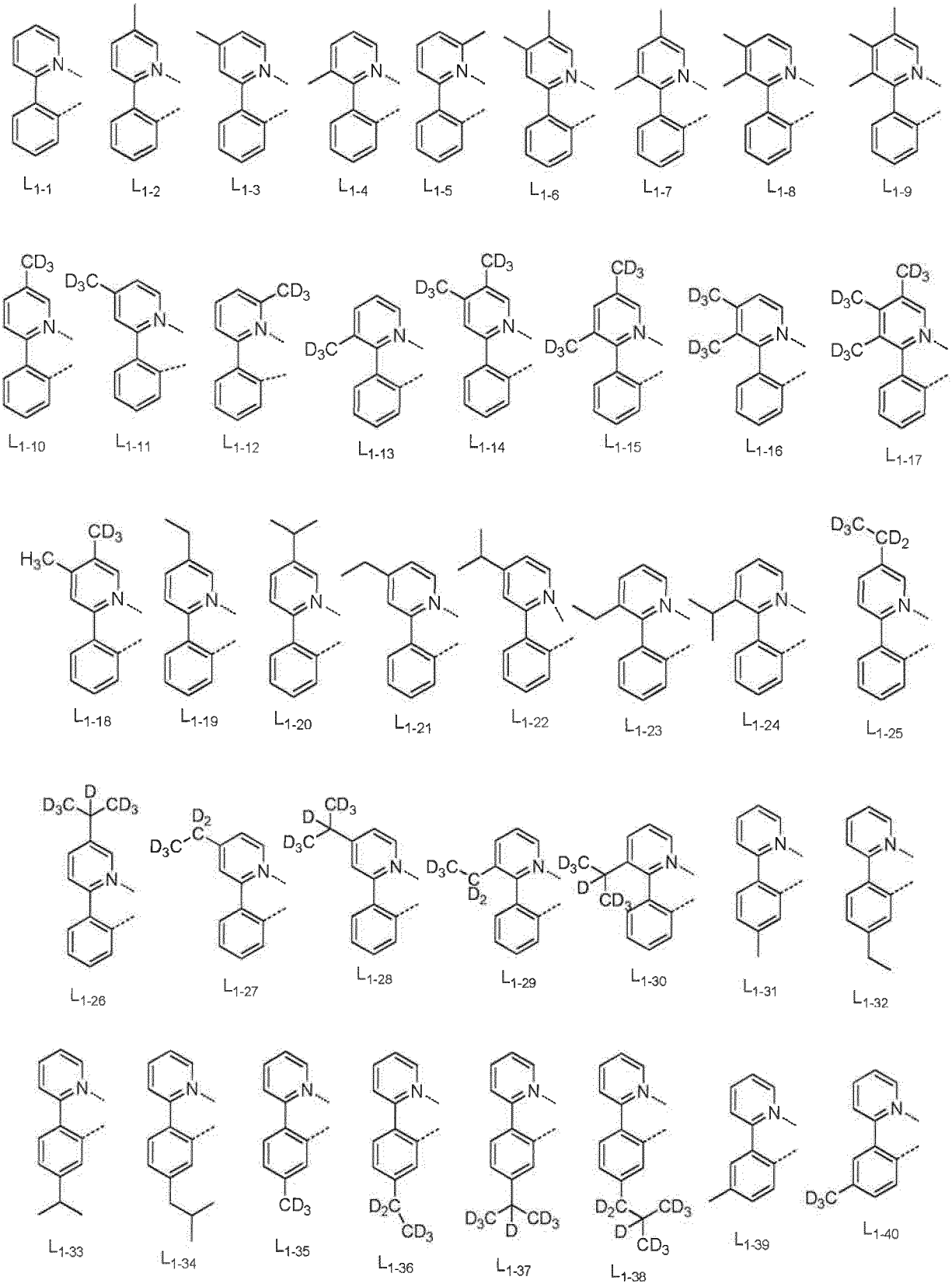
wherein L^2 has the formula:



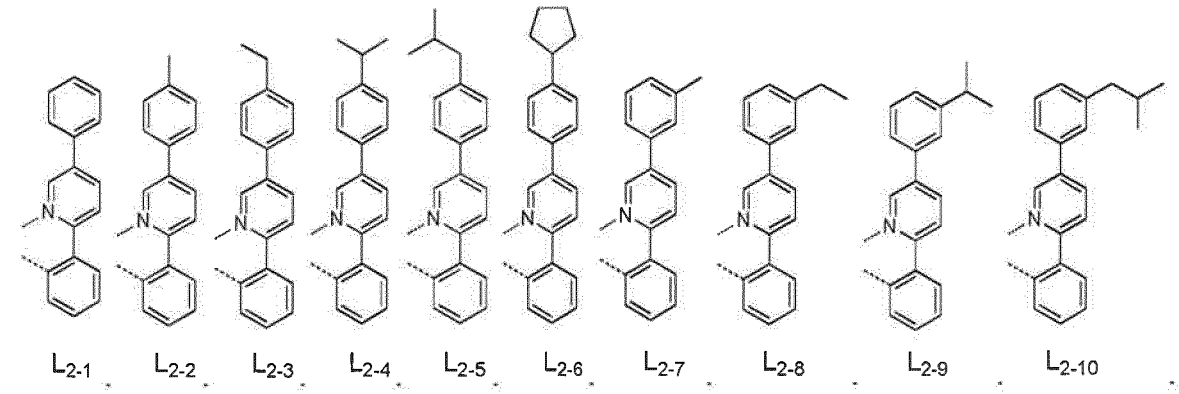
wherein L^1 is different from L^2;
wherein R_{aa}, R_{bb}, R_{cc}, and R_{dd} may represent mono, di, tri, or tetra substitution, or no substitution;
wherein R_{aa}, R_{bb}, R_{cc}, and R_{dd} are independently selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; wherein two adjacent substituents of R_{aa}, R_{bb}, R_{cc}, and R_{dd} are optionally joined to form a fused ring or form a multidentate ligand; and
wherein at least one of R_{cc} is a 5 or 6-membered carbocyclic or heterocyclic ring.

[0107] In the aspect
of the composition where the first compound and the second
compound each independently has the formula of $Ir(L^1)_2(L^2)$ as defined above, at least one of R_{cc} is benzene or pyridine.

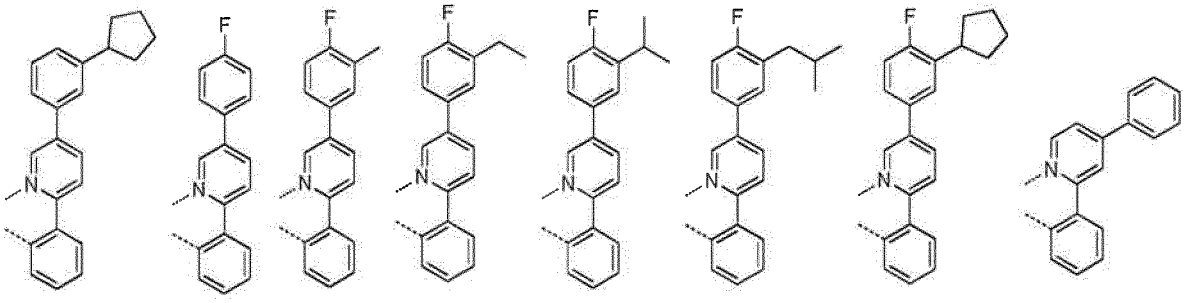
[0108] In the aspect
of the composition where the first compound and the second
compound each independently has the formula of $Ir(L^1)_2(L^2)$ as defined above, L^1 is selected from the group consisting of:



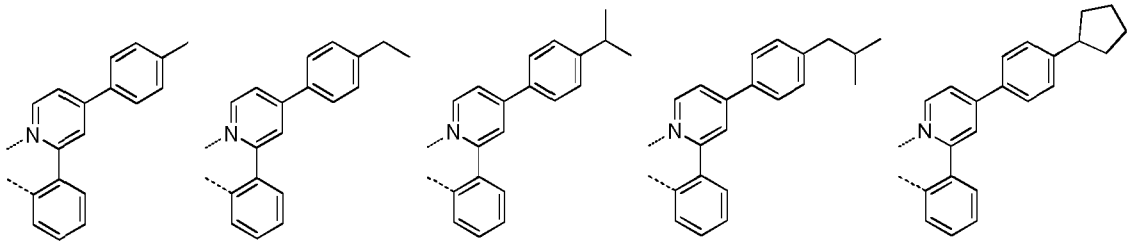
[0109] In the aspect of the composition where the first compound and the second compound each independently has the formula of $Ir(L^1)_2(L^2)$ as defined above, L^2 is selected from the group consisting of:



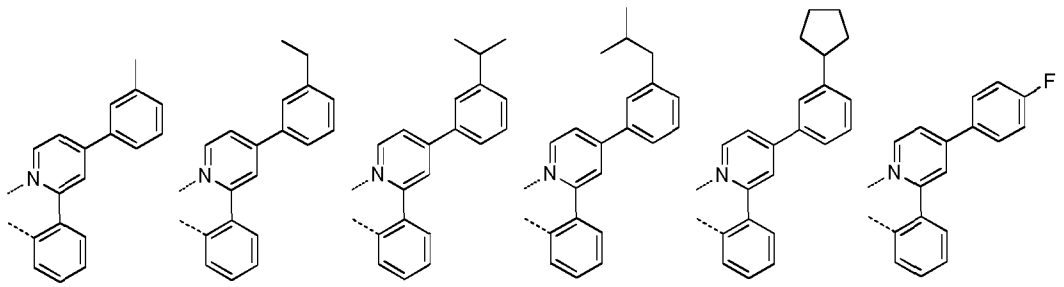
L_{2-1} L_{2-2} L_{2-3} L_{2-4} L_{2-5} L_{2-6} L_{2-7} L_{2-8} L_{2-9} L_{2-10}



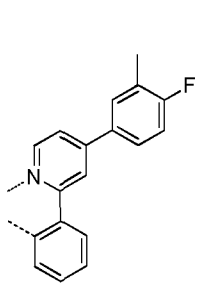
L_{2-11} L_{2-12} L_{2-13} L_{2-14} L_{2-15} L_{2-16} L_{2-17} L_{2-18}



L_{2-19}, L_{2-20}, L_{2-21}, L_{2-22}, L_{2-23},



L_{2-24}, L_{2-25}, L_{2-26}, L_{2-27}, L_{2-28}, L_{2-29},



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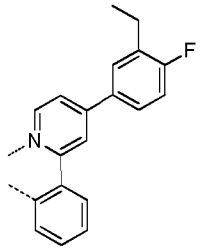

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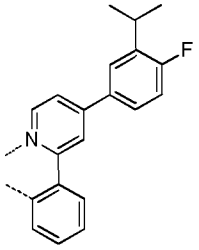

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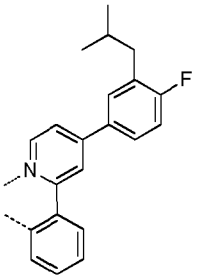

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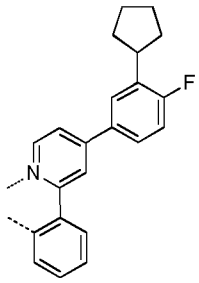

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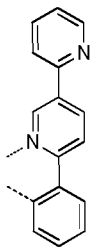

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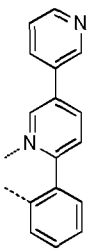

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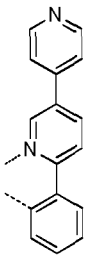

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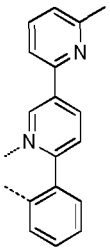

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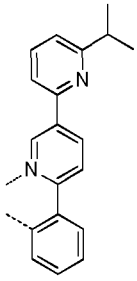

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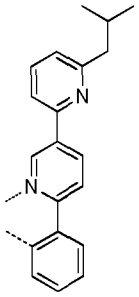

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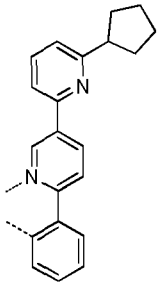

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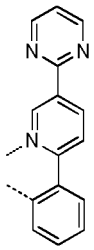

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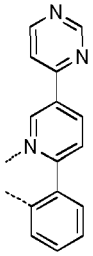

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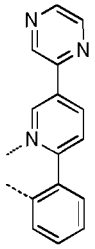

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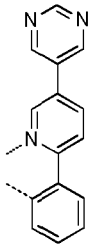
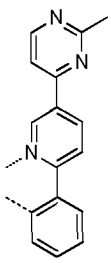


$L_{2\text{-}45}$



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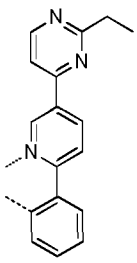

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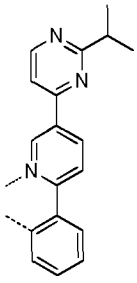

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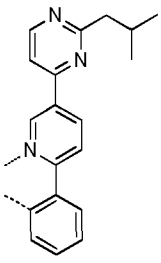

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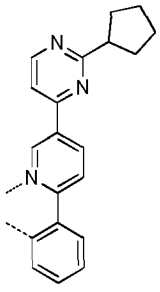

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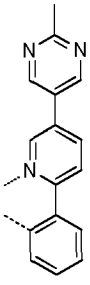

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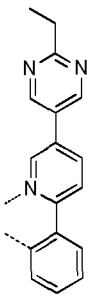

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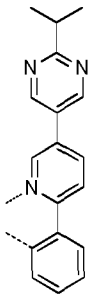

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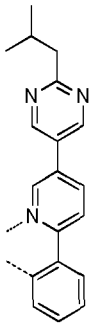

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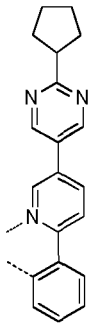

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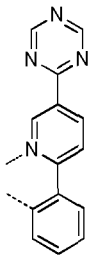

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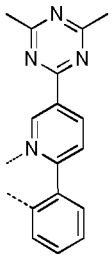

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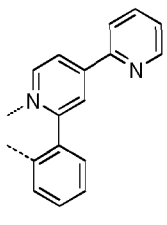

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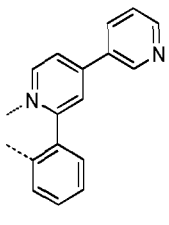

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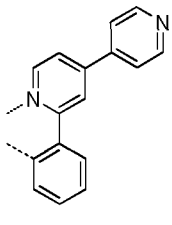

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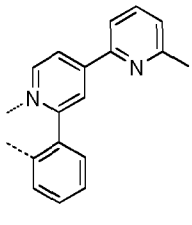

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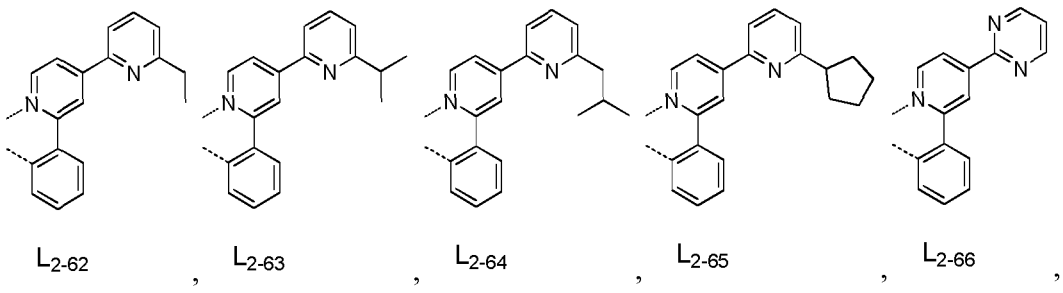

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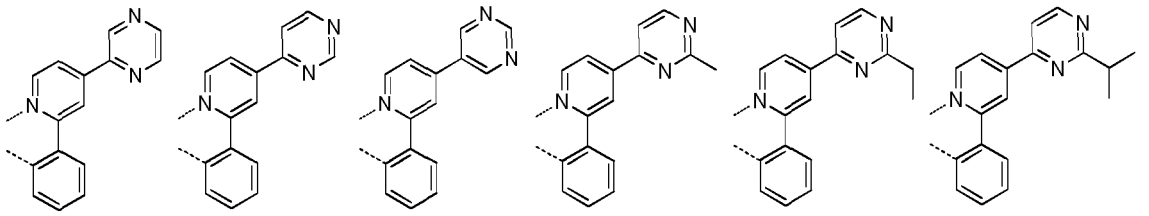
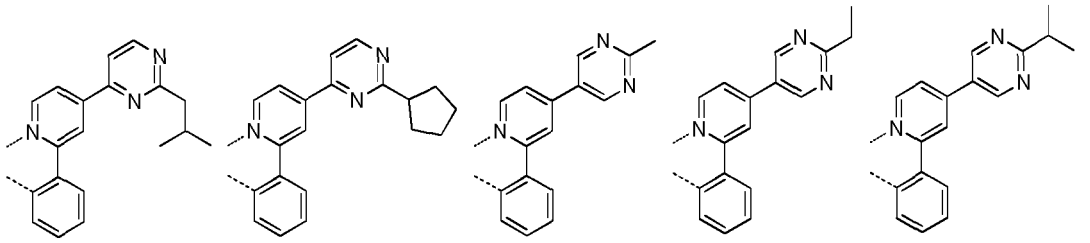


$L_{2\text{-}67}$, $L_{2\text{-}68}$, $L_{2\text{-}69}$, $L_{2\text{-}70}$, $L_{2\text{-}71}$, $L_{2\text{-}72}$,



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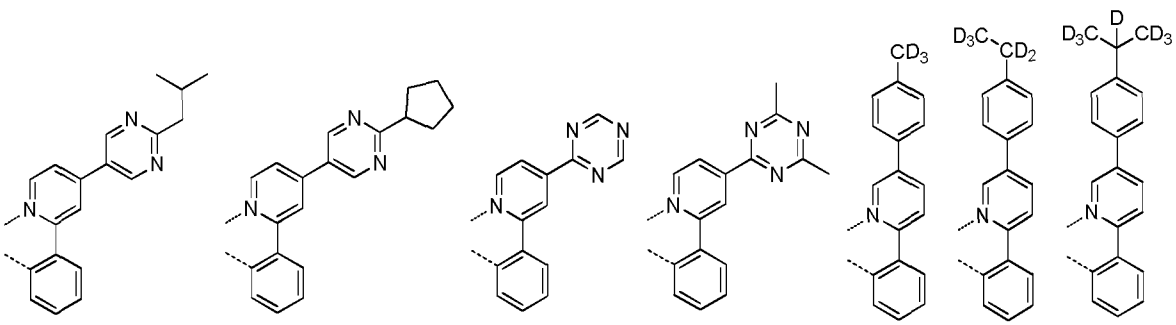
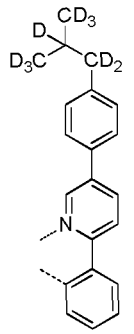


$L_{2\text{-}78}$, $L_{2\text{-}79}$, $L_{2\text{-}80}$, $L_{2\text{-}81}$, $L_{2\text{-}82}$, $L_{2\text{-}83}$, $L_{2\text{-}84}$,



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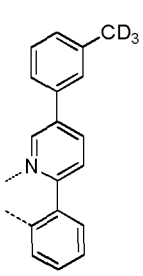
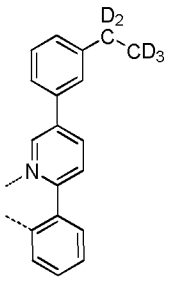


$L_{2\text{-}86}$,



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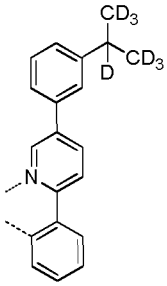

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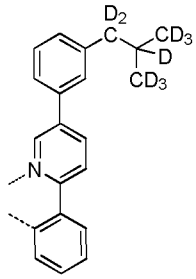

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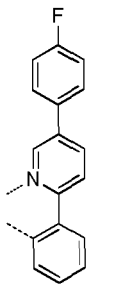

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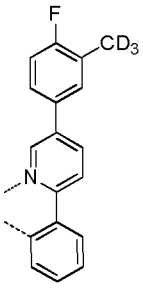

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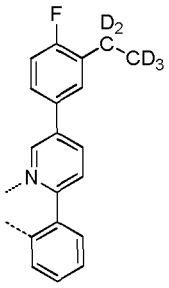

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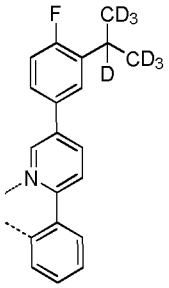

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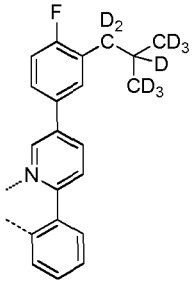

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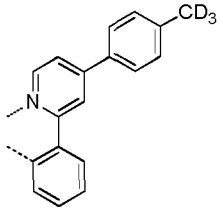

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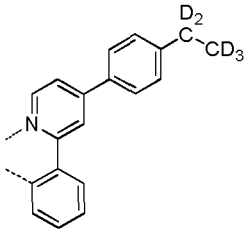

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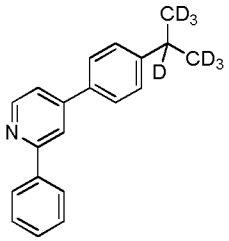

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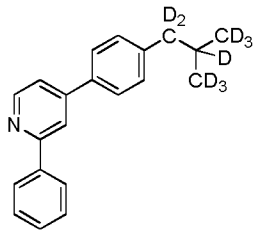

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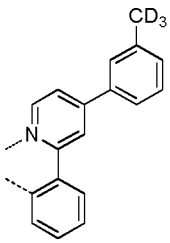

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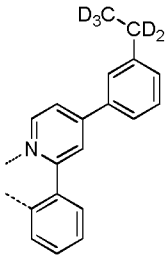

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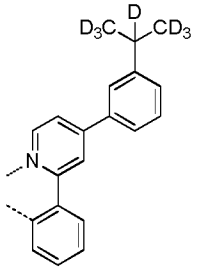
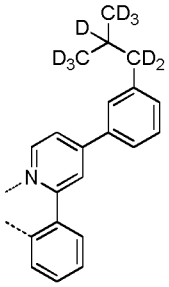
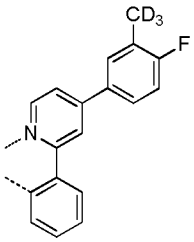


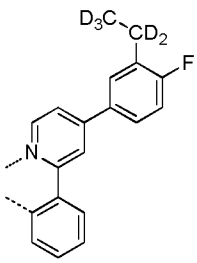
$L_{2\text{-}101}$,



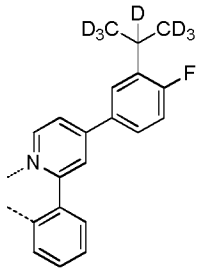
$L_{2\text{-}102}$,



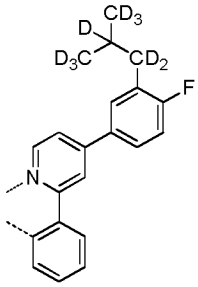
$L_{2\text{-}103}$,



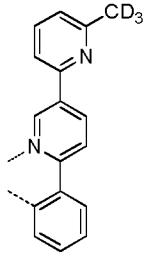
$L_{2\text{-}104}$,



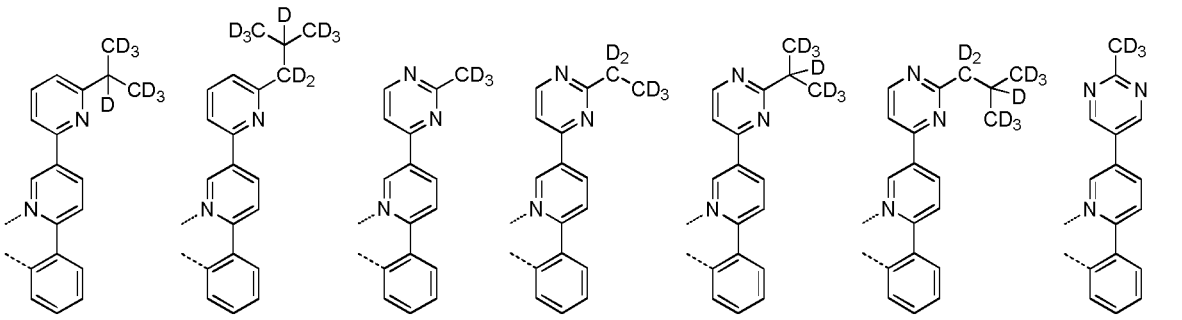
$L_{2\text{-}105}$,



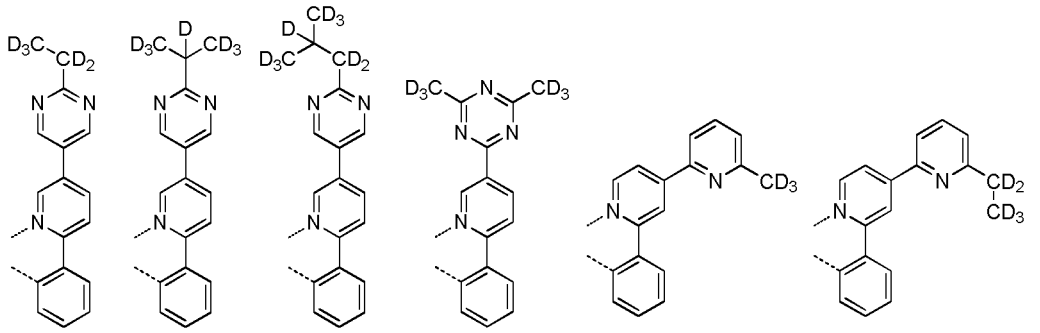
$L_{2\text{-}106}$,



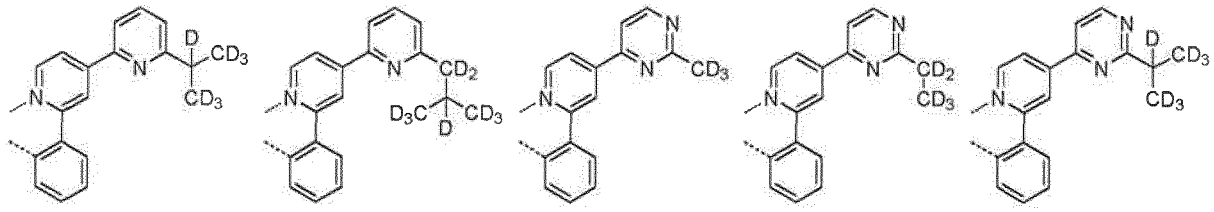
$L_{2\text{-}107}$,



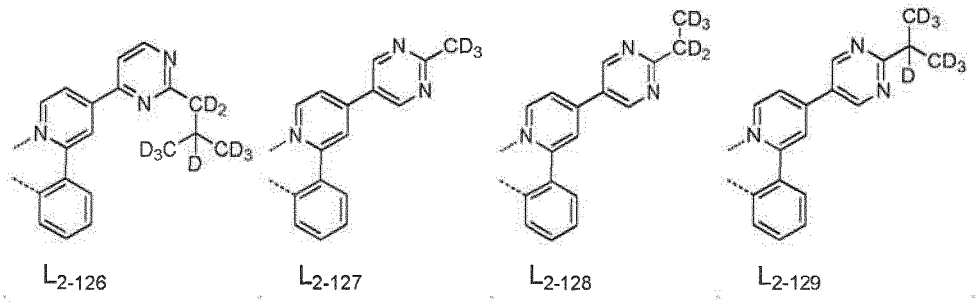
$L_{2\text{-}108}$, $L_{2\text{-}109}$, $L_{2\text{-}110}$, $L_{2\text{-}111}$, $L_{2\text{-}112}$, $L_{2\text{-}113}$, $L_{2\text{-}114}$,



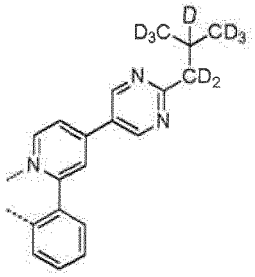
$L_{2\text{-}115}$, $L_{2\text{-}116}$, $L_{2\text{-}117}$, $L_{2\text{-}118}$, $L_{2\text{-}119}$, $L_{2\text{-}120}$,

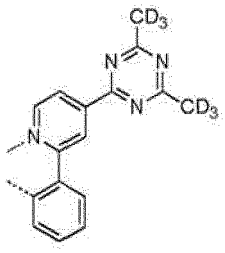


$L_{2\text{-}121}$ $L_{2\text{-}122}$ $L_{2\text{-}123}$ $L_{2\text{-}124}$ $L_{2\text{-}125}$

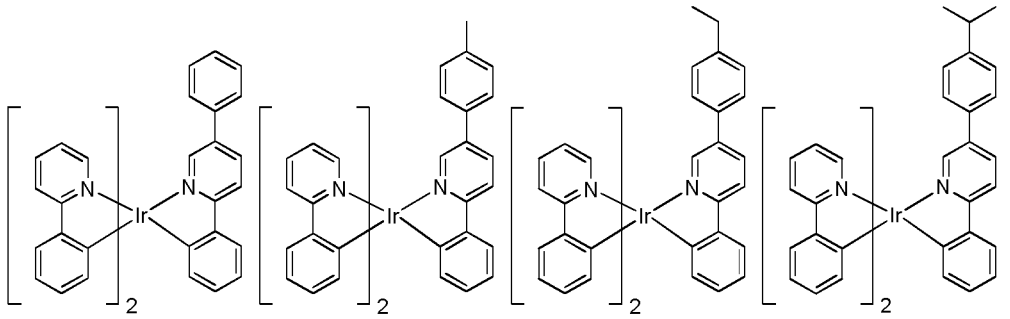


$L_{2\text{-}126}$ $L_{2\text{-}127}$ $L_{2\text{-}128}$ $L_{2\text{-}129}$

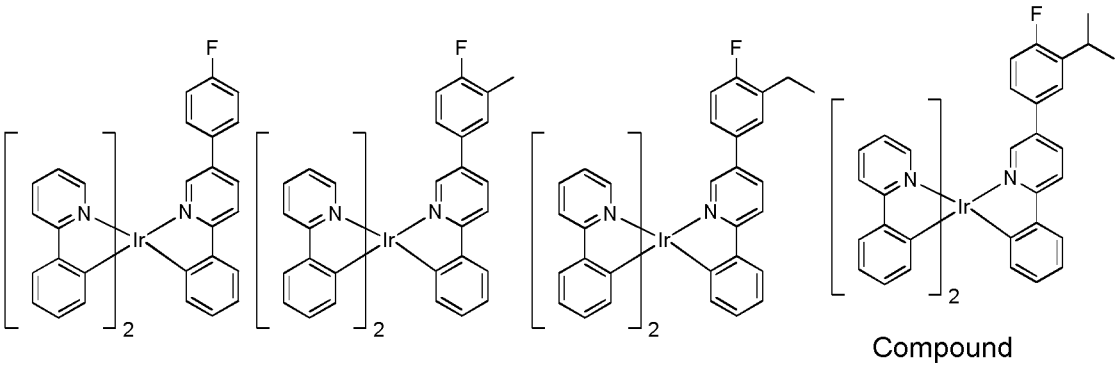


$L_{2\text{-}130}$, and  $L_{2\text{-}131}$.

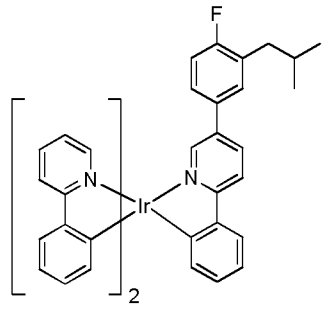
[0110] In the aspect of the composition where the first compound and the second compound each independently has the formula of $Ir(L^1)_2(L^2)$ as defined above, the first compound and the second compound are each independently selected from the group consisting of:

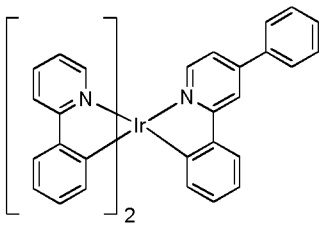
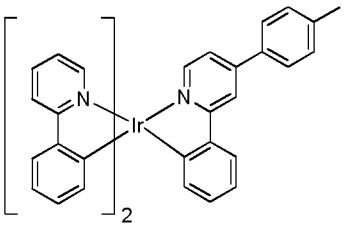


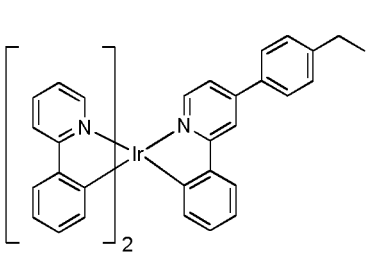
Compound 7 , Compound 8 , Compound 9 , Compound 10 ,

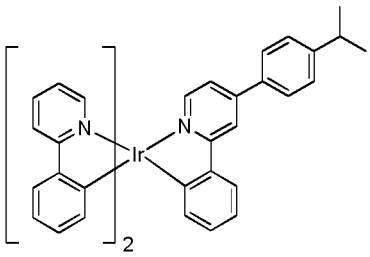
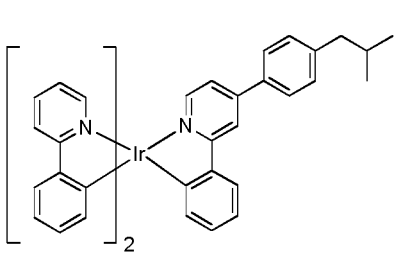


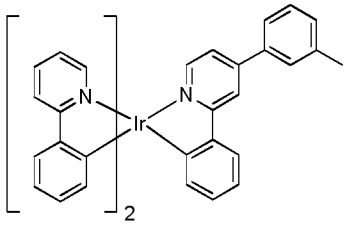
Compound 11 , Compound 12 , Compound 13 , Compound 14 ,

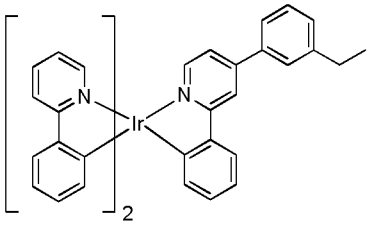
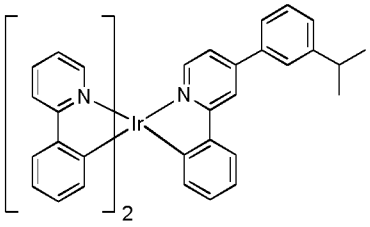


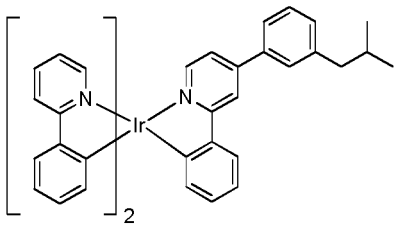
Compound 15 ,  Compound 20 ,  Compound 21 ,

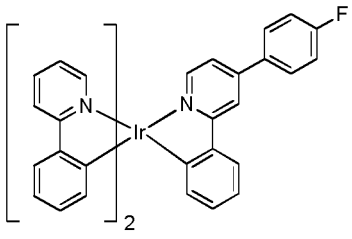
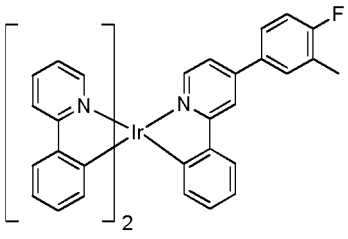


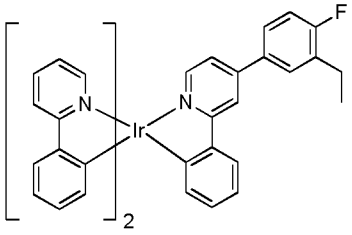
Compound 22 ,  Compound 23 ,  Compound 24 ,

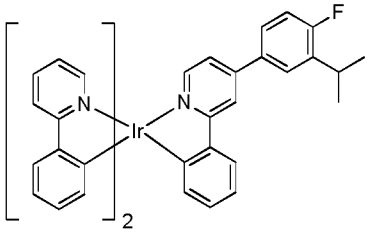
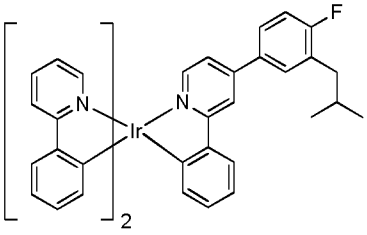


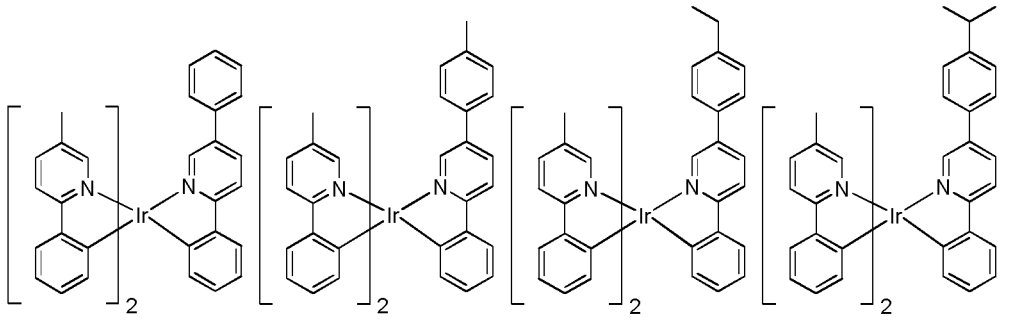
Compound 25 ,  Compound 26 ,  Compound 27 ,



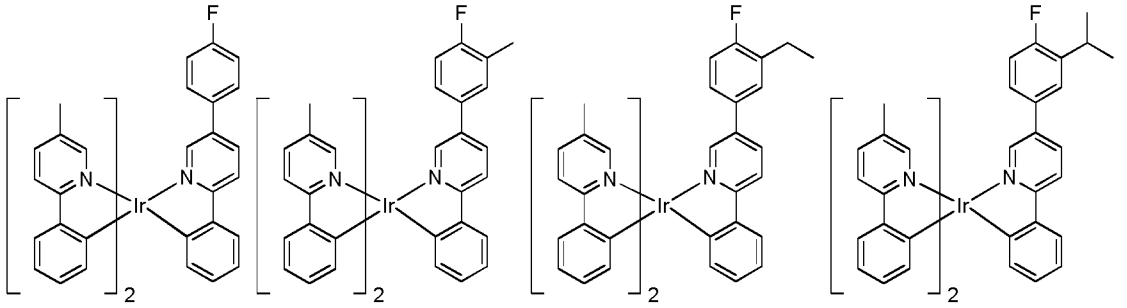
Compound 28 ,  Compound 29 ,  Compound 30 ,



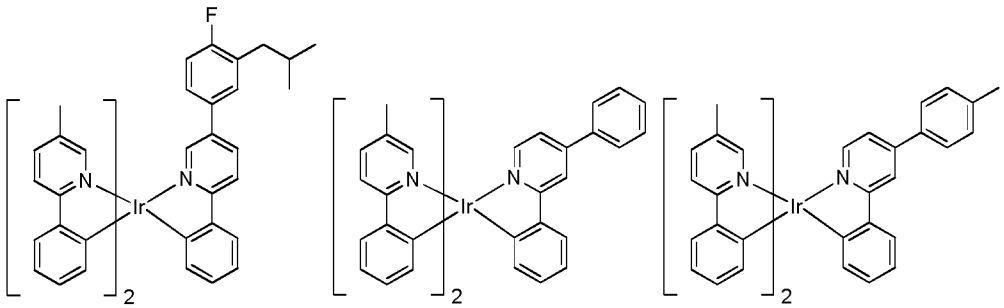
Compound 31 ,  Compound 32 ,  Compound 33 ,



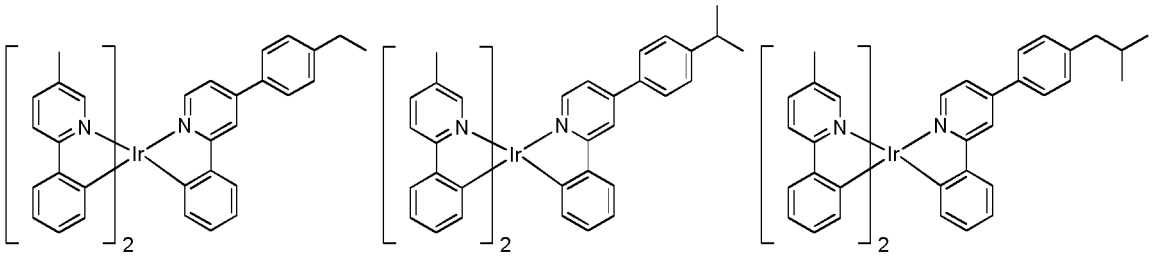
Compound 40 , Compound 41 , Compound 42 , Compound 43 ,



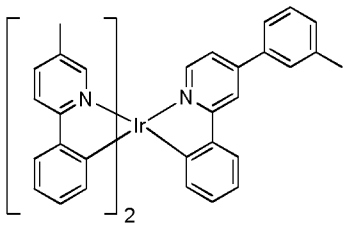
Compound 44 , Compound 45 , Compound 46 , Compound 47 ,

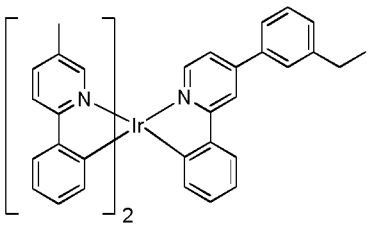


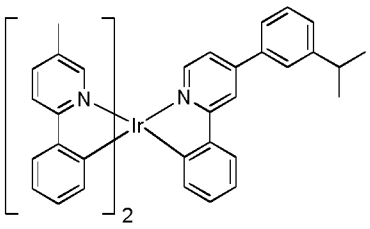
Compound 48 , Compound 53 , Compound 54 ,



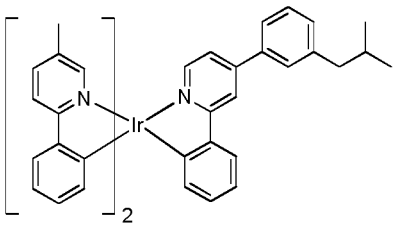
Compound 55 , Compound 56 , Compound 57 ,

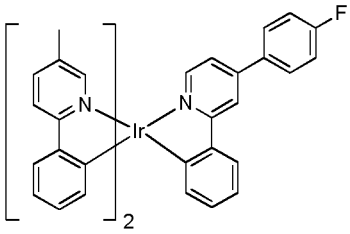


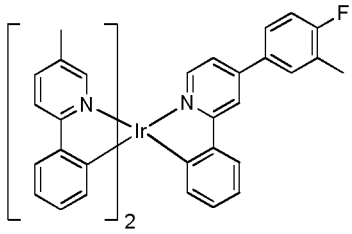
Compound 58 , 

Compound 59 , 

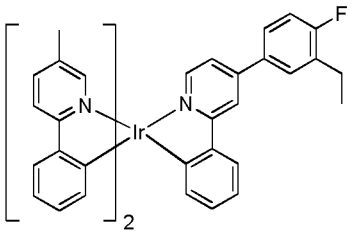
Compound 60 ,

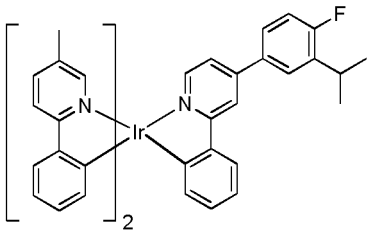


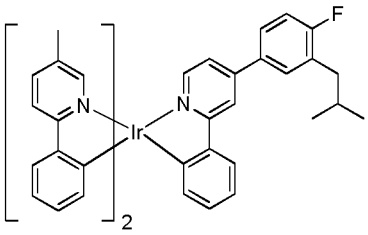
Compound 61 , 

Compound 62 , 

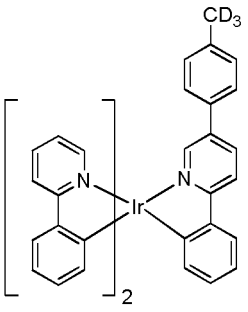
Compound 63 ,

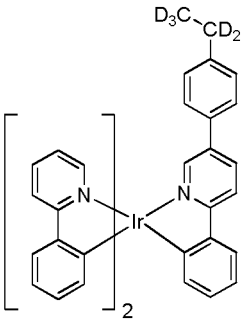


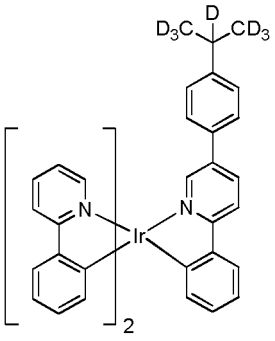
Compound 64 , 

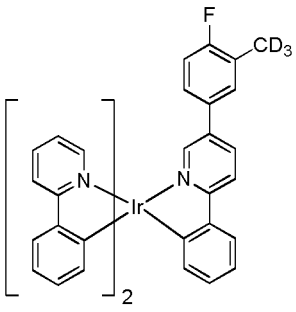
Compound 65 , 

Compound 66 ,

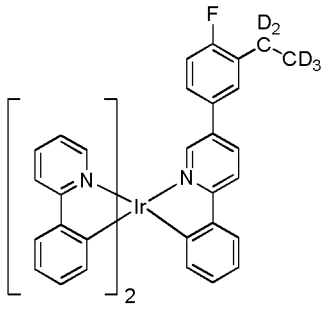


Compound 73 , 

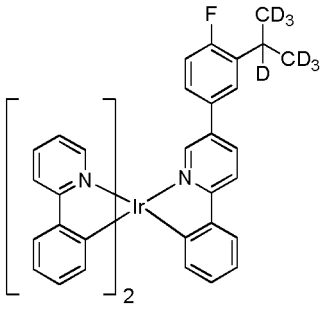
Compound 74 , 

Compound 75 , 

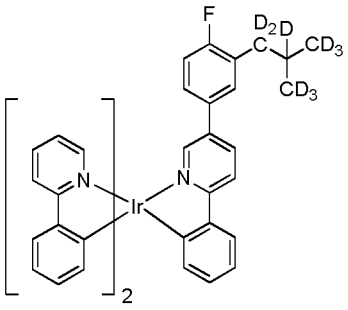
Compound 76 ,



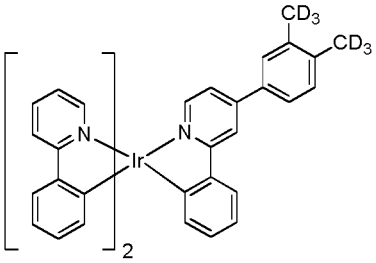
Compound 77 ,



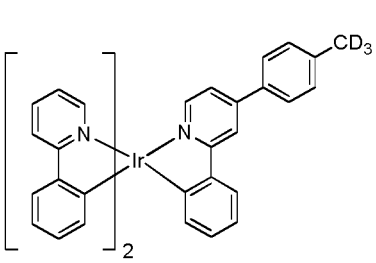
Compound 78 ,



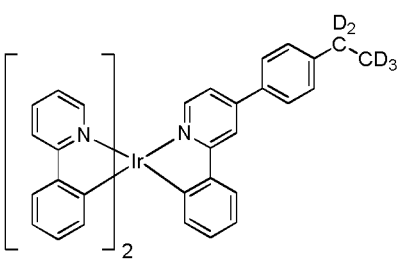
Compound 79 ,



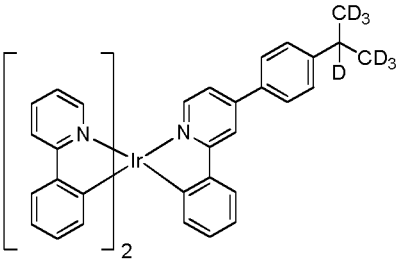
Compound 84 ,



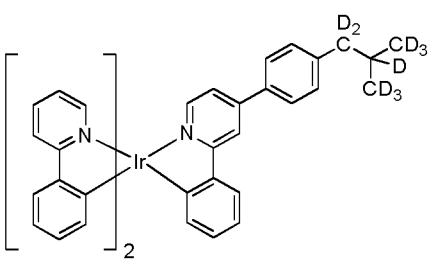
Compound 85 ,



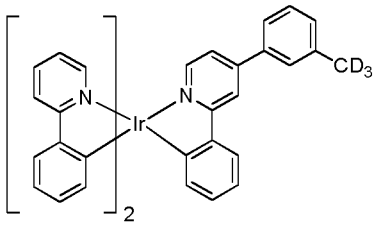
Compound 86 ,



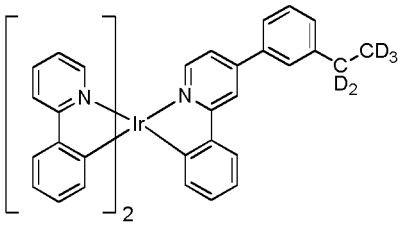
Compound 87 ,



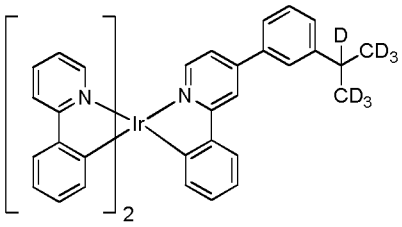
Compound 88 ,



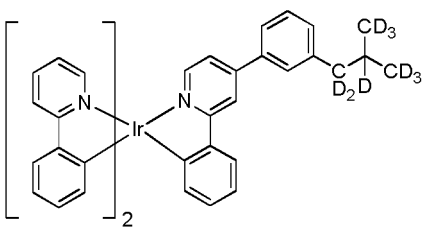
Compound 89 ,



Compound 90 ,



Compound 91 ,



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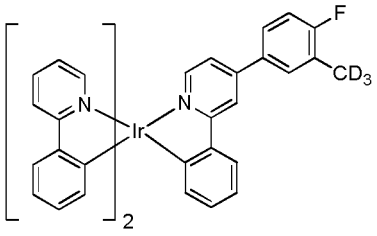

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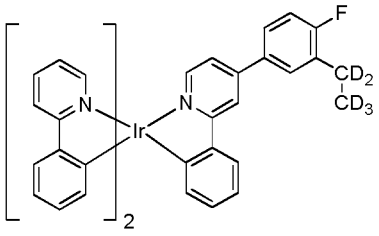

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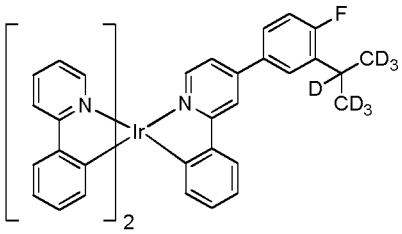

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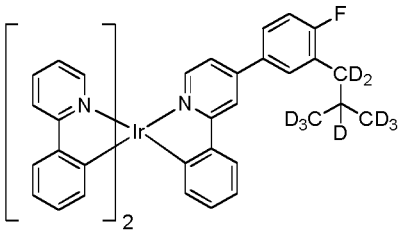

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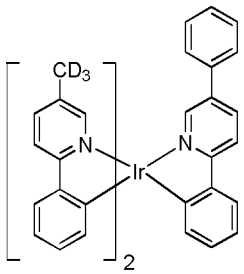

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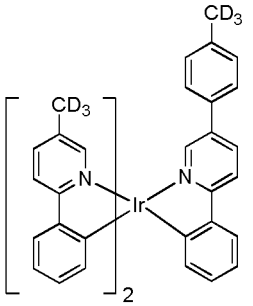

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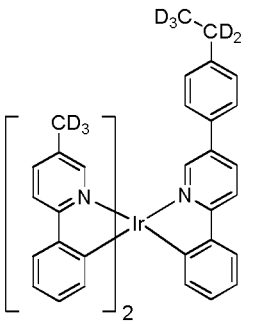

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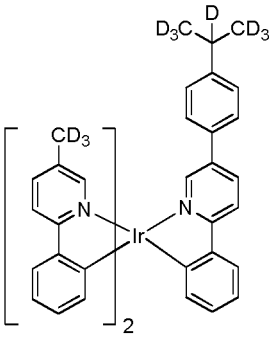

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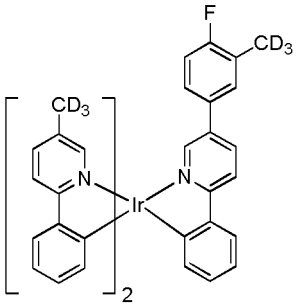

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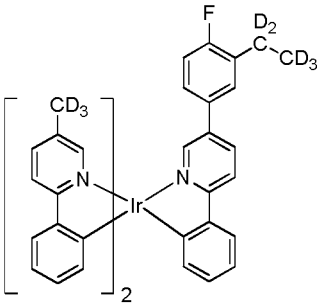

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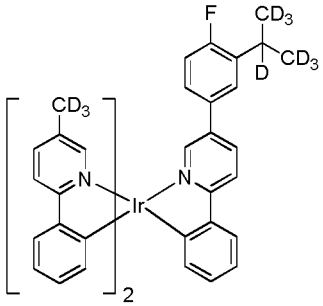

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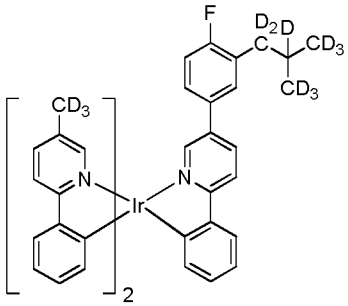

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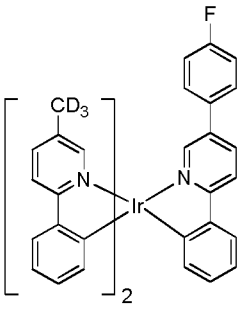

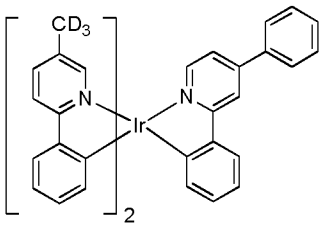

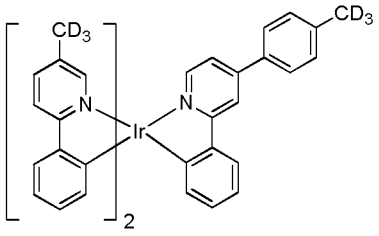

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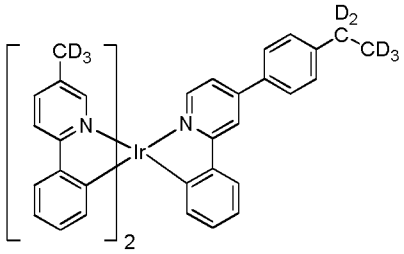

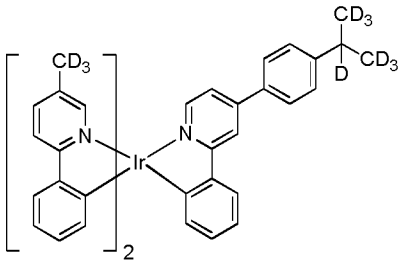

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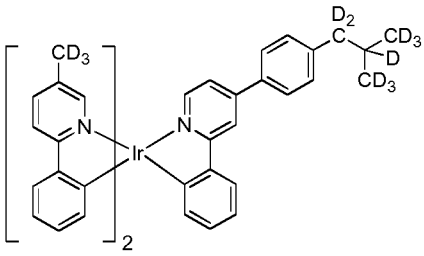

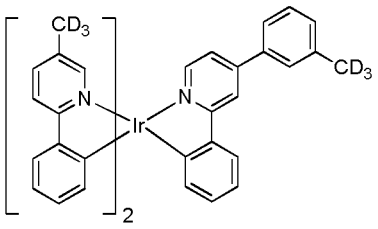

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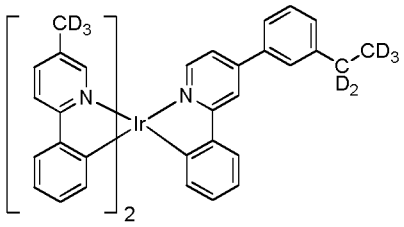

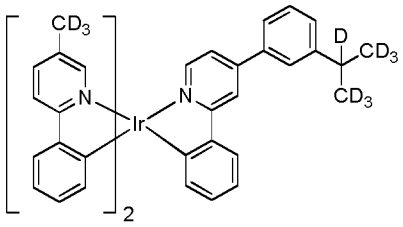

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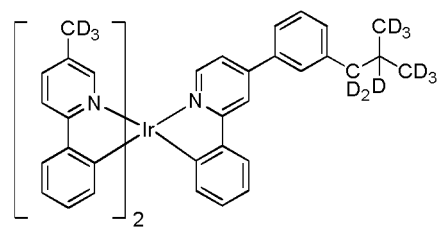
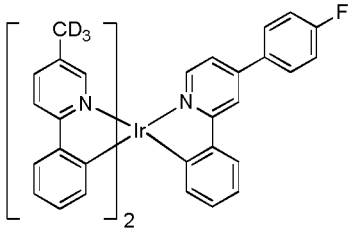
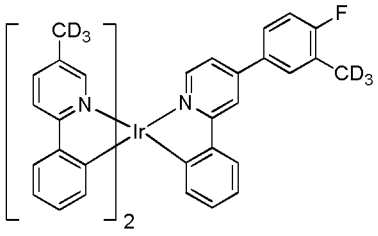


Compound 124 , 

Compound 125 , 

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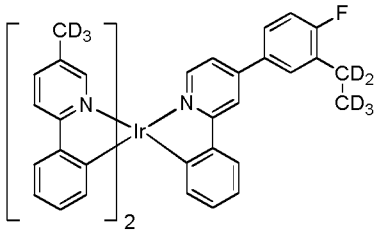
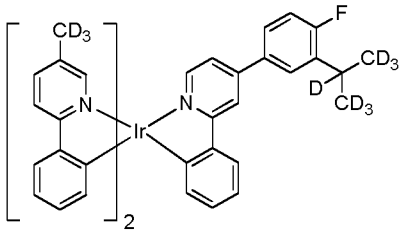
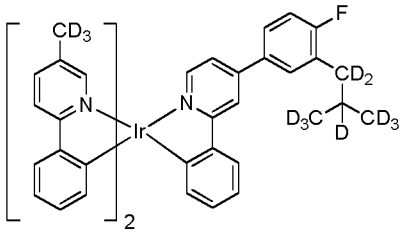


Compound 127 , 

Compound 128 , 

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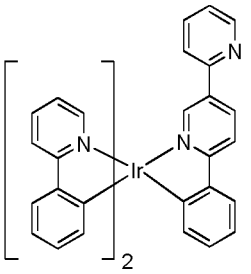
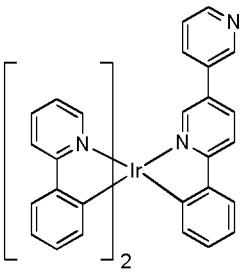
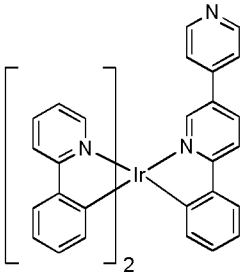
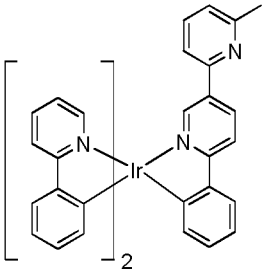


Compound 130 , 

Compound 131 , 

Compound132 , 

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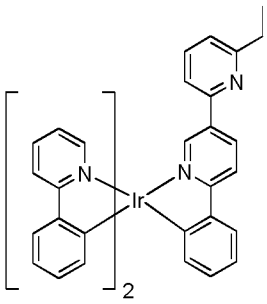
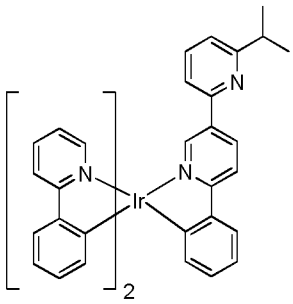
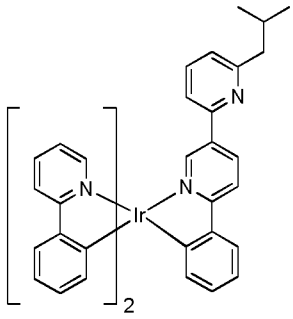
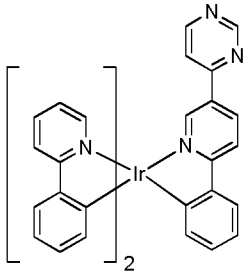


Compound 134 , 

Compound 135 , 

Compound 136 , 

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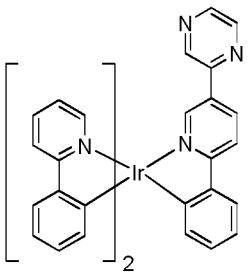

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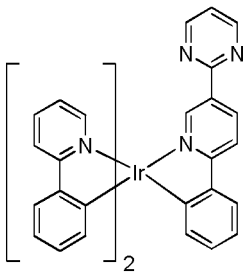

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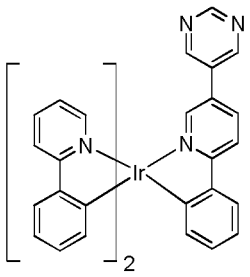

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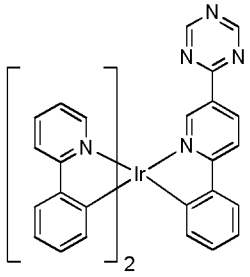

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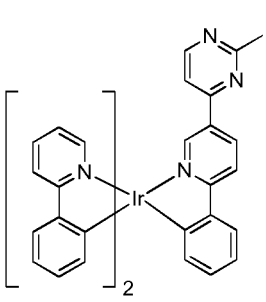

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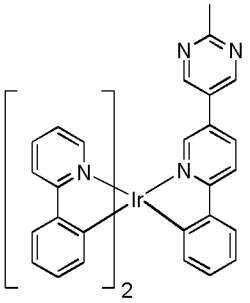

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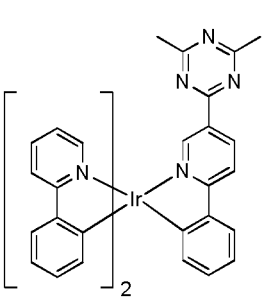

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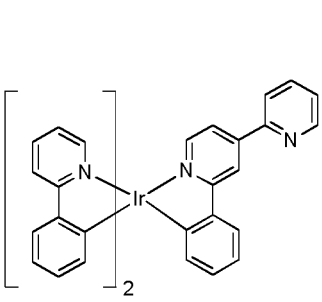

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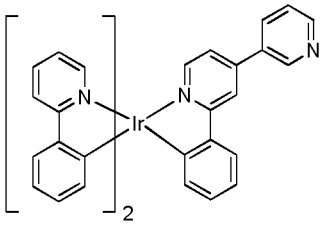

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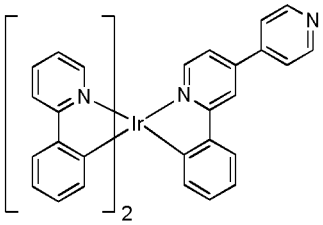

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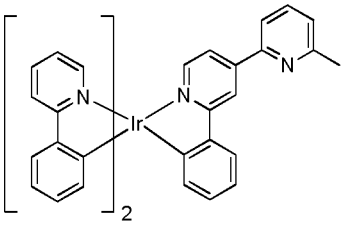

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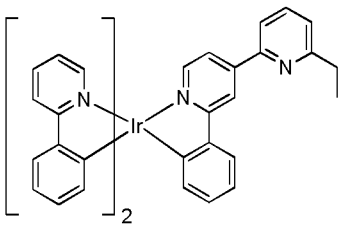

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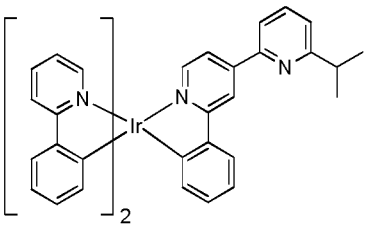

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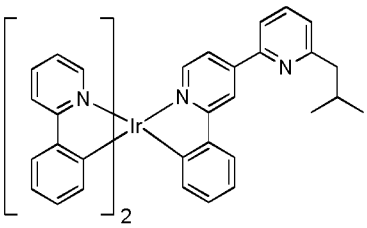

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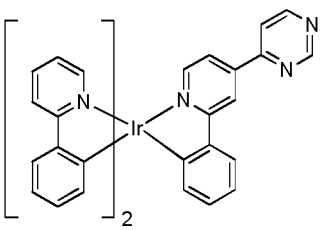

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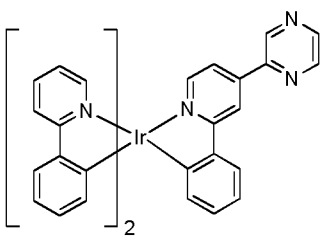

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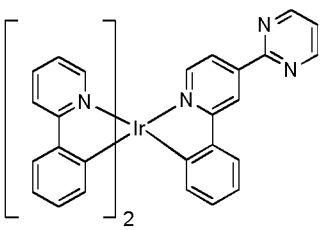

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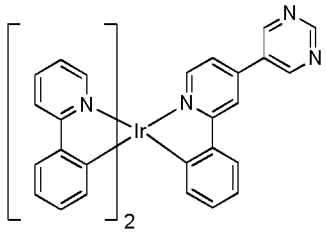
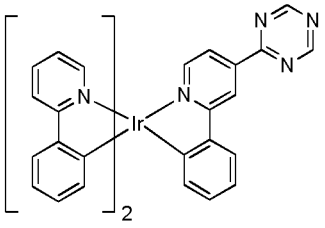
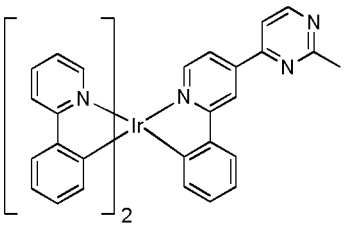


Compound 155 , 

Compound 156 , 

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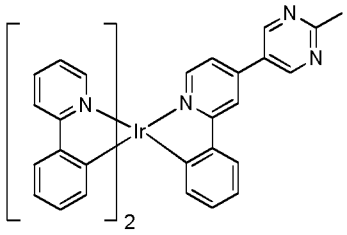
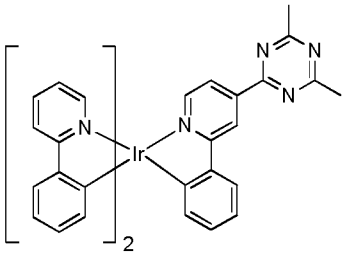
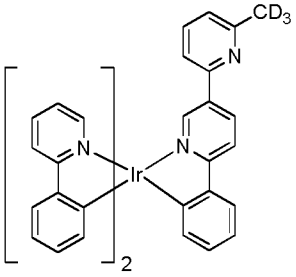


Compound 158 , 

Compound 159 , 

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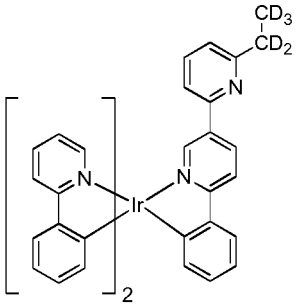
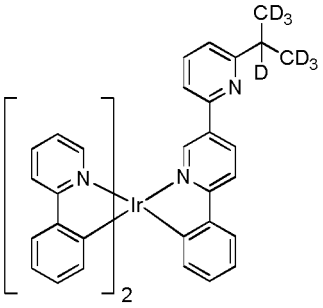
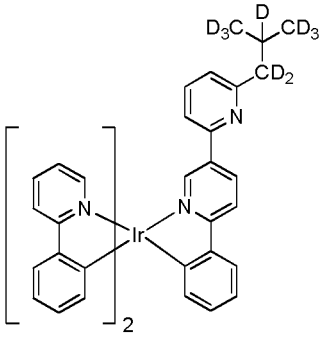


Compound 161 , 

Compound 162 , 

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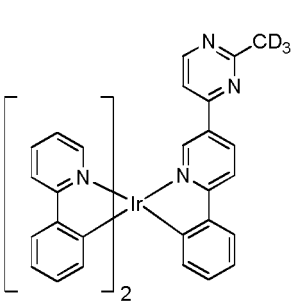
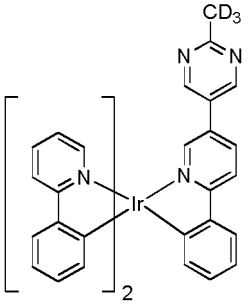
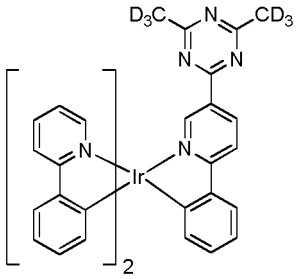


Compound 164 , 

Compound 165 , 

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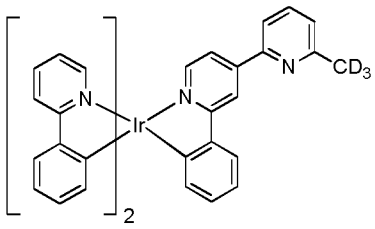

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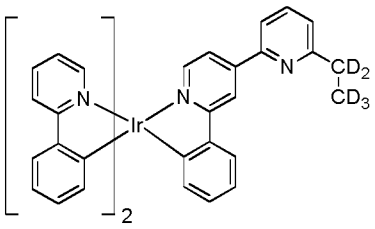

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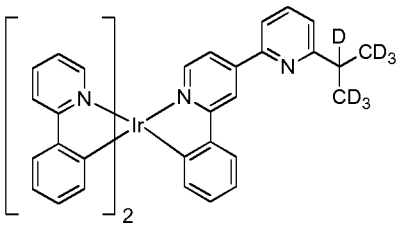

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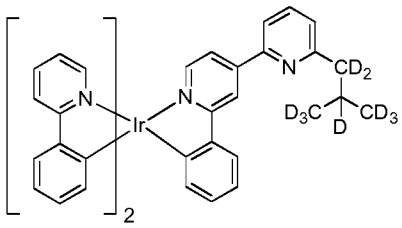

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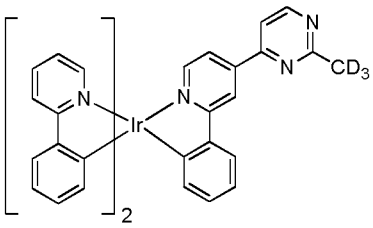

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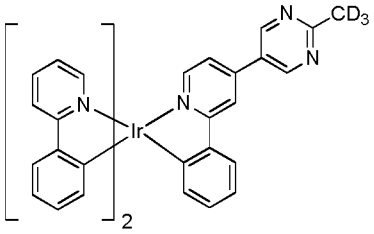

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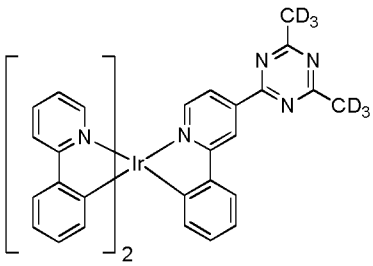

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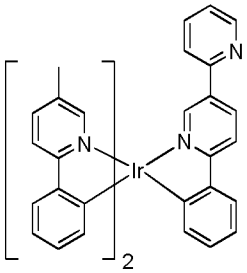

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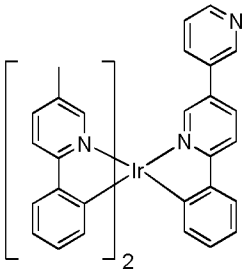

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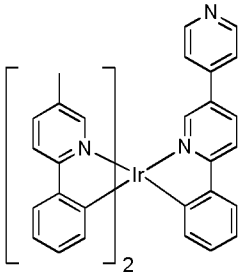

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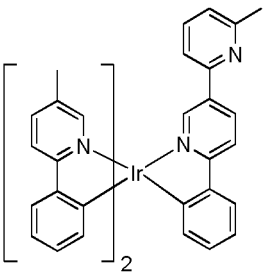

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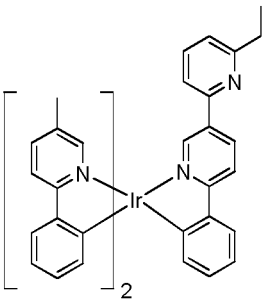

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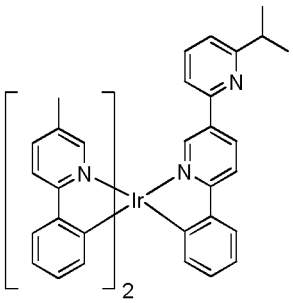

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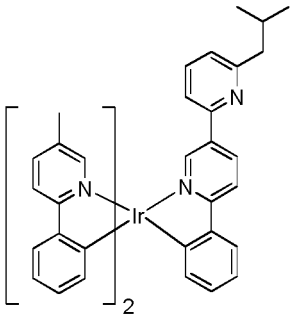

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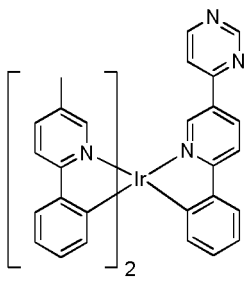

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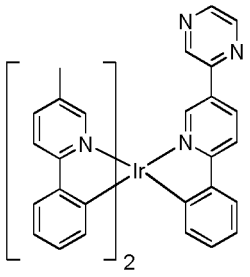

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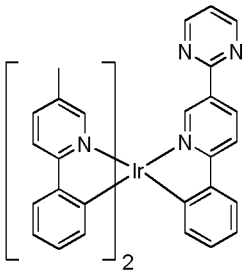

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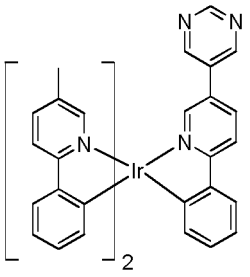

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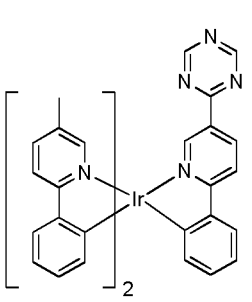

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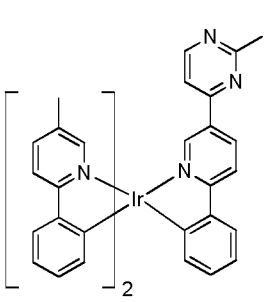

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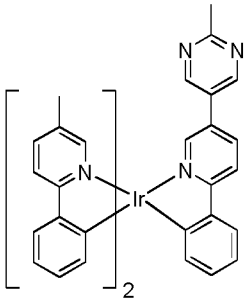

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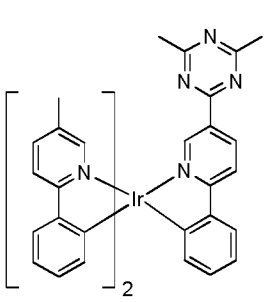

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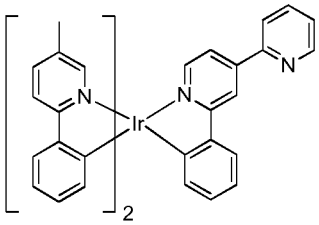

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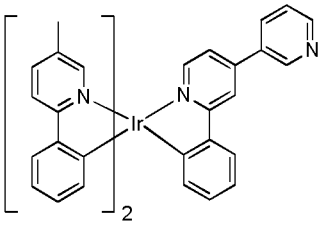

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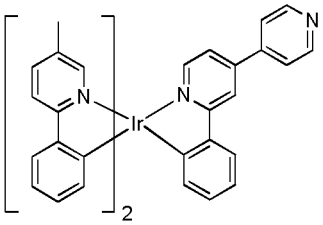

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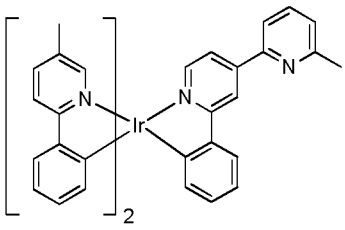

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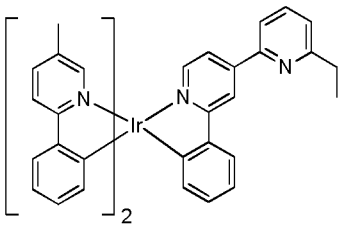

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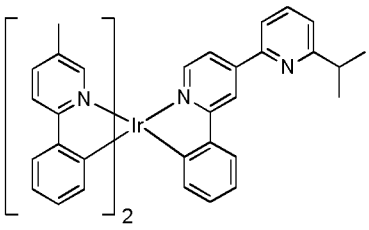

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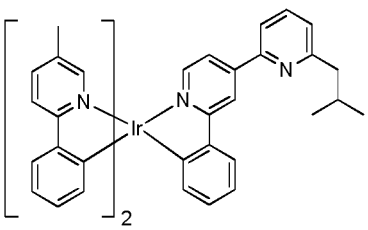

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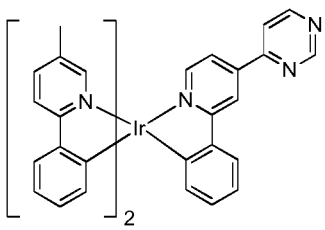

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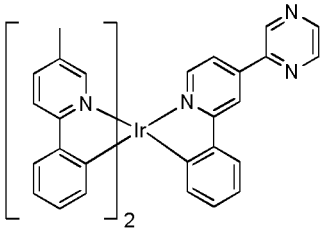

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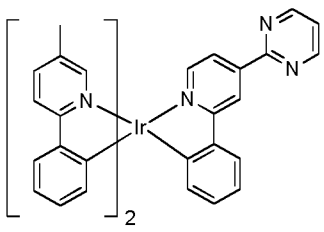

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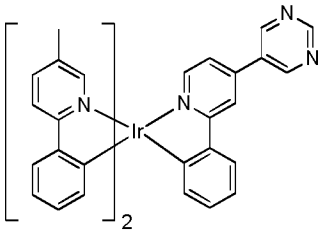

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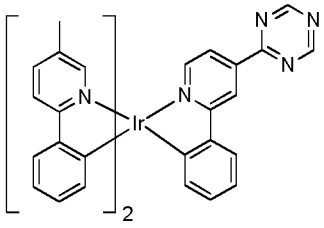

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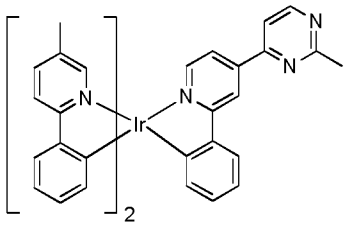

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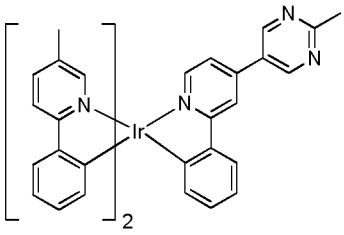

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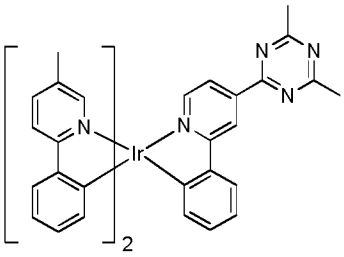

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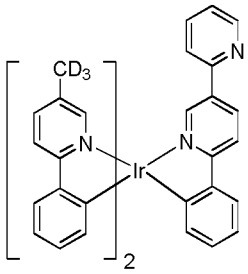

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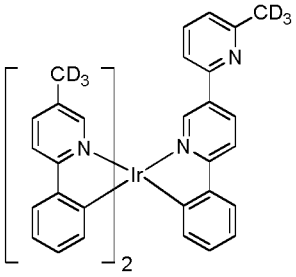

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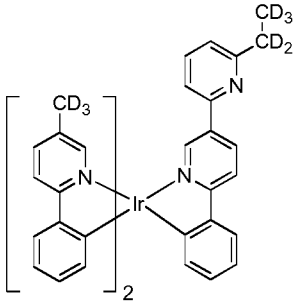

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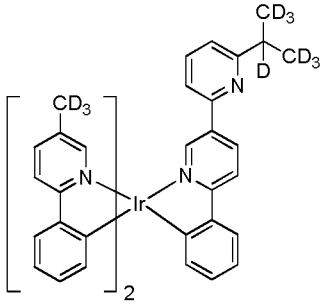

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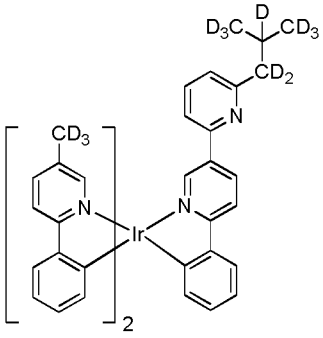

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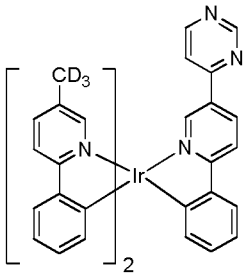

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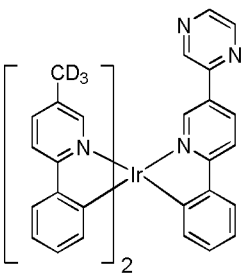

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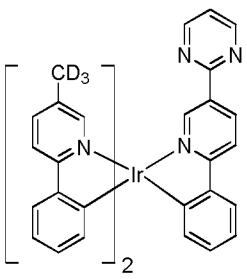

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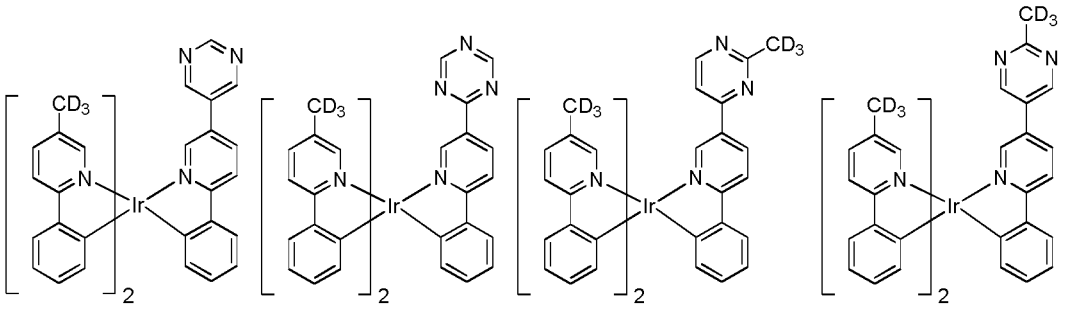

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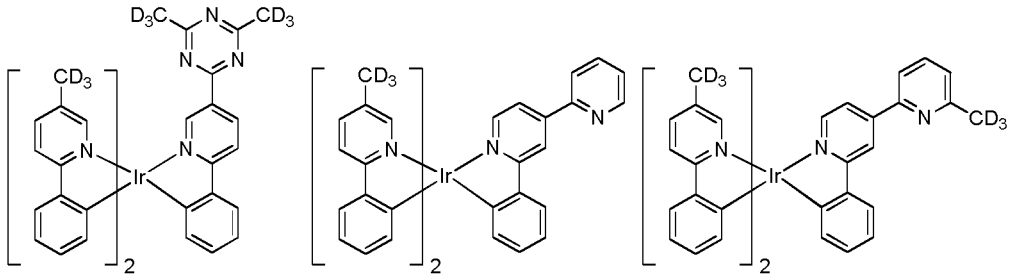

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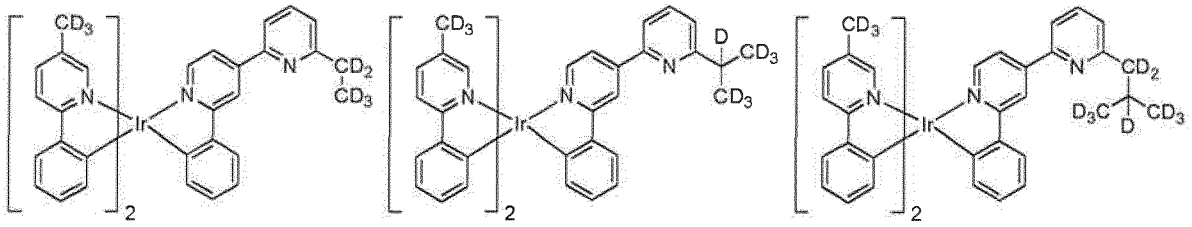

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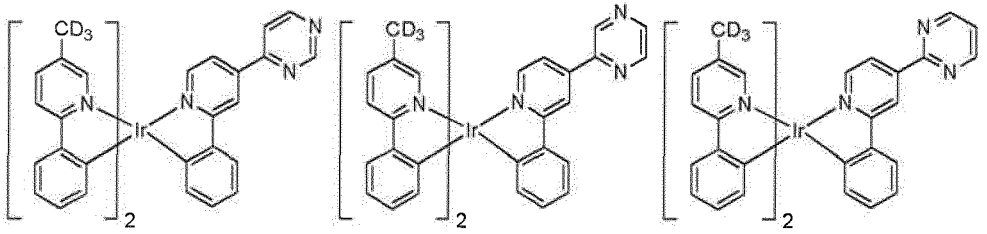
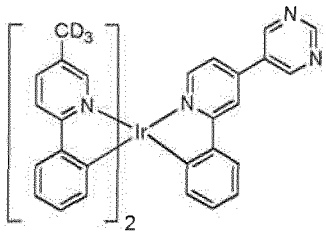
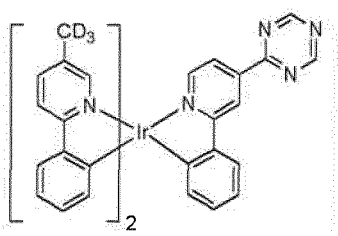


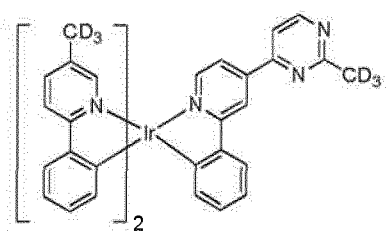
Compound 222, Compound 223, Compound 224.



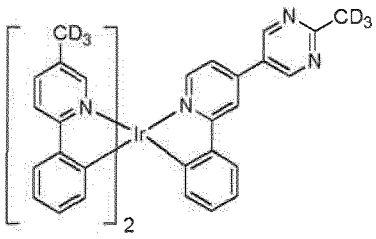
Compound 225



Compound 226

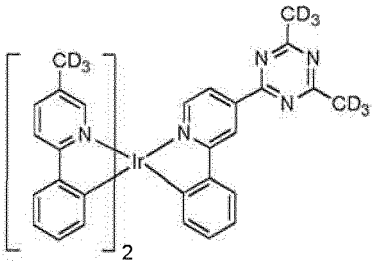


Compound 227



Compound 228

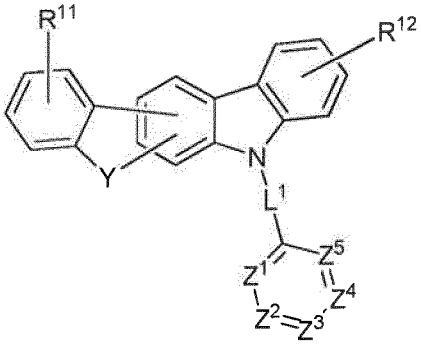
, and



Compound 229

[0111] In the aspect of the composition wherein the first compound and the second compound each independently has the formula of $Ir(L^1)_2(L^2)$ as defined above, the mixture of the first compound and the second compound is selected from the group consisting of: (Compound 7 and Compound 130), (Compound 8 and Compound 131), (Compound 25 and Compound 131), (Compound 27 and Compound 135), (Compound 20 and Compound 145), (Compound 25 and Compound 148), (Compound 40 and Compound 174), (Compound 103 and Compound 204), and (Compound 116 and Compound 217).

[0112] In an aspect of the composition comprising a mixture of a first compound and a second compound, wherein the first compound has a difference chemical structure than the second compound, wherein the first compound is capable of functioning as a phosphorescent emitter in an OLED at room temperature, the first compound has a structure accoreding to Formula V:



, Formula V;

wherein

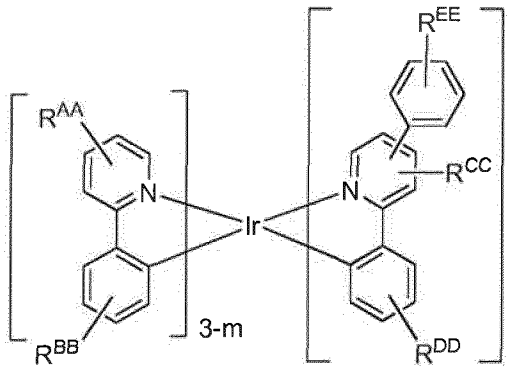
R^{11} and R^{12} each independently represent mono, di, tri, tetra substitutions, or no substitution; Y is selected from the group consisting of O, S. Se, NR' and CR"R"';

L^1 is a single bond or comprises an aryl or heteroaryl group having from 5-24 carbon atoms, which is optionally further substituted;

Z^1, Z^2, Z^3, Z^4 and Z^5 are each independently selected from group consisting of CR"" and N; at least one of Z^1, Z^2, Z^3, Z^4 and Z^5 is N; and

R^{11}, R^{12}, R', R", R'" and R""are each 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 acid, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; wherein the second compound has the Formula VI:



, Formula VI;

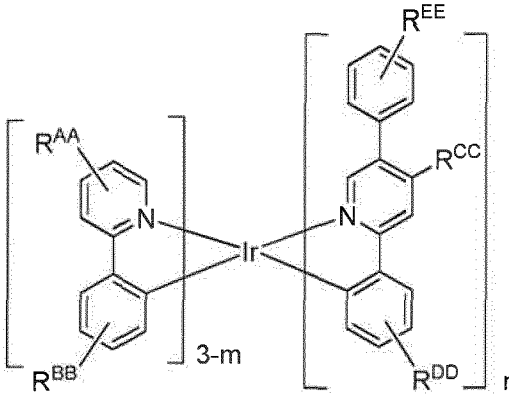
wherein

R^{AA}, R^{BB} , R^{DD}, and R^{EE} each independently represent mono, di, tri, tetra substitutions, or no substitution;
R^{CC} represent mono, di, tri substitutions, or no substitution;
R^{AA}, R^{BB}, R^{CC}, R^{DD}, and R^{EE} are each 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 acid, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; and
m is 1 or 2.

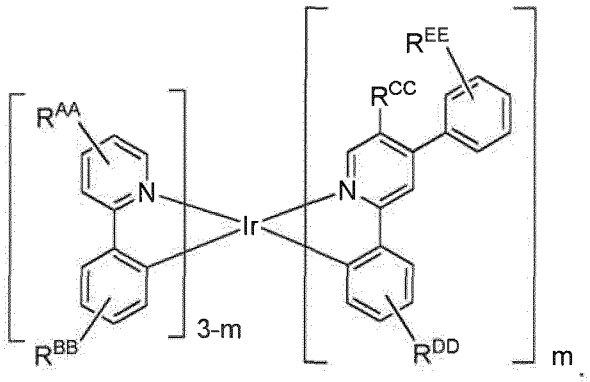
[0113] In one embodiment, where the second compound has the structure according to Formula II defined above, X^1, X^3 and X^5 are N; and X^2 and X^4 are CR"".

[0114] In an aspect
, where the second compound has the structure according to
Formula VI, m is 1. In another embodiment, R^{AA}, R^{BB}, R^{CC}, and R^{DD} are each independently selected from the group consisting of hydrogen, deuterium, alkyl, cycloalkyl, and combinations thereof. In another embodiment, R^{EE} is selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, and combinations thereof.

[0115] In the aspect
, where the second compound has the structure according to
Formula VI defined above, the second compound is selected from the group consisting of:

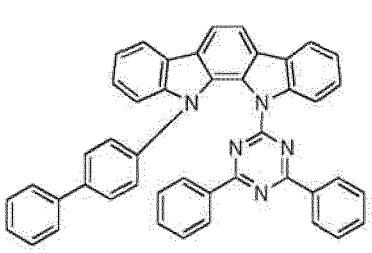


, and

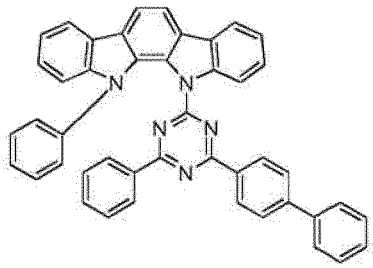


.

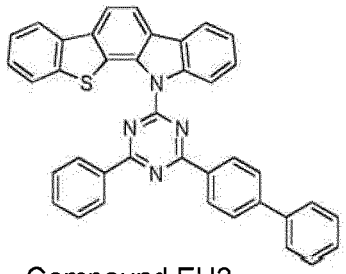
[0116] In the aspect
, where the first compound has the structure according to
Formula V defined above, the first compound is selected from the group consisting of:



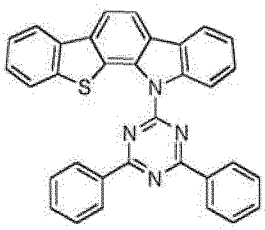
Compound EH1



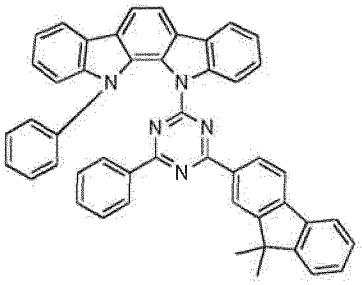
Compound EH2



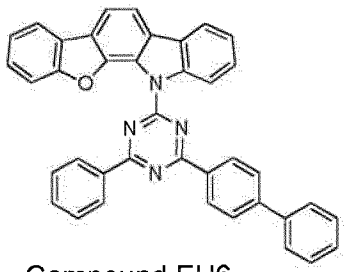
Compound EH3



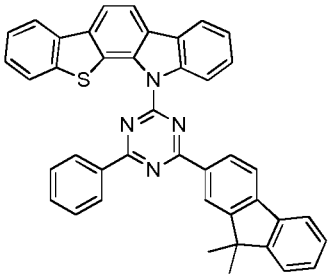
Compound EH4



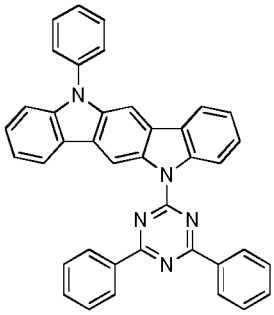
Compound EH5



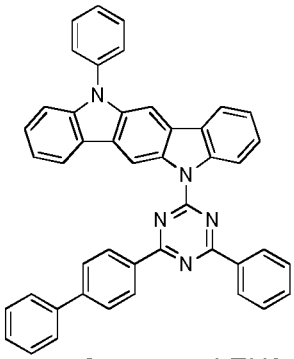
Compound EH6



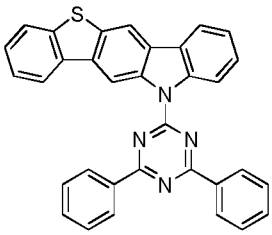
Compound EH7



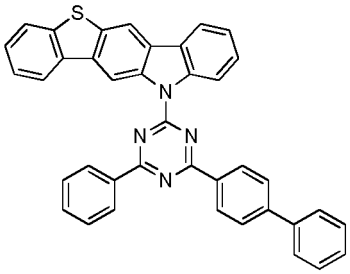
Compound EH8



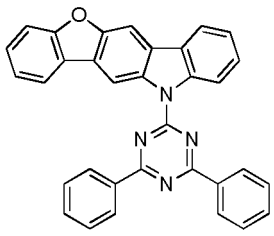
Compound EH9



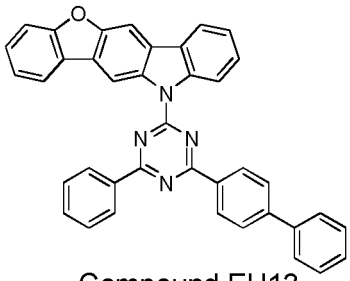
Compound EH10



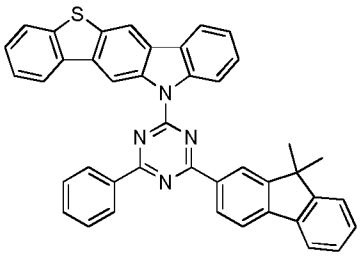
Compound EH11



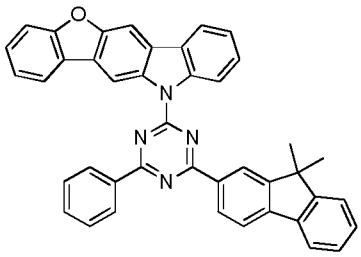
Compound EH12



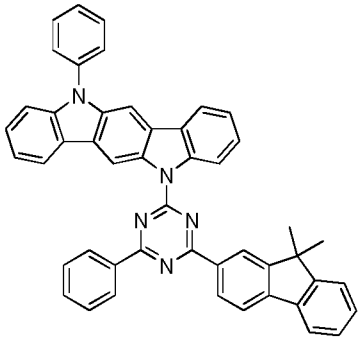
Compound EH13



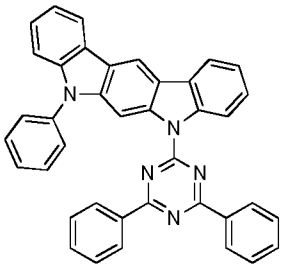
Compound EH14 ,



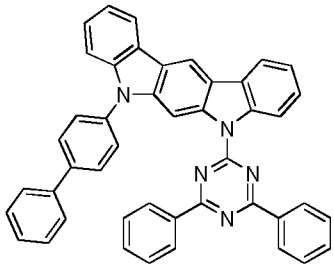
Compound EH15 ,



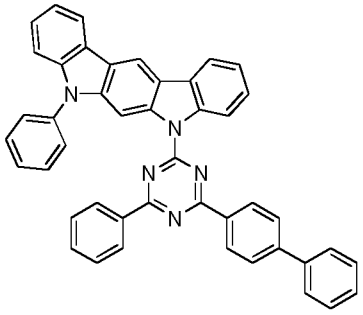
Compound EH16 ,



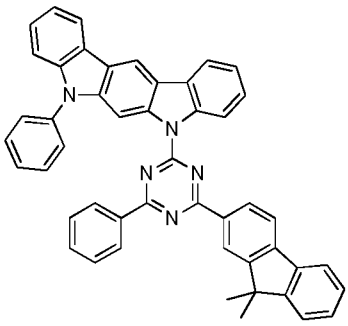
Compound EH17 ,



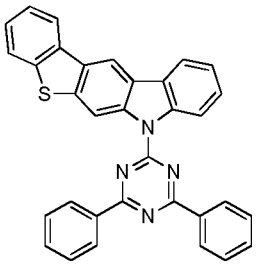
Compound EH18 ,



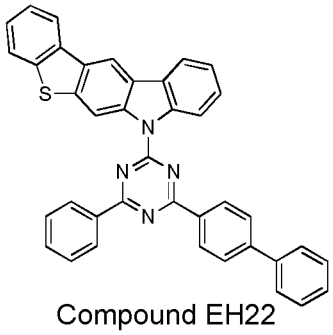
Compound EH19 ,



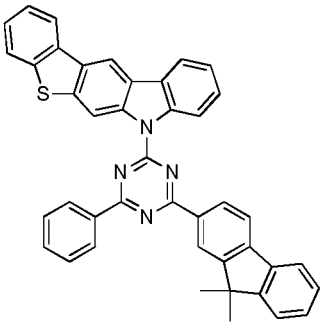
Compound EH20 ,



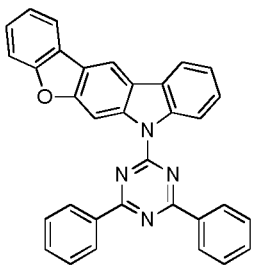
Compound EH21 ,



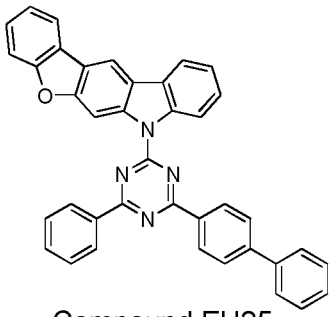
Compound EH22 ,



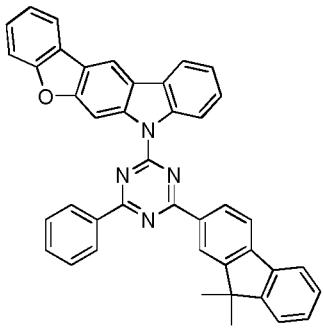
Compound EH23 ,



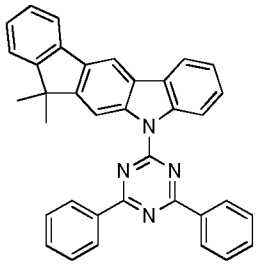
Compound EH24 ,



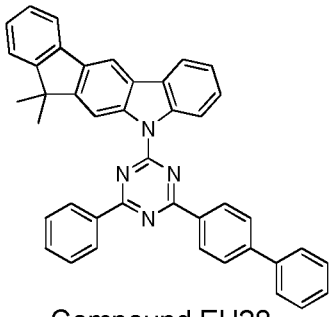
Compound EH25 ,



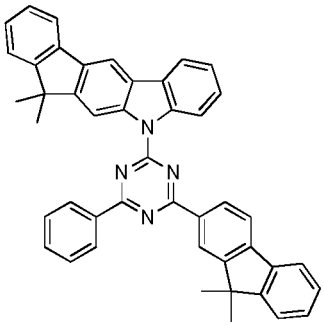
Compound EH26 ,



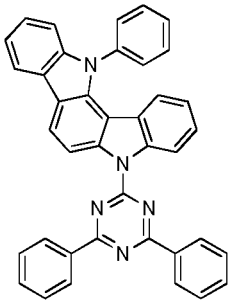
Compound EH27 ,



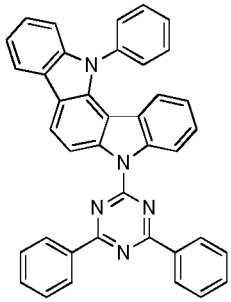
Compound EH28 ,



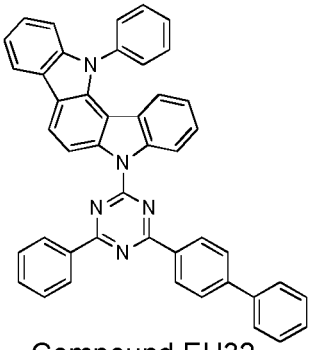
Compound EH29 ,



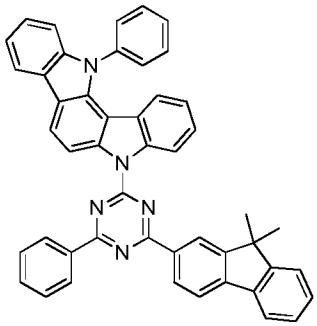
Compound EH30 ,



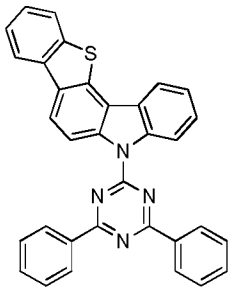
Compound EH31 ,



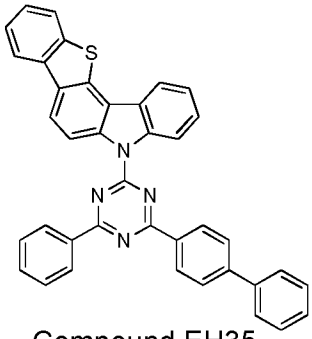
Compound EH32 ,



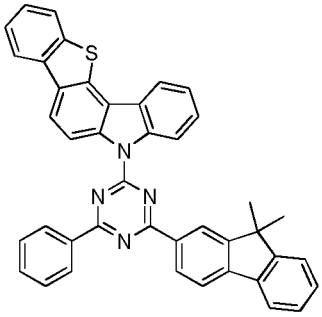
Compound EH33 ,



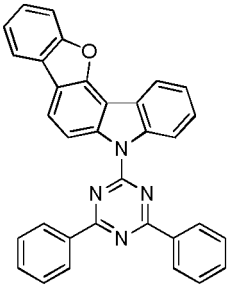
Compound EH34 ,



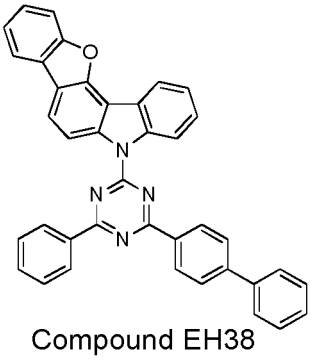
Compound EH35 ,



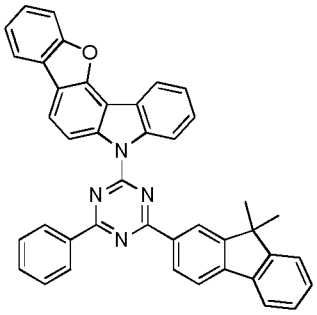
Compound EH36 ,



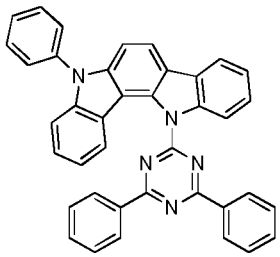
Compound EH37 ,



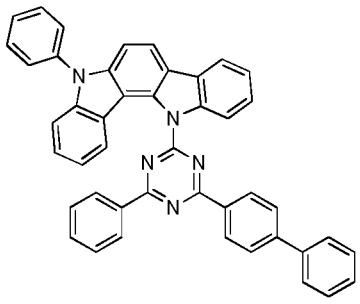
Compound EH38 ,



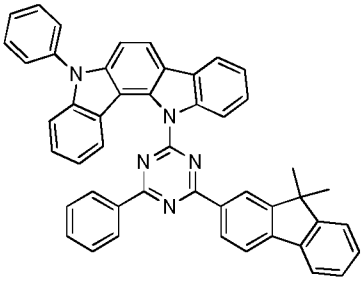
Compound EH39 ,



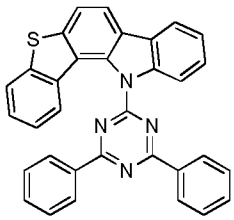
Compound EH40 ,



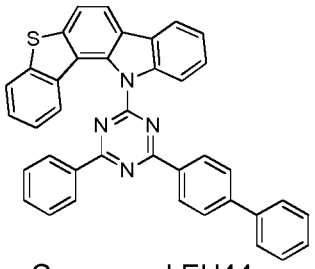
Compound EH41 ,



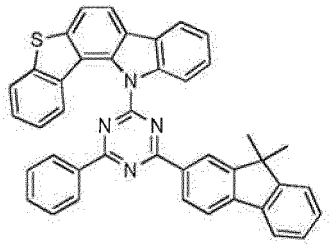
Compound EH42 ,



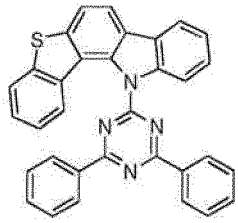
Compound EH43 ,



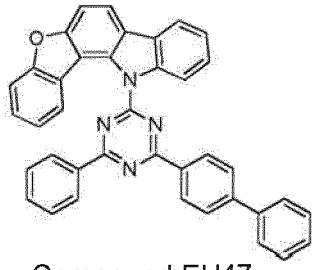
Compound EH44 ,



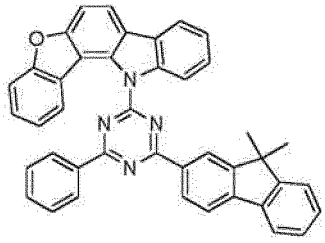
Compound EH45



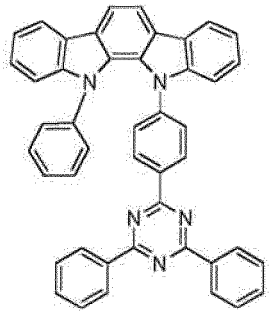
Compound EH46



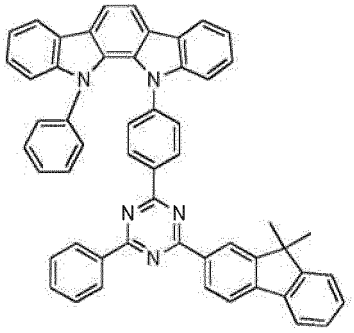
Compound EH47



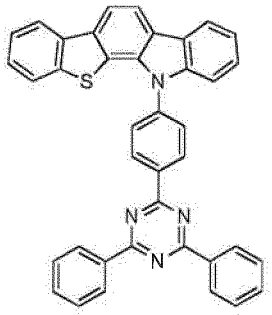
Compound EH48



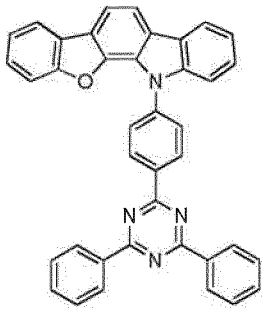
Compound EH49



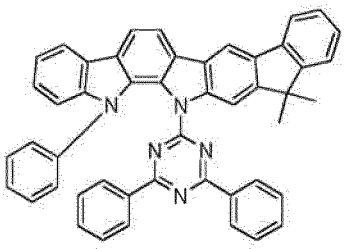
Compound EH50



Compound EH51 ,

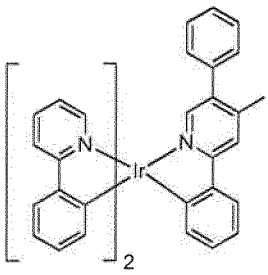


Compound EH52 , and

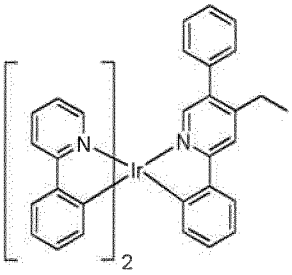


Compound EH53 .

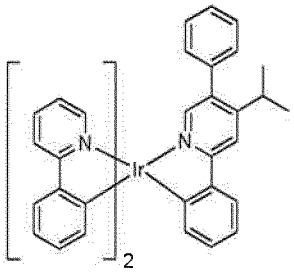
[0117] In the aspect of the composition, where the second compound has the structure according to Formula VI, the second compound is selected from the group consisting of:



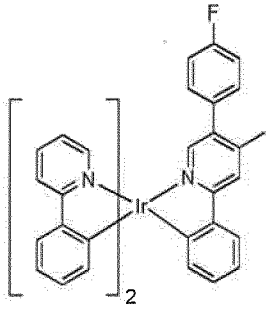
Compound 1 ,



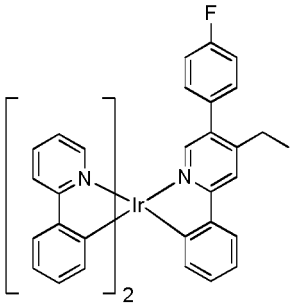
Compound 2 ,



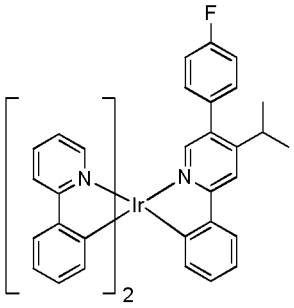
Compound 3 ,



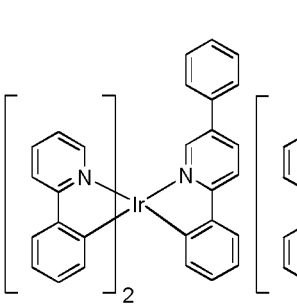
Compound 4 .



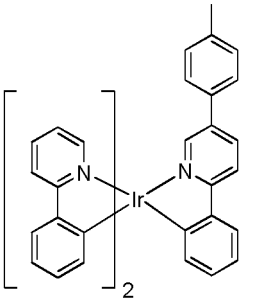
Compound 5 ,



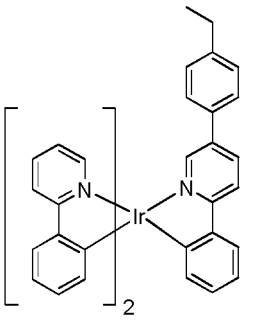
Compound 6 ,



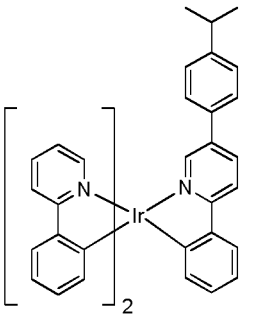
Compound 7 ,



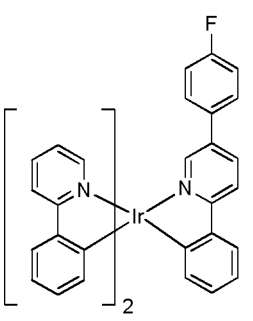
Compound 8 ,



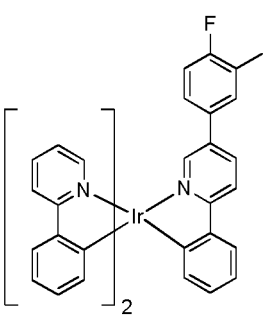
Compound 9 ,



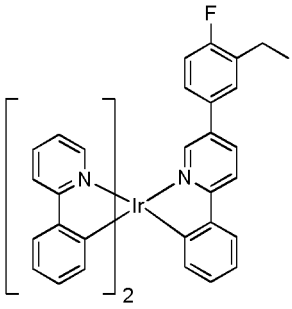
Compound 10 ,



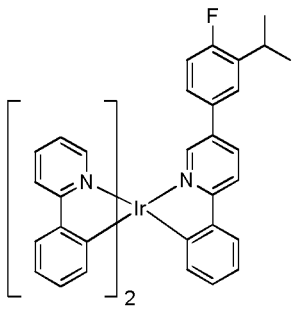
Compound 11 ,



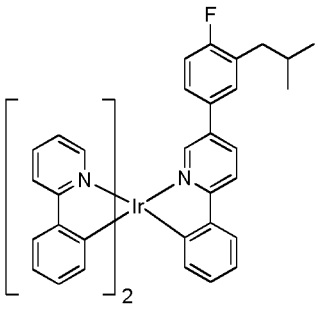
Compound 12 ,



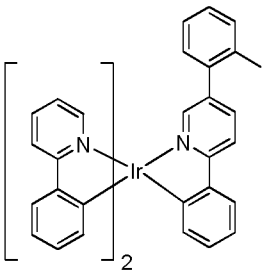
Compound 13 ,



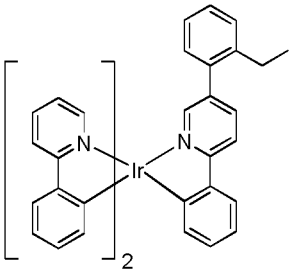
Compound 14 ,



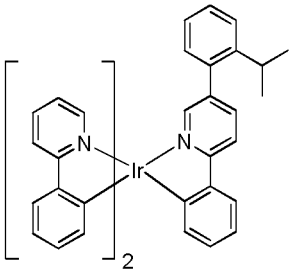
Compound 15 ,



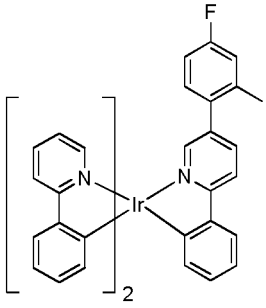
Compound 16 ,



Compound 17 ,



Compound 18 ,



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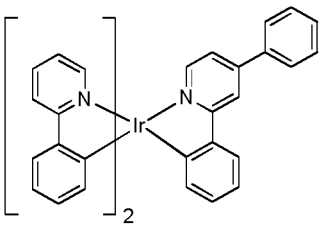
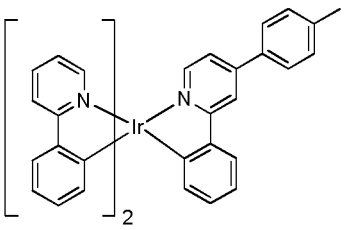
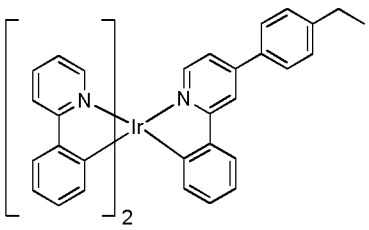


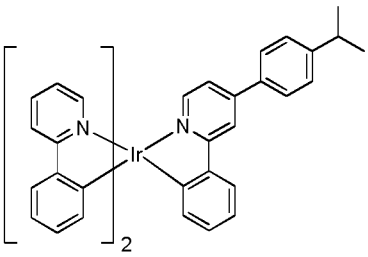
Compound 20 ,



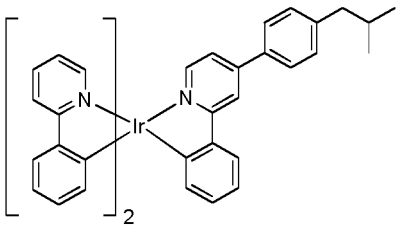
Compound 21 ,



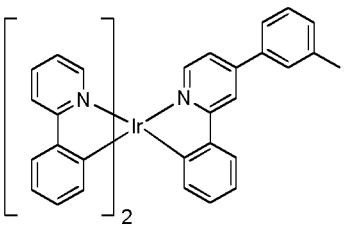
Compound 22 ,



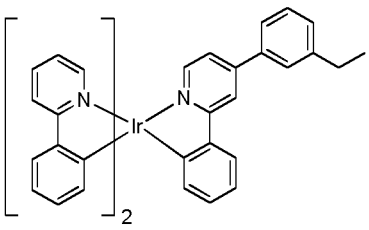
Compound 23 ,



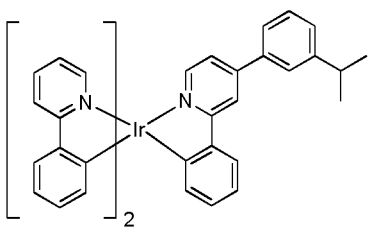
Compound 24 ,

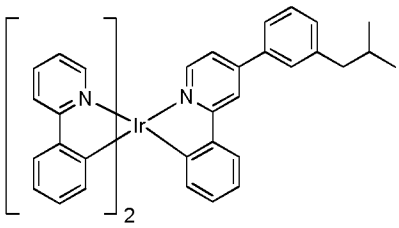


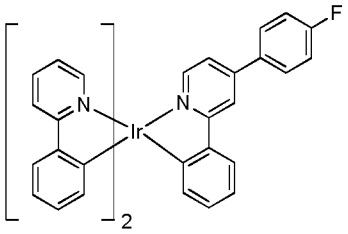
Compound 25 ,



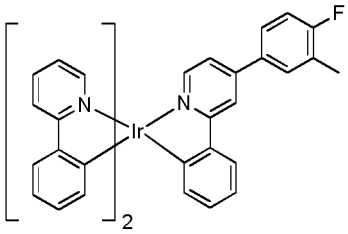
Compound 26 ,

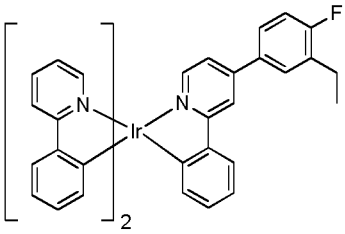


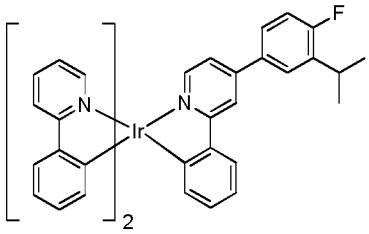
Compound 27 , 

Compound 28 , 

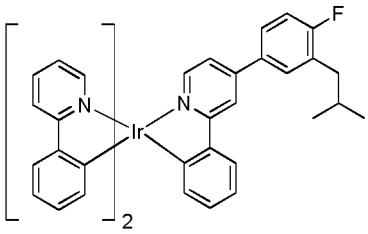
Compound 29 ,

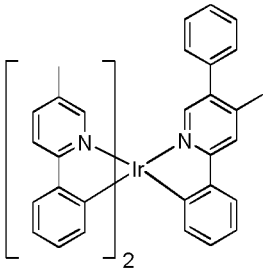


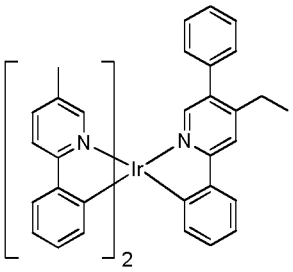
Compound 30 , 

Compound 31 , 

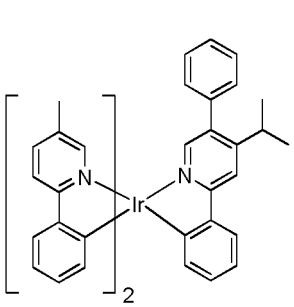
Compound 32 ,

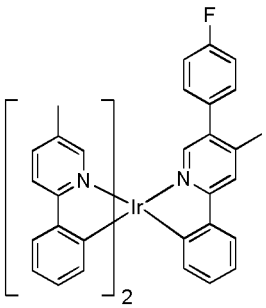


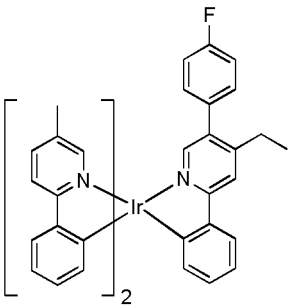
Compound 33 , 

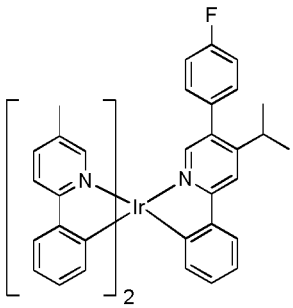
Compound 34 , 

Compound 35 ,

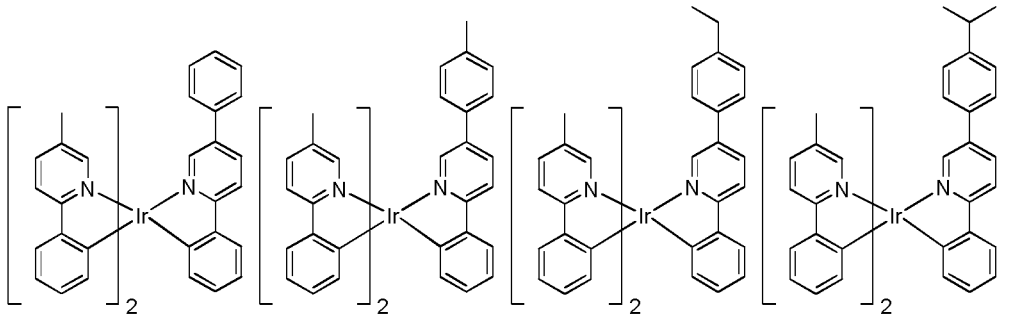


Compound 36 , 

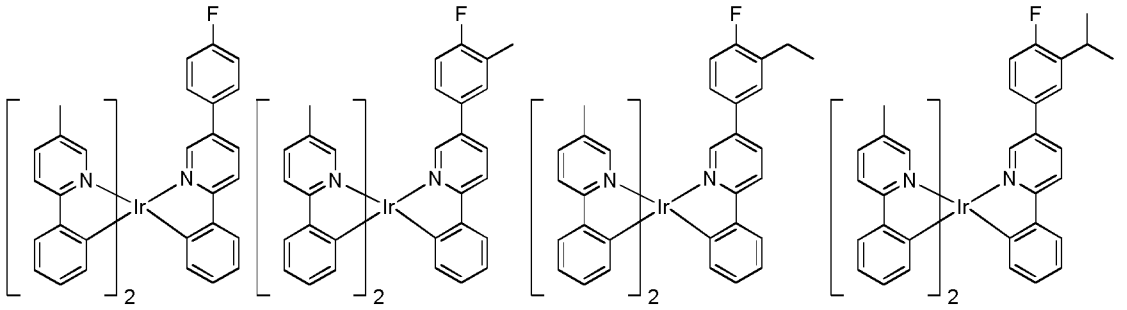
Compound 37 , 

Compound 38 , 

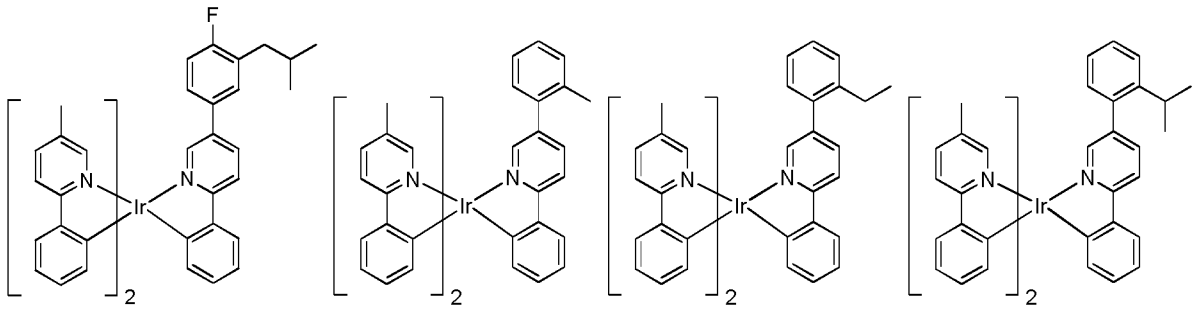
Compound 39 ,



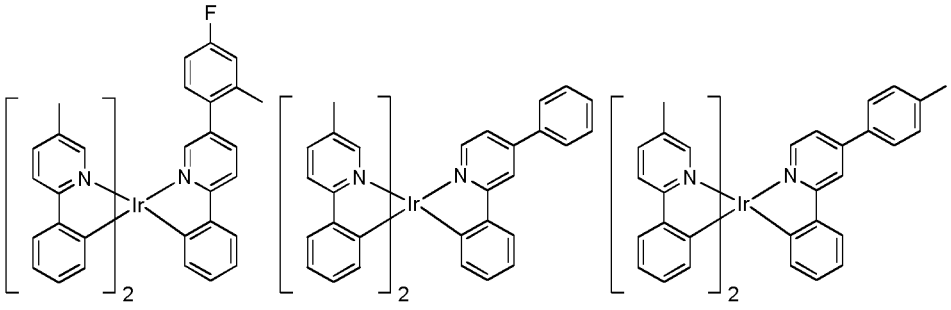
Compound 40 , Compound 41 , Compound 42 , Compound 43 ,



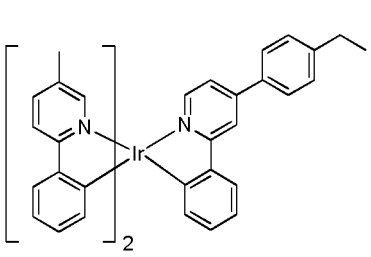
Compound 44 , Compound 45 , Compound 46 , Compound 47 ,



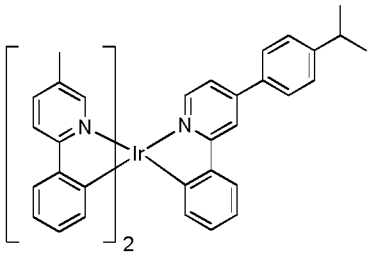
Compound 48 , Compound 49 , Compound 50 , Compound 51 ,



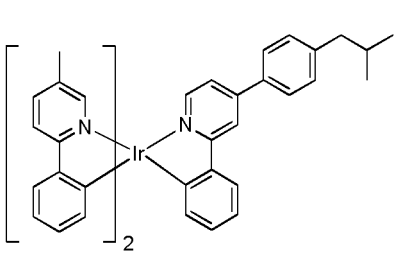
Compound 52 , Compound 53 , Compound 54 ,



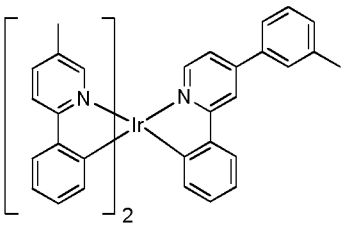
Compound 55 ,



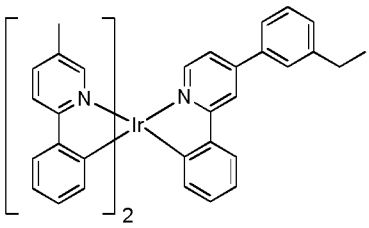
Compound 56 ,



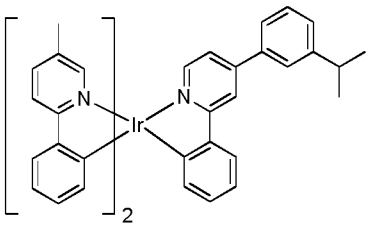
Compound 57 ,



Compound 58 ,



Compound 59 ,



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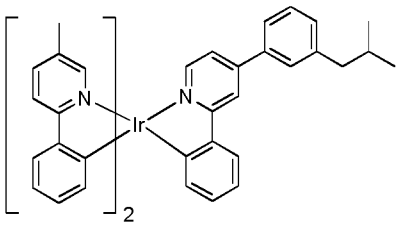

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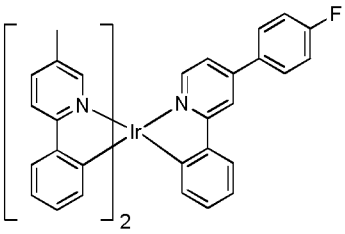

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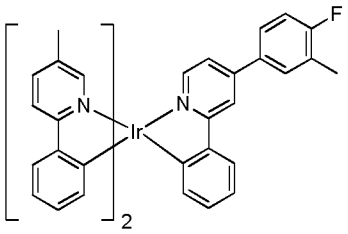

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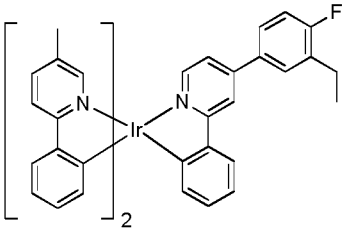

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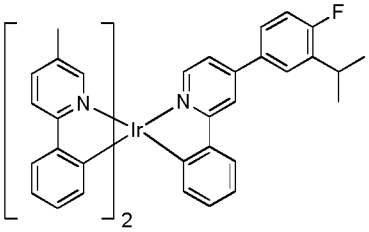

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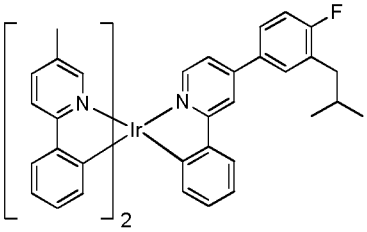

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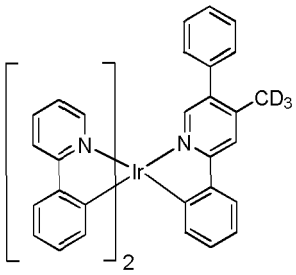

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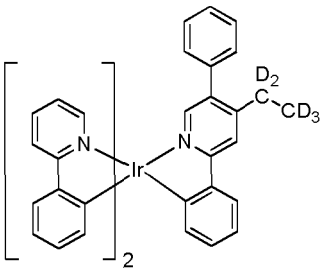

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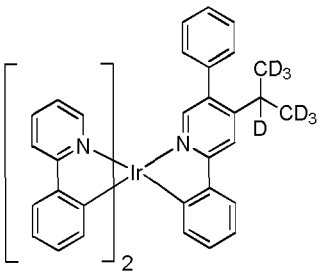

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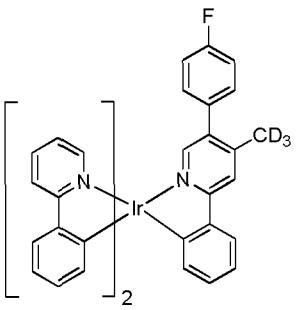

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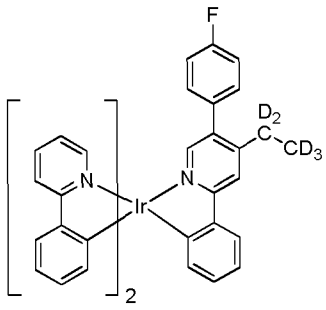

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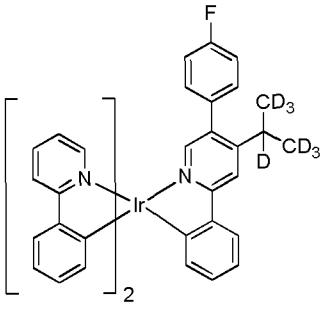

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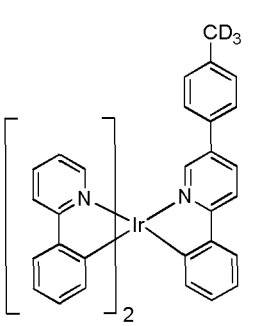

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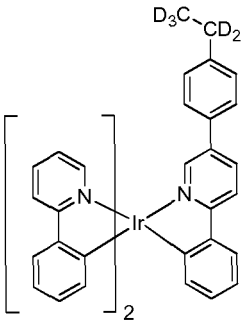

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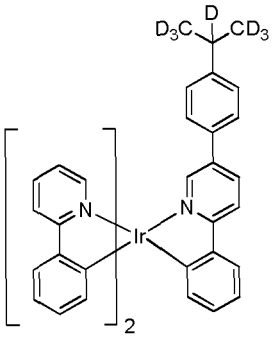

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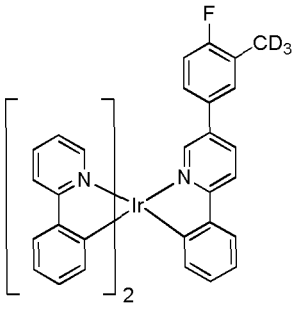

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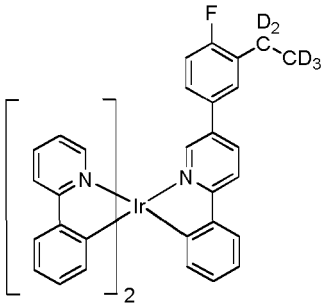

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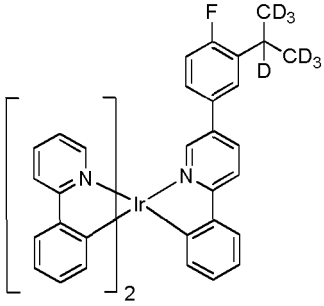

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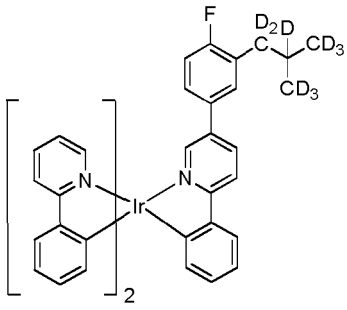

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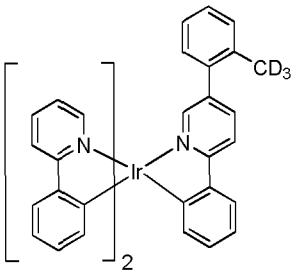

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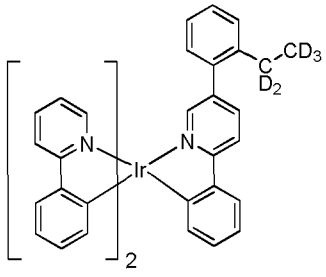

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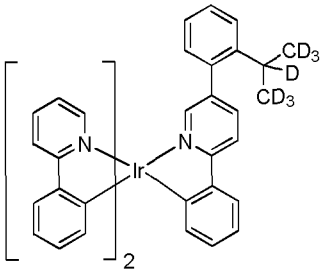

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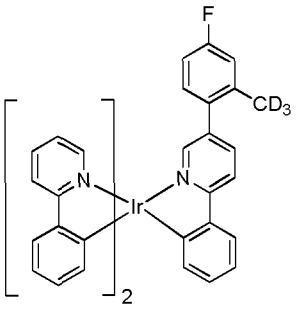

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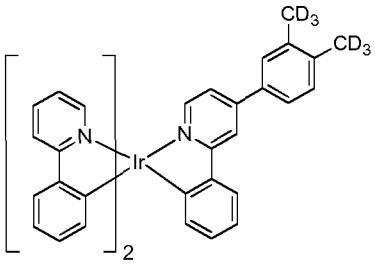

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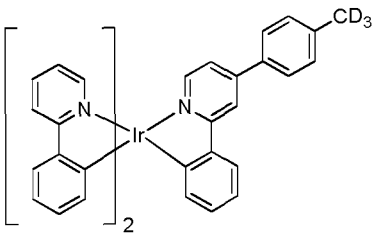

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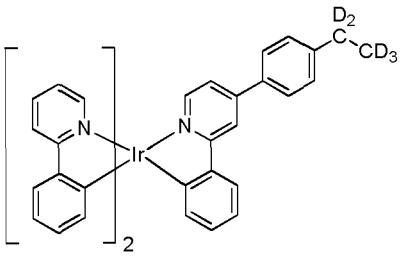

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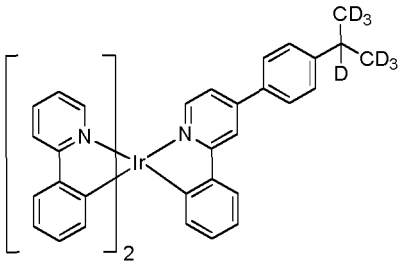

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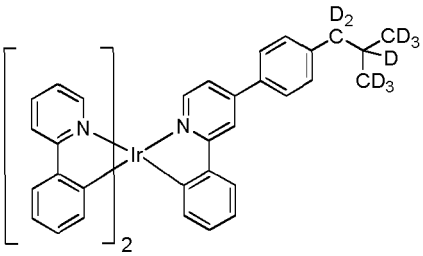

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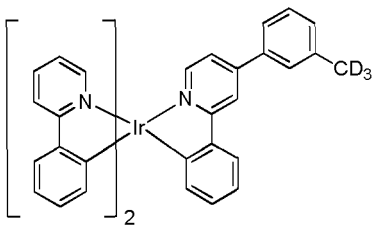

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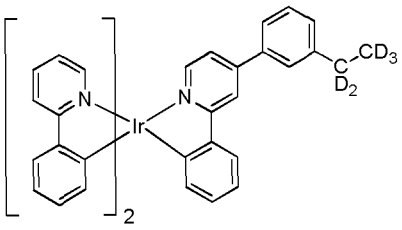

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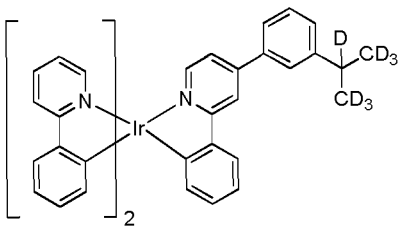

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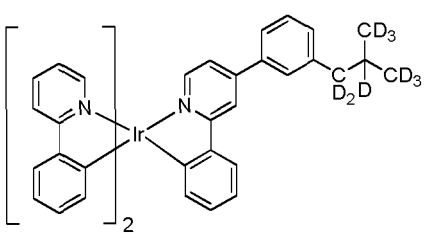

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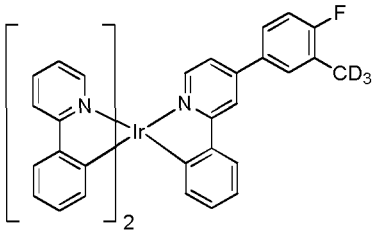

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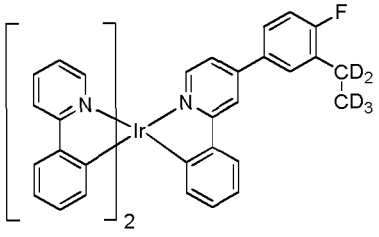

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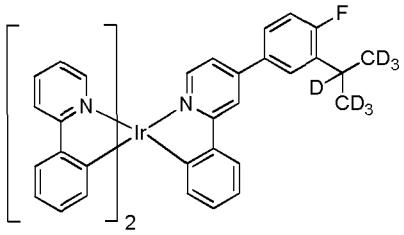

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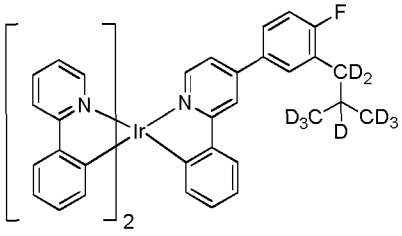

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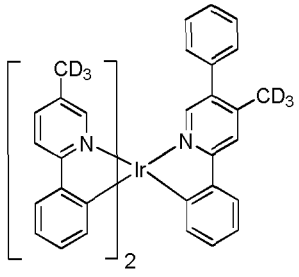

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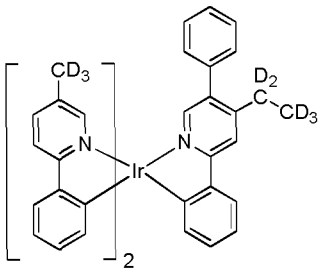

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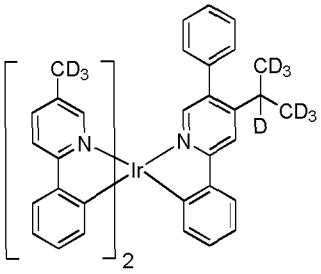

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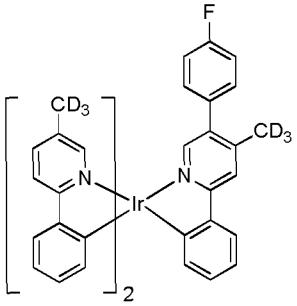

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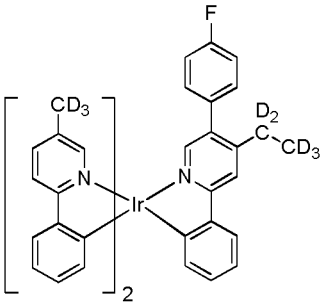

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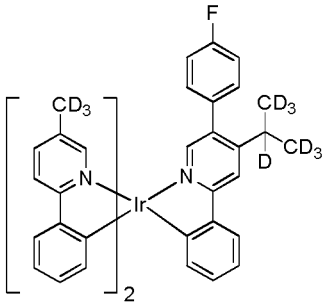

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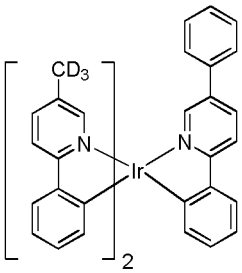

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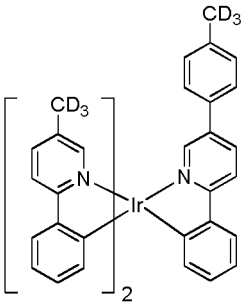

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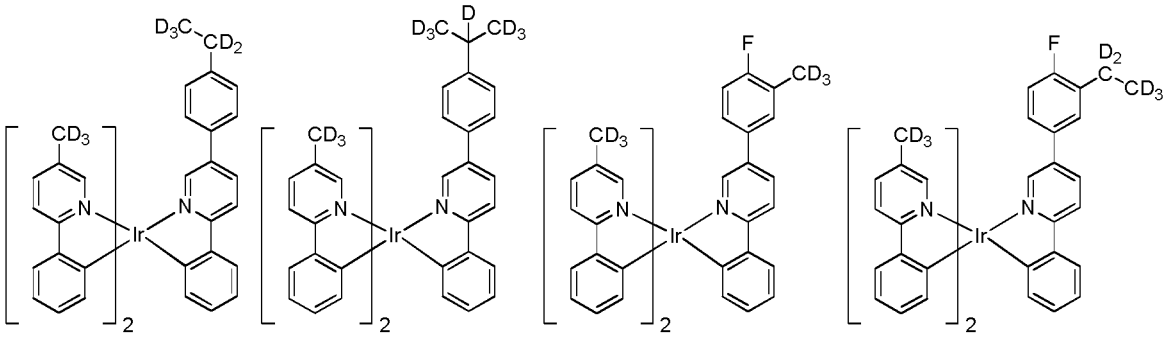
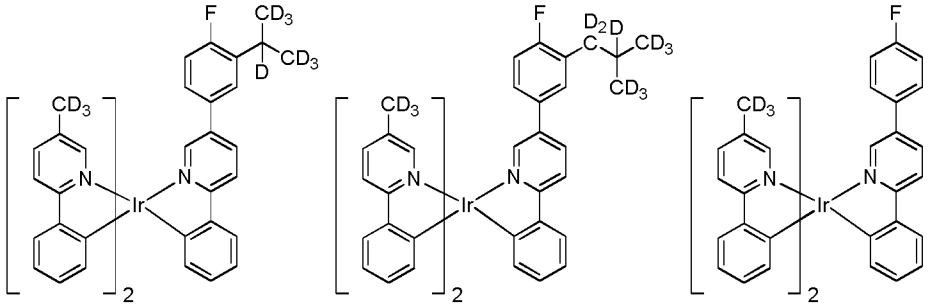
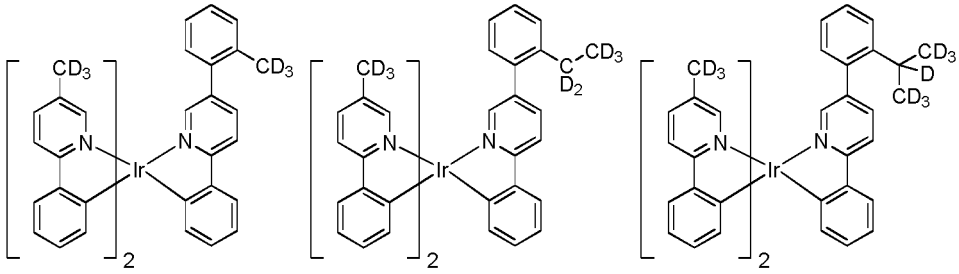


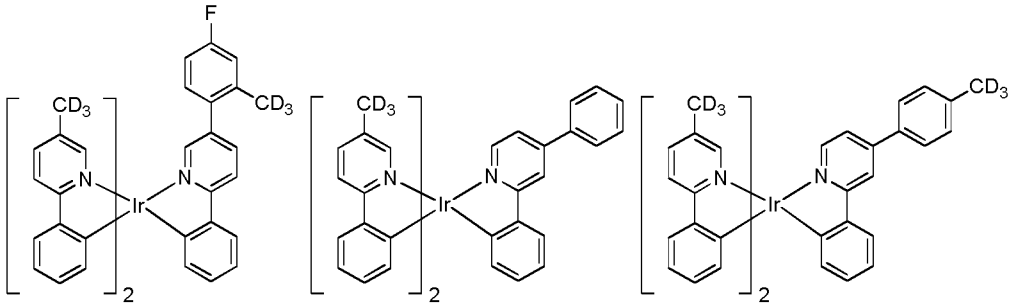
Compound 105, Compound 106, Compound 107, Compound 108,



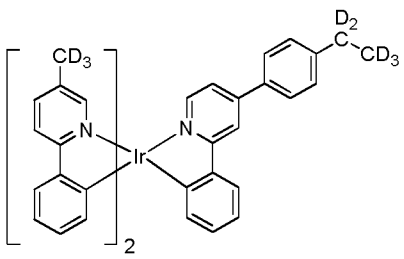
Compound 109, Compound 110, Compound 111,



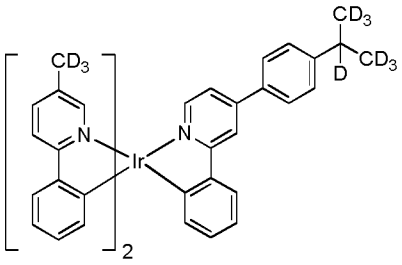
Compound 112, Compound 113, Compound 114,



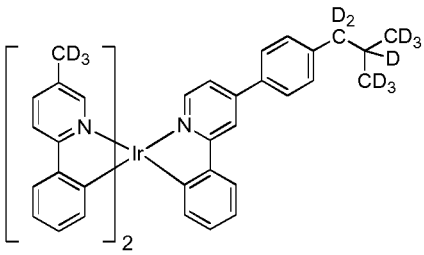
Compound 115, Compound 116, Compound 117,



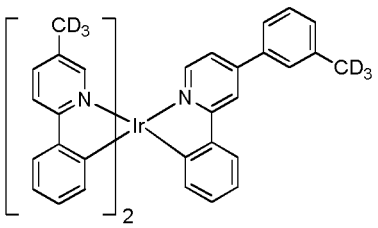
Compound 118



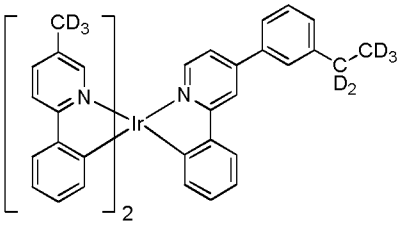
Compound 119



Compound 120



Compound 121



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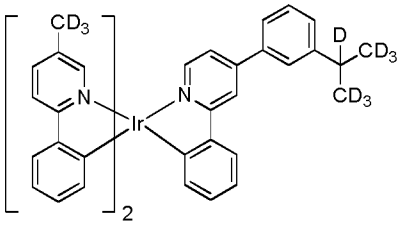

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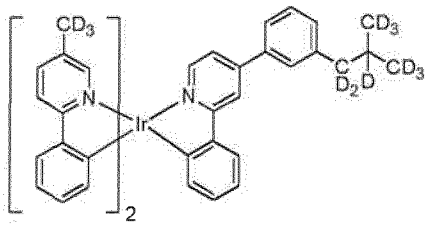
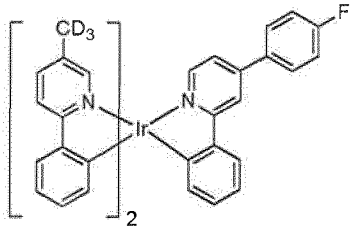
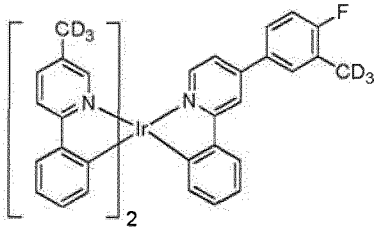


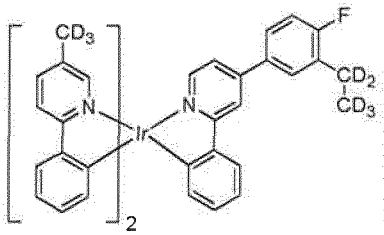
Compound 124



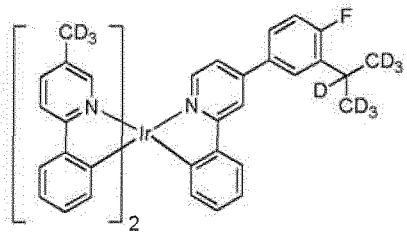
Compound 125



Compound 126

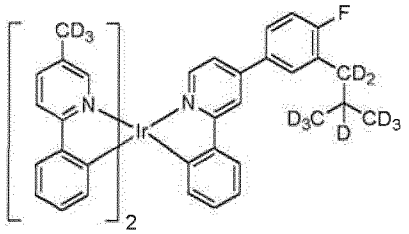


Compound 127



Compound 128

and



Compound 129

[0118] In the aspect
of the composition wherein the first compound has the structure
according to Formula V and the second compound has the structure according to Formula VI defined above, the mixture of the first compound and the second compound is selected from the group consisting of: (Compound EH1 and Compound 4), (Compound EH2 and Compound 7), (Compound EH4 and Compound 3), (Compound EH5 and Compound 11), (Compound EH8 and Compound 1), (Compound EH8 and Compound 67), (Compound EH16 and Compound 21), (Compound EH28 and Compound 29), (Compound EH40 and Compound 34), and (Compound EH40 and Compound 97).

[0119] In the aspect
of the composition wherein the first compound has the structure
according to Formula V and the second compound has the structure according to Formula VI defined above, the mixture of the first compound and the second compound is (Compound EH40 and Compound 97).

[0120] According to another aspect of the present disclosure, a first device comprising a first OLED is disclosed. The first OLED comprising: an anode; a cathode; and
an organic layer, disposed between the anode and the cathode, comprising a first composition comprising a mixture of a first compound and a second compound, according to the claims wherein the first compound has different chemical structure than the second compound;
wherein the first compound is capable of functioning as a phosphorescent emitter in an organic light emitting device at room temperature;
wherein the first compound has an evaporation temperature T1 of 150 to 350 °C;
wherein the second compound has an evaporation temperature T2 of 150 to 350 °C;
wherein the absolute value of T1-T2 is less than 20 °C;
wherein the first compound has a concentration C1 in said mixture, and a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between $1x10^{-6}$ Torr to $1x10^{-9}$ Torr, at a 2Å/sec deposition rate on a surface positioned at a predefined distance away from the material; and
wherein the absolute value of (C1-C2)/C1 is less than 5%. Preferably the absolute value of (C1-C2)/C1 is less than 3%.

[0121] In one embodiment of the first device, the organic layer is an emissive layer. In another embodiment of the first device, the organic layer is a non-emissive layer.

[0122] In one embodiment of the first device, the organic layer further comprises a phosphorescent emitting material.

[0123] In one embodiment of the first device, the organic layer further comprises a host.

[0124] In one embodiment of the first device, the first compound functions as a phosphorescent emitting material.

[0125] In one embodiment of the first device, the first compound functions as a host.

[0126] In one embodiment of the first device, the first device further comprises a second organic light emitting device separate from the first organic light emitting device, and wherein the second organic light emitting device comprises an emitting dopant having a peak wavelength of between 400 to 500 nanometers.

[0127] In one embodiment of the first device, the first organic light emitting device comprises a first emissive layer and a second emissive layer; wherein the first emissive layer comprises the first composition; and the second emissive layer comprises an emitting dopant having a peak wavelength of between 400 to 500 nanometers.

[0128] In one embodiment of the first device, the first device is a consumer product. In another embodiment, the first device is an organic light-emitting device. In another embodiment, the first device is a lighting panel.

[0129] In one embodiment of the first device, the first composition leaves a residue corresponding to less than 5 wt% of the original charge in the sublimation crucible after the depletion of the first composition in the evaporation process. Preferably, the first composition is deposited in a vacuum system having a pressure level in the range of $1x10^{-8}$ Torr to $1x10^{-12}$ Torr.

[0130] According to another aspect of the present disclosure, a method for fabricating an organic light emitting device comprising a first electrode, a second electrode, and a first organic layer disposed between the first electrode and the second electrode, wherein the first organic layer comprises a first composition comprising a mixture of a first compound and a second compound is disclosed. The method comprises the following: providing a substrate having the first electrode

disposed thereon; depositing the first composition according to the claims over the first electrode; and depositing the second electrode over the first organic layer,
wherein the first compound has different chemical structure than the second compound,
wherein the first compound is capable of functioning as a phosphorescent emitter in an organic light emitting device at room temperature,
wherein the first compound has an evaporation temperature T1 of 150 to 350 °C, wherein the second compound has an evaporation temperature T2 of 150 to 350 °C, wherein the absolute value of T1-T2 is less than 20 °C,
wherein the first compound has a concentration C1 in said mixture, and a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between $1x10^{-6}$ Torr to $1x10^{-9}$ Torr, at a 2Å/sec deposition rate on a surface positioned at a predefined distance away from the material, and wherein the absolute value of (C1-C2)/C1 is less than 5%.

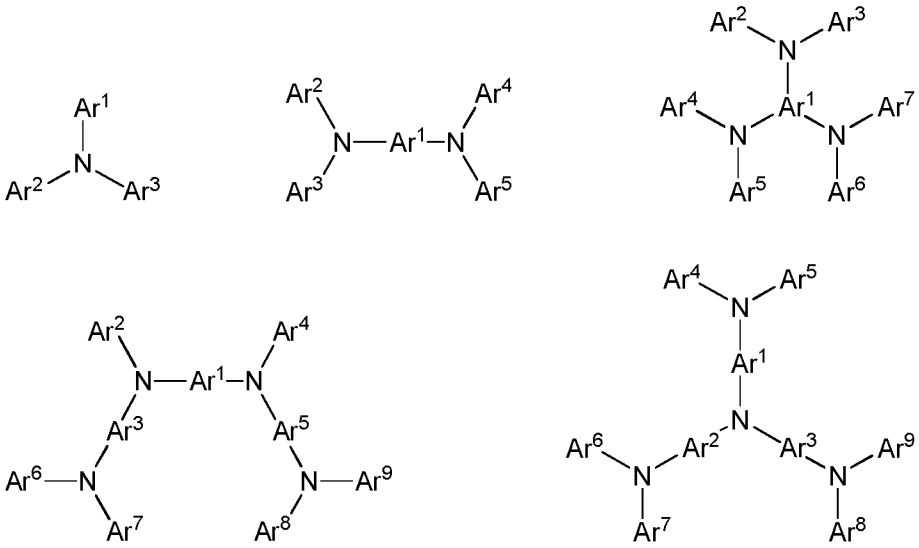
COMBINATION WITH OTHER MATERIALS

[0131] 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:

[0132] 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.

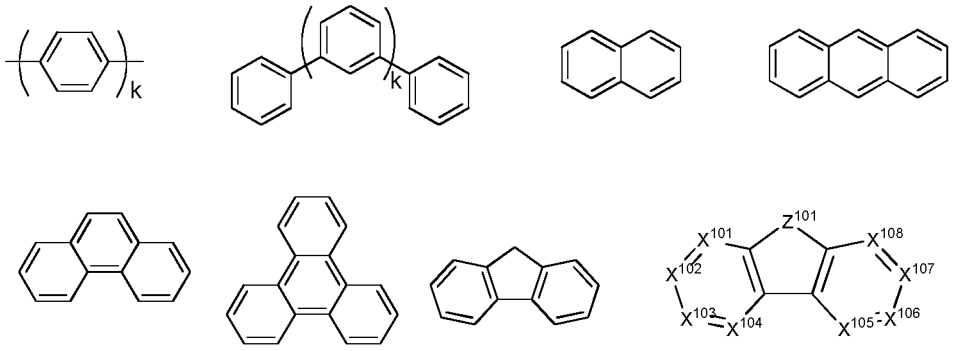
[0133] Examples of aromatic amine derivatives used in HIL or HTL include, but not limit to the following general structures:



[0134] 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, benzimi-

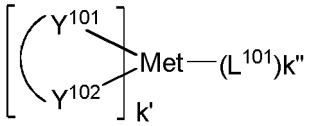
dazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuropyridine, furodipyridine, benzothienopyridine, thienodipyridine, 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.

[0135] 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.

[0136] Examples of metal complexes used in HIL or HTL include, but not limit to the following general formula:



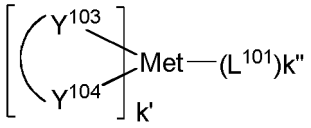
wherein Met is a metal, which can have an atomic weight greater than 40; (Y^{101}-Y^{102}) is a bidentate ligand, Y^{101} and Y^{102} are independently selected from C, N, O, P, and S; L^{101} is an ancillary ligand; k' is an integer value from 1 to the maximum number of ligands that may be attached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

[0137] 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:

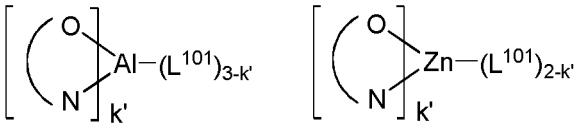
[0138] The light emitting layer of the organic EL device of the present invention preferably contains at least a metal complex as light emitting material, and may contain a host material using the metal complex as a dopant material. Examples of the host material are not particularly limited, and any 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.

[0139] 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.

[0140] In one aspect, the metal complexes are:

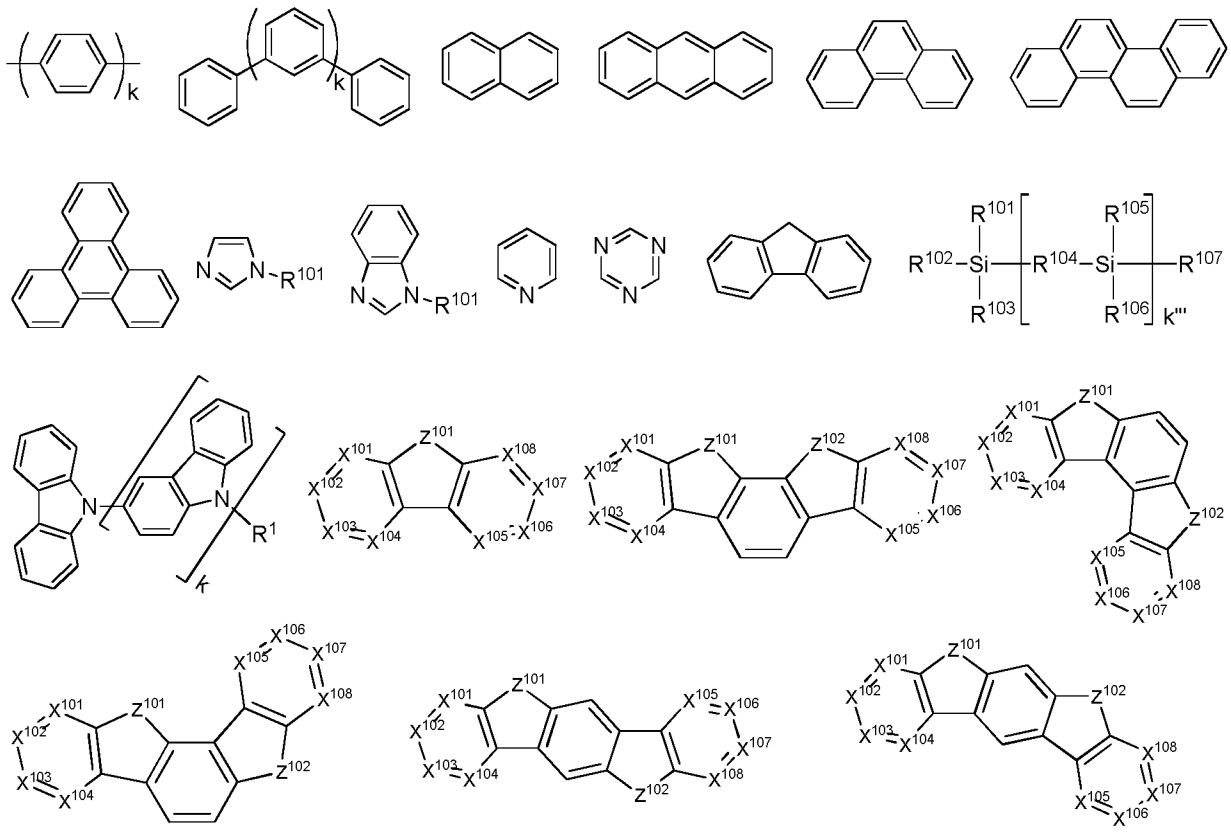


wherein (O-N) is a bidentate ligand, having metal coordinated to atoms O and N.

[0141] In another aspect, Met is selected from Ir and Pt. In a further aspect, (Y^{103}-Y^{104}) is a carbene ligand.

[0142] 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.

[0143] In one aspect, host compound contains at least one of the following groups in the molecule:



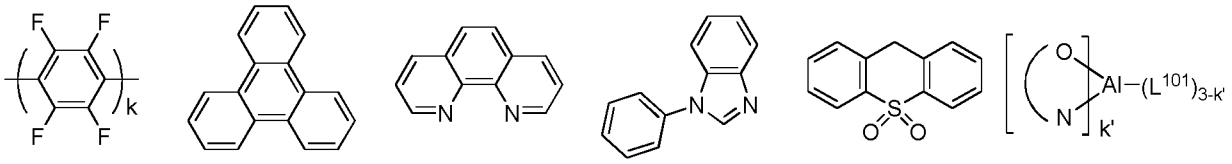
wherein R^{101} to R^{107} is independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile,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

HBL:

[0144] 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.

[0145] In one aspect, compound used in HBL contains the same molecule or the same functional groups used as host described above.

[0146] In another aspect, compound used in HBL contains at least one of the following groups in the molecule:

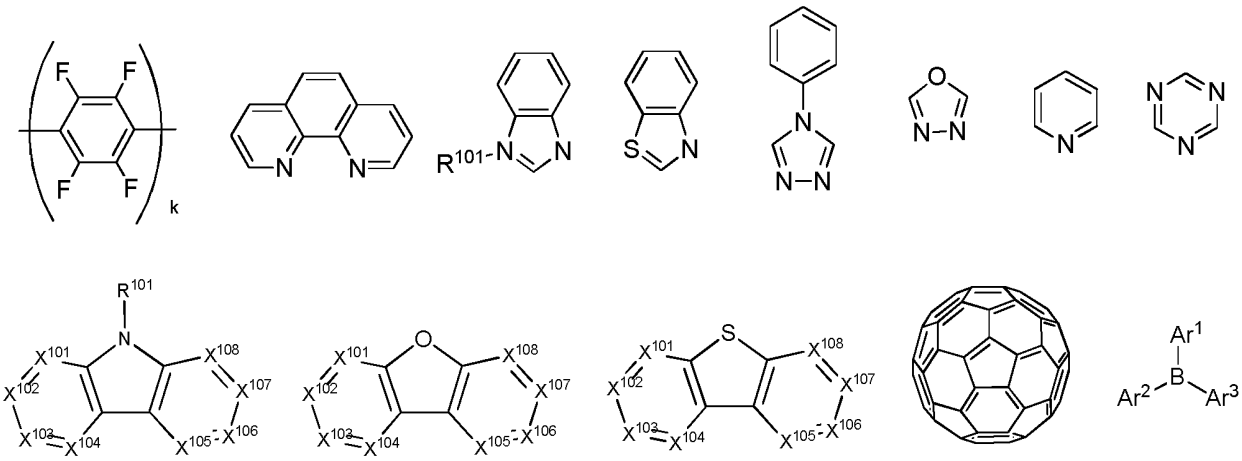


wherein k is an integer from 1 to 20; L^{101} is an another ligand, k' is an integer from 1 to 3.

ETL:

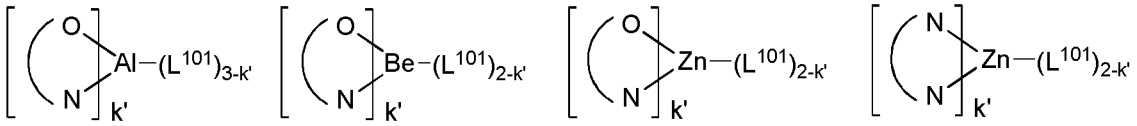
[0147] Electron transport layer (ETL) may include a material capable of transporting electrons. Electron transport layer may be intrinsic (undoped), or doped. Doping may be used to enhance conductivity. Examples of the ETL material are not particularly limited, and any metal complexes or organic compounds may be used as long as they are typically used to transport electrons.

[0148] In one aspect, compound used in ETL contains at least one of the following groups in the molecule:



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.

[0149] In another aspect, the metal complexes used in ETL contains, but not limit to the following general formula:

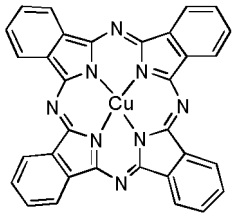
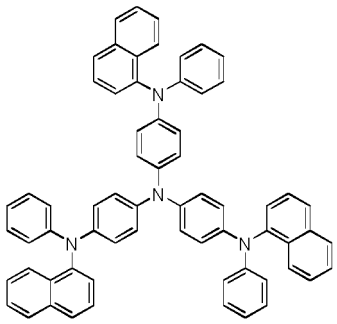
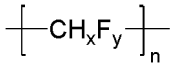
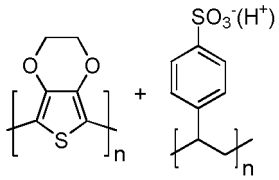
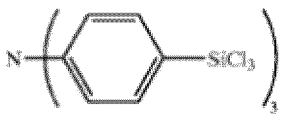


wherein (O-N) or (N-N) is a bidentate ligand, having metal coordinated to atoms O, N or N, N; L^{101} is another ligand; k' is an integer value from 1 to the maximum number of ligands that may be attached to the metal.

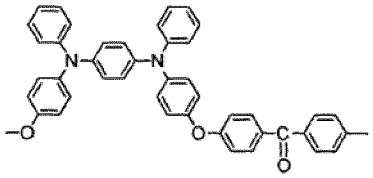
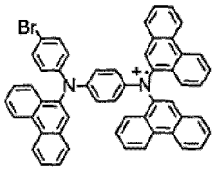
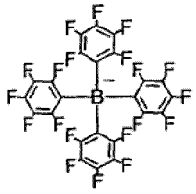
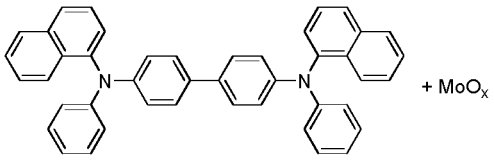
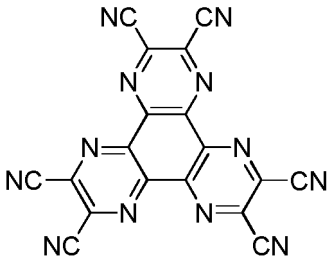
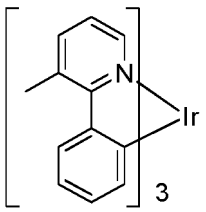
[0150] In any above-mentioned compounds used in each layer of the OLED device, the hydrogen atoms can be partially or fully deuterated. Thus, any specifically listed substituent, such as, without limitation, methyl, phenyl, pyridyl, etc. encompasses undeuterated, partially deuterated, and fully deuterated 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.

[0151] 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 5 below. Table 5 lists non-limiting classes of materials, non-limiting examples of compounds for each class, and references that disclose the materials.

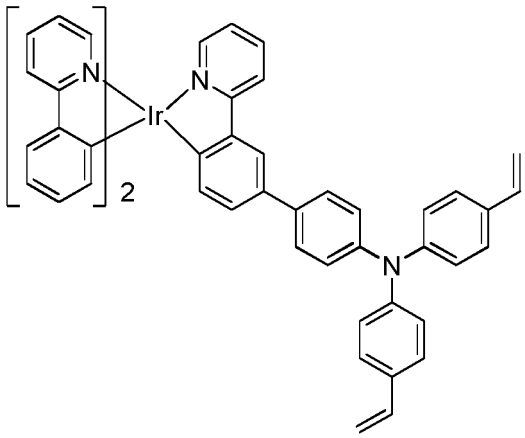
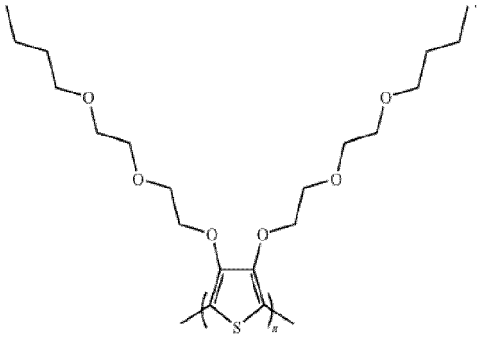
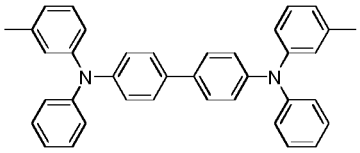
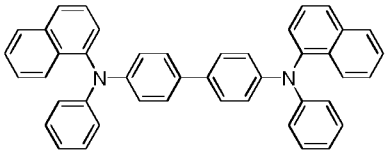
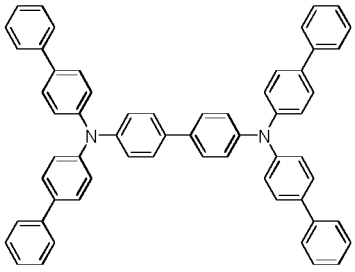
TABLE 5

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Hole injection materials		
Phthalocyanine and porphryin compounds		Appl. Phys. Lett. 69, 2160 (1996)
Starburst triarylamines		J. Lumin. 72-74, 985 (1997)
CF_x Fluorohydrocarbon polymer		Appl. Phys. Lett. 78, 673 (2001)
Conducting polymers (e.g., PEDOT:PSS, polyaniline, polypthiophene)		Synth. Met. 87, 171 (1997) WO2007002683
Phosphonic acid and sliane SAMs		US20030162053

(continued)

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Hole injection materials		
Triarylamine or polythiophene polymers with conductivity dopants	 and  	EP1725079A1
Organic compounds with conductive inorganic compounds, such as molybdenum and tungsten oxides		US20050123751 SID Symposium Digest, 37, 923 (2006) WO2009018009
n-type semiconducting organic complexes		US20020158242
Metal organometallic complexes		US20060240279

(continued)

MATERIAL	EXAMPLES OF MATERIAL	PUBLICATIONS
Hole injection materials		
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)
		US5061569
		EP650955

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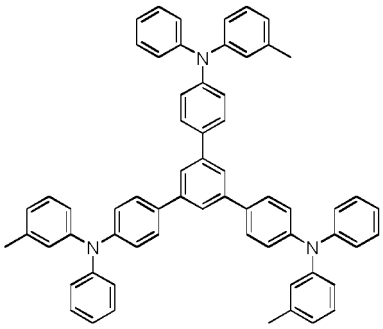
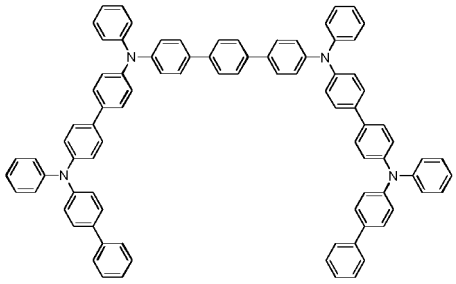
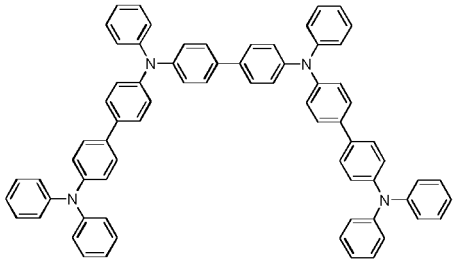
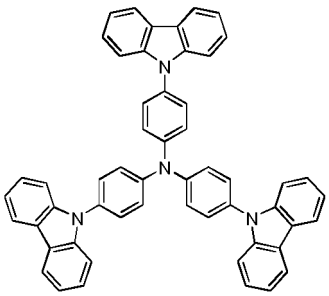
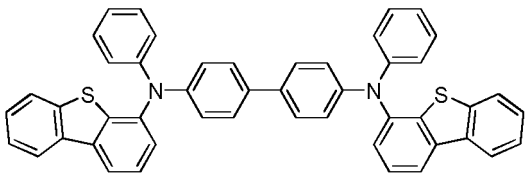
Hole transporting materials		
		J. Mater. Chem. 3, 319 (1993)
		Appl. Phys. Lett. 90, 183503 (2007)
		Appl. Phys. Lett. 90, 183503 (2007)
Triaylamine on spirofluorene core		Synth. Met. 91, 209 (1997)
Arylamine carbazole compounds		Adv. Mater. 6, 677 (1994), US20080124572
Triarylamine with (di) benzothiophene/(di)benzofuran		US20070278938, US20080106190 US20110163302

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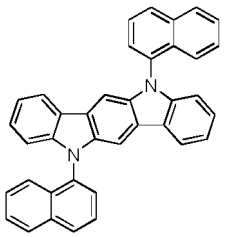
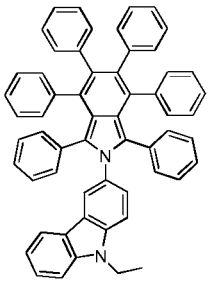
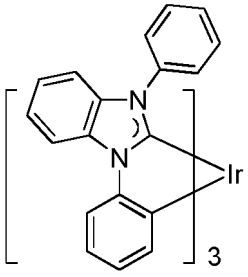
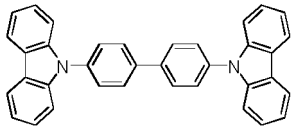
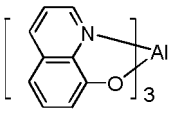
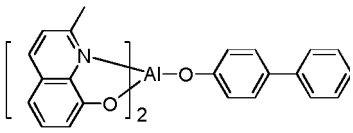
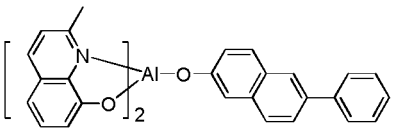
Hole transporting materials		
Indolocarbazoles		Synth. Met. 111, 421 (2000)
Isoindole compounds		Chem. Mater. 15, 3148 (2003)
Metal carbene complexes		US20080018221
Phosphorescent OLED host materials		
Red hosts		
Arylcarbazoles		Appl. Phys. Lett. 78, 1622 (2001)
Metal 8-hydroxyquinolates (e.g., Alq_3, BAlq)		Nature 395, 151 (1998)
		US20060202194
		WO2005014551

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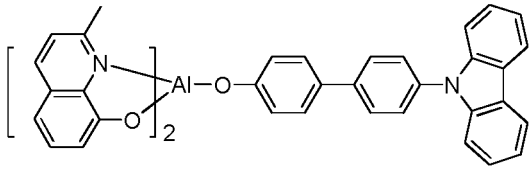
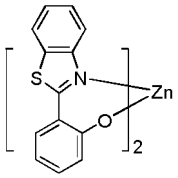
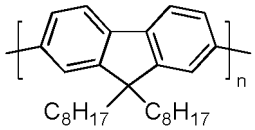
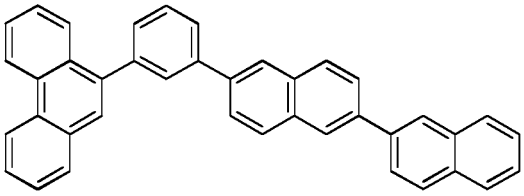
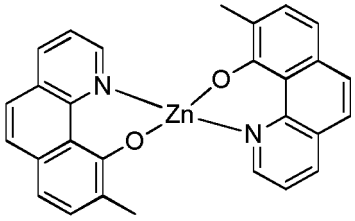
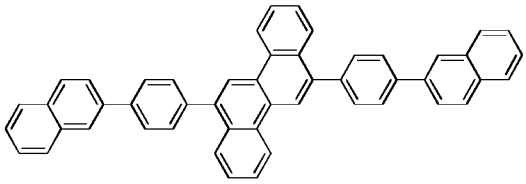
Hole transporting materials		
		WO2006072002
Metal phenoxybenzothiazole compounds		Appl. Phys. Lett. 90, 123509 (2007)
Conjugated oligomers and polymers (e.g., polyfluorene)		Org. Electron. 1, 15 (2000)
Aromatic fused rings		WO2009066779, WO2009066778, WO2009063833, US20090045731, US20090045730, WO2009008311, US20090008605, US20090009065
Zinc complexes		WO2010056066
Chrysene based compounds		WO2011086863

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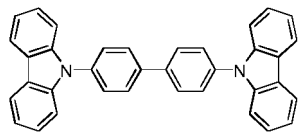
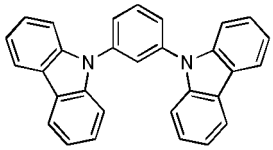
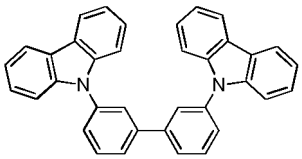
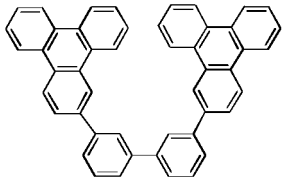
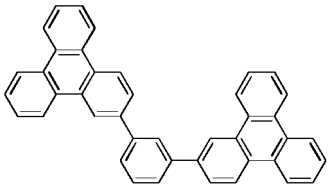
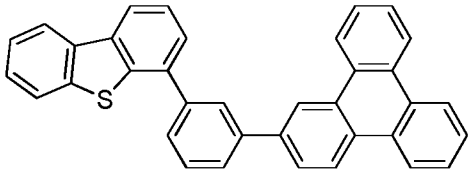
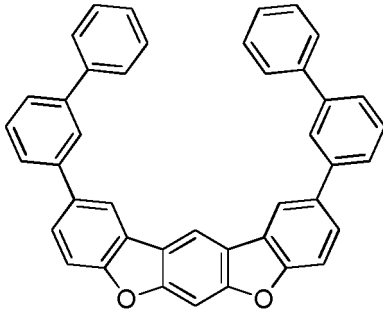
Green hosts		
Arylcarbazoles		Appl. Phys. Lett. 78, 1622 (2001)
		US20030175553
		WO2001039234
Aryltriphenylene compounds		US20060280965
		US20060280965
		WO2009021126
Poly-fused heteroaryl compounds		US20090309488 US20090302743 US20100012931

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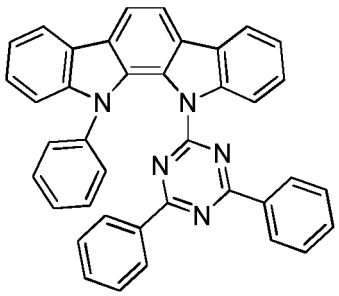
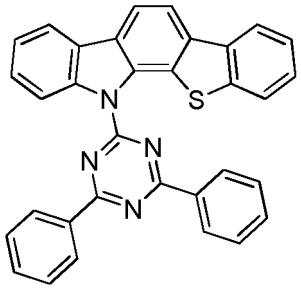
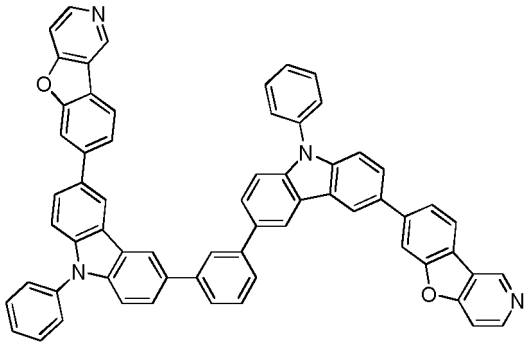
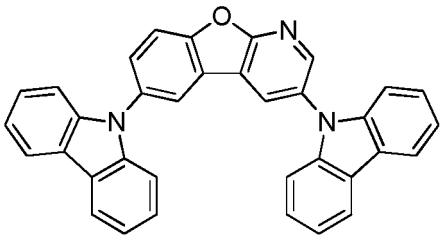
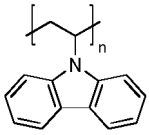
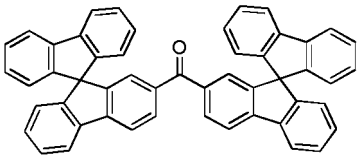
Green hosts		
Donor acceptor type molecules		WO2008056746
		WO2010107244
Aza-carbazole/DBT/DBF		JP2008074939
		US20100187984
Polymers (e.g., PVK)		Appl. Phys. Lett. 77, 2280 (2000)
Spirofluorene compounds		WO2004093207

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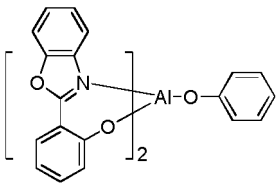
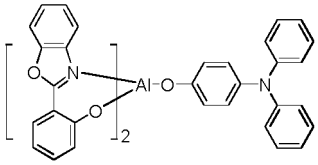
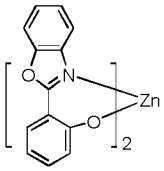
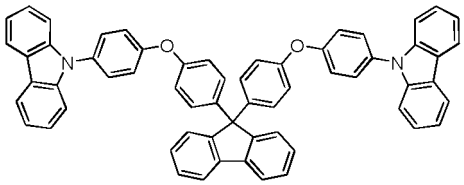
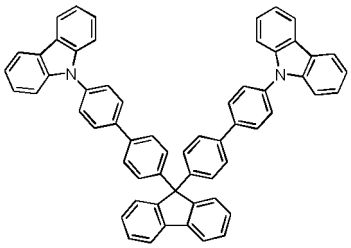
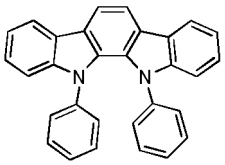
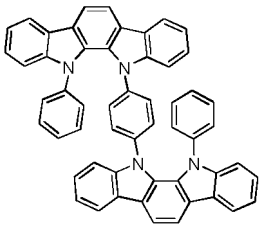
Green hosts		
Metal phenoxybenzooxazole compounds		WO2005089025
		WO2006132173
		JP200511610
Spirofluorene-carbazole compounds		JP2007254297
		JP2007254297
Indolocabazoles		WO2007063796
		WO2007063754

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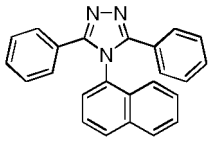
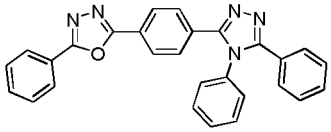
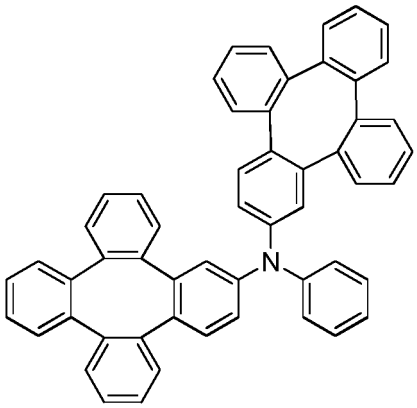
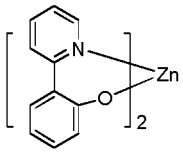
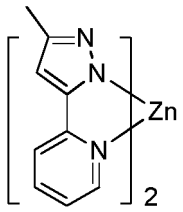
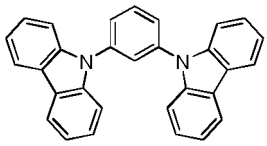
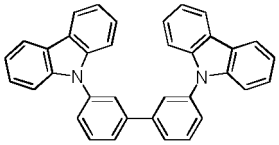
Green hosts		
5-member ring electron deficient heterocycles (e.g., triazole, oxadiazole)		J. Appl. Phys. 90, 5048 (2001)
		WO2004107822
Tetraphenylene complexes		US20050112407
Metal phenoxypyridine compounds		WO2005030900
Metal coordination complexes (e.g., Zn, Al with N^N ligands)		US20040137268, US20040137267
Blue hosts		
Arylcarbazoles		Appl. Phys. Lett, 82, 2422 (2003)
		US20070190359

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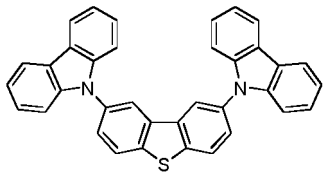
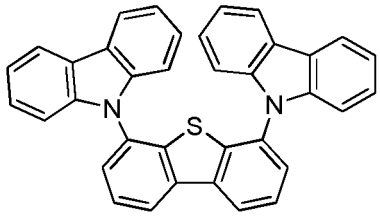
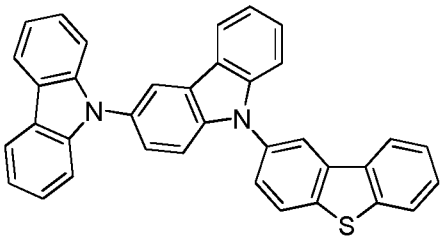
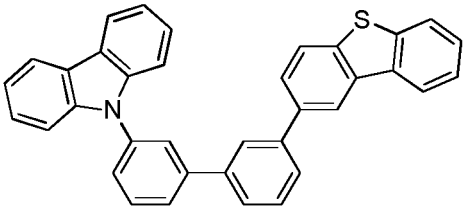
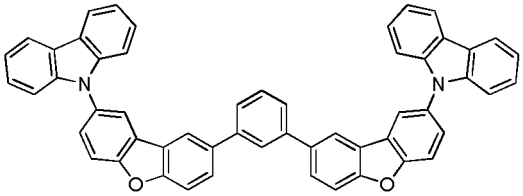
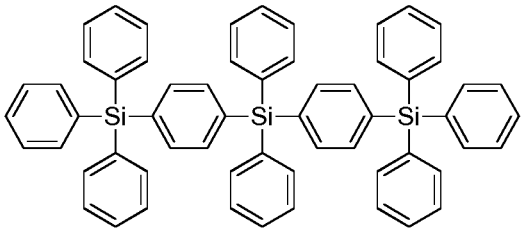
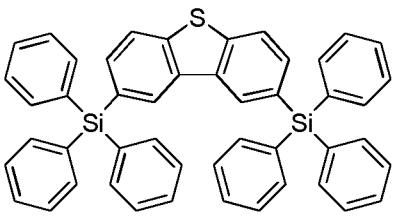
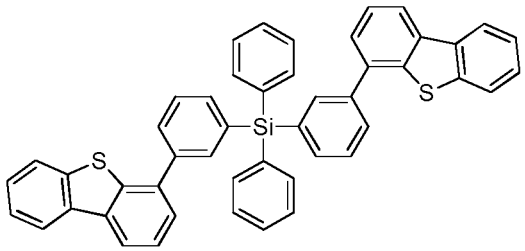
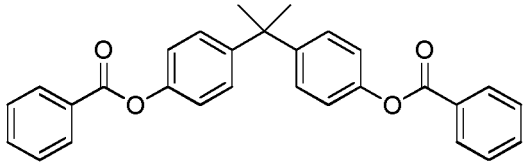
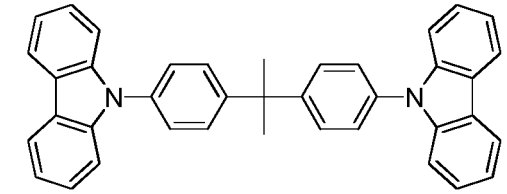
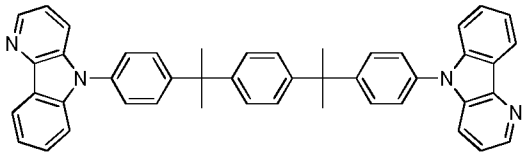
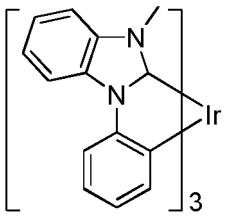
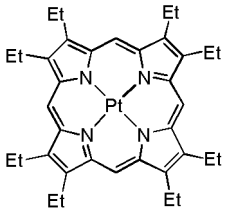
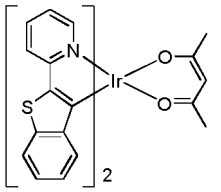
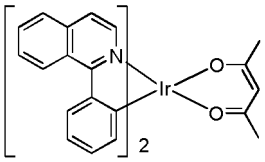
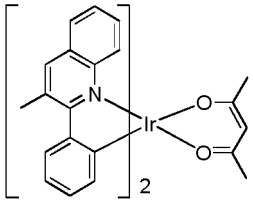
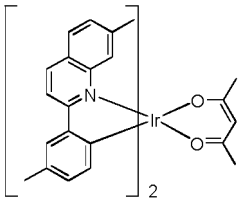
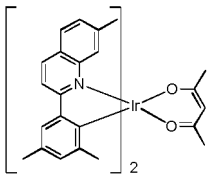
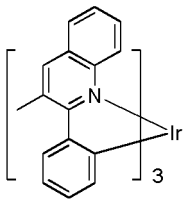
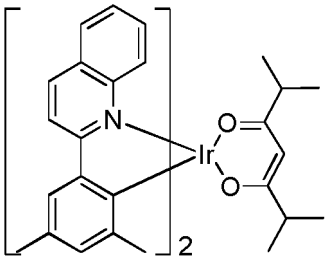
Blue hosts		
Dibenzothiophene/ Dibenzofuran-carbazole compounds		WO2006114966, US20090167162
		US20090167162
		WO2009086028
		US20090030202, US20090017330
		US20100084966
Silicon aryl compounds		US20050238919
		WO2009003898

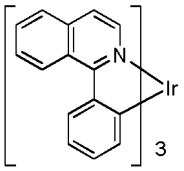
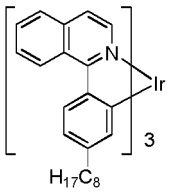
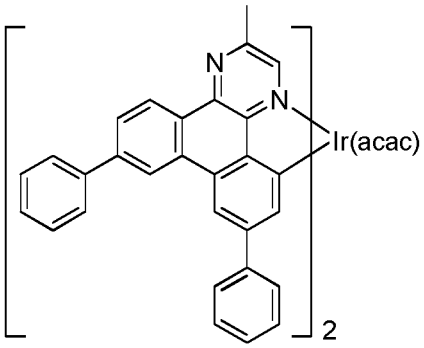
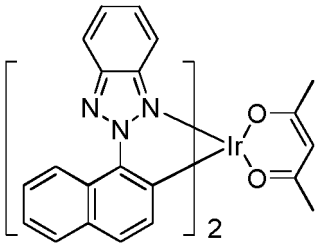
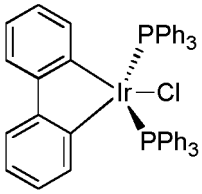
(continued)

Blue hosts		
Silicon/Germanium aryl compounds		EP2034538A
Aryl benzoyl ester		WO2006100298
Carbazole linked by nonconjugated groups		US20040115476
Aza-carbazoles		US20060121308
High triplet metal organometallic complex		US7154114
Phosphorescent dopants		
Red dopants		
MATERIAL	**EXAMPLES OF MATERIAL**	**PUBLICATIONS**
Heavy metal porphyrins (e.g., PtOEP)		Nature 395, 151 (1998)

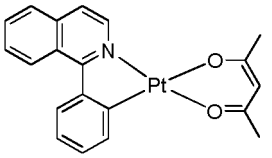
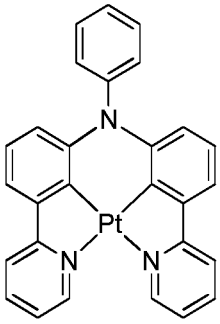
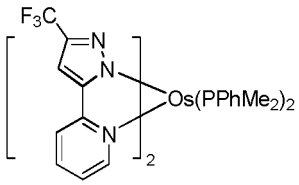
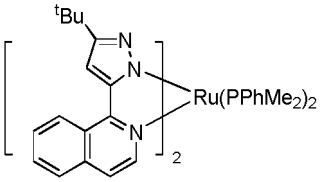
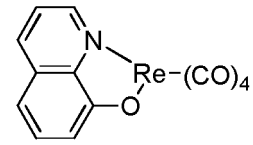
(continued)

Phosphorescent dopants		
Red dopants		
MATERIAL	**EXAMPLES OF MATERIAL**	**PUBLICATIONS**
Iridium(III) organometallic complexes		Appl. Phys. Lett. 78, 1622 (2001)
		US20030072964
		US20030072964
		US20060202194
		US20060202194
		US20070087321
		US20080261076 US20100090591

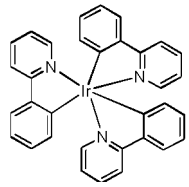
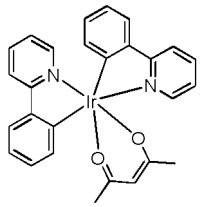
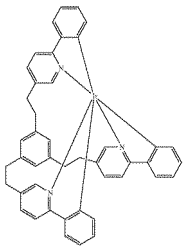
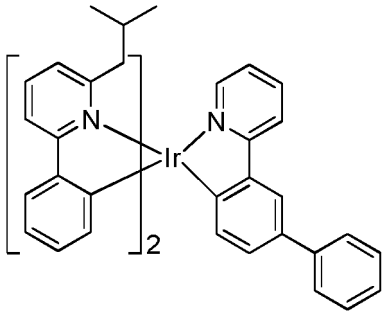
(continued)

Phosphorescent dopants		
Red dopants		
MATERIAL	**EXAMPLES OF MATERIAL**	**PUBLICATIONS**
		US20070087321
		Adv. Mater. 19, 739 (2007)
		WO2009100991
		WO2008101842
		US7232618

(continued)

Phosphorescent dopants		
Red dopants		
MATERIAL	**EXAMPLES OF MATERIAL**	**PUBLICATIONS**
Platinum(II) organometallic complexes		WO2003040257
		US20070 103060
Osminum(III) complexes		Chem. Mater. 17, 3532 (2005)
Ruthenium(II) complexes		Adv. Mater. 17, 1059 (2005)
Rhenium (I), (II), and (III) complexes		US20050244673

(continued)

Green dopants		
Iridium(III) organometallic complexes	 and its derivatives	Inorg. Chem. 40, 1704 (2001)
		US20020034656
		US7332232
		US20090108737

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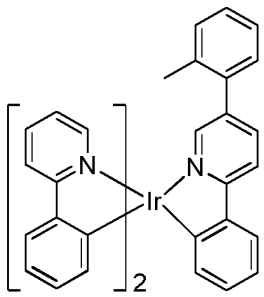
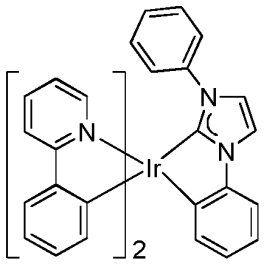
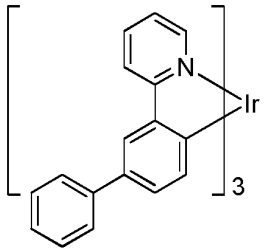
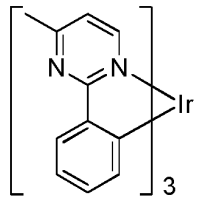
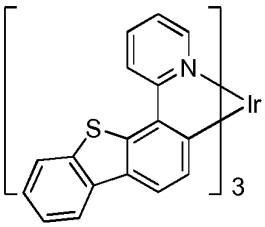
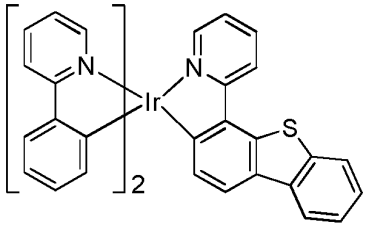
Green dopants		
		WO2010028151
		EP1841834B
		US20060127696
		US20090039776
		US6921915
		US20100244004

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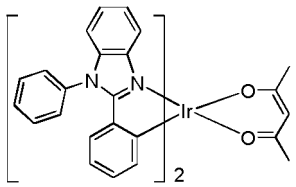
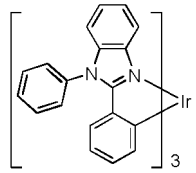
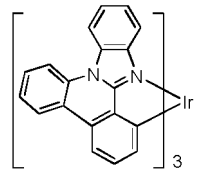
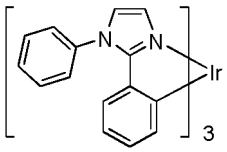
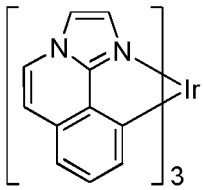
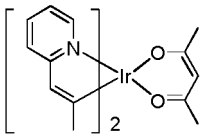
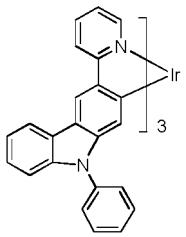
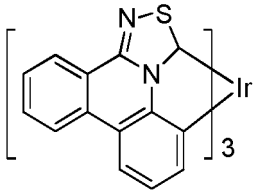
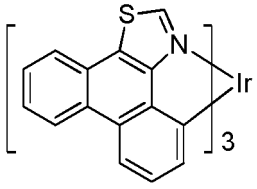
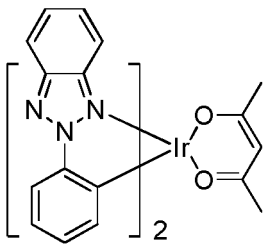
Green dopants		
		US6687266
		Chem. Mater. 16, 2480 (2004)

(continued)

Green dopants		
		US20070190359
		US20060008670 JP2007123392
		WO2010086089, WO2011044988
		Adv. Mater. 16, 2003 (2004)
		Angew. Chem. Int. Ed. 2006, 45, 7800
		WO2009050290
		US20090165846
		US20080015355

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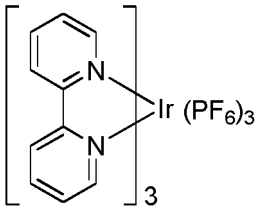
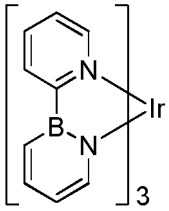
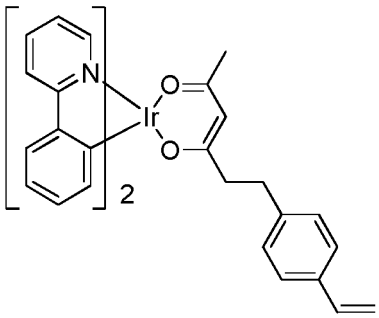
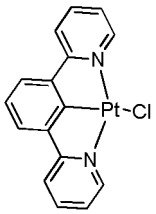
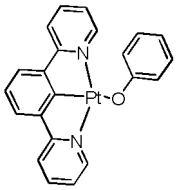
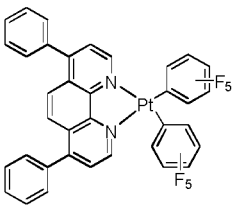
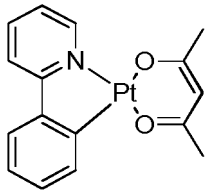
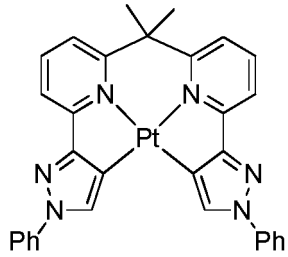
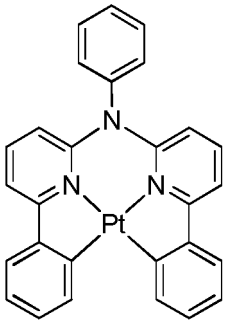
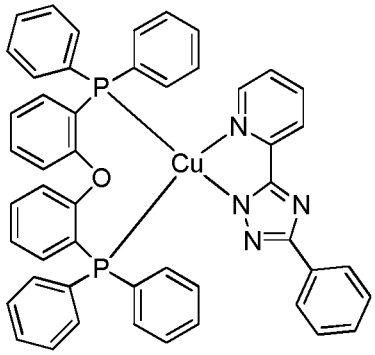
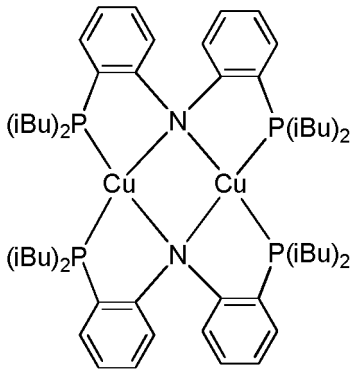
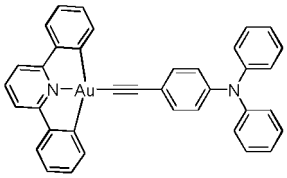
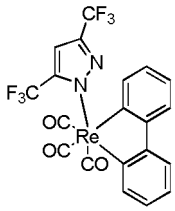
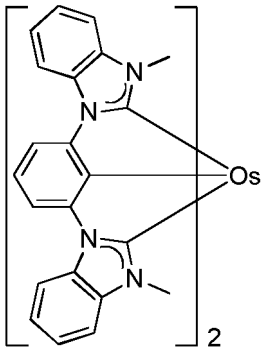
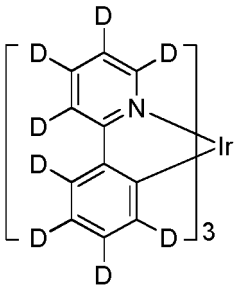
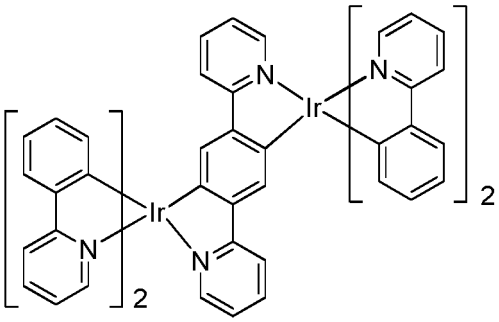
Green dopants		
		US20010015432
		US20100295032
Monomer for polymeric metal organometallic compounds		US7250226, US7396598
Pt(II) organometallic complexes, including polydentated ligands		Appl. Phys. Lett. 86, 153505 (2005)
		Appl. Phys. Lett. 86, 153505 (2005)
		Chem. Lett. 34, 592 (2005)

(continued)

Green dopants		
		WO2002015645
		US20060263635
		US20060182992 US20070103060
Cu complexes		WO2009000673
		US20070111026

(continued)

Green dopants		
Gold complexes		Chem. Commun. 2906 (2005)
Rhenium(III) complexes		Inorg. Chem. 42, 1248 (2003)
Osmium(II) complexes		US7279704
Deuterated organometallic complexes		US20030138657
Organometallic complexes with two or more metal centers		US20030152802

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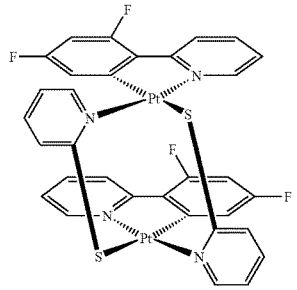
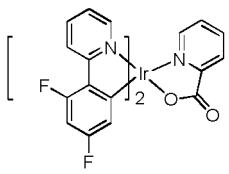
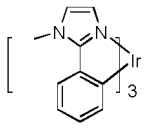
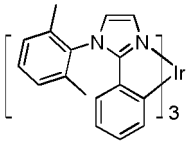
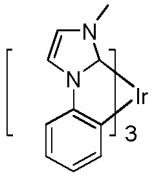
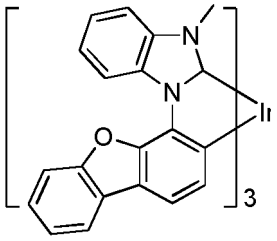
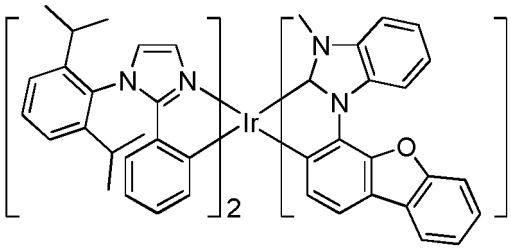
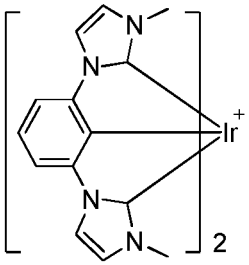
Green dopants		
		US7090928

(continued)

Blue dopants		
Iridium(III) organometallic complexes		WO2002002714
		WO2006009024
		US20060251923 US20110057559 US20110204333
		US7393599, WO2006056418, US20050260441, WO2005019373
		US7534505
		WO2011051404
		US7445855

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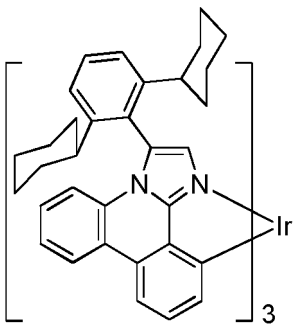
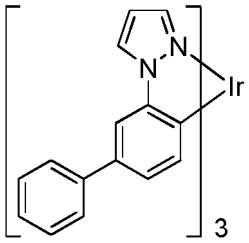
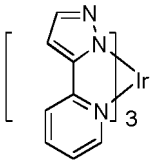
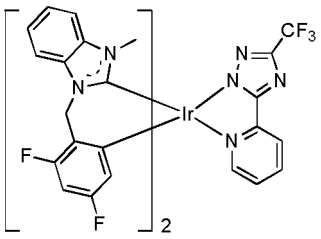
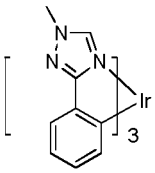
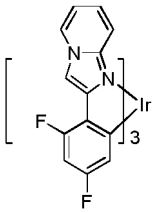
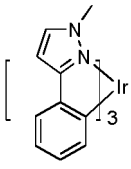
Blue dopants		
		US20070190359, US20080297033 US20100148663
		US7338722
		US20020134984
		Angew. Chem. Int. Ed. 47, 4542 (2008)
		Chem. Mater. 18, 5119 (2006)
		Inorg. Chem. 46, 4308 (2007)
		WO2005123873

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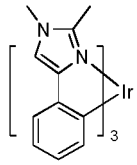
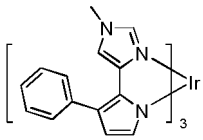
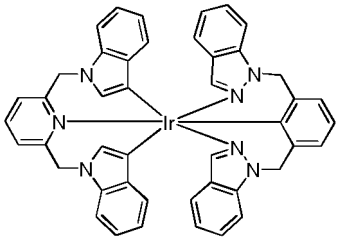
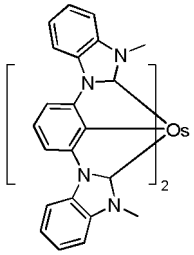
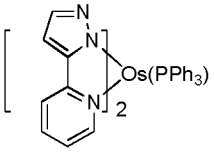
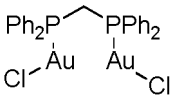
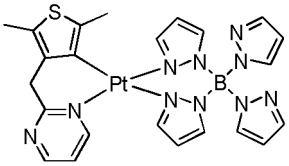
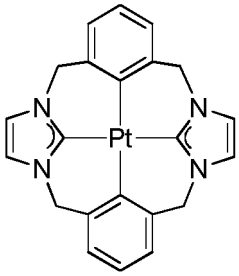
Blue dopants		
		WO2005123873
		WO2007004380
		WO2006082742
Osmium(II) complexes		US7279704
		Organometallics 23, 3745 (2004)
Gold complexes		Appl. Phys. Lett.74,1361 (1999)
Platinum(II) complexes		WO2006098120, WO2006103874
Pt tetradentate complexes with at least one metal-carbene bond		US7655323

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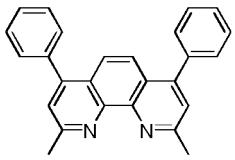
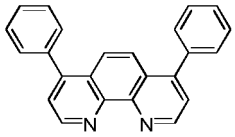
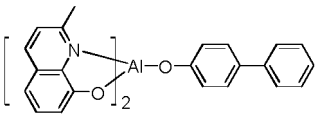
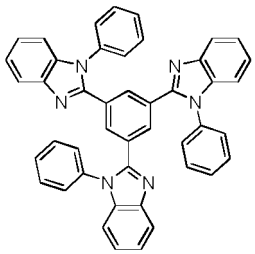
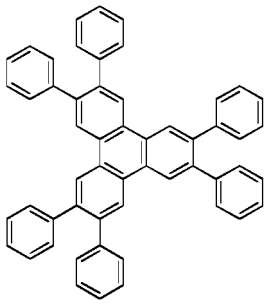
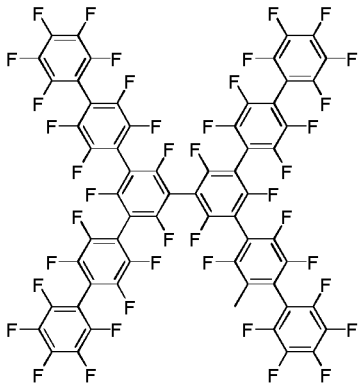
Exciton/hole blocking layer materials		
MATERIAL	**EXAMPLES OF MATERIAL**	**PUBLICATIONS**
Bathocuprine compounds (e.g., BCP, BPhen)		Appl. Phys. Lett. 75, 4 (1999)
		Appl. Phys. Lett. 79, 449 (2001)
Metal 8-hydroxyquinolates (e.g., BAlq)		Appl. Phys. Lett. 81, 162 (2002)
5-member ring electron deficient 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)

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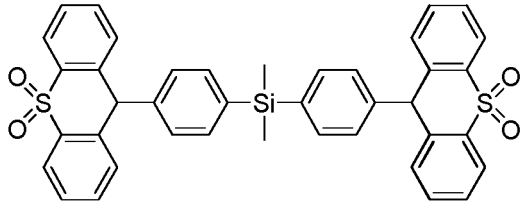
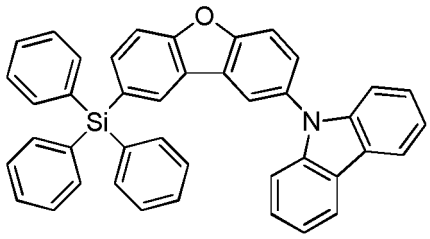
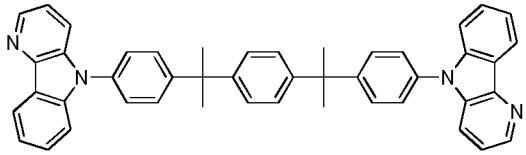
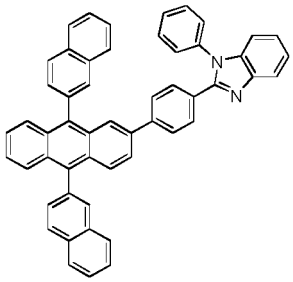
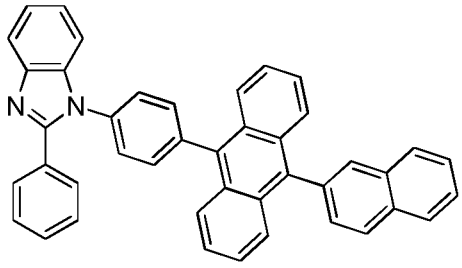
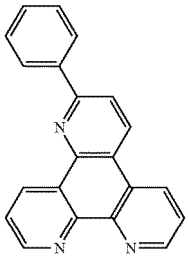
Exciton/hole blocking layer materials		
MATERIAL	**EXAMPLES OF MATERIAL**	**PUBLICATIONS**
Phenothiazine-S-oxide		WO2008132085
Silylated five-membered nitrogen, oxygen, sulfur or phosphorus dibenzoheterocycles		WO2010079051
Aza-carbazoles		US20060121308
Electron transporting materials		
Anthracene-benzoimidazole compounds		WO2003060956
		US20090179554
Aza triphenylene derivatives		US20090115316

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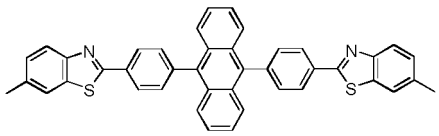
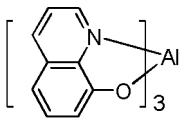
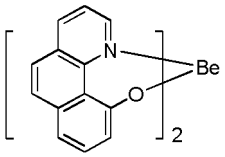
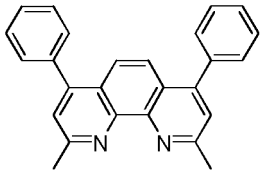
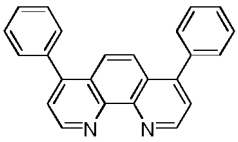
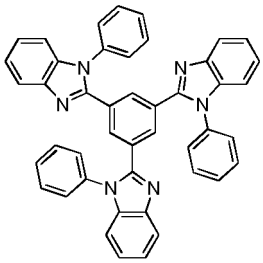
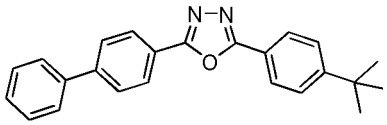
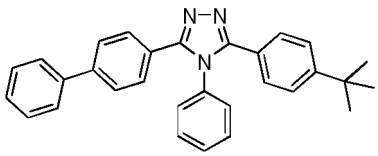
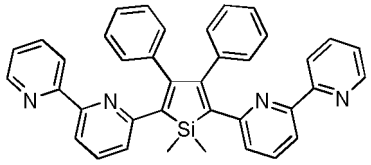
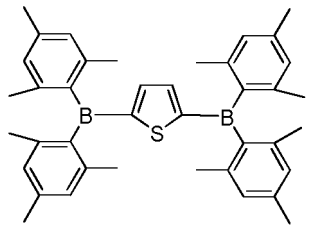
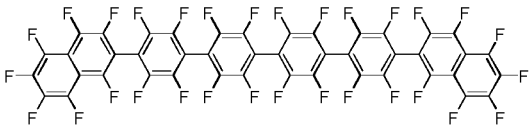
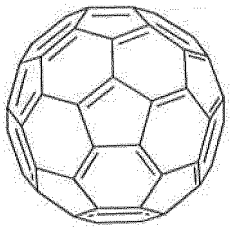
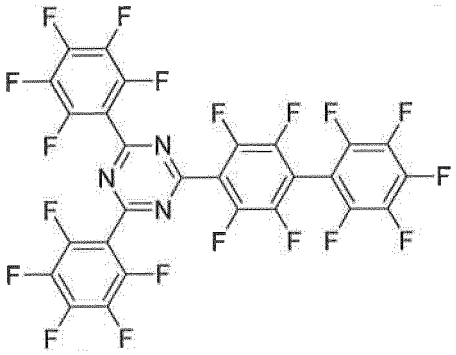
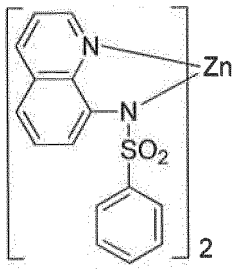
Electron transporting materials		
Anthracene-benzothiazole compounds		Appl. Phys. Lett. 89, 063504 (2006)
Metal 8-hydroxyquinolates (e.g., Alq_3, Zrq_4)		Appl. Phys. Lett. 51, 913 (1987) US7230107
Metal hydroxybenoquinolates		Chem. Lett. 5, 905 (1993)
Bathocuprine compounds such as BCP, BPhen, etc		Appl. Phys. Lett. 91, 263503 (2007)
		Appl. Phys. Lett. 79, 449 (2001)
5-member ring electron deficient heterocycles (e.g.,triazole, oxadiazole, imidazole, 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)

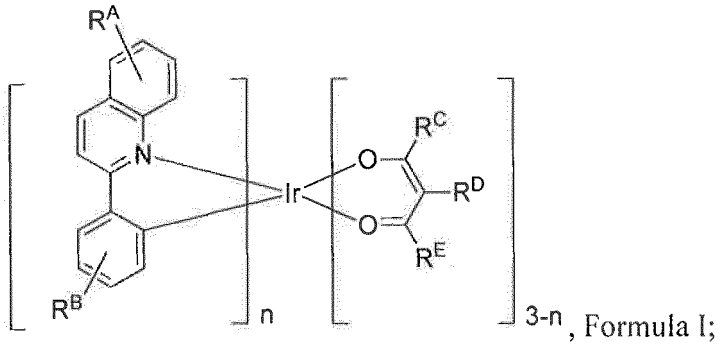
(continued)

Electron transporting materials		
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		US6528187

Claims

1. A composition comprising: a mixture of a first compound and a second compound;
wherein the first compound has a different chemical structure than the second compound; wherein the first compound is capable of functioning as a phosphorescent emitter in an organic light emitting device at room temperature;
wherein the first compound has an evaporation temperature T1 of 150 to 350 °C and the second compound has an evaporation temperature T2 of 150 to 350 °C, wherein the evaporation temperature of the first and the second compound is measured in a vaccuum deposition tool at a constant pressure between 1.33322×10^{-4} Pa (1×10^{-6} Torr) to 1.33322×10^{-7} Pa (1×10^{-9} Torr) at a 0.2 nm/sec (2Å/sec)
deposition rate on a surface positioned at a predefined distance away from the mixture being evaporated;

wherein the absolute value of T1-T2 is less than 20 °C;
wherein the first compound has a concentration C1 in said mixture and a concentration C2 in a film formed by evaporating the mixture in a vacuum deposition tool at a constant pressure between 1.33322x10^{-4} Pa (1x10^{-6} Torr) to 1.33322x10^{-7} Pa (1x10^{-9} Torr) at a 0.2 nm/sec (2Å/sec) deposition rate on a surface positioned at a predefined distance away from the mixture being evaporated;
wherein the absolute value of (Cl-C2)/Cl is less than 5% wherein the first compound has a structure according to Formula I:

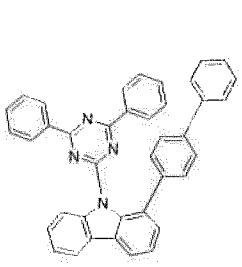


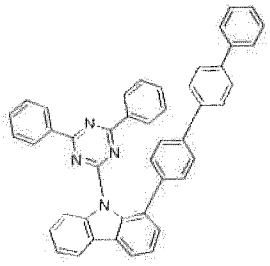
, Formula I;

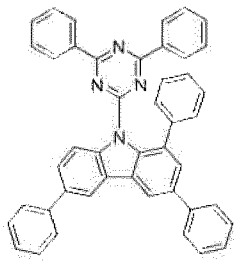
wherein

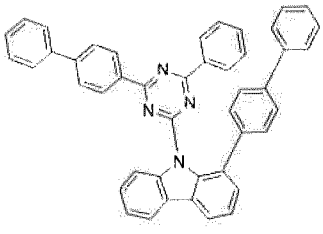
R^A represents mono, di, tri, tetra, penta, hexa substitutions, or no substitution;
R^B represents mono, di, tri, tetra substitutions, or no substitution;
R^A, R^B, R^C, R^D, and R^E are each independently selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, 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;
wherein n is 1 or 2; and

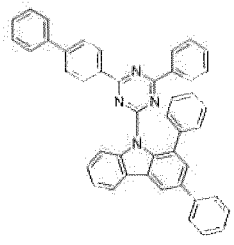
characterized in that: the second compound is selected from the group consisting of:

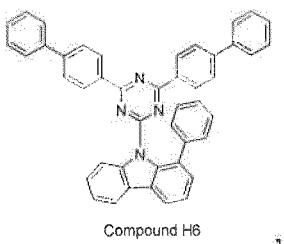

Compound H1 ,

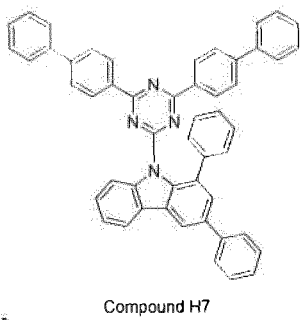

Compound H2 ,

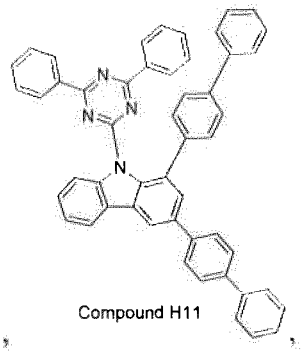

Compound H3 ,

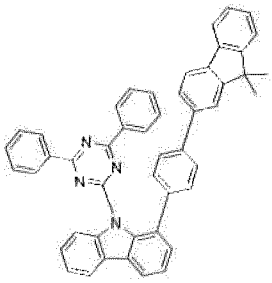

Compound H4 ,


Compound H5 ,

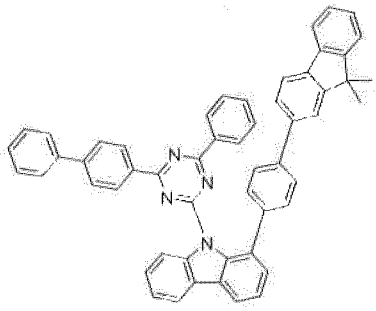

Compound H6 ,


Compound H7 ,

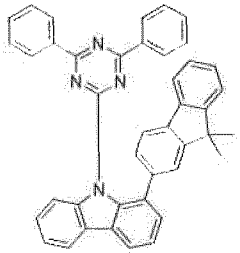

Compound H11 ,



Compound H12 ,



Compound H13 ,



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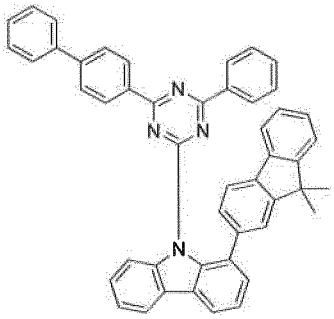

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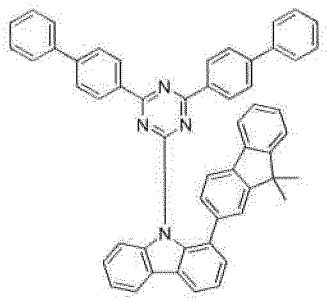

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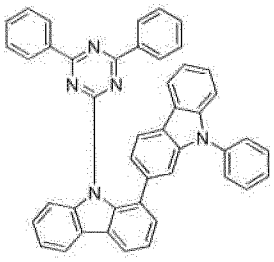

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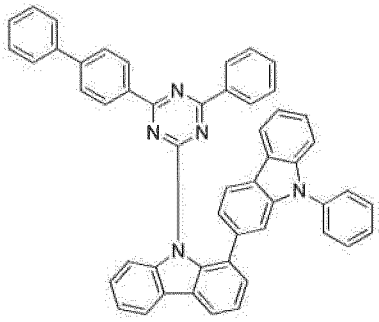

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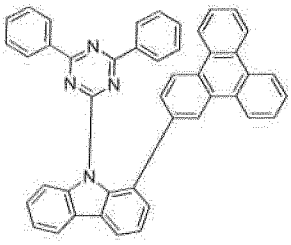

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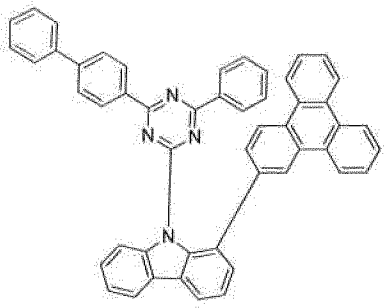

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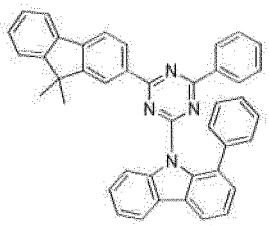

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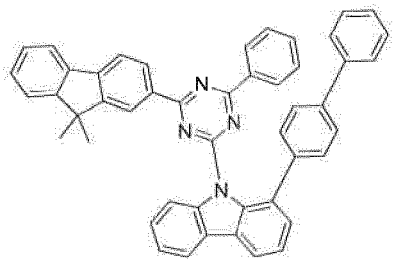

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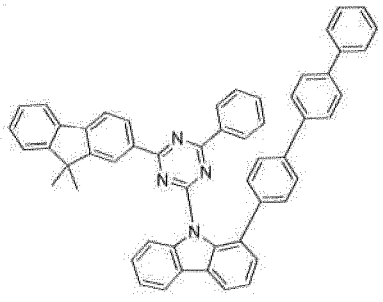

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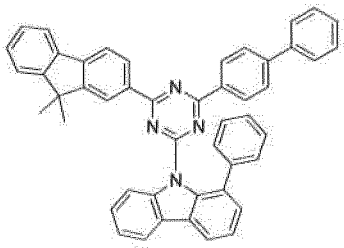
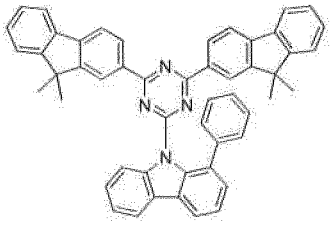


Compound H24 ,



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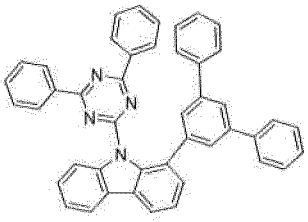

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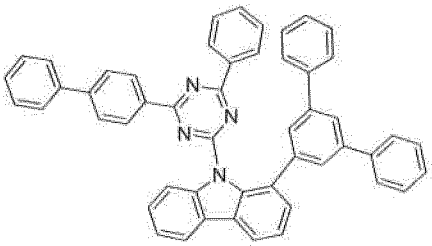

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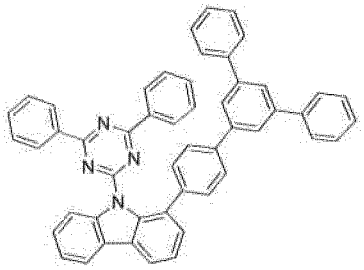
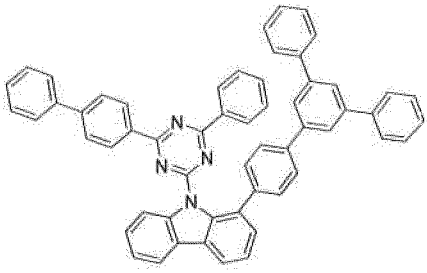


Compound H28 ,



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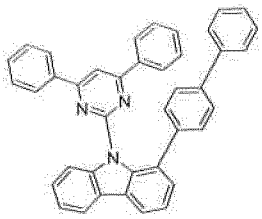

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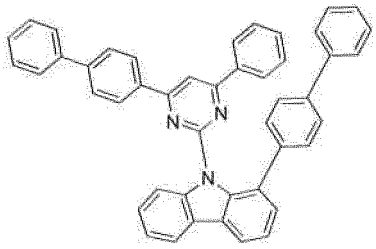
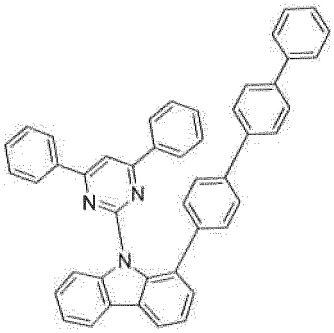


Compound H31 ,



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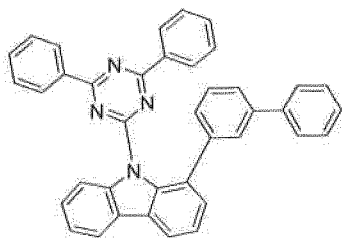
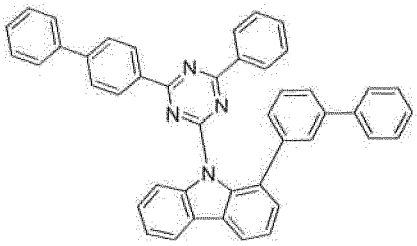


Compound H33,



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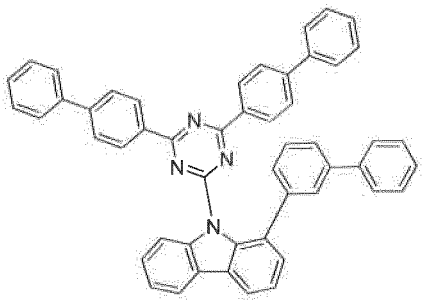

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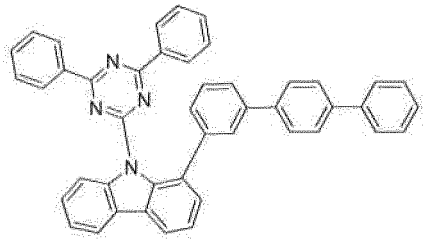
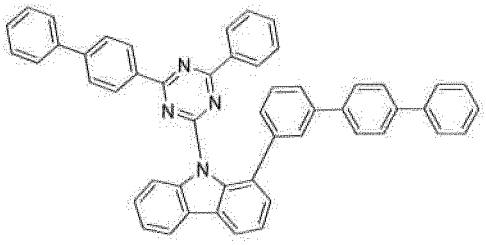


Compound H36,



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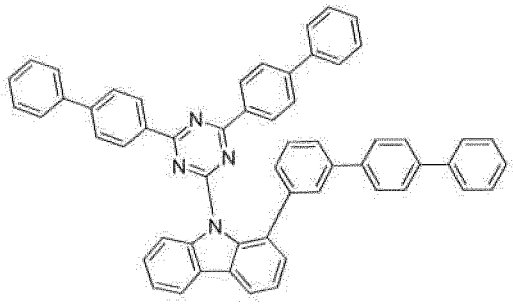

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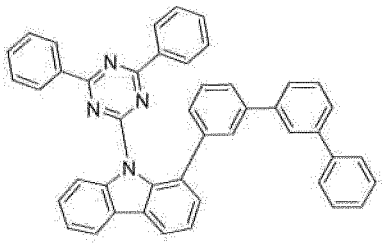

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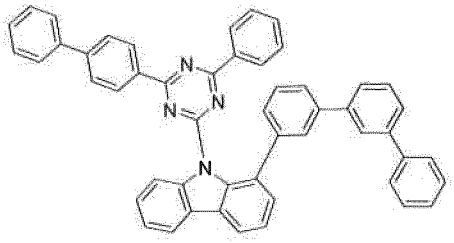
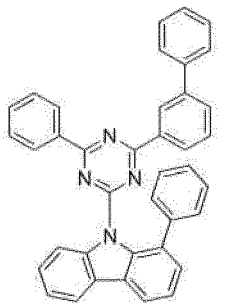
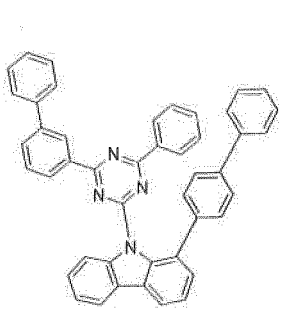


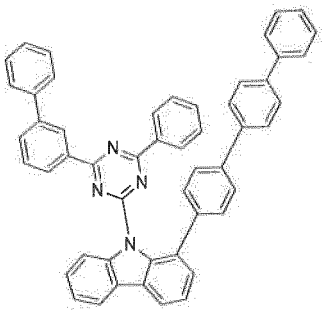
Compound H40,



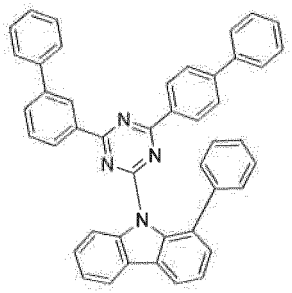
Compound H41 ,



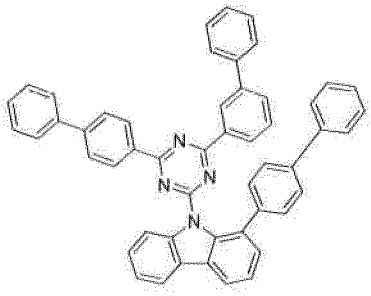
Compound H42 ,



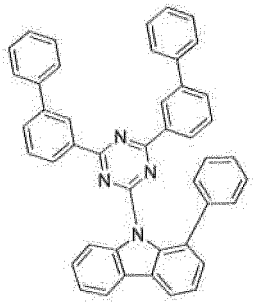
Compound H43 ,



Compound H44 ,



Compound H45 ,



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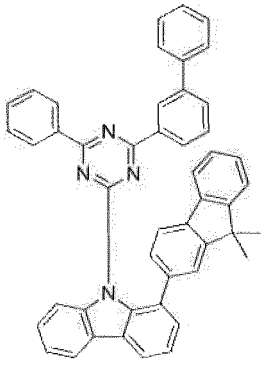
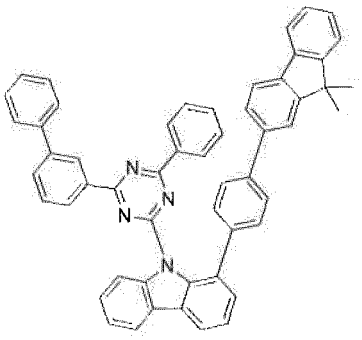


Compound H47 ,



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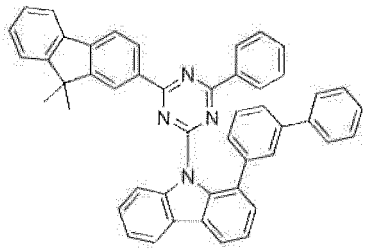
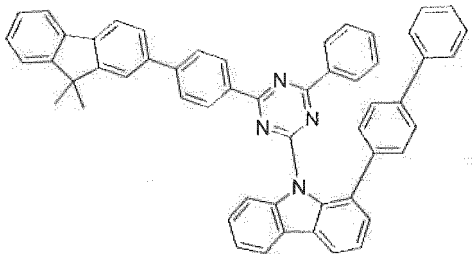


Compound H49 ,

and

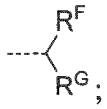


Compound H50 .

2. The composition of claim 1, wherein the first compound has a vapor pressure of P1 at T1 at 101325 Pa (1 atm), the second compound has a vapor pressure of P2 at T2 at 101325 Pa (1 atm) ; and wherein the ratio of P1/P2 is within the range of 0.90 to 1.10.

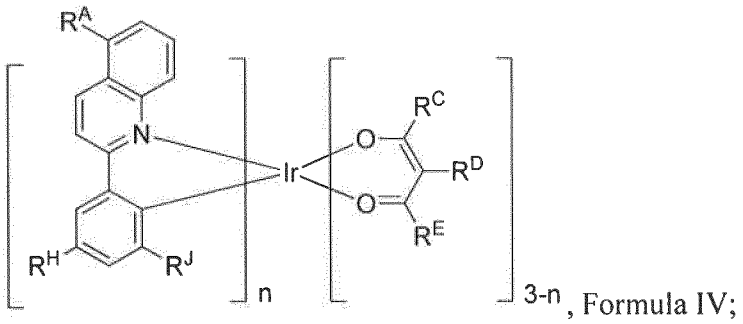
3. The composition of claim 1 or 2, wherein the first compound has a first mass loss rate and the second compound has a second mass loss rate, wherein the ratio between the first mass loss rate and the second mass loss rate is within the range of 0.90 to 1.10.

4. The composition of any one of claims 1 to 3, wherein at least one of R^C and R^E has the following structure:



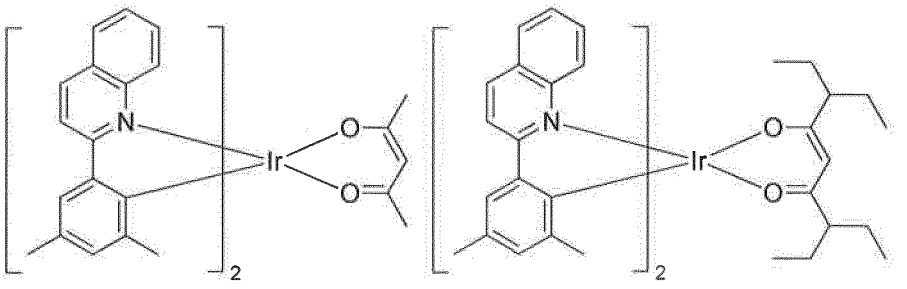
wherein R^F, and R^G are independently selected from group consisting of alkyl and cycloalkyl; and wherein at least one of R^F, and R^G has at least two C.

5. The composition of any one of claims 1 to 4 wherein the first compound has a structure according to Formula IV:

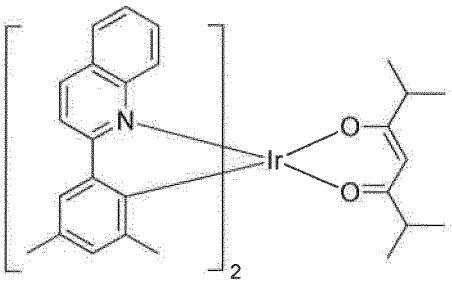


wherein R^H and R^J are each independently selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, cyclic amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acid, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

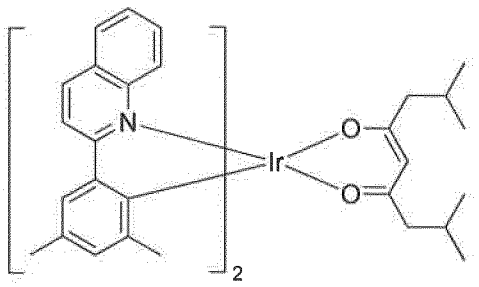
6. The composition of any one of claims 1 to 3 or 5, wherein the first compound is selected from the group consisting of:



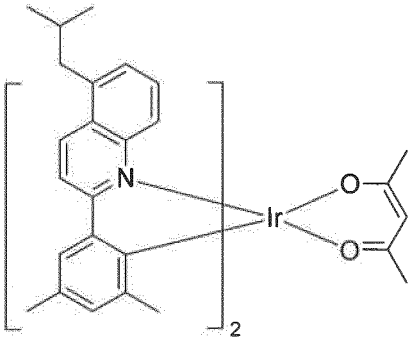
Compound E1 , Compound E2 ,



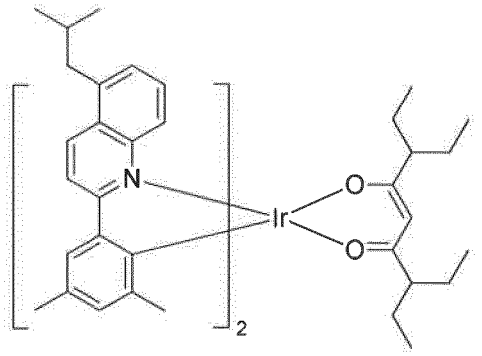
Compound E3



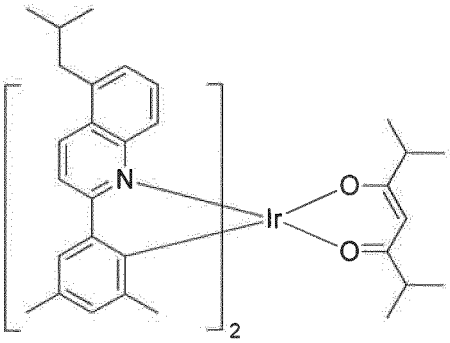
Compound E4



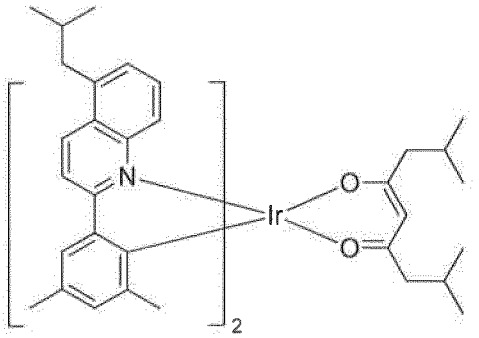
Compound E5



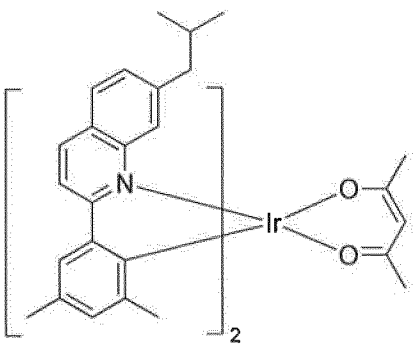
Compound E6



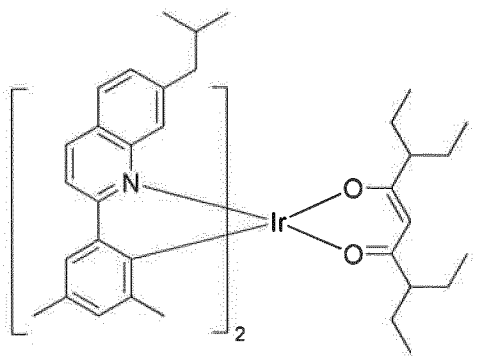
Compound E7



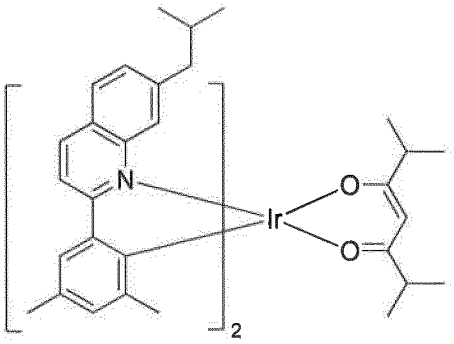
Compound E8



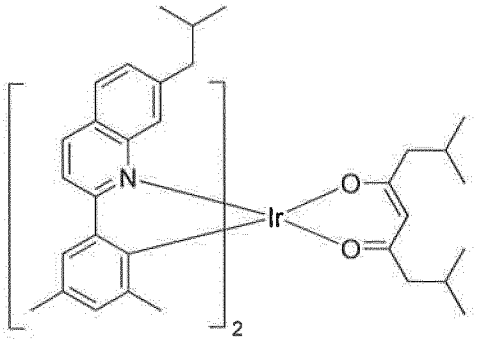
Compound E9



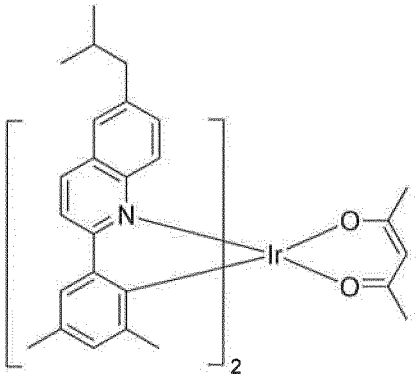
Compound E10



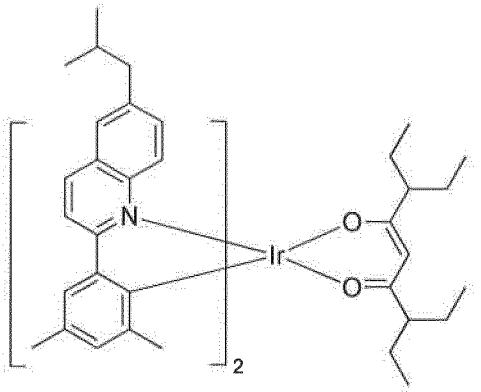
Compound E11



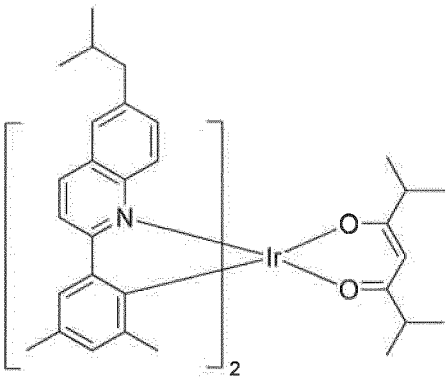
Compound E12



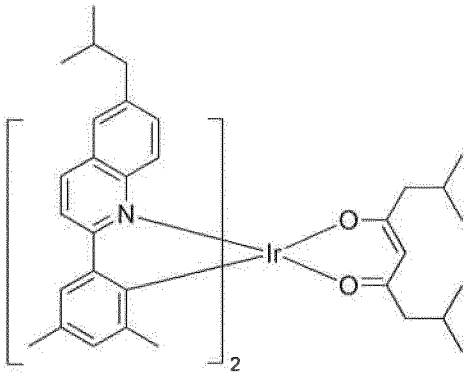
Compound E13



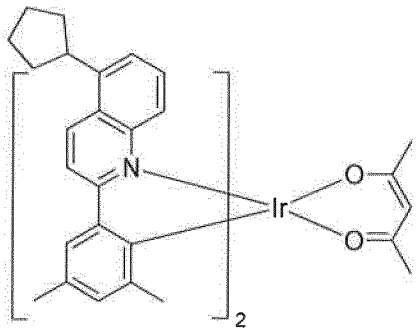
Compound E14



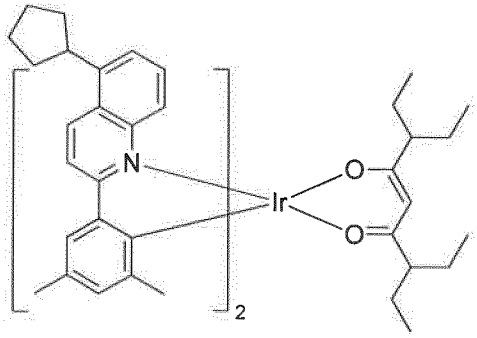
Compound E15



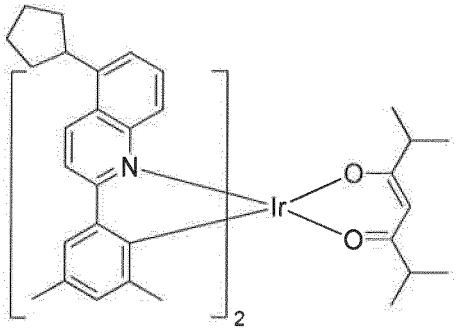
Compound E16



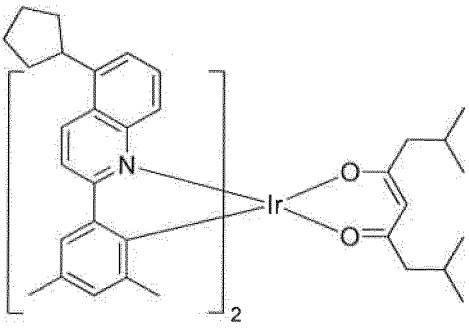
Compound E17



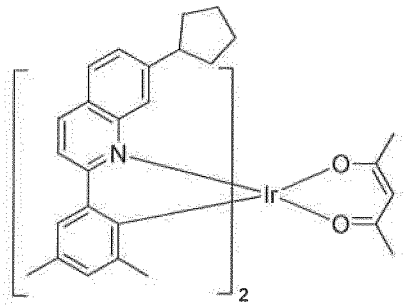
Compound E18



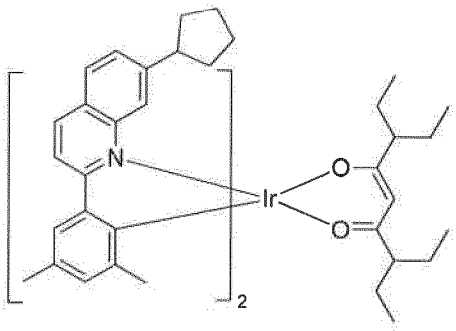
Compound E19



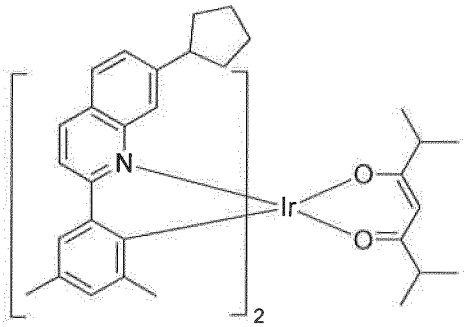
Compound E20



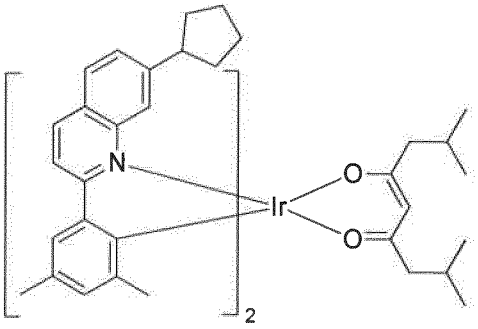
Compound E21



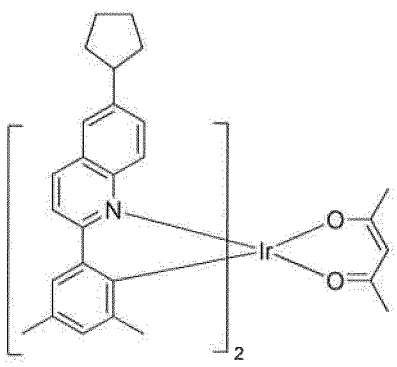
Compound E22



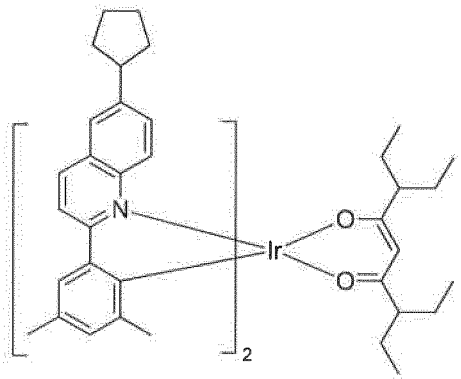
Compound E23



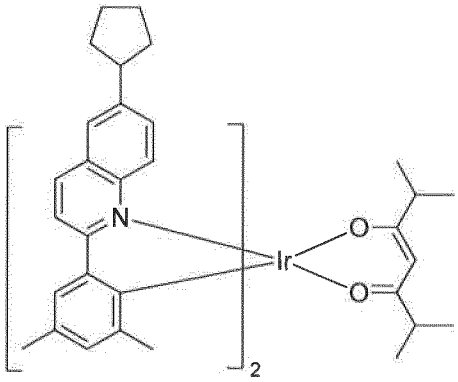
Compound E24



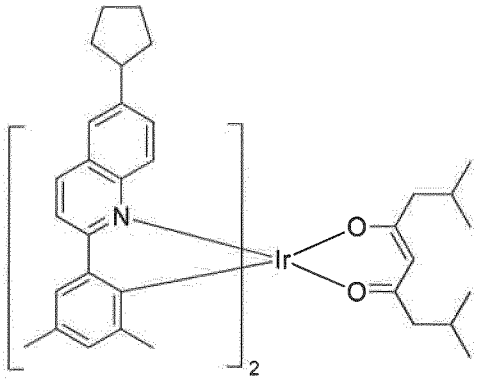
Compound E25



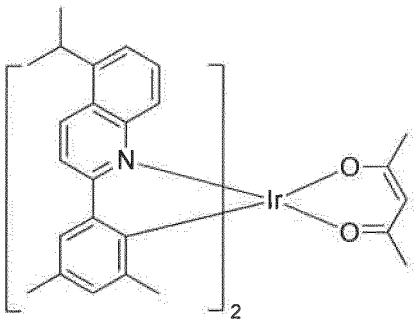
Compound E26



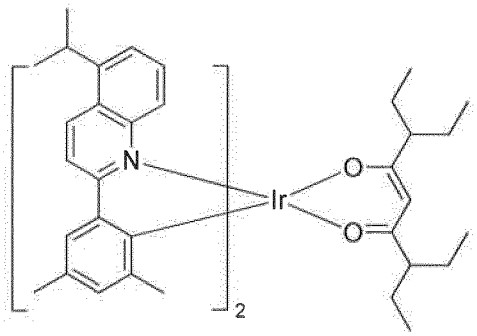
Compound E27



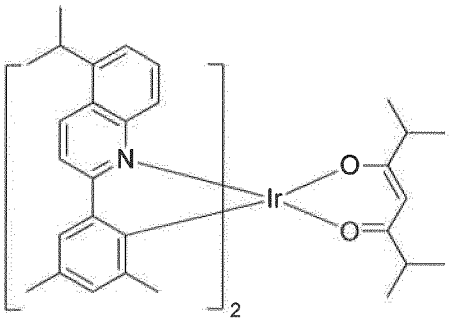
Compound E28



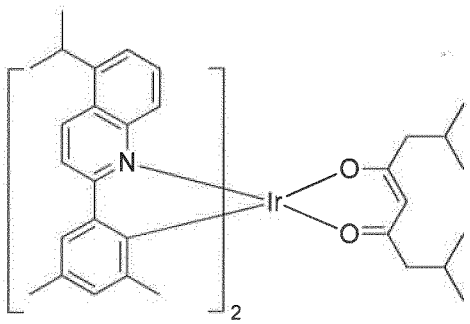
Compound E29



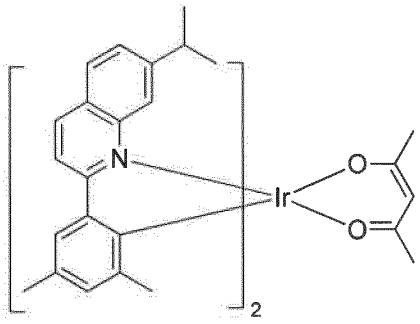
Compound E30



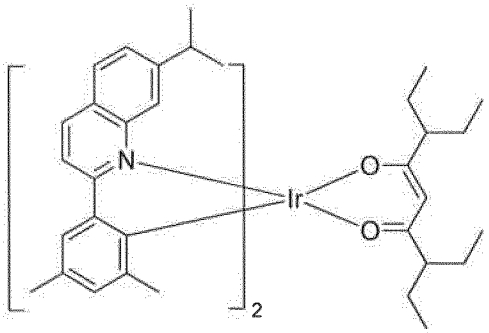
Compound E31



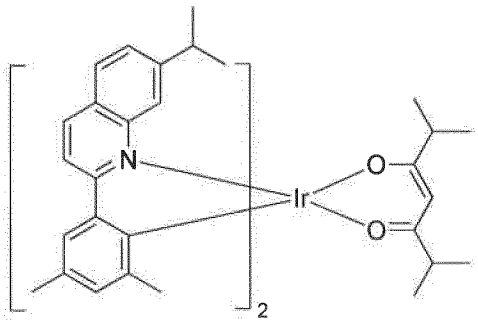
Compound E32



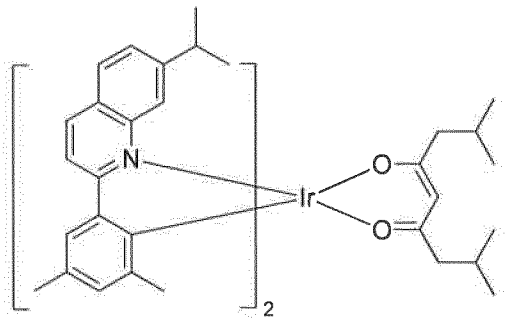
Compound E33



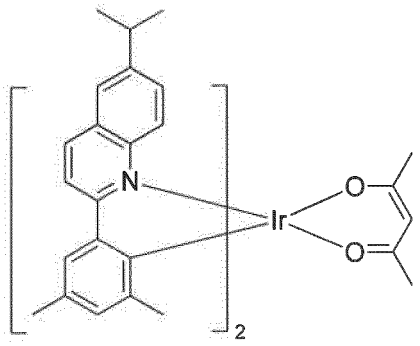
Compound E34



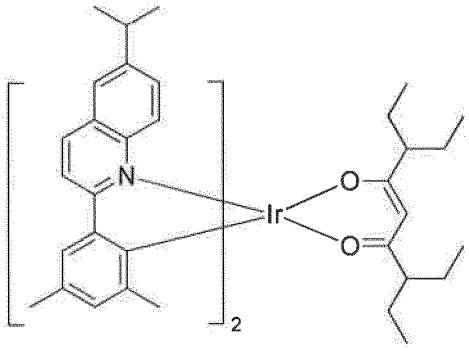
Compound E35



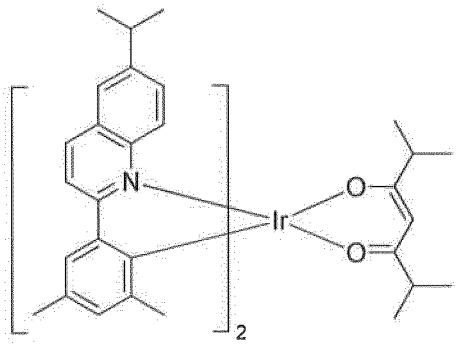
Compound E36



Compound E37

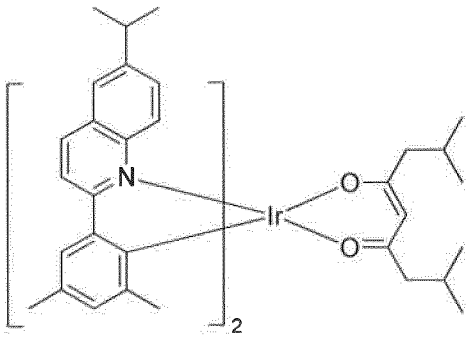


Compound E38



Compound E39

, and

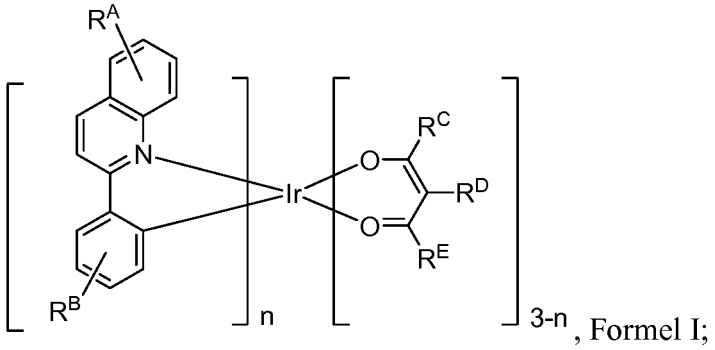


Compound E40

7. The composition of any one of claims 1 to 3, wherein the mixture of the first compound and the second compound is selected from the group consisting of: (Compound E5 and Compound H1), (Compound E1 and Compound H14), (Compound E4 and Compound H21), (Compound E9 and Compound H30), (Compound E17 and Compound H21), and (Compound E13 and Compound H33).

Patentansprüche

1. Eine Zusammensetzung umfassend: Eine Mischung aus einer ersten Verbindung und einer zweiten Verbindung;
wobei die erste Verbindung eine unterschiedliche chemische Struktur als die zweite Verbindung besitzt;
wobei die erste Verbindung in der Lage ist, als ein phosphoreszenter Emitter in einer organischen Licht emittierenden Vorrichtung bei Raumtemperatur zu wirken;
wobei die erste Verbindung eine Verdampfungstemperatur T1 von 150 bis 350 °C besitzt und die zweite Verbindung eine Verdampfungstemperatur T2 von 150 bis 350 °C besitzt, wobei die Verdampfungstemperatur der ersten und der zweiten Verbindung in einem Vakuumabscheidungsgerät bei einem konstanten Druck zwischen $1{,}33322x10^{-4}$ Pa ($1x10^{-6}$ Torr) und $1{,}33322x10^{-7}$ Pa ($1x10^{-9}$ Torr) bei einer Abscheiderate von 0,2 nm/sec (2 Å/sec) auf einer Oberfläche, die mit einer vordefinierten Entfernung entfernt von der Mischung, die verdampft wird, positioniert ist, gemessen wird;
wobei der absolute Wert von T1-T2 weniger als 20 °C beträgt;
wobei die erste Verbndung eine Konzentration C1 in der Mischung und eine Konzentration C2 in einem Film, der durch Verdampfung der Mischung in einer Vakuumabscheidevorrichtung bei einem konstanten Druck zwischen $1{,}33322x10^{-4}$ Pa ($1x10^{-6}$ Torr) und $1{,}33322x10^{-7}$ Pa ($1x10^{-9}$ Torr) bei einer Abscheiderate von 0,2 nm/sec (2 Å/sec) auf einer Oberfläche, die mit einer vordefinierten Entfernung entfernt von der Mischung, die verdampft wird, positioniert ist, besitzt;
wobei der absolute Wert von (C1-C2)/C1 weniger als 5 % beträgt wobei die erste Verbindung eine Struktur gemäß Formel I besitzt:

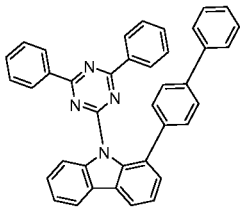


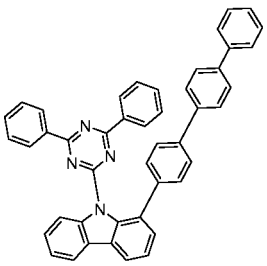
, Formel I;

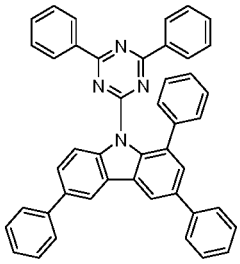
wobei

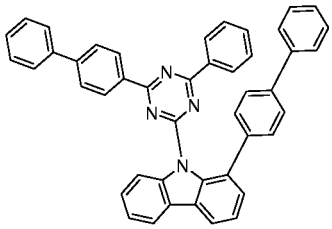
R^A eine mono-, di-, tri-, tetra-, penta-, hexa-Substitution oder keine Substitution darstellt;
R^B eine mono-, di-, tri-, tetra-Substitution oder keine Substitution darstellt;
R^A, R^B, R^C, R^D und R^E jeweils unabhängig voneinander ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, Deuterium, Halogen, Alkyl, Cycloalkyl, Heteroalkyl, Arylalkyl, Alkoxy, Aryloxy, Amino, zyklisches Amino, Silyl, Alkenyl, Cycloalkenyl, Heteroalkenyl, Alkinyl, Aryl, Heteroaryl, Acyl, Carbonyl, Carbonsäure, Ether, Ester, Nitril, Isonitril, Sulfanyl, Sulfinyl, Sulfonyl, Phosphin und deren Kombinationen; wobei n 1 oder 2 ist; und **dadurch gekennzeichnet, dass**

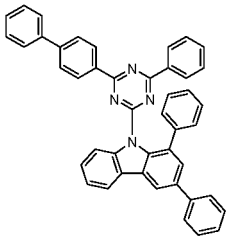
die zweite Verbindung ausgewählt ist aus der Gruppe bestehend aus:

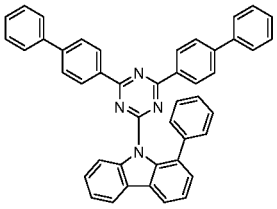

Verbindung H1 ,

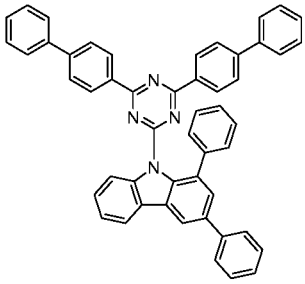

Verbindung H2 ,

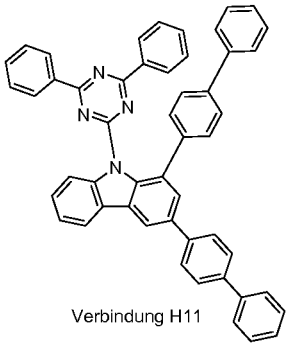

Verbindung H3 ,

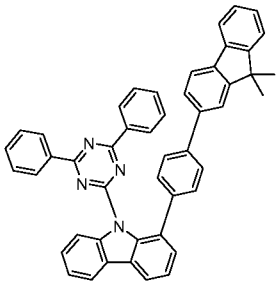

Verbindung H4 ,

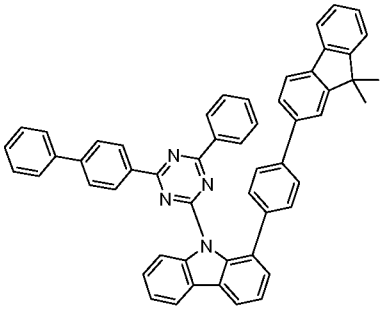

Verbindung H5 ,


Verbindung H6 ,


Verbindung H7 ,


Verbindung H11 ,


Verbindung H12 ,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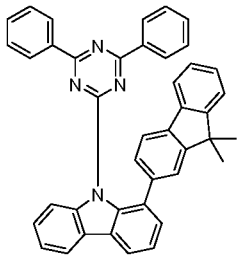
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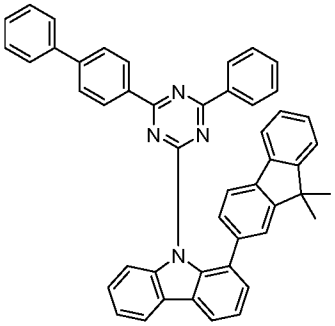
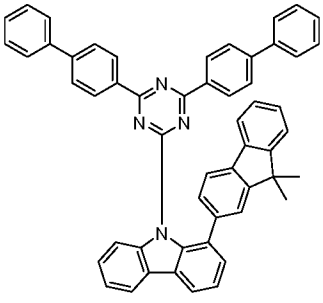

Verbindung H15 ,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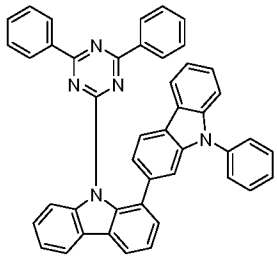
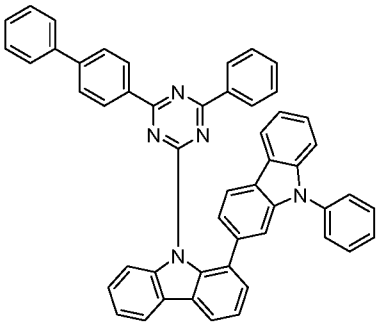
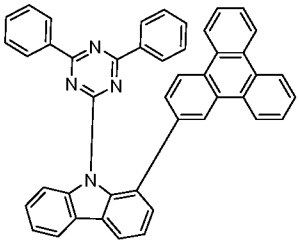
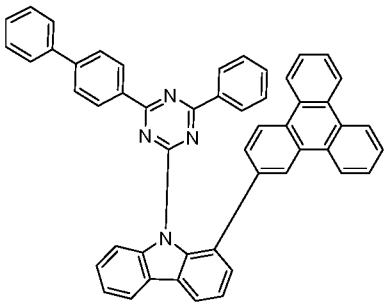

Verbindung H17 ,



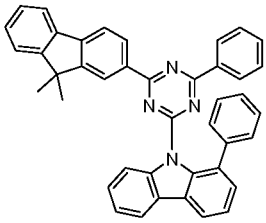
Verbindung H18 ,



Verbindung H19 ,



Verbindung H20 ,



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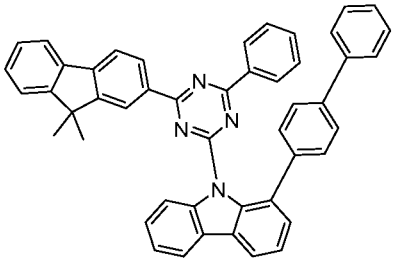

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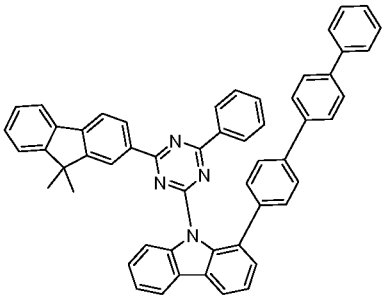
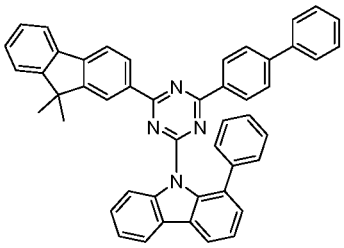


Verbindung H23 ,



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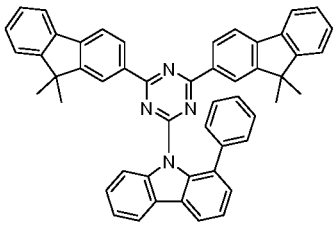
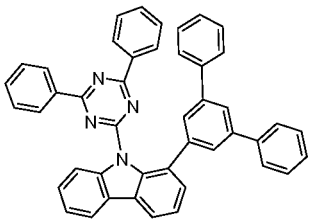


Verbindung H25 ,



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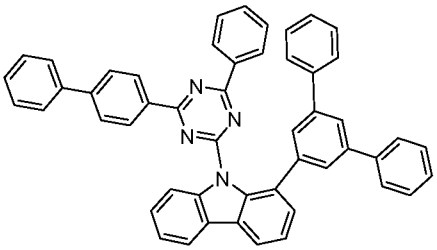
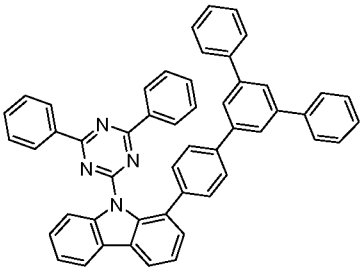
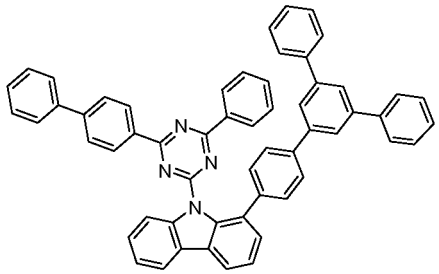


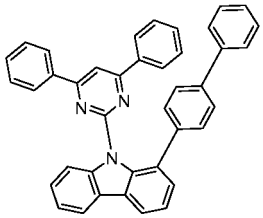
Verbindung H27 ,



Verbindung H28 ,



Verbindung H29 ,



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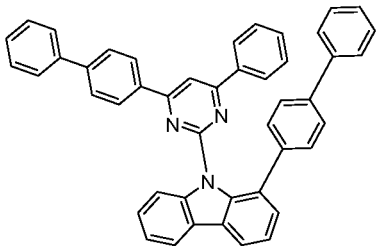

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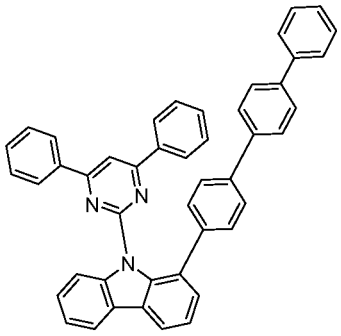

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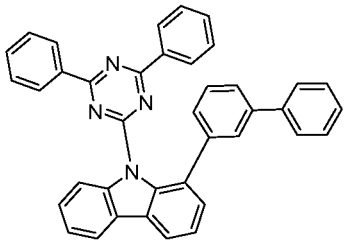

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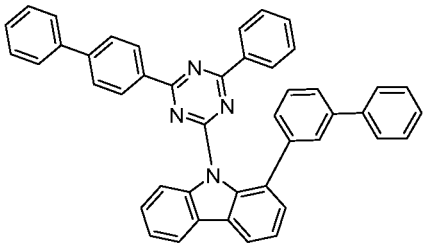

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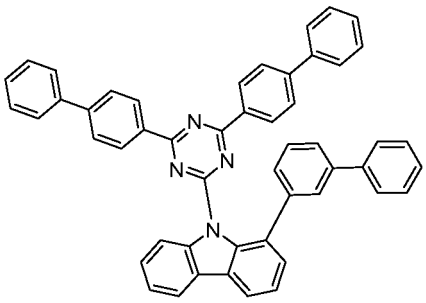

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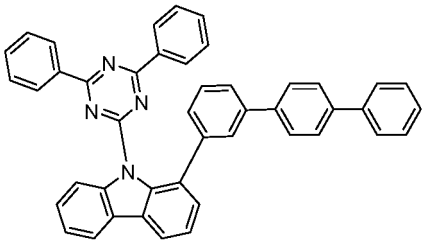

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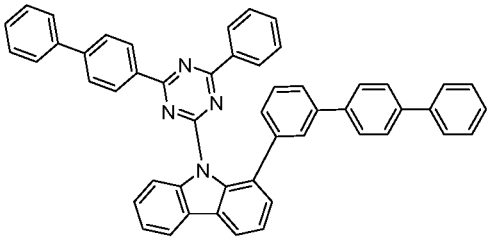

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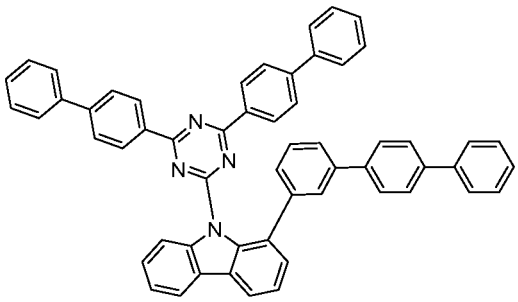
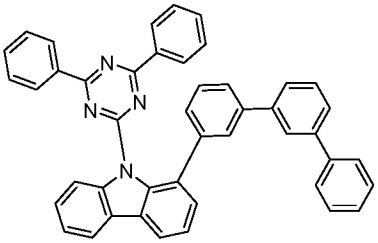


Verbindung H38 ,



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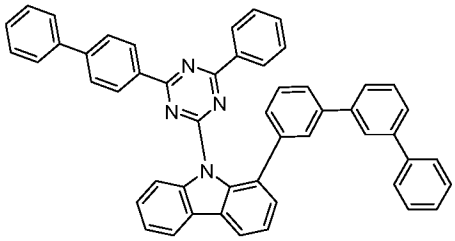
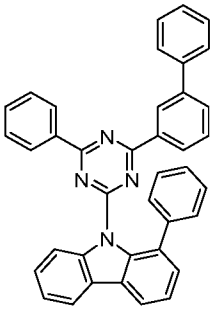


Verbindung H40 ,



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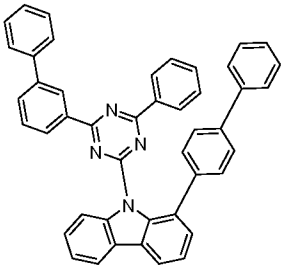
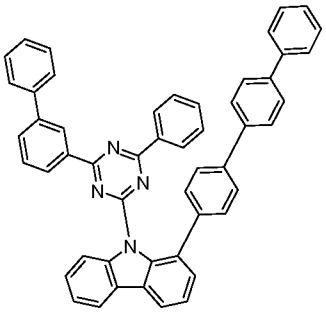
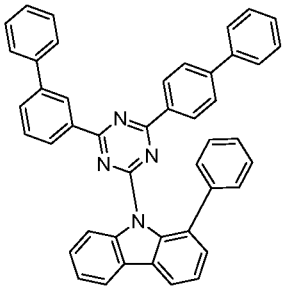


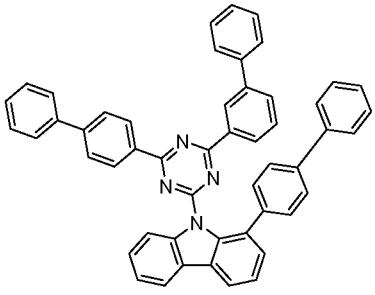
Verbindung H42 ,



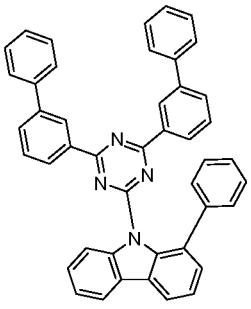
Verbindung H43 ,



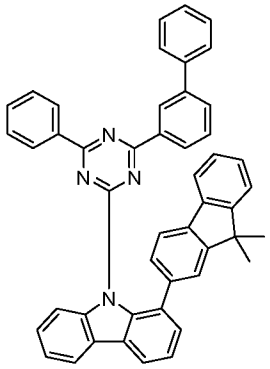
Verbindung H44 ,



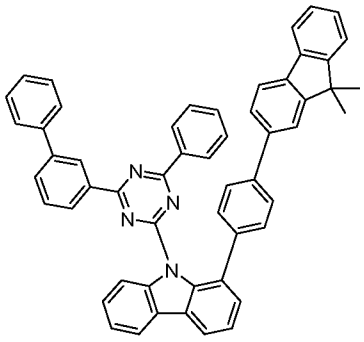
Verbindung H45 ,



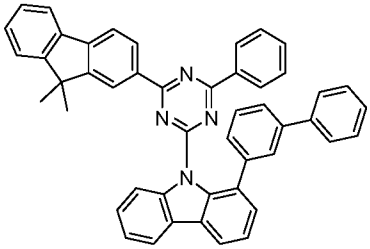
Verbindung H46 ,



Verbindung H47 ,

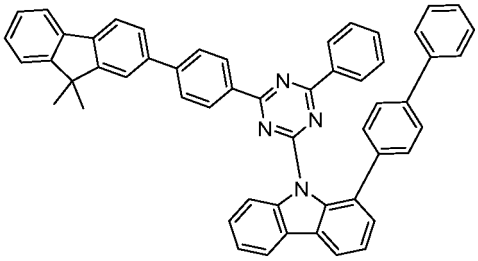


Verbindung H48 ,



Verbindung H49 ,

und

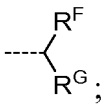


Verbindung H50 .

2. Die Zusammensetzung gemäß Anspruch 1, wobei die erste Verbindung einen Verdampfungsdruck von P1 bei T1 von 101325 Pa (1 atm) besitzt, die zweite Verbindung einen Verdampfungsdruck von P2 bei T2 von 101325 Pa (1 atm) besitzt; und
wobei das Verhältnis von P1/P2 im Bereich von 0,90 bis 1,10 ist.

3. Die Zusammensetzung gemäß Anspruch 1 oder 2, wobei die erste Verbindung eine erste Massenverlustrate und die zweite Verbindung eine zweite Massenverlustrate besitzt, wobei das Verhältnis zwischen der ersten Massenverlustrate und der zweiten Massenverlustrate im Bereich von 0,90 bis 1,10 liegt.

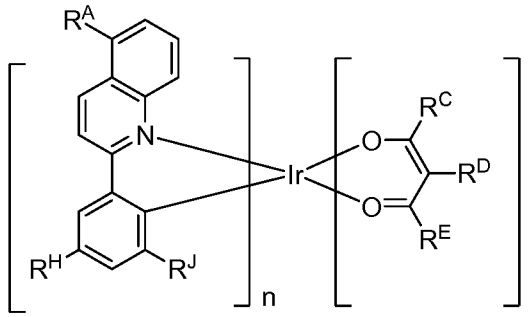
4. Die Zusammensetzung gemäß irgendeinem der Ansprüche 1 bis 3, wobei mindestens eines von R^C und R^E die folgende Struktur besitzt:



;

wobei R^F und R^G unabhängig voneinander ausgewählt sind aus der Gruppe bestehend aus Alkyl und Cycloalkyl; und
wobei mindestens eines von R^F und R^G mindestens zwei C besitzt.

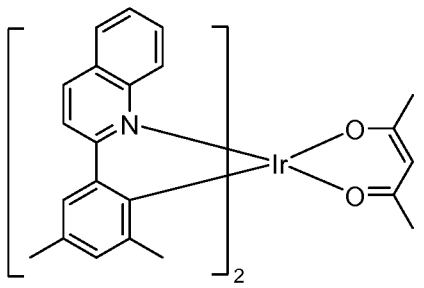
5. Die Zusammensetzung gemäß irgendeinem der Ansprüche 1 bis 4, wobei die erste Verbindung eine Struktur gemäß Formel IV besitzt:



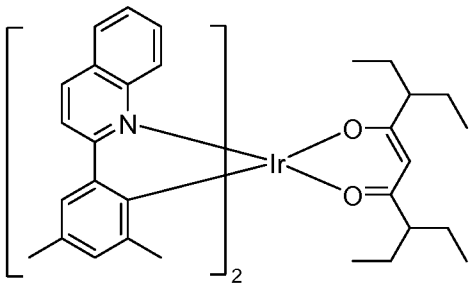
, Formel IV

wobei R^H und R^J jeweils unabhängig voneinander ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, Deuterium, Halogen, Alkyl, Cycloalkyl, Heteroalkyl, Arylalkyl, Alkoxy, Aryloxy, Amino, Cycloamino, Silyl, Alkenyl, Cycloalkenyl, Heteroalkenyl, Alkinyl, Aryl, Heteroaryl, Acyl, Carbonyl, Carbonsäure, Ether, Ester, Nitril, Isonitril, Sulfanyl, Sulfinyl, Sulfonyl, Phosphin und deren Kombinationen.

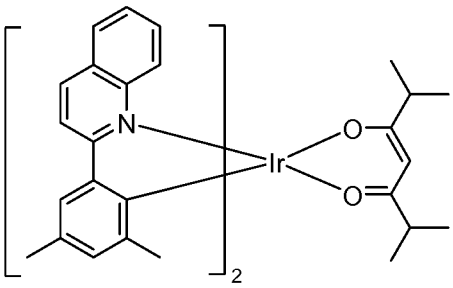
6. Die Zusammensetzung gemäß irgendeinem der Ansprüche 1 bis 3 oder 5, wobei die erste Verbindung ausgewählt ist aus der Gruppe bestehend aus:



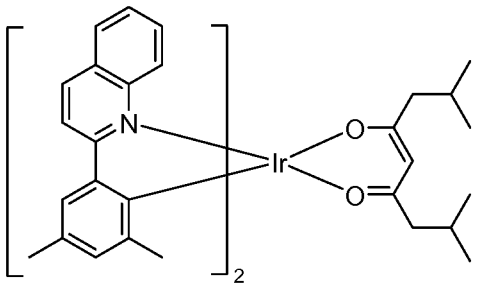
Verbindung E1 ,



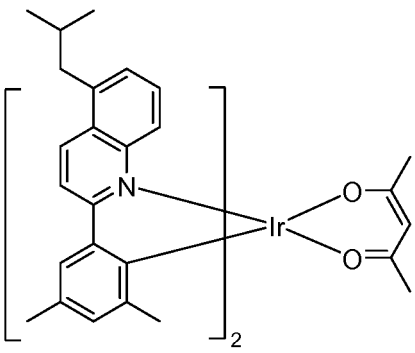
Verbindung E2 ,



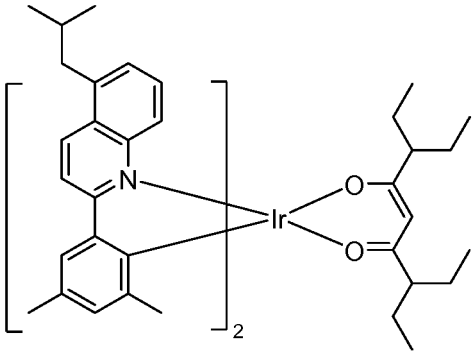
Verbindung E3 ,



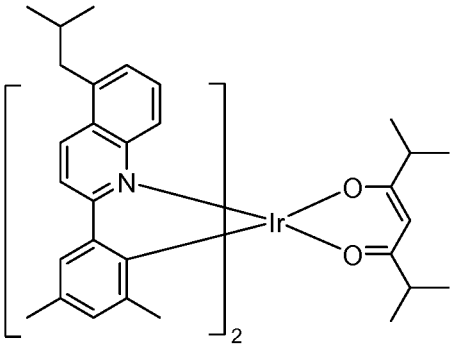
Verbindung E4 ,



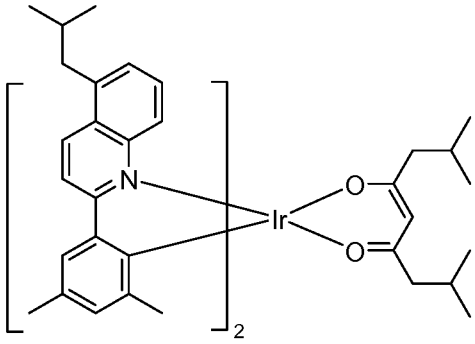
Verbindung E5 ,



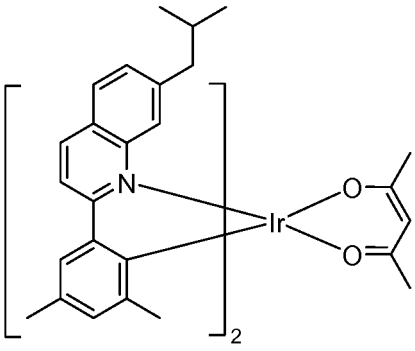
Verbindung E6 ,



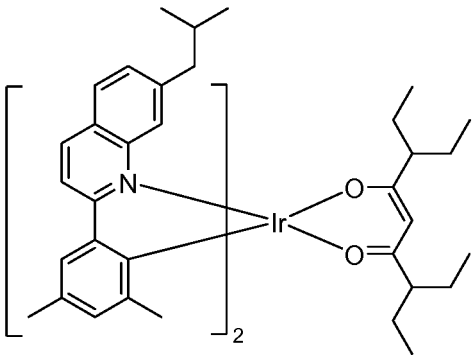
Verbindung E7 ,



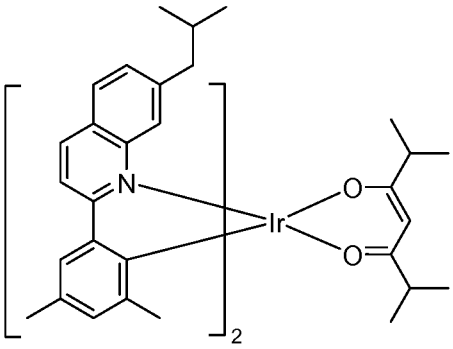
Verbindung E8 ,



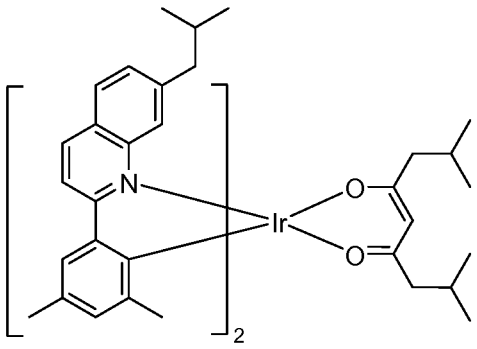
Verbindung E9 ,



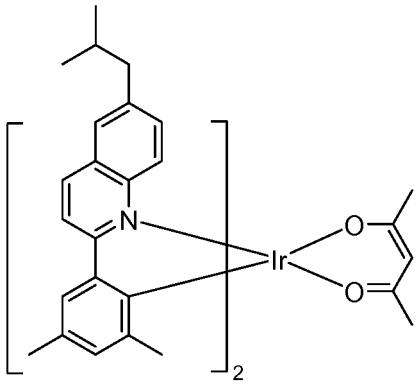
Verbindung E10 ,



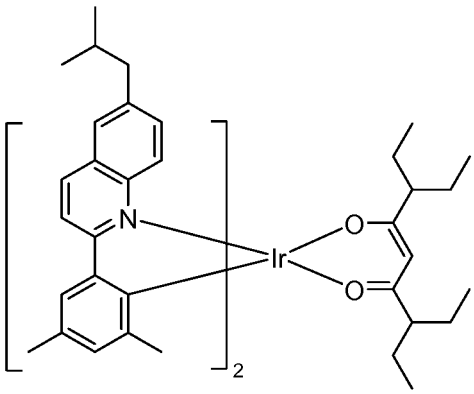
Verbindung E11 ,



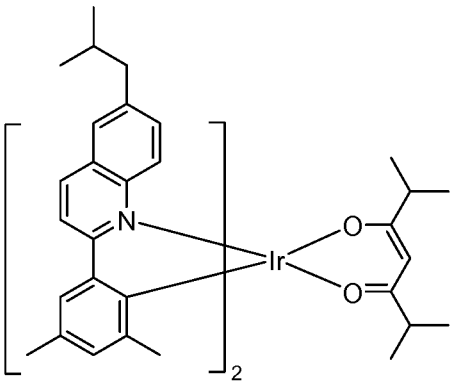
Verbindung E12 ,



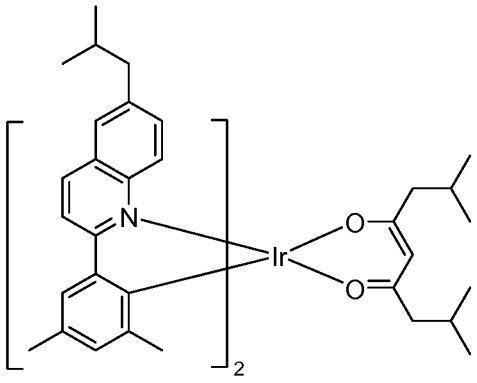
Verbindung E13 ,



Verbindung E14 ,



Verbindung E15 ,



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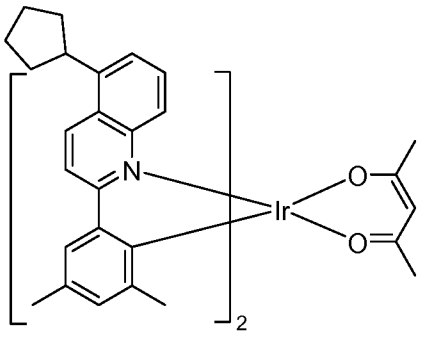

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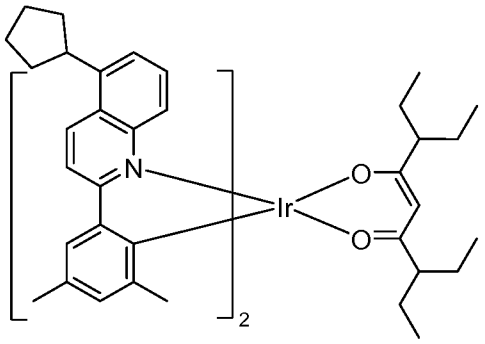

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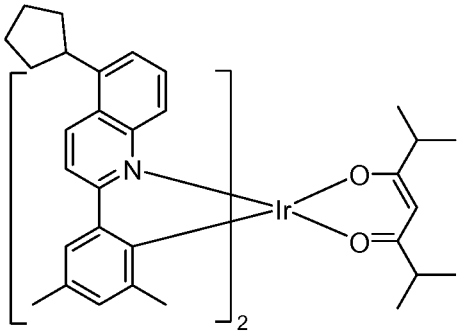

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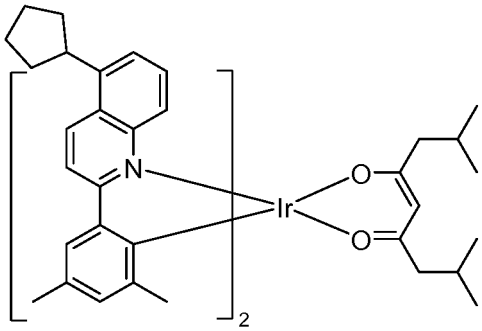

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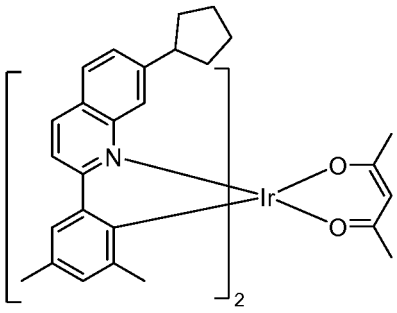

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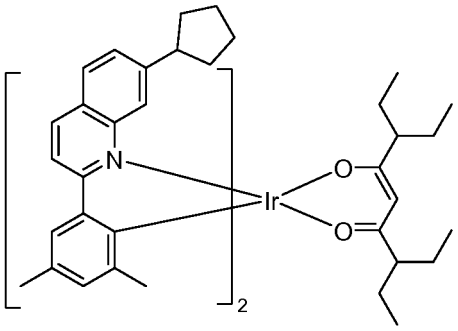

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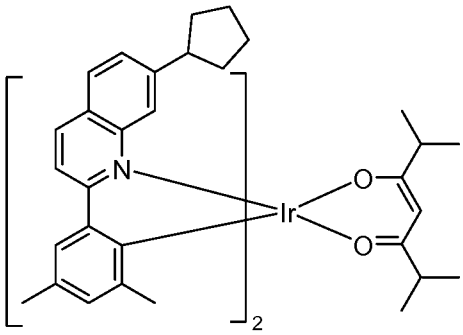
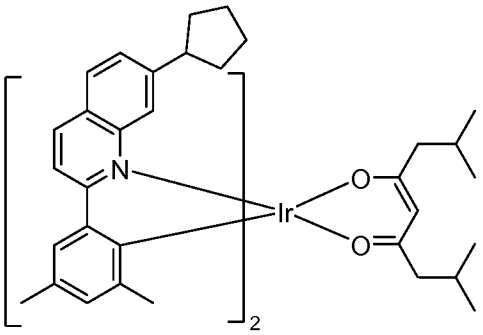


Verbindung E23



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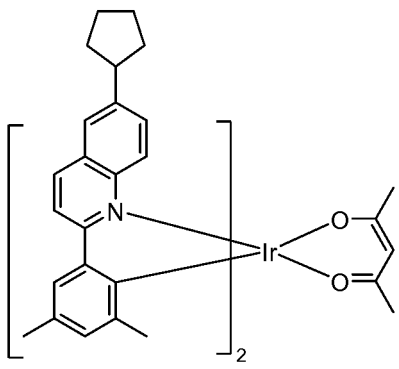

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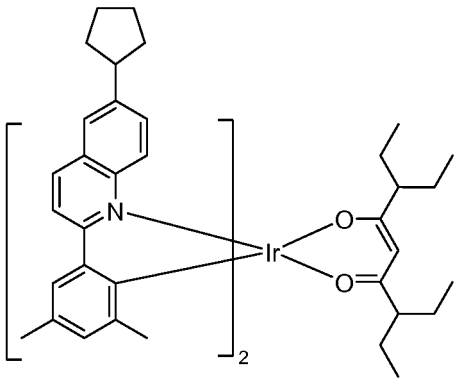

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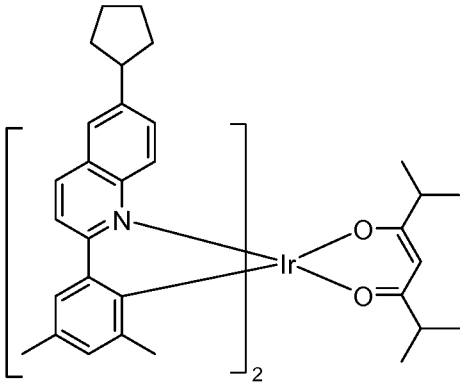
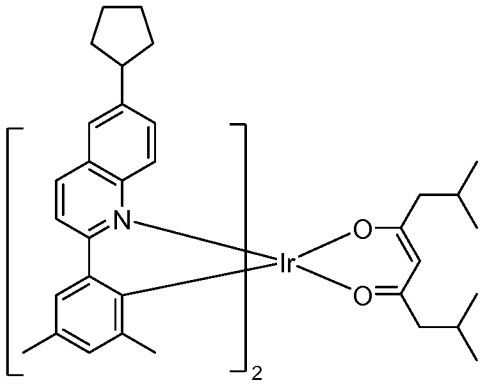


Verbindung E27



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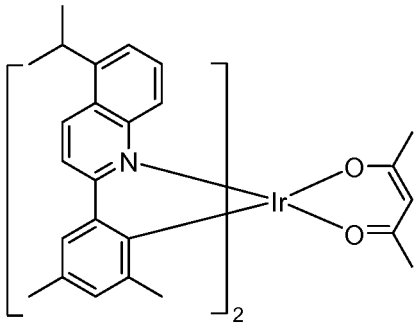

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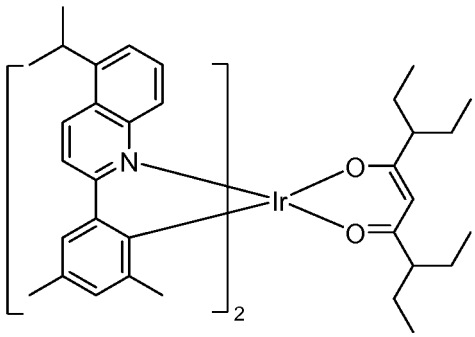

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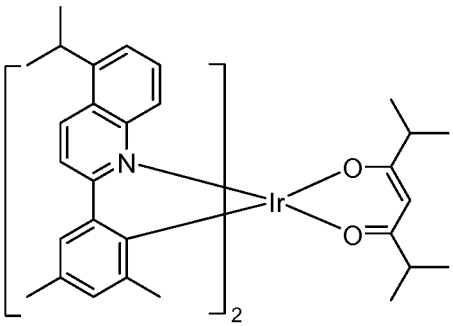

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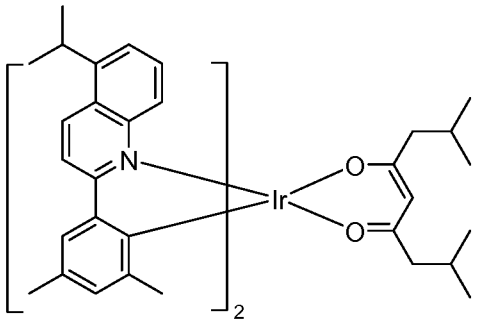

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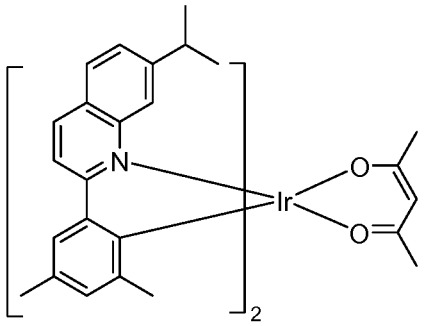

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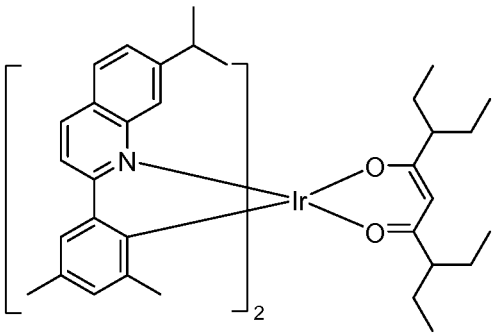

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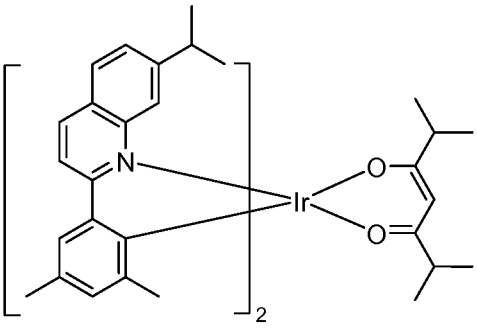

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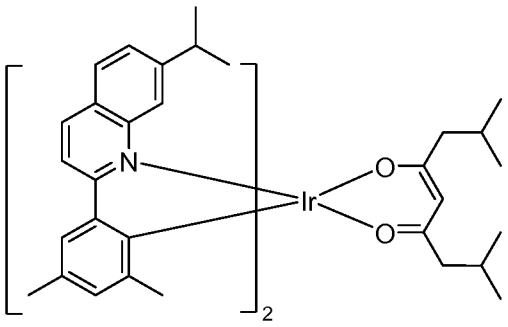

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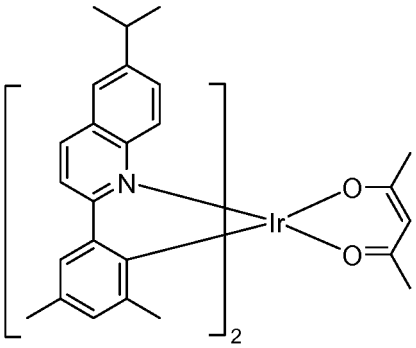

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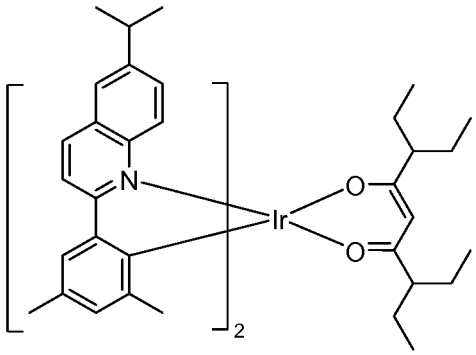

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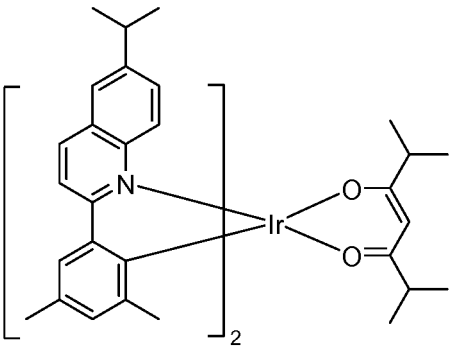
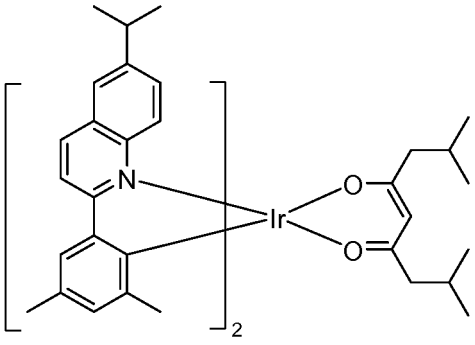


Verbindung E39 , und

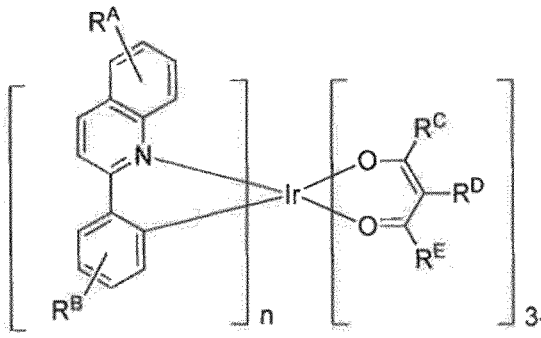


Verbindung E40 .

7. Die Zusammensetzung gemäß irgendeinem der Ansprüche 1 bis 3, wobei die Mischung aus der ersten Verbindung und der zweiten Verbindung ausgewählt ist aus der Gruppe bestehend aus: (Verbindung E5 und Verbindung H1), (Verbindung E1 and Verbindung H14), (Verbindung E4 und Verbindung H21), (Verbindung E9 und Verbindung H30), (Verbindung E17 und Verbindung H21), und (Verbindung E13 und Verbindung H33).

Revendications

1. Composition comprenant: un mélange d'un premier composé et d'un second composé ;
dans laquelle le premier composé a une structure chimique différente du second composé ;
dans laquelle le premier composé est capable de fonctionner en tant qu'émetteur phosphorescent dans un dispositif électroluminescent organique à la température ambiante ;
dans laquelle le premier composé a une température d'évaporation T1 de 150 à 350 °C et le second composé a une température d'évaporation T2 de 150 à 350 °C,
dans laquelle la température d'évaporation du premier et du second composé est mesurée dans un outil de dépôt sous vide à une pression constante entre 1,33322x10^{-4} Pa (1x10^{-6} Torr) et 1,33322x10^{-7} Pa (1x10^{-9} Torr) à une vitesse de dépôt de 0,2 nm/sec (2 Å/sec) sur une surface positionnée à une distance prédéfinie du mélange qui est évaporé;
dans laquelle la valeur absolue de T1-T2 est inférieure à 20 °C ;
dans laquelle le premier composé a une concentration C1 dans ledit mélange et une concentration C2 dans un film formé par évaporation du mélange dans un outil de dépôt sous vide à une pression constante entre 1,33322x10^{-4} Pa (1x10^{-6} Torr) et 1,33322x10^{-7} Pa (1x10^{-9} Torr) à une vitesse de dépôt de 0,2 nm/sec (2 Å/sec) sur une surface positionnée à une distance prédéfinie du mélange qui est évaporé; dans laquelle la valeur absolue de (C1-C2)/C1 est inférieure à 5 %
dans laquelle le premier composé a une structure selon la Formule I :

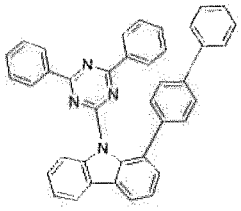


, Formule I ;

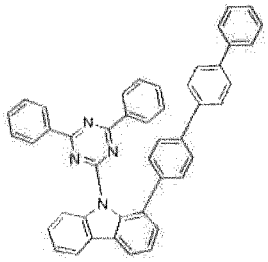
dans laquelle

R^A représente des mono, di, tri, tétra, penta, hexa substitutions, ou aucune substitution ;
R^B représente des mono, di, tri, tétra substitutions, ou aucune substitution ;
R^A, R^B, R^C, R^D, et R^E sont chacun indépendamment choisis dans le groupe constitué par hydrogène, deutérium, halogène, alkyle, cycloalkyle, hétéroalkyle, arylalkyle, alcoxy, aryloxy, amino, amino cyclique, silyle, alcényle, cycloalcényle, hétéroalcényle, alcynyle, aryle, hétéroaryle, acyle, carbonyle, acide carboxylique, éther, ester, nitrile, isonitrile, sulfanyle, sulfinyle, sulfonyle, phosphino, et leurs combinaisons ;
dans laquelle n est 1 ou 2 ; et

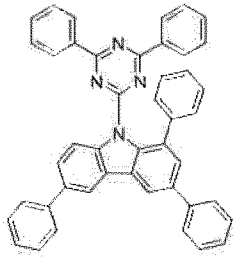
caractérisée en ce que : le second composé est choisi dans le groupe constitué par :



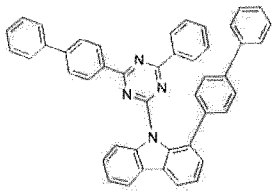
Composé H1,



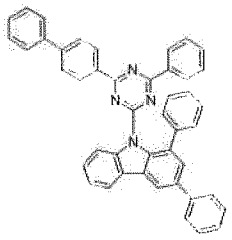
Composé H2,



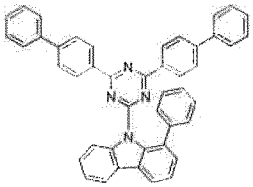
Composé H3,



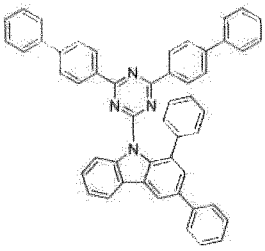
Composé H4,



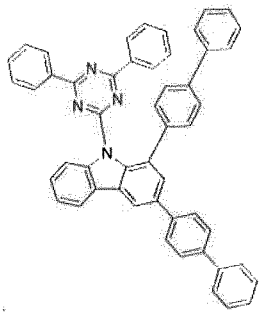
Composé H5,



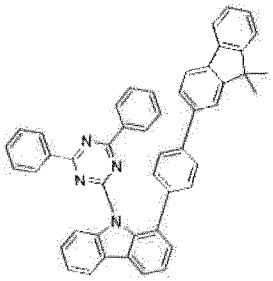
Composé H6,



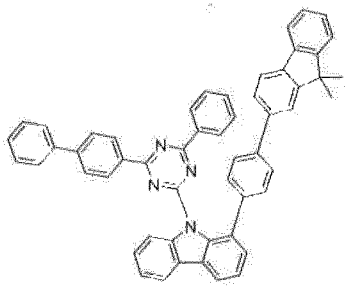
Composé H7,



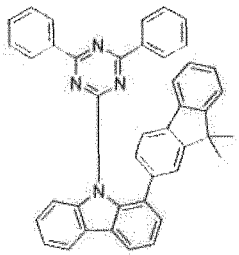
Composé H11,



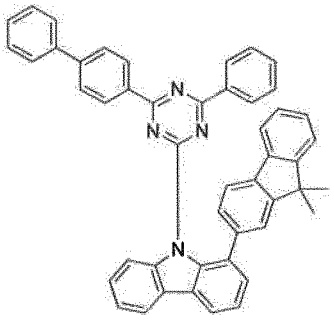
Composé H12,



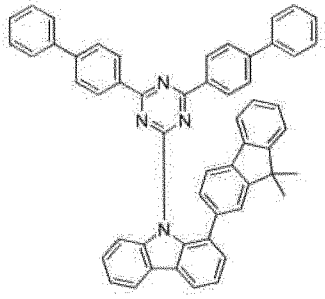
Composé H13,



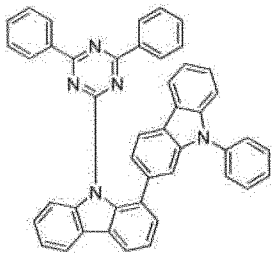
Composé H14,



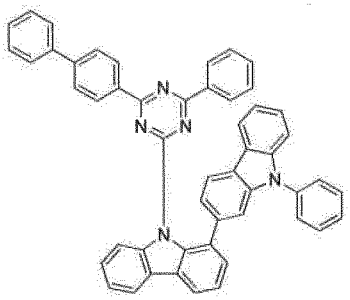
Composé H15,



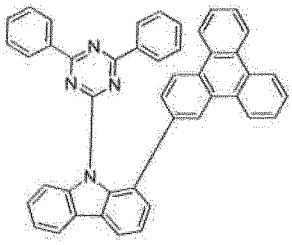
Composé H16,



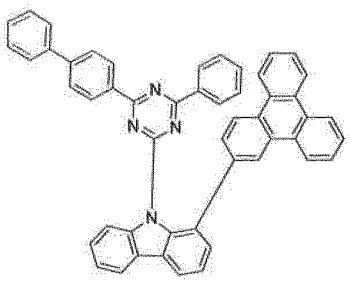
Composé H17,



Composé H18,



Composé H19,



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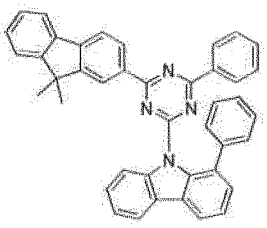

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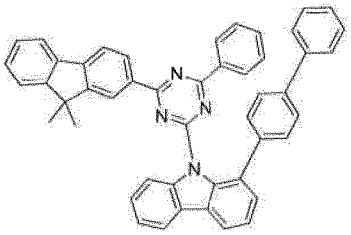

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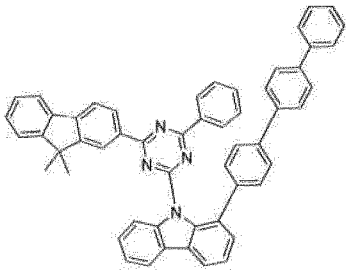

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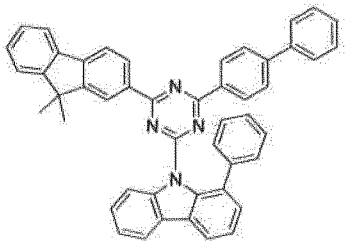

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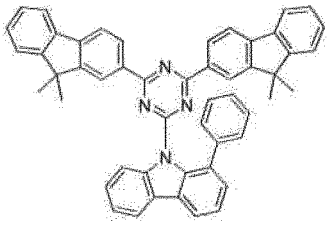
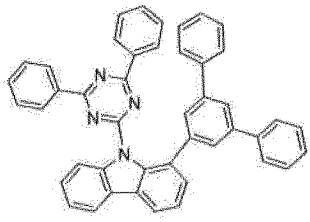
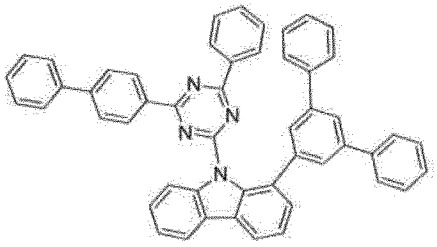


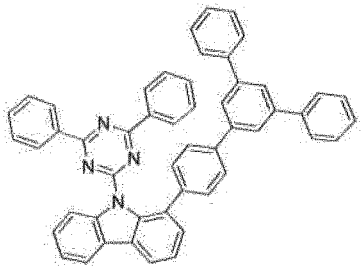
Composé H25,



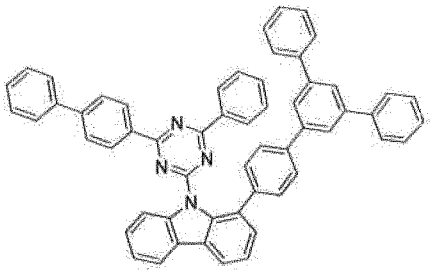
Composé H26,



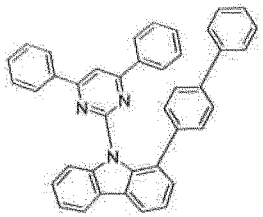
Composé H27,



Composé H28,



Composé H29,



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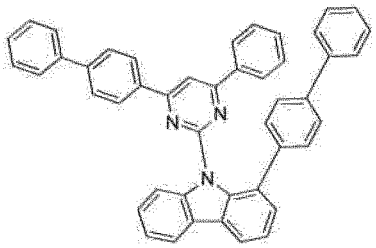

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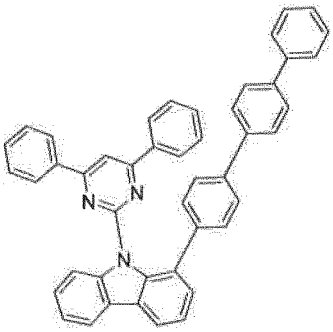

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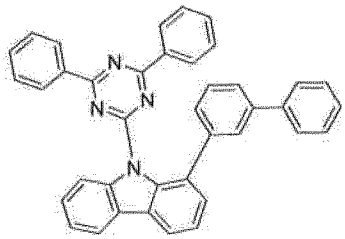

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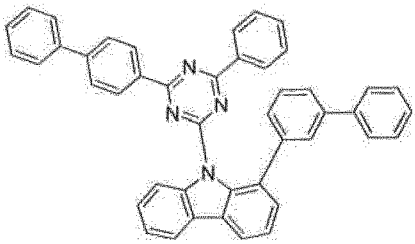

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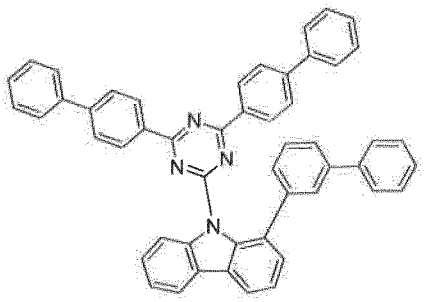

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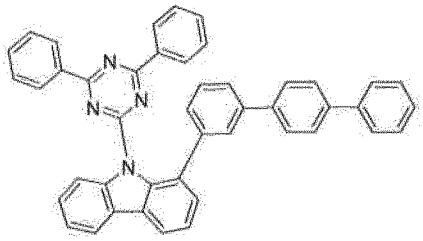

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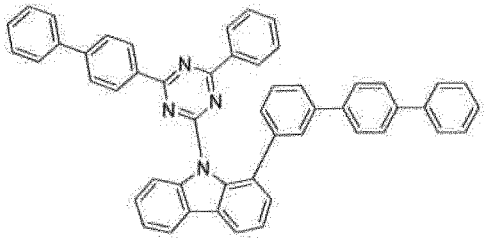

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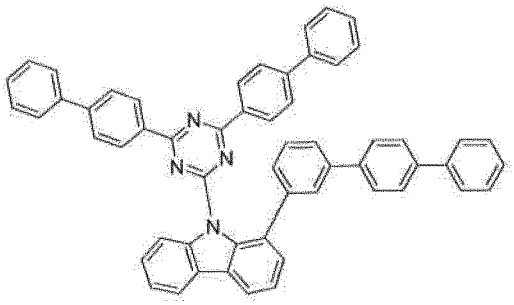

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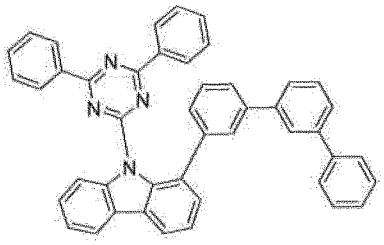

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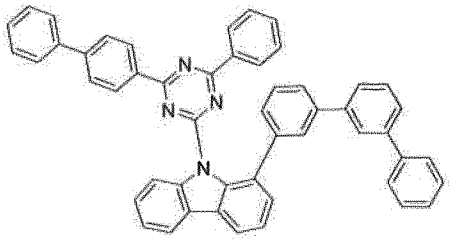

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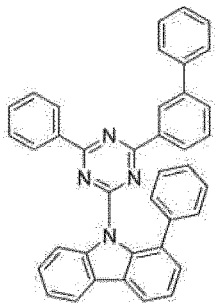

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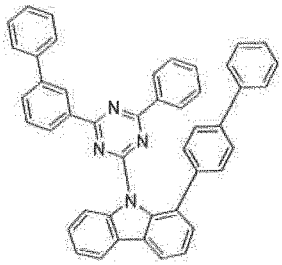

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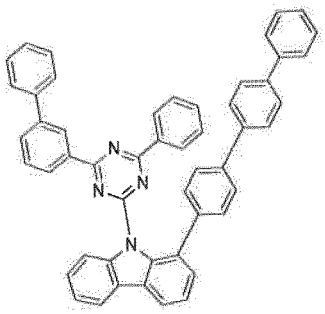

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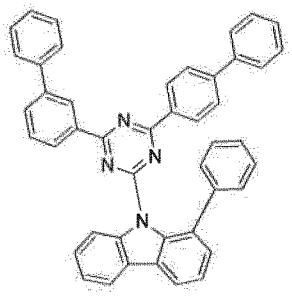

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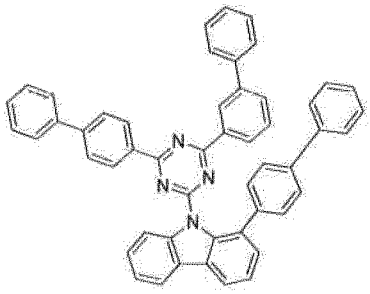

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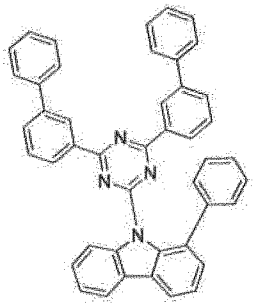

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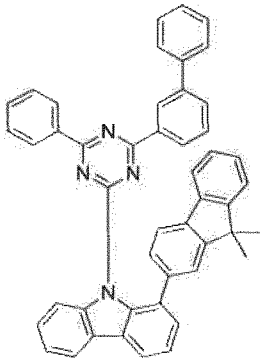

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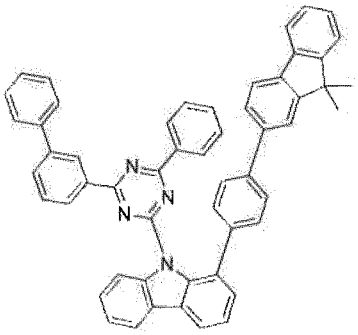
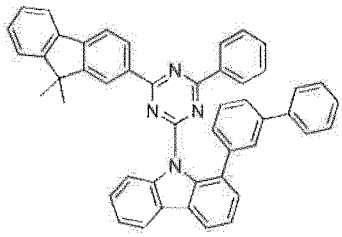
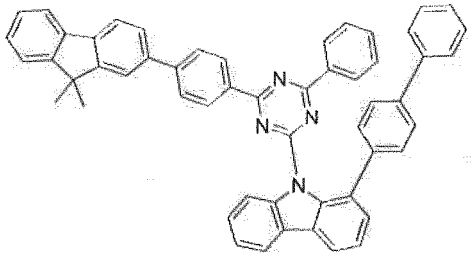


Composé H48,



Composé H49,

et

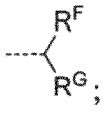


Composé H50.

2. Composition de la revendication 1, dans laquelle le premier composé a une tension de vapeur de P1 à T1 à 101 325 Pa (1 atm), le second composé a une tension de vapeur de P2 à T2 à 101 325 Pa (1 atm) ; et dans laquelle le rapport de P1/P2 se situe dans la plage de 0,90 à 1,10.

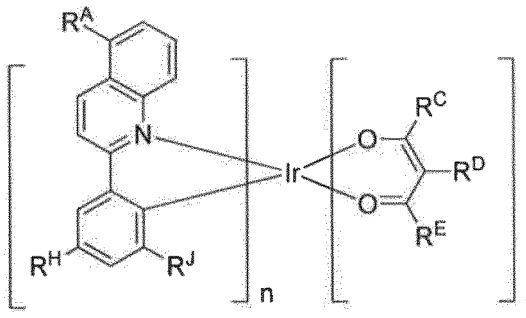
3. Composition de la revendication 1 ou 2, dans laquelle le premier composé a un premier taux de perte de masse et le second composé a un second taux de perte de masse, le rapport entre le premier taux de perte de masse et le second taux de perte de masse se situant dans la plage de 0,90 à 1,10.

4. Composition de l'une quelconque des revendications 1 à 3, dans laquelle au moins l'un parmi R^C et R^E a la structure suivante :



dans laquelle R^F, et R^G sont indépendamment choisis dans le groupe constitué par alkyle et cycloalkyle ; et dans laquelle au moins l'un parmi R^F, et R^G a au moins deux C.

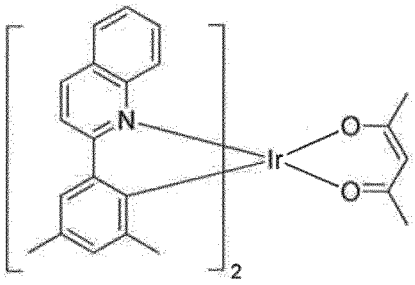
5. Composition de l'une quelconque des revendications 1 à 4, dans laquelle le premier composé a une structure selon la Formule IV :



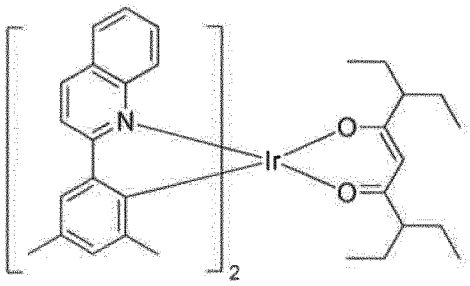
, Formule IV ;

dans laquelle R^H et R^J sont chacun indépendamment choisis dans le groupe constitué par hydrogène, deutérium, halogène, alkyle, cycloalkyle, hétéroalkyle, arylalkyle, alcoxy, aryloxy, amino, amino cyclique, silyle, alcényle, cycloalcényle, hétéroalcényle, alcynyle, aryle, hétéroaryle, acyle, carbonyle, acide carboxylique, éther, ester, nitrile, isonitrile, sulfanyle, sulfinyle, sulfonyle, phosphino, et leurs combinaisons ;

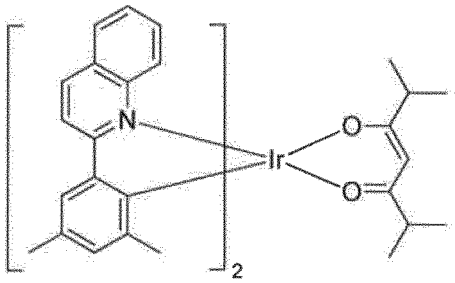
6. Composition de l'une quelconque des revendications 1 à 3 ou 5, dans laquelle le premier composé est choisi dans le groupe constitué par :



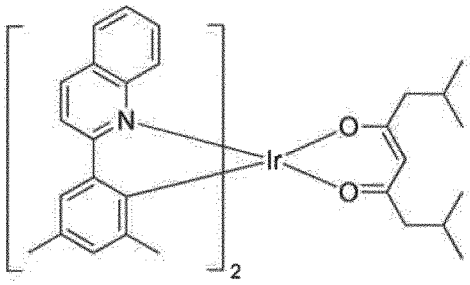
Composé E1,



Composé E2,



Composé E3,



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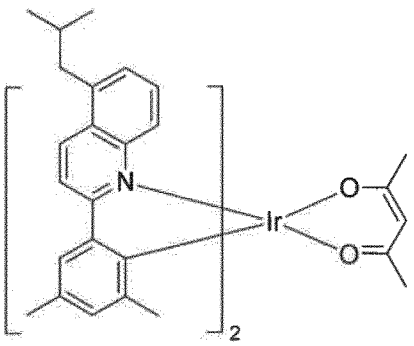
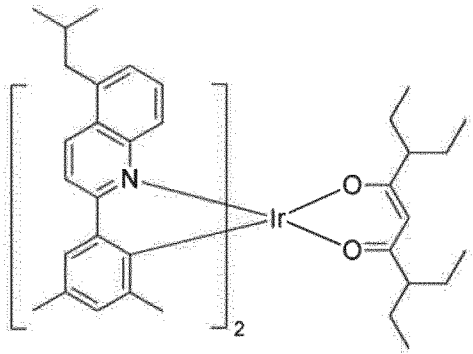
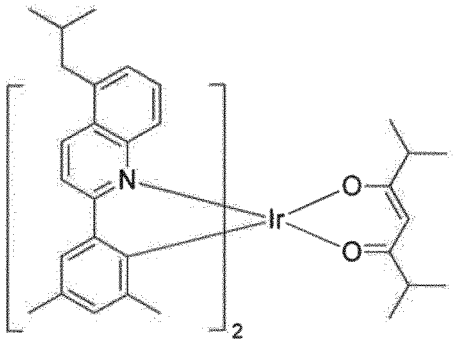


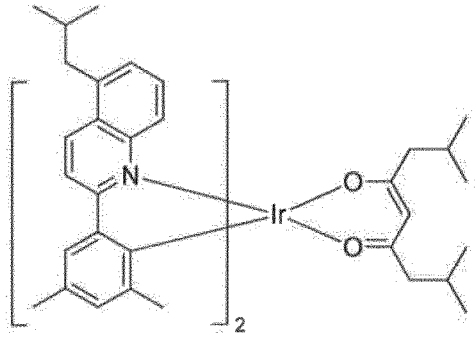
Composé E5,



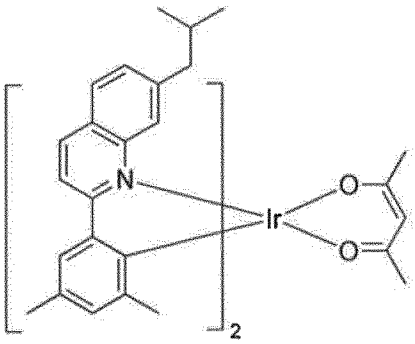
Composé E6,



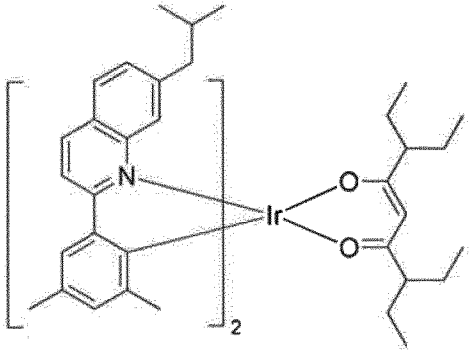
Composé E7,



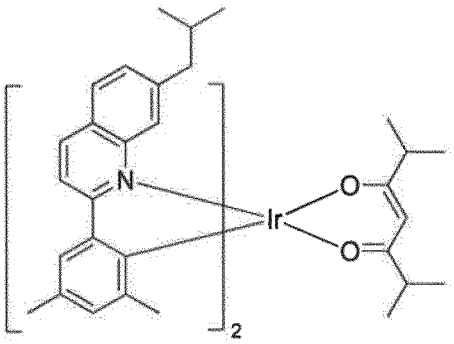
Composé E8,



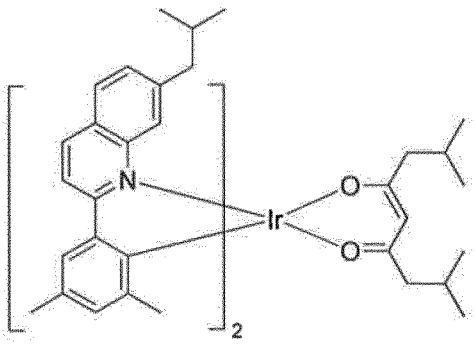
Composé E9,



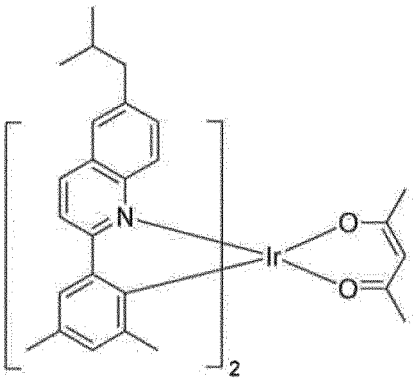
Composé E10,



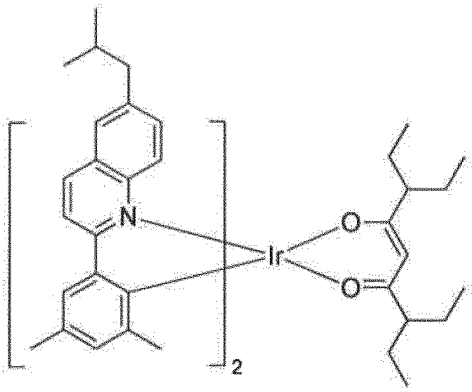
Composé E11,



Composé E12,



Composé E13,



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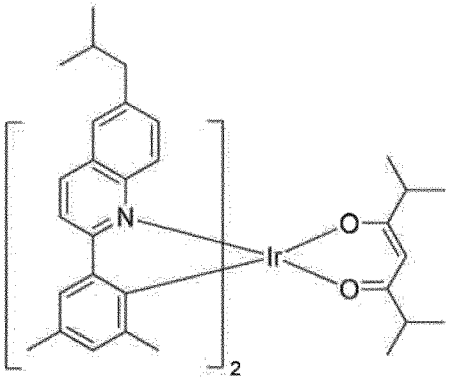

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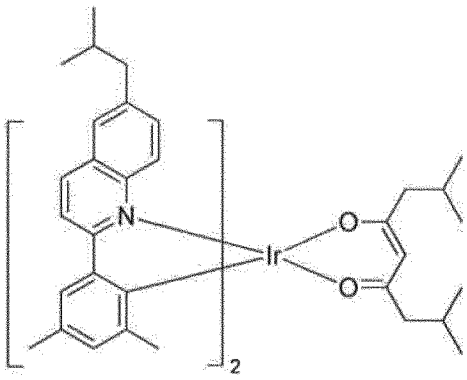
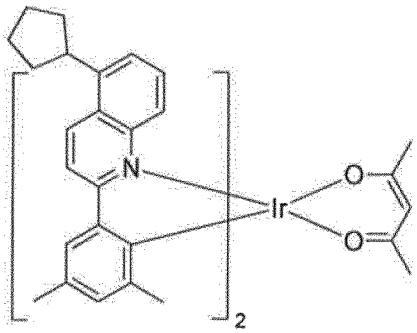


Composé E16,



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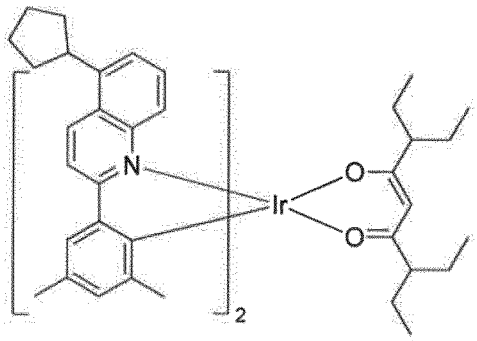

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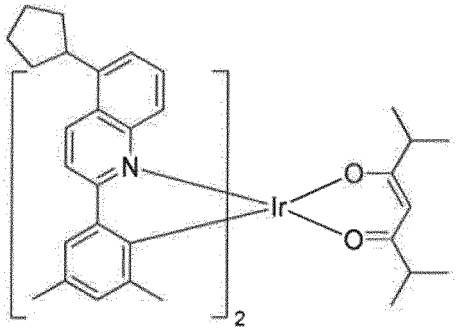

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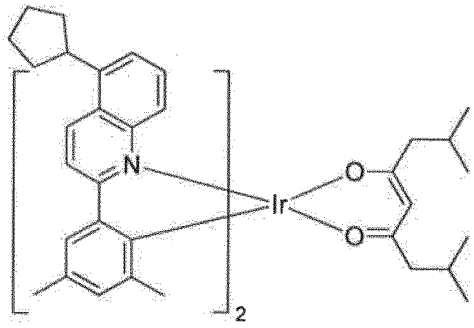

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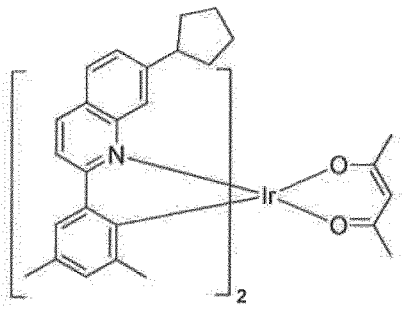

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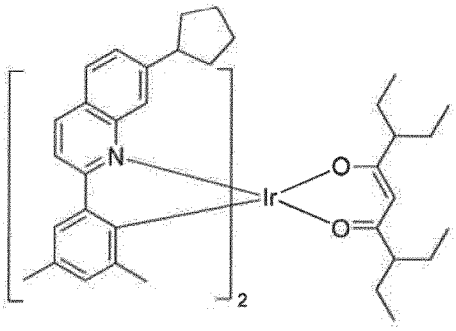

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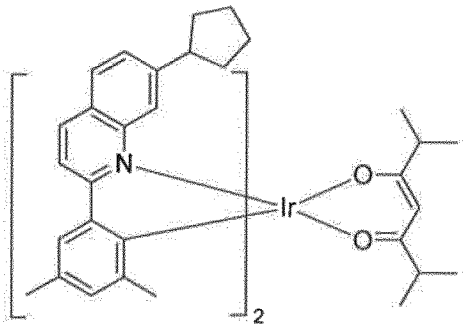

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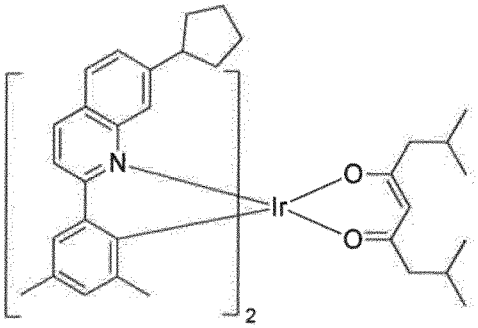

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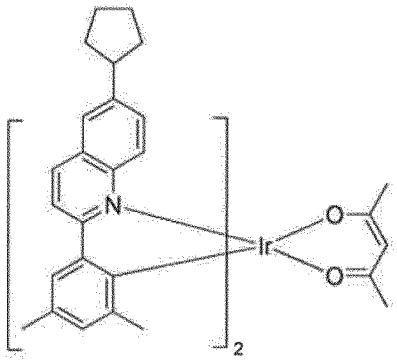

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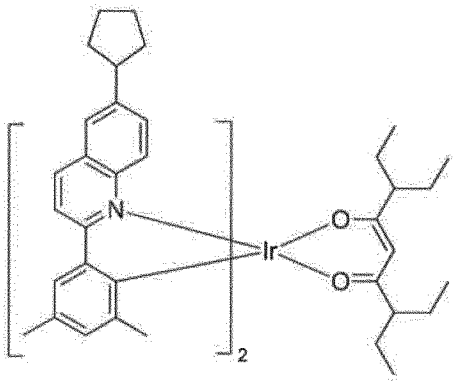
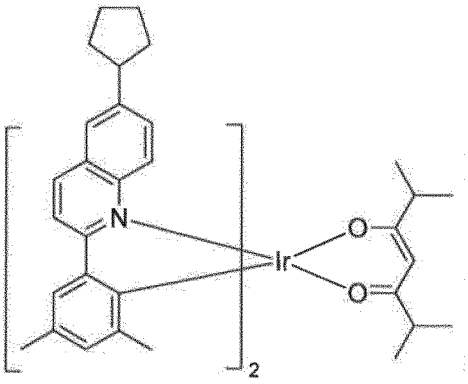


Composé E26,



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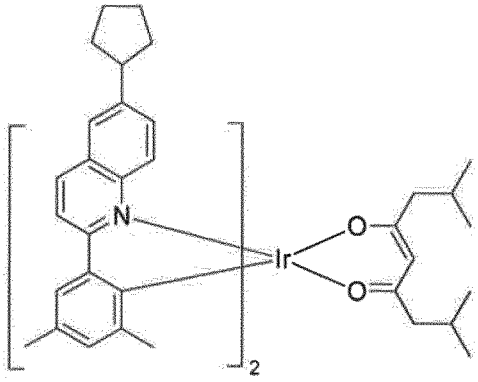

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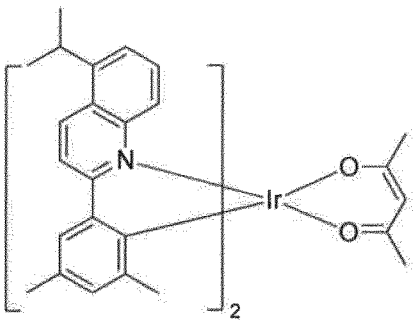

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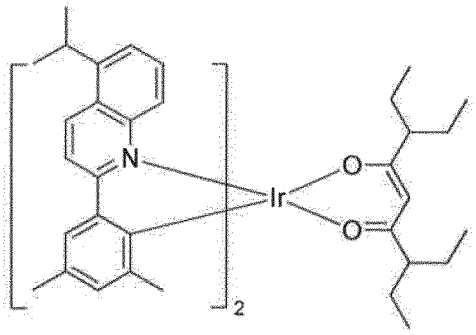

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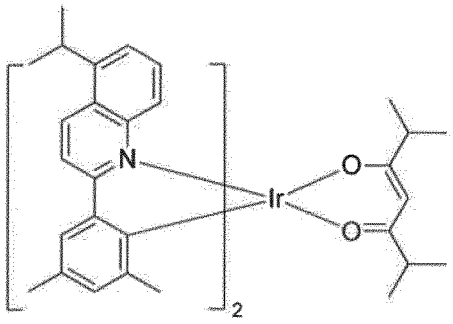

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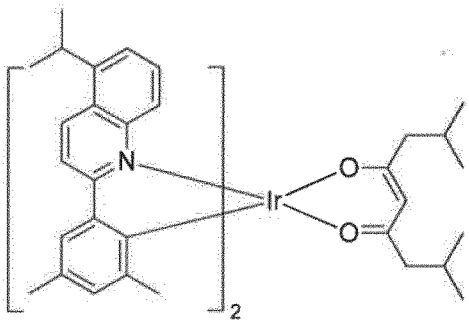

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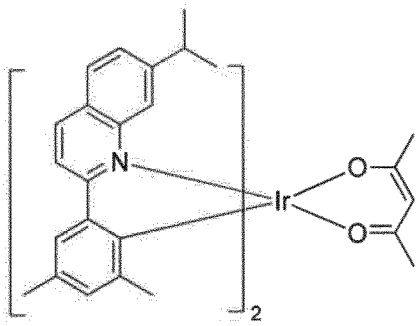

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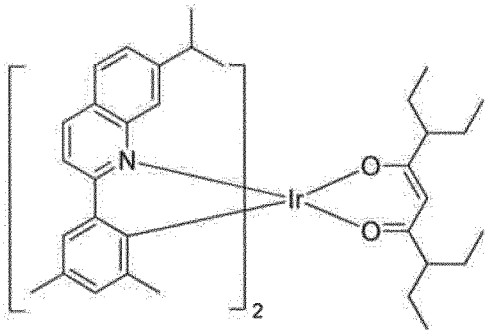

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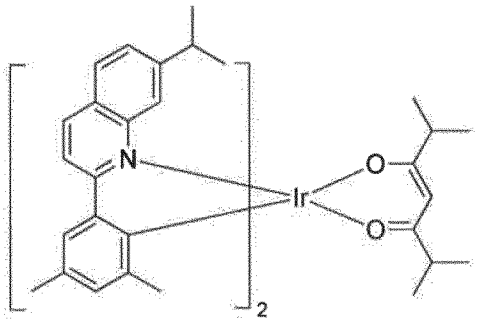

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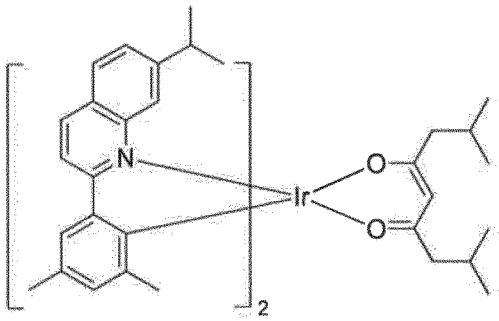

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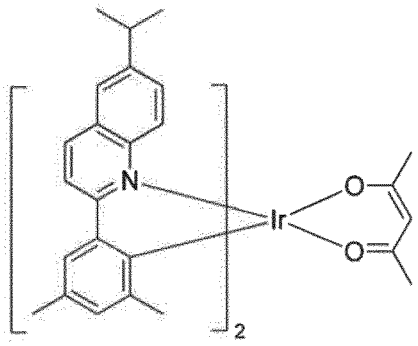

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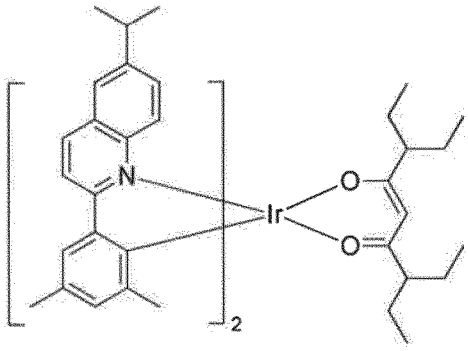
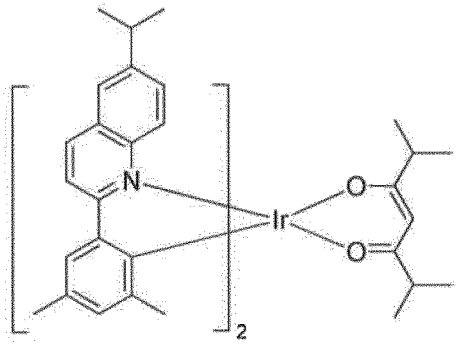
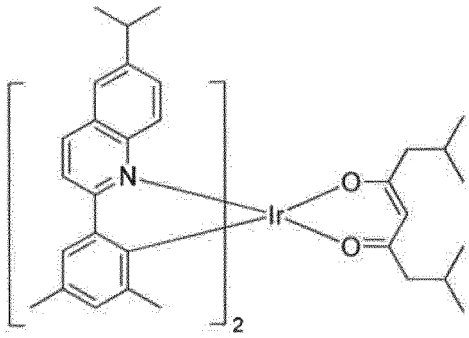


Composé E38,



Composé E39, et



Composé E40.

7. Composition de l'une quelconque des revendications 1 à 3, dans laquelle le mélange du premier composé et du second composé est choisi dans le groupe constitué par: (Composé E5 et Composé H1), (Composé E1 et Composé H14), (Composé E4 et Composé H21), (Composé E9 et Composé H30), (Composé E17 et Composé H21), et (Composé E13 et Composé H33).

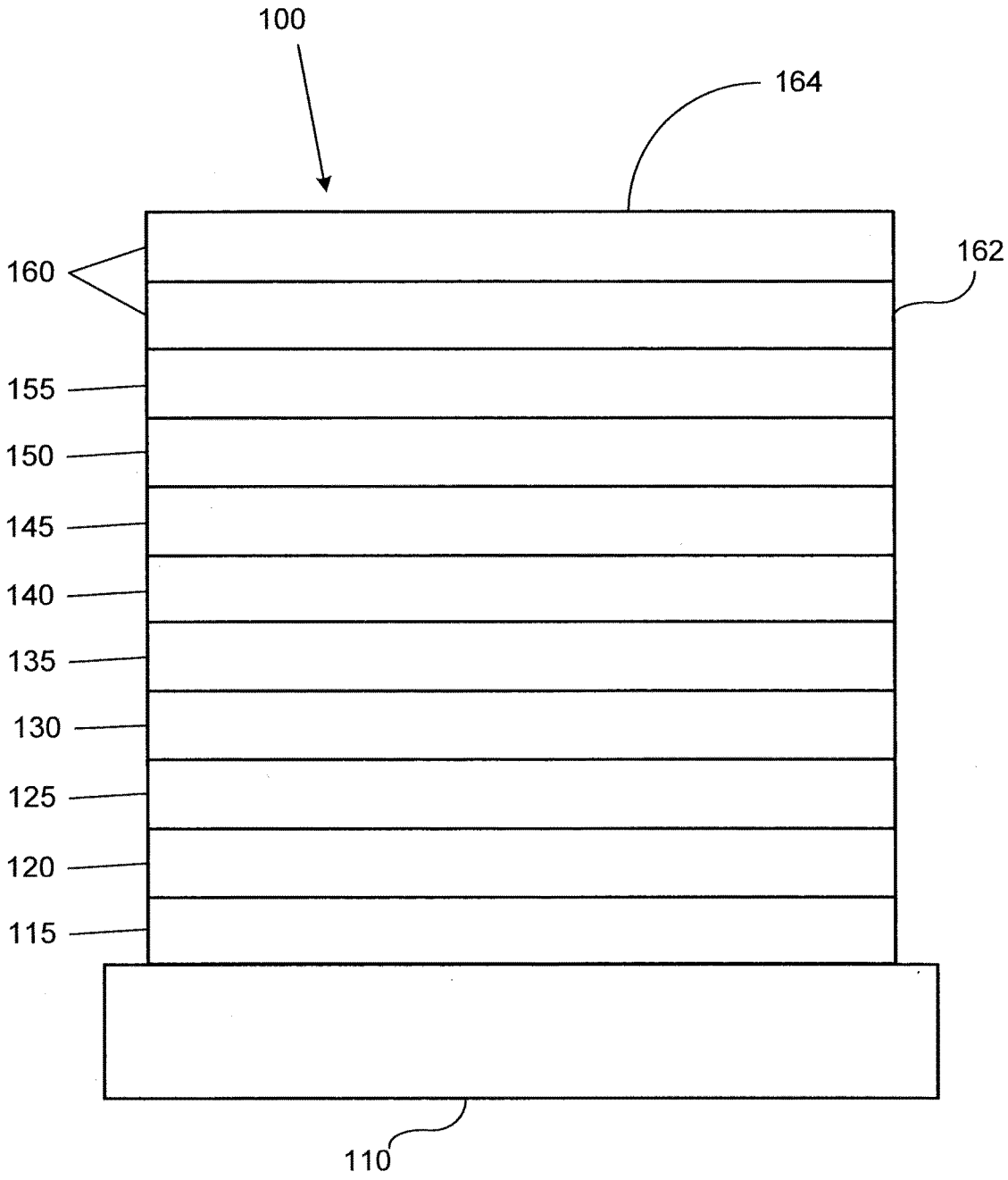


FIG. 1

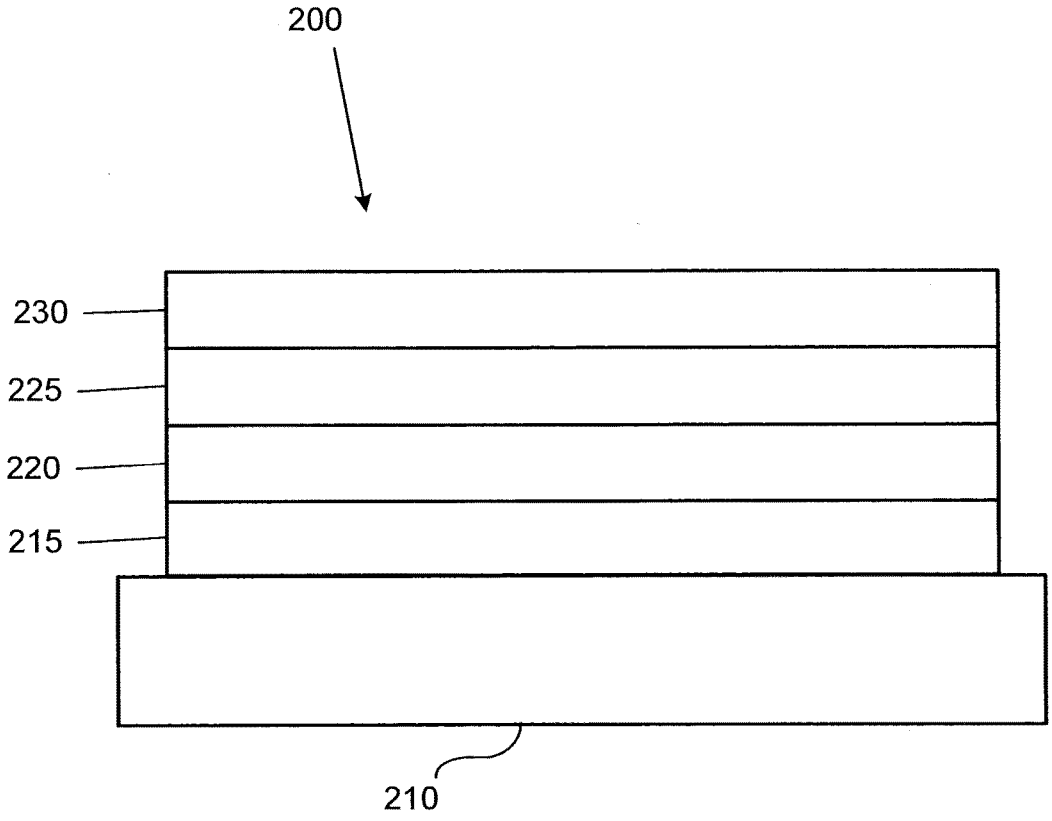


FIG. 2

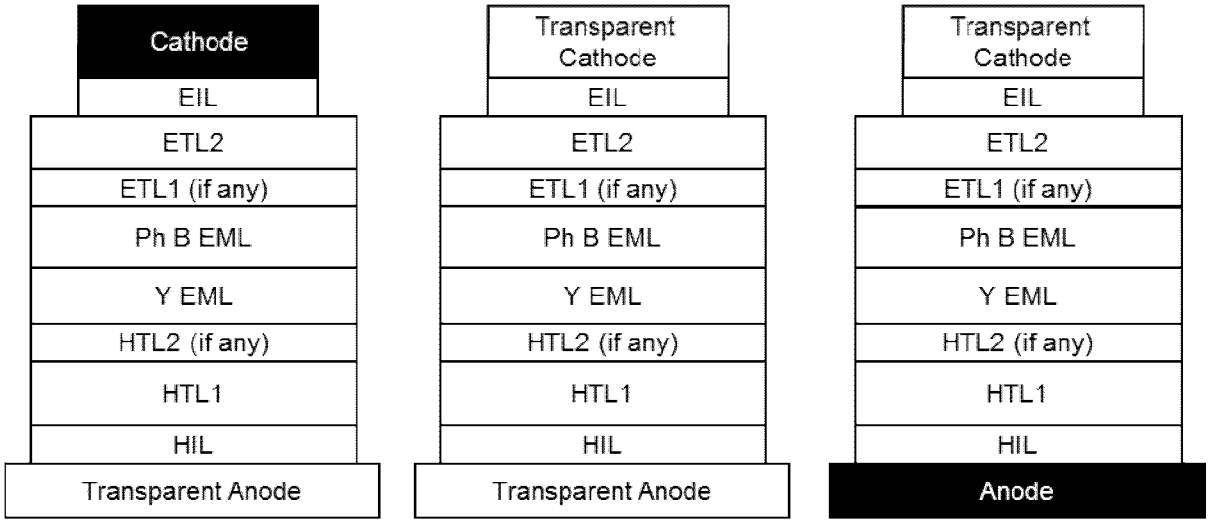

Cathode
EIL
ETL2
ETL1 (if any)
Ph B EML
Y EML
HTL2 (if any)
HTL1
HIL
Transparent Anode
(a)
Transparent Cathode
EIL
ETL2
ETL1 (if any)
Ph B EML
Y EML
HTL2 (if any)
HTL1
HIL
Transparent Anode
(b)
Transparent Cathode
EIL
ETL2
ETL1 (if any)
Ph B EML
Y EML
HTL2 (if any)
HTL1
HIL
Anode
(c)

FIG. 3

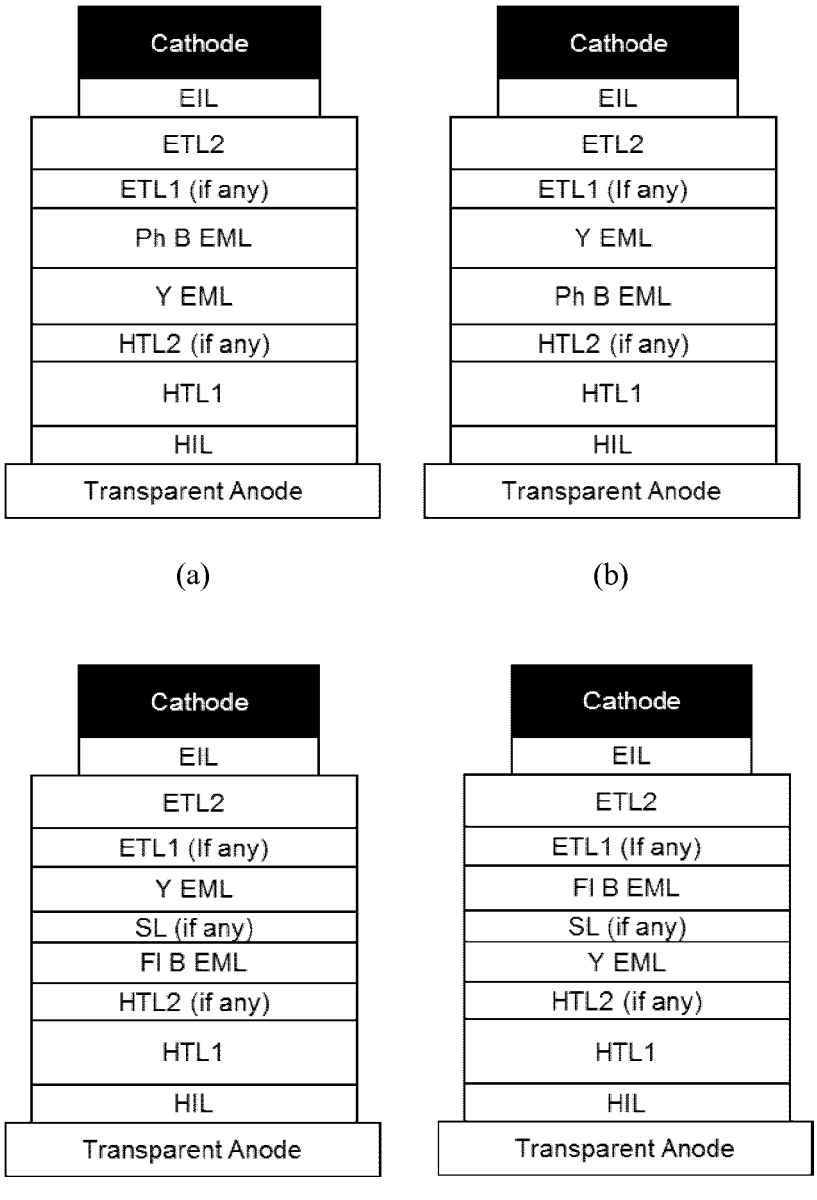

Cathode
EIL
ETL2
ETL1 (if any)
Ph B EML
Y EML
HTL2 (if any)
HTL1
HIL
Transparent Anode
(a)
Cathode
EIL
ETL2
ETL1 (If any)
Y EML
Ph B EML
HTL2 (if any)
HTL1
HIL
Transparent Anode
(b)
Cathode
EIL
ETL2
ETL1 (If any)
Y EML
SL (if any)
Fl B EML
HTL2 (if any)
HTL1
HIL
Transparent Anode
(c)
Cathode
EIL
ETL2
ETL1 (If any)
Fl B EML
SL (if any)
Y EML
HTL2 (if any)
HTL1
HIL
Transparent Anode
(d)

FIG. 4

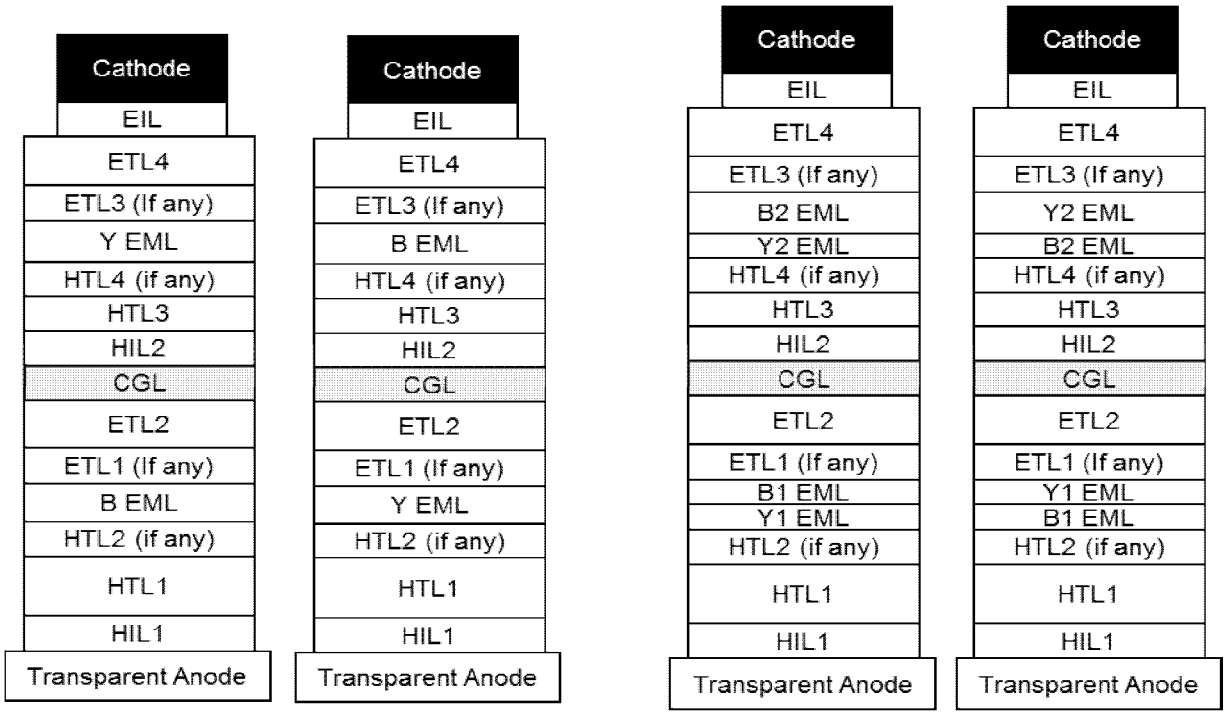
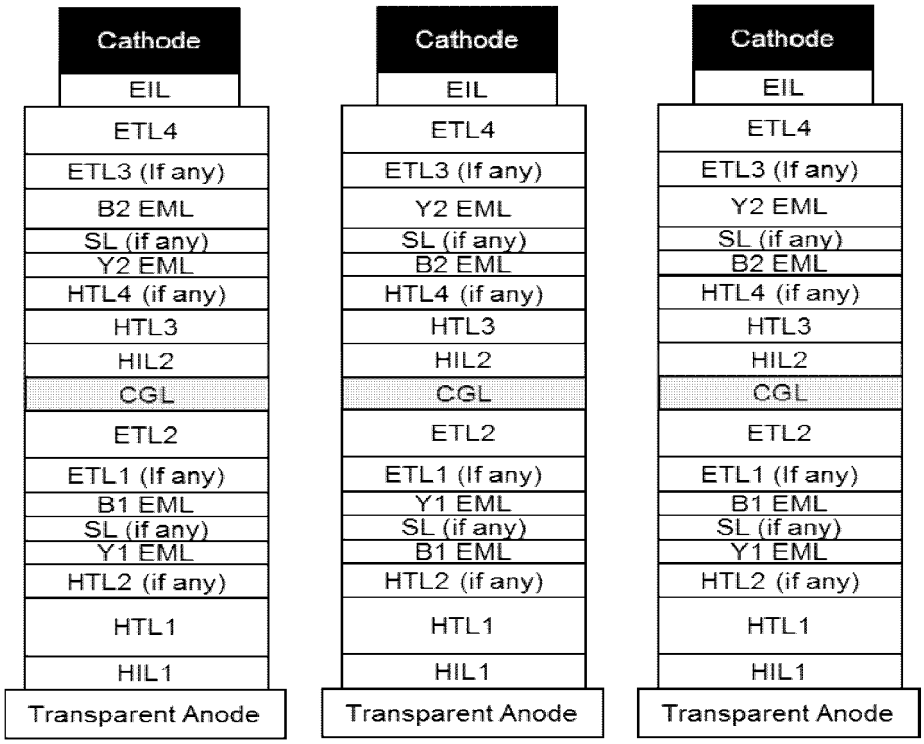

Cathode
EIL
ETL4
ETL3 (If any)
Y EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
B EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
(a)
Cathode
EIL
ETL4
ETL3 (If any)
B EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
Y EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
(b)
Cathode
EIL
ETL4
ETL3 (If any)
B2 EML
Y2 EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
B1 EML
Y1 EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
(c)
Cathode
EIL
ETL4
ETL3 (If any)
Y2 EML
B2 EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
Y1 EML
B1 EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
(d)

FIG. 5


Cathode
EIL
ETL4
ETL3 (If any)
B2 EML
SL (if any)
Y2 EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
B1 EML
SL (if any)
Y1 EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
Cathode
EIL
ETL4
ETL3 (If any)
Y2 EML
SL (if any)
B2 EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
Y1 EML
SL (if any)
B1 EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
Cathode
EIL
ETL4
ETL3 (If any)
Y2 EML
SL (if any)
B2 EML
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
B1 EML
SL (if any)
Y1 EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode

(e) (f) (g)

FIG. 5

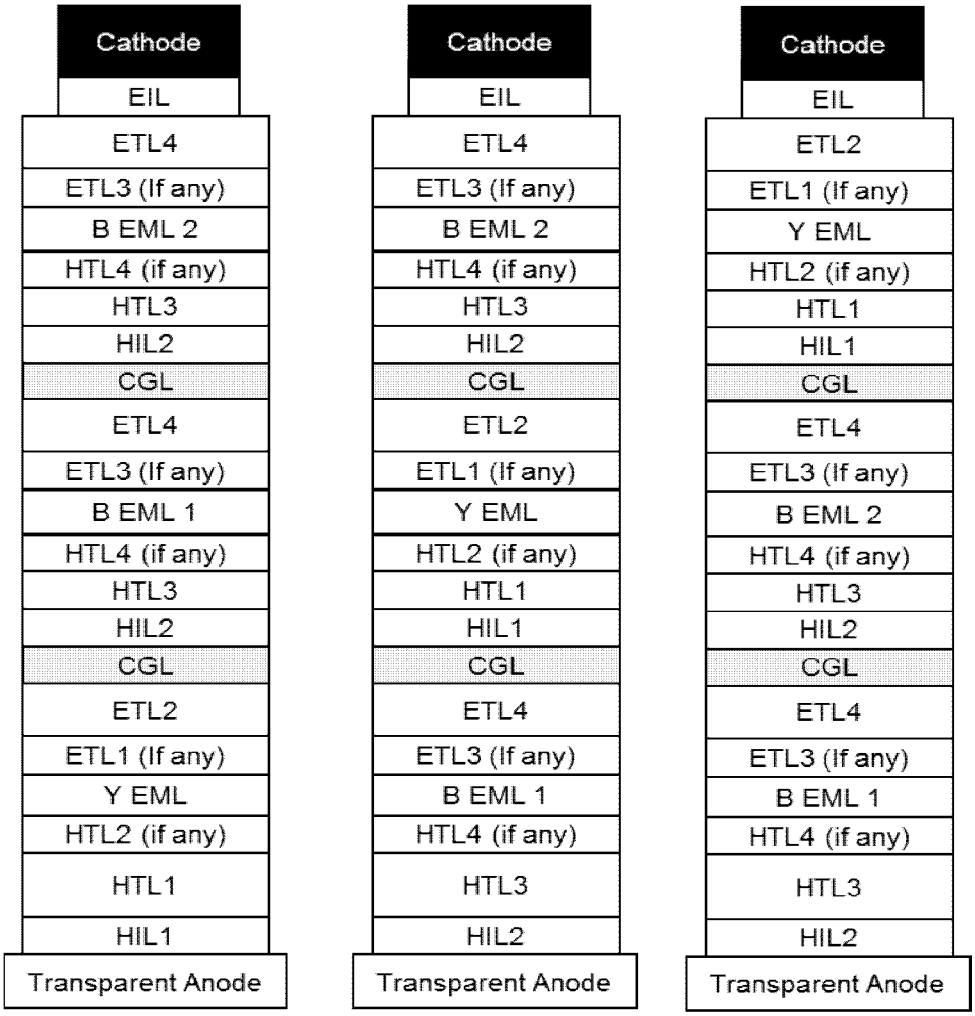

Cathode
EIL
ETL4
ETL3 (If any)
B EML 2
HTL4 (if any)
HTL3
HIL2
CGL
ETL4
ETL3 (If any)
B EML 1
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
Y EML
HTL2 (if any)
HTL1
HIL1
Transparent Anode
(a)
Cathode
EIL
ETL4
ETL3 (If any)
B EML 2
HTL4 (if any)
HTL3
HIL2
CGL
ETL2
ETL1 (If any)
Y EML
HTL2 (if any)
HTL1
HIL1
CGL
ETL4
ETL3 (If any)
B EML 1
HTL4 (if any)
HTL3
HIL2
Transparent Anode
(b)
Cathode
EIL
ETL2
ETL1 (If any)
Y EML
HTL2 (if any)
HTL1
HIL1
CGL
ETL4
ETL3 (If any)
B EML 2
HTL4 (if any)
HTL3
HIL2
CGL
ETL4
ETL3 (If any)
B EML 1
HTL4 (if any)
HTL3
HIL2
Transparent Anode
(c)

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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[标]发明人	ADAMOVICH VADIM YAMAMOTO HITOSHI WANG TING CHIH WEAVER MICHAEL S XIA CHUANJUN ALLEYENE BERT BOUDREAULT PIERRE LUC T DYATKIN ALEXEY BORISOVICH JOSEPH SCOTT		
发明人	ADAMOVICH, VADIM YAMAMOTO, HITOSHI WANG, TING-CHIH WEAVER, MICHAEL S. XIA, CHUANJUN ALLEYENE, BERT BOUDREAULT, PIERRE-LUC T. DYATKIN, ALEXEY BORISOVICH JOSEPH, SCOTT		
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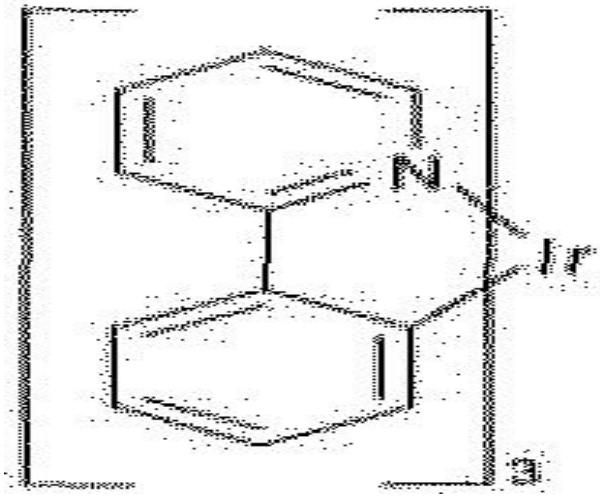
摘要(译)

本发明公开了一种由具有相似热蒸发性质的两种化合物的混合物形成的组合物，其预先混合到蒸发源中，该蒸发源可用于通过真空热蒸发工艺将两种化合物共蒸发成OLED中的发光层。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