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Lee et al.

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(45) **Date of Patent: Jun. 13, 2017**

(54) **ORGANIC LIGHT EMITTING DIODE AND ORGANIC LIGHT EMITTING DISPLAY DEVICE INCLUDING THE SAME**

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(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**, Yongin, Gyeonggi-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 181 days.

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(22) Filed: **Jun. 18, 2015**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 19, 2014 (KR) 10-2014-0107647

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

(52) **U.S. Cl.**
CPC ***H01L 51/0059*** (2013.01); ***H01L 51/006*** (2013.01); ***H01L 51/0052*** (2013.01);
(Continued)

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

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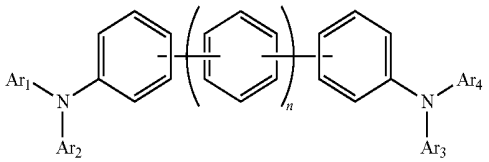
Primary Examiner — Gregory Clark
(74) *Attorney, Agent, or Firm* — Lee & Morse, P.C.

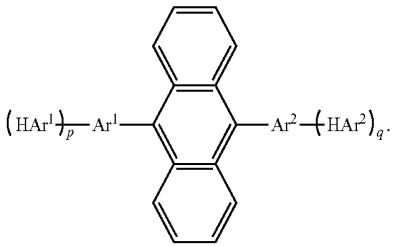
(57) **ABSTRACT**

An organic light emitting diode and an organic light emitting device, the organic light emitting diode including a first compound represented by the following Formula 1; and a second compound represented by the following Formula 2,

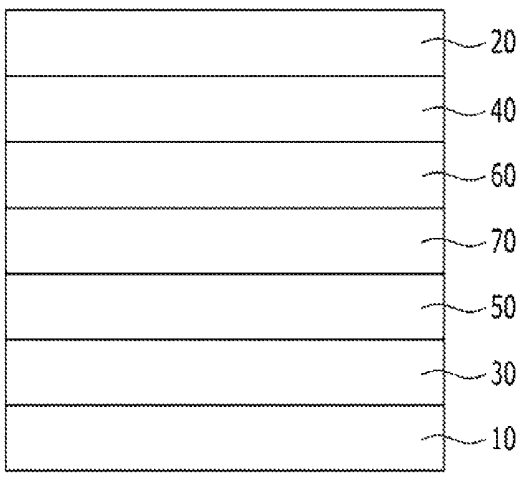
[Formula 1]



[Formula 2]



18 Claims, 4 Drawing Sheets



(52) **U.S. Cl.**
CPC ***H01L 51/0058*** (2013.01); ***H01L 51/0067*** (2013.01); *H01L 51/0054* (2013.01); *H01L 51/0081* (2013.01); *H01L 51/5096* (2013.01); *H01L 2227/323* (2013.01)

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FIG. 1

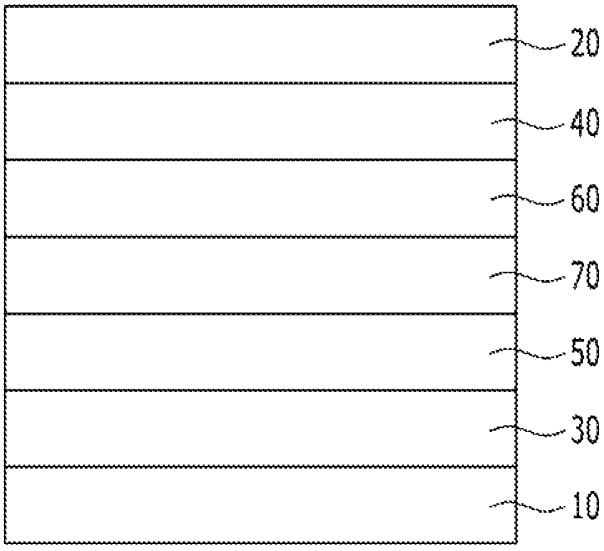
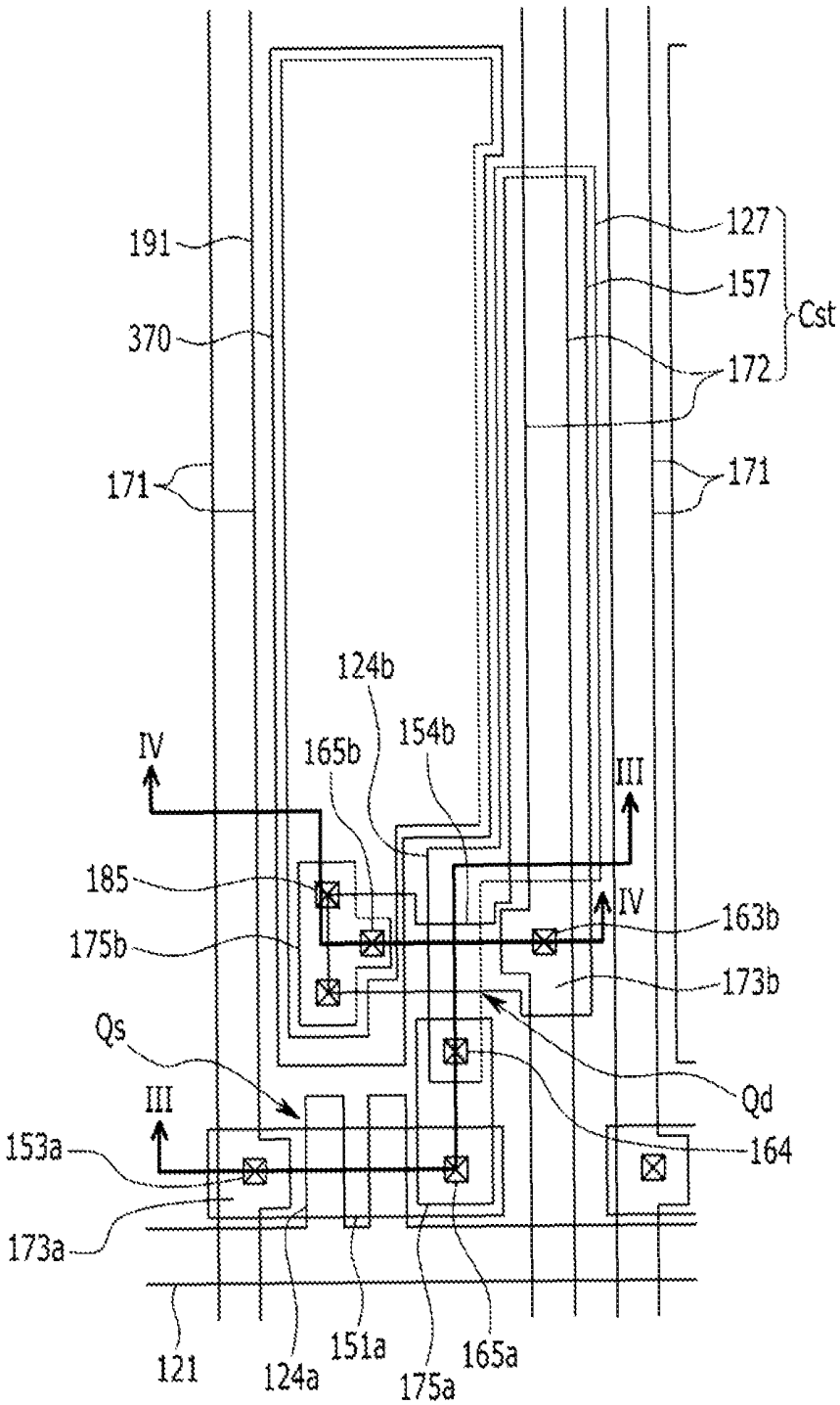


FIG. 2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370
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127
157
Cst
172
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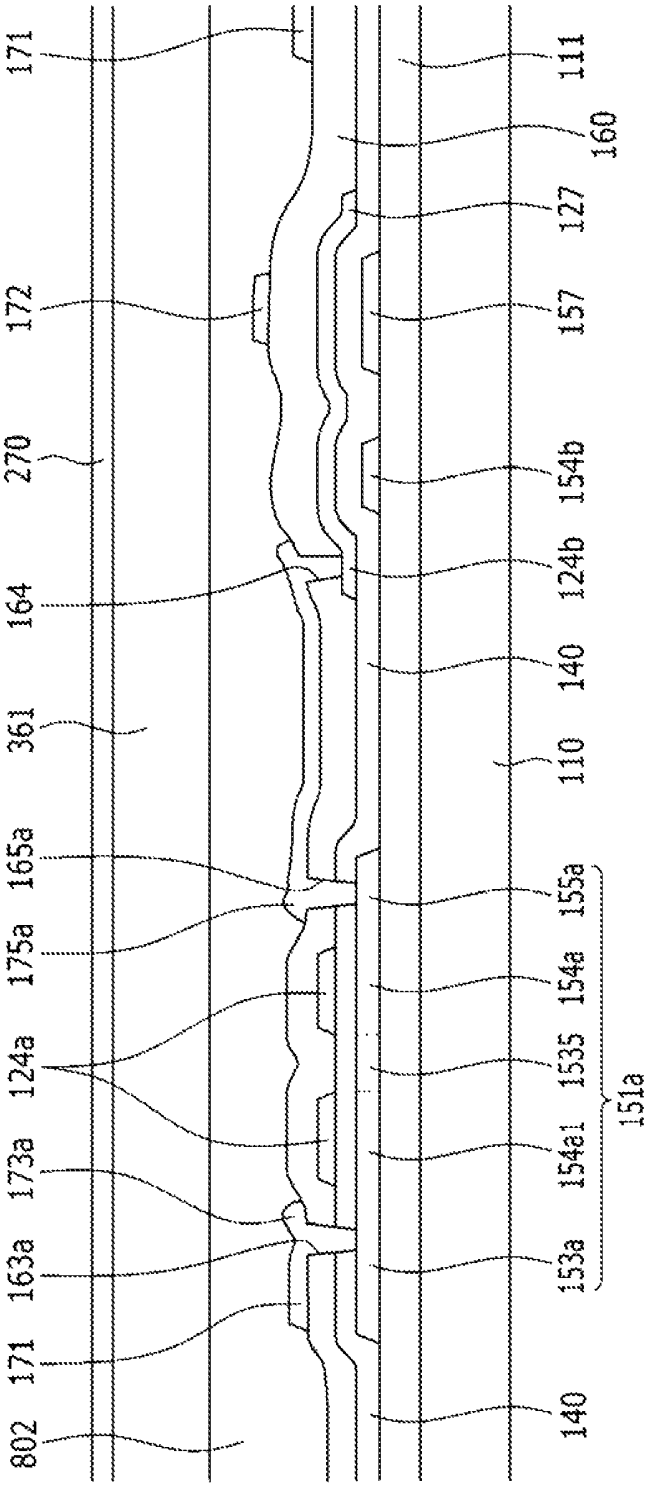
124b
154b
165b
IV
III
185
IV
163b
175b
173b
Qs
Qd
III
153a
164
173a
121
124a
151a
175a
165a

FIG. 3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124b
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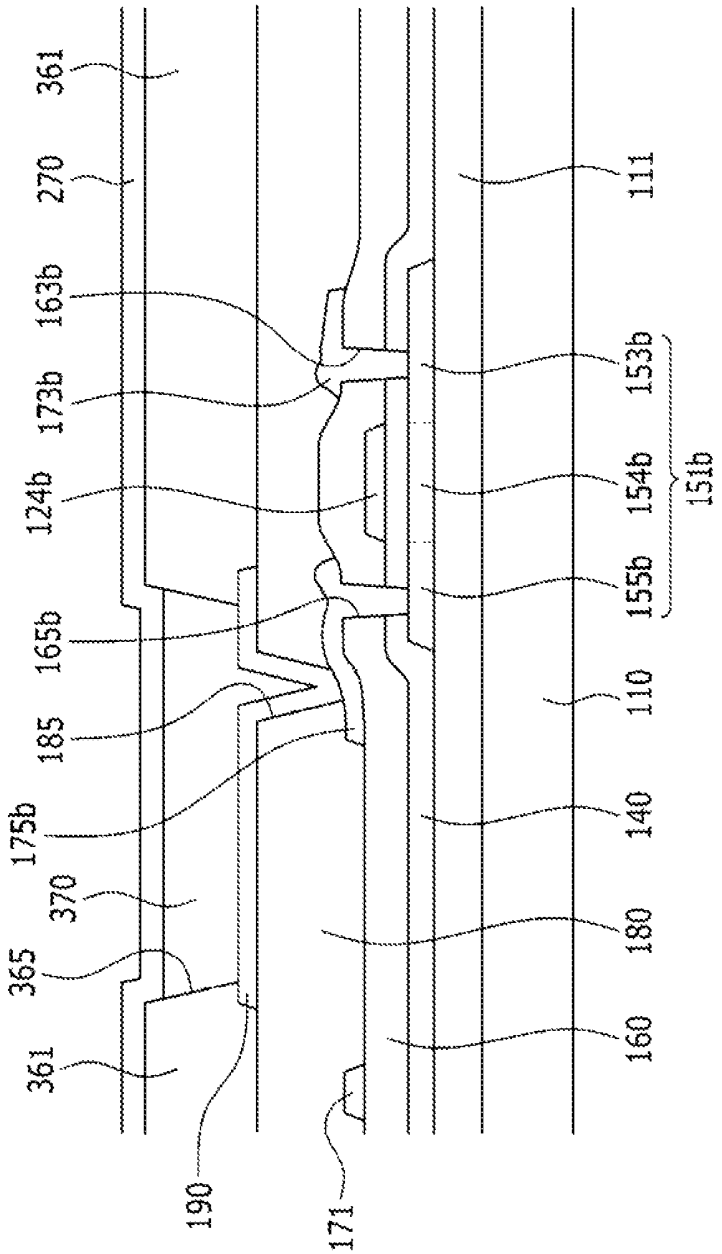
111
151a

FIG. 4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151b
155b
110
140
180
160

ORGANIC LIGHT EMITTING DIODE AND ORGANIC LIGHT EMITTING DISPLAY DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

Korean Patent Application No. 10-2014-0107647 filed on Aug. 19, 2014, in the Korean Intellectual Property Office, and entitled: "Organic Light Emitting Diode and Organic Light Emitting Display Device Including the Same," is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

Embodiments relate to an organic light emitting diode and an organic light emitting device including the same.

2. Description of the Related Art

Lightweight and thin personal computers and televisions sets may use lightweight and thin display devices. Flat panel displays satisfying such features are replacing conventional cathode ray tubes (CRT). An LCD is a passive display device, an additional backlight as a light source may be used, and the LCD may exhibit a slow response time and a narrow viewing angle.

An organic light emitting diode (OLED) display may have merits such as a wide viewing angle, outstanding contrast, and a fast response time. In the organic light emitting diode device, electrons injected from one electrode and holes injected from another electrode may be combined with each other in an emission layer, thereby generating excitons, and energy may be outputted from the excitons to thereby emit light.

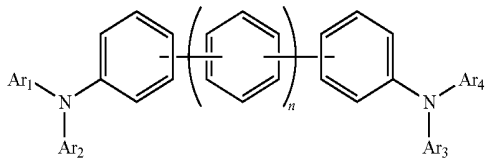
The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

Embodiments are directed to an organic light emitting diode and an organic light emitting device including the same.

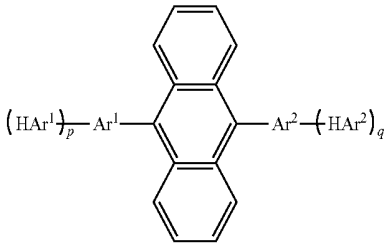
The embodiments may be realized by providing an organic light emitting diode including a first compound represented by the following Formula 1; and a second compound represented by the following Formula 2,

[Formula 1]



wherein, in Formula 1, Ar_1 to Ar_4 are each independently a substituted or unsubstituted aromatic hydrocarbon group, a substituted or unsubstituted aromatic heterocyclic group, or a substituted or unsubstituted condensed polycyclic aromatic group, and n is an integer of 2 to 4,

[Formula 2]

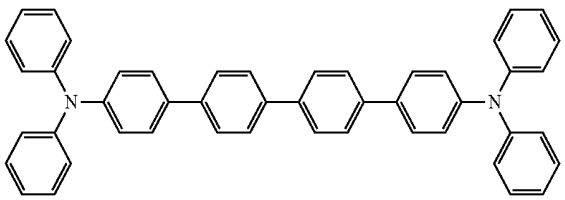


wherein, in Formula 2, Ar^1 is a substituted or unsubstituted phenylene group, Ar^2 is a substituted or unsubstituted phenylene group or a substituted or unsubstituted naphthylene group, HAr^1 and HAr^2 are each independently a substituted or unsubstituted pyridine group, a quinoline group, or an isoquinoline group, p and q are each independently integers of 0 to 3, and when p or q is 2 or greater, each HAr^1 is the same as or different from each other or each HAr^2 is the same as or different from each other.

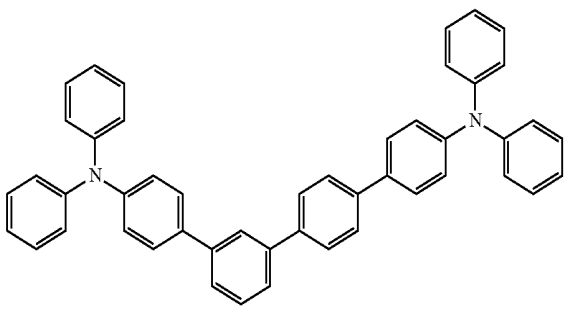
The organic light emitting diode may include an anode, a cathode facing the anode, an emission layer between the anode and the cathode, a hole transport layer between the anode and the emission layer, an electron blocking layer between the emission layer and the hole transport layer, an electron transport layer between the cathode and the emission layer, and a hole blocking layer between the emission layer and the electron transport layer, the electron blocking layer includes the first compound, and the hole blocking layer includes the second compound.

The first compound represented by Formula 1 may be represented by one of Formula 1-1 to Formula 1-15:

(1-1)



(1-2)



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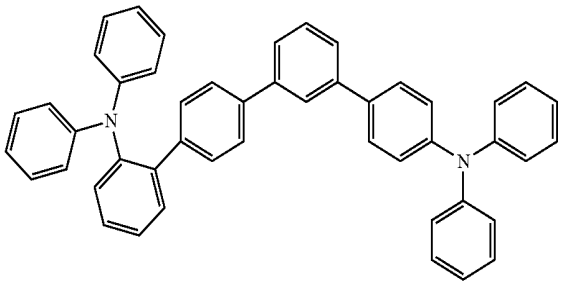

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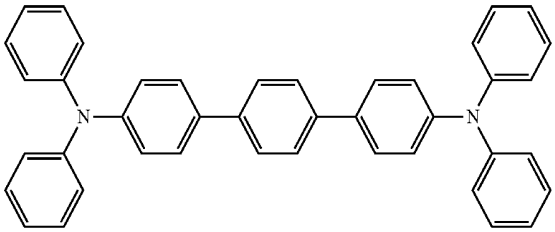

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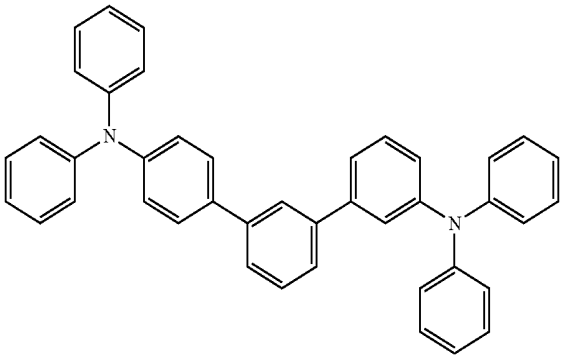
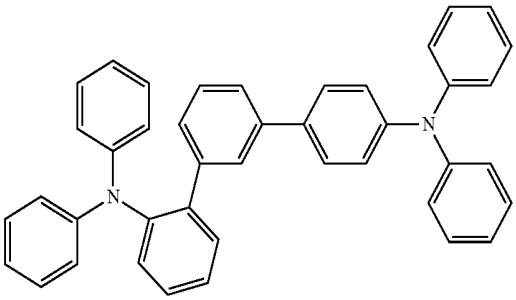
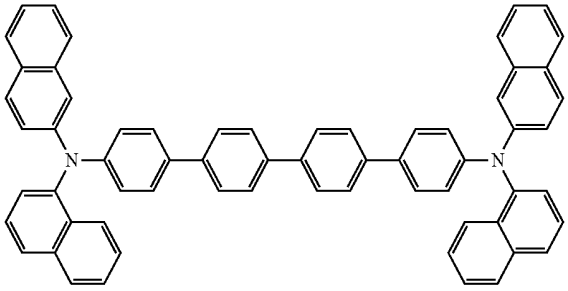


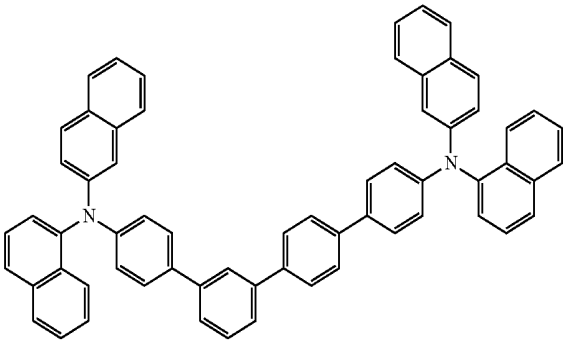
(1-6)



(1-7)



(1-8)



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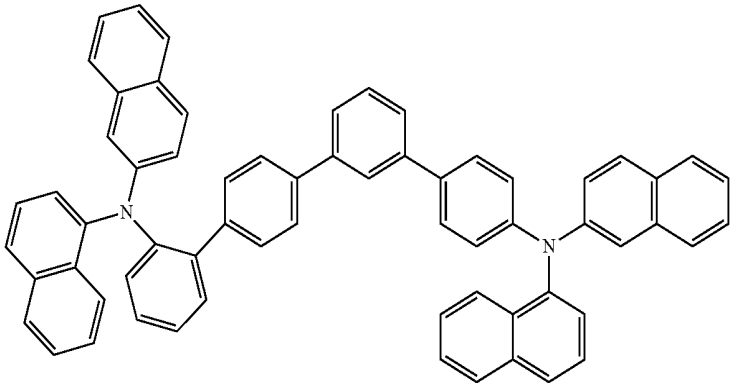

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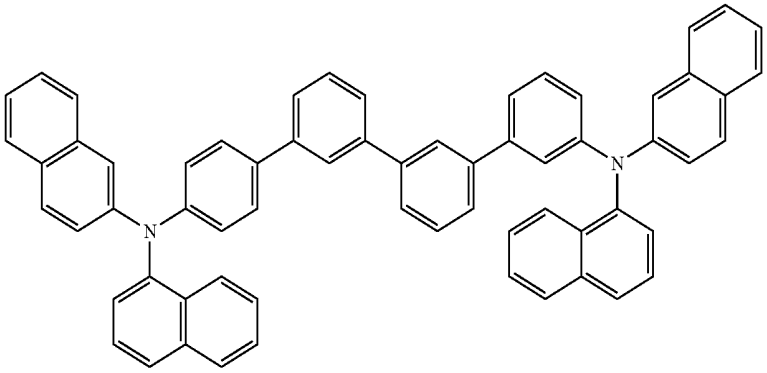
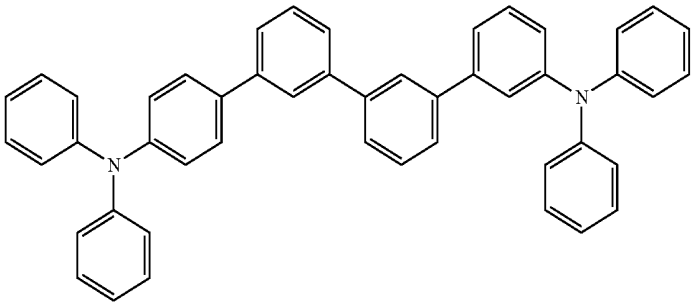
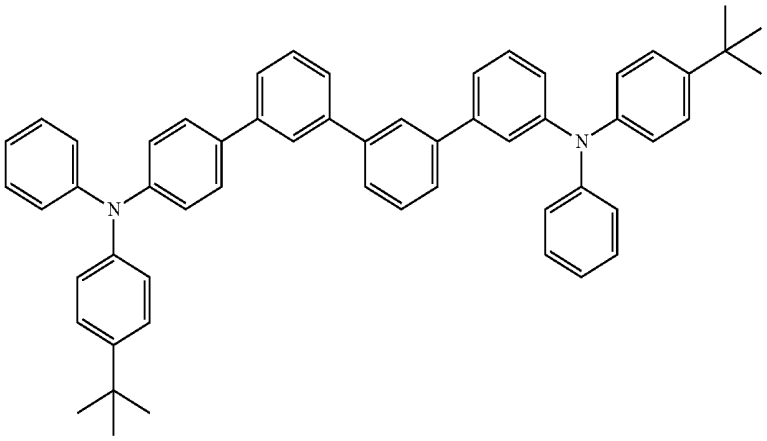
(1-10)



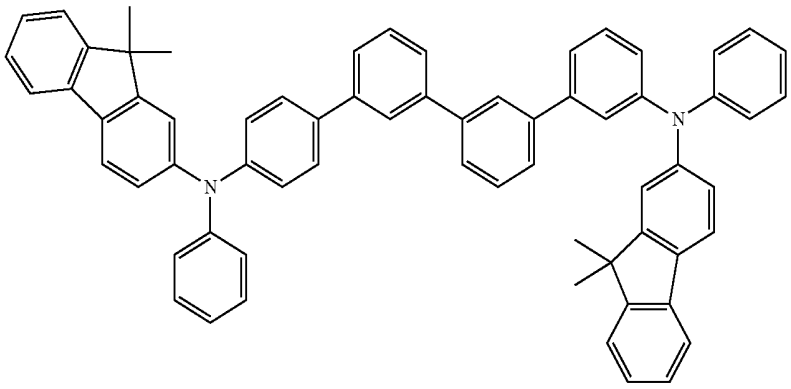
(1-11)



(1-12)



(1-13)



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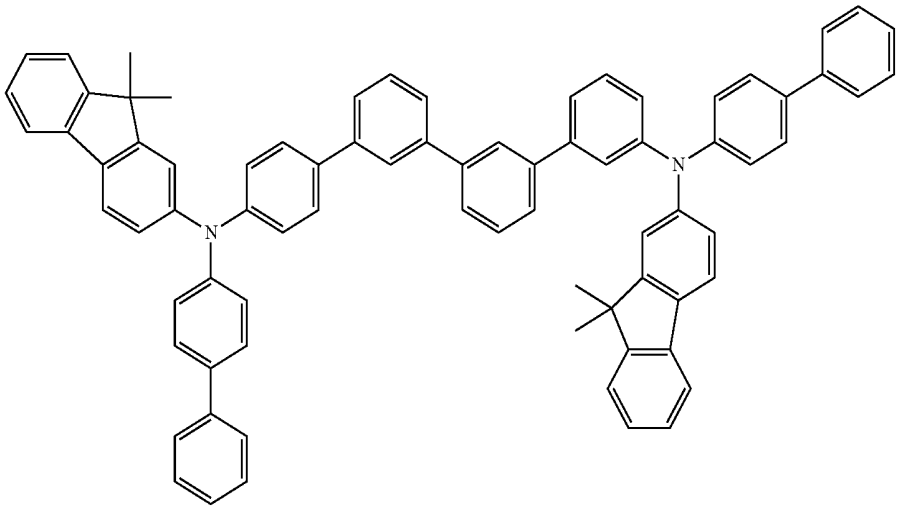
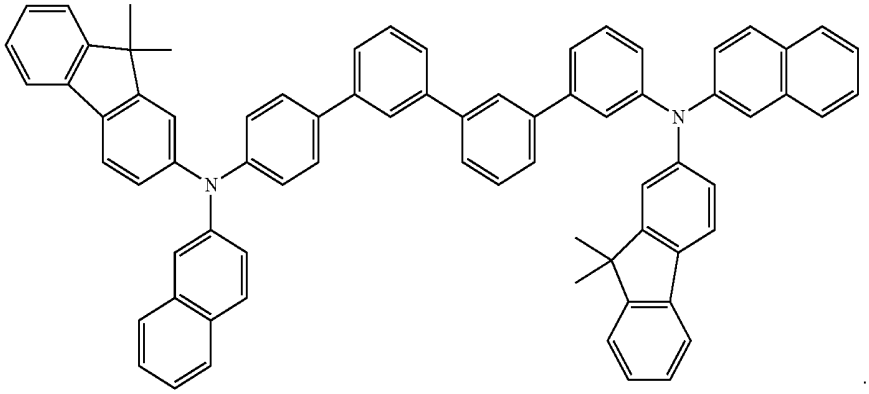
(1-14)

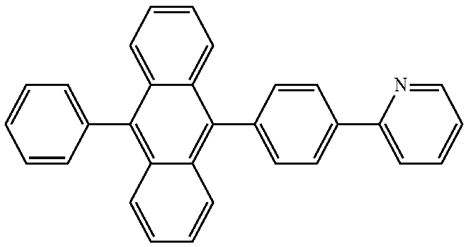


(1-15)

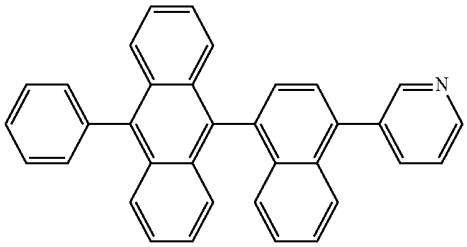


The second compound represented by Formula 2 may be represented by one of Formula 2-1 to Formula 2-9:

(2-1)



(2-2)



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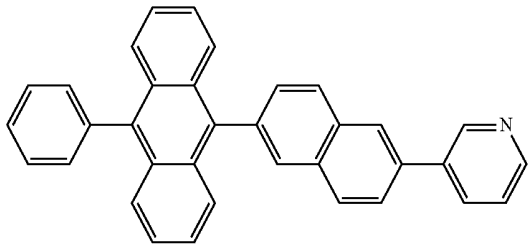
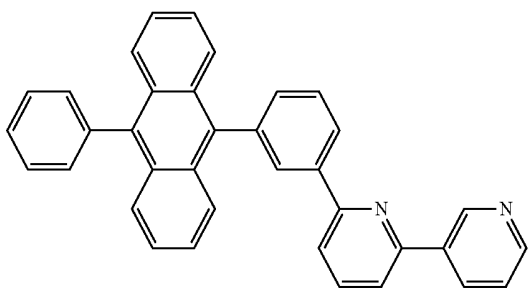
(2-3)



(2-4)



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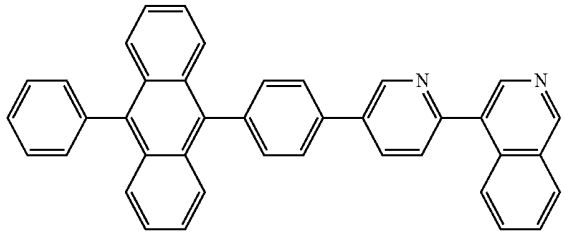
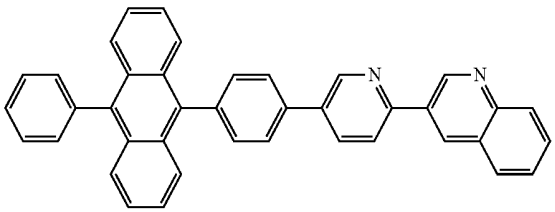
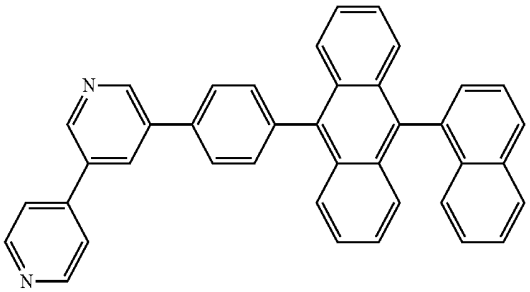
(2-5)



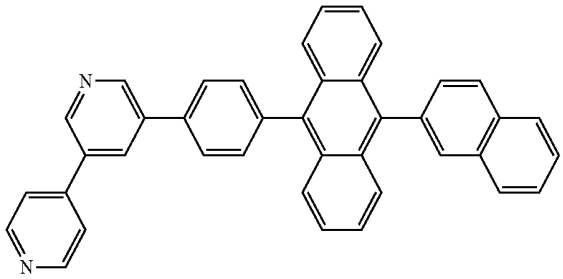
(2-6)



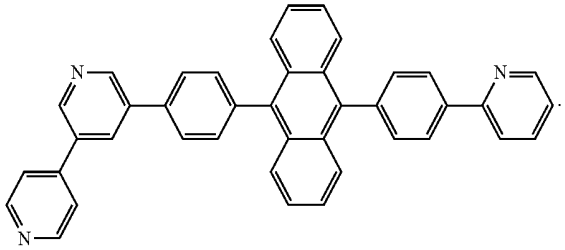
(2-7)



(2-8)



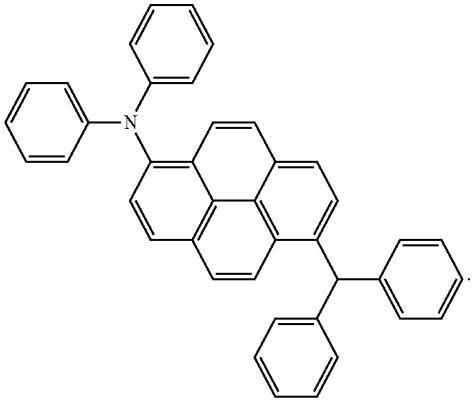
(2-9)



The emission layer may include at least one of tris(8-quinolinolate)aluminum (Alq3), 2-methyl-9,10-di(2-naphthyl) anthracene (MADN), 4,4'-N,N'-dicarbazol-biphenyl (CBP), or poly(n-vinylcarbazole) (PVK).

The emission layer may be doped with a third compound represented by the following Formula 3:

[Formula 3]



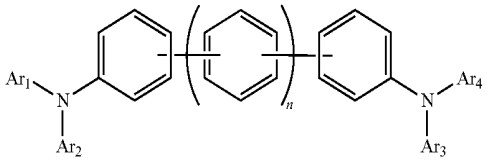
The third compound may be included in the emission layer in an amount of about 5 wt % or less, based on a total weight of the emission layer.

The hole transport layer may include at least one of 4,4",4""-tris[(3-methylphenyl(phenyl)amino)]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDATB), copper phthalocyanine (CuPc), N-phenylcarbazole, polyvinylcarbazole, N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl benzidine (α-NPD), or 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPB).

The electron transport layer may include at least one of Alq3, TAZ, Balq, or Bebq2.

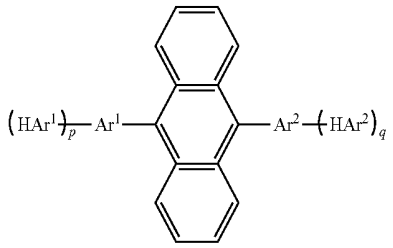
The embodiments may be realized by providing an organic light emitting device including a substrate; a gate line on the substrate; a data line and a driving voltage line crossing the gate line; a switching thin film transistor connected to the gate line and the data line; a driving thin film transistor connected to the switching thin film transistor and the driving voltage line; and an organic light emitting diode connected to the driving thin film transistor, wherein the organic light emitting diode includes a first compound represented by the following Formula 1, and a second compound represented by the following Formula 2:

[Formula 1]



wherein, in Formula 1, Ar_1 to Ar_4 are each independently a substituted or unsubstituted aromatic hydrocarbon group, a substituted or unsubstituted aromatic heterocyclic group, or a substituted or unsubstituted condensed polycyclic aromatic group, and n is an integer of 2 to 4,

[Formula 2]

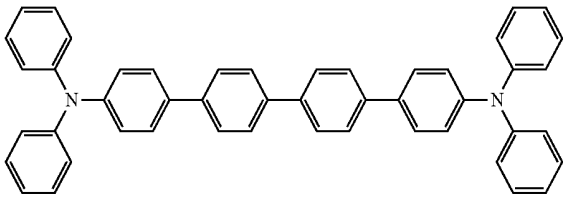


wherein, in Formula 2, Ar^1 is a substituted or unsubstituted phenylene group, Ar^2 is a substituted or unsubstituted phenylene group or a substituted or unsubstituted naphthylene group, HAr^1 and HAr^2 are each independently a substituted or unsubstituted pyridine group, a quinoline group, or an isoquinoline group, p and q are each independently integers of 0 to 3, and when p or q is 2 or greater, each HAr^1 is the same as or different from each other or each HAr^2 is the same as or different from each other.

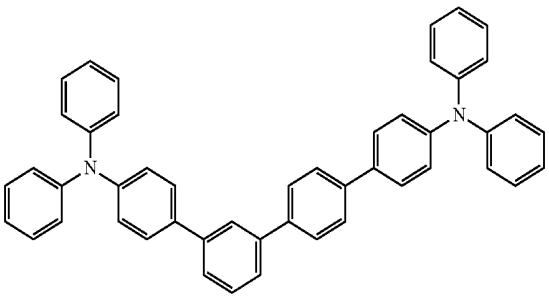
The organic light emitting diode may include an anode, a cathode facing the anode, an emission layer between the anode and the cathode, a hole transport layer between the anode and the emission layer, an electron blocking layer between the emission layer and the hole transport layer, an electron transport layer between the cathode and the emission layer, and a hole blocking layer between the emission layer and the electron transport layer, the electron blocking layer includes the first compound, and the hole blocking layer includes the second compound.

The first compound represented by Formula 1 may be represented by one of Formula 1-1 to Formula 1-15:

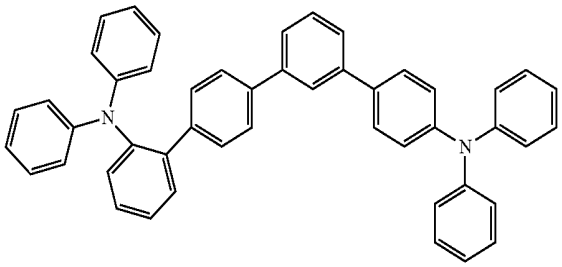
(1-1)



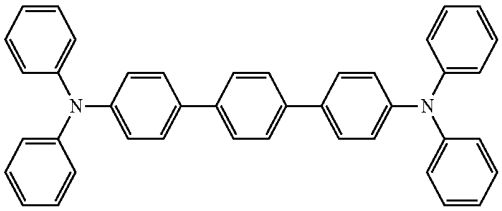
(1-2)



(1-3)



(1-4)



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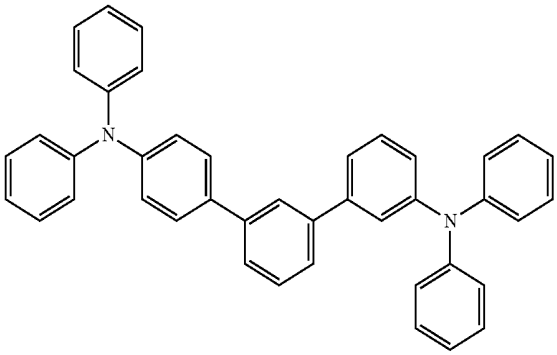

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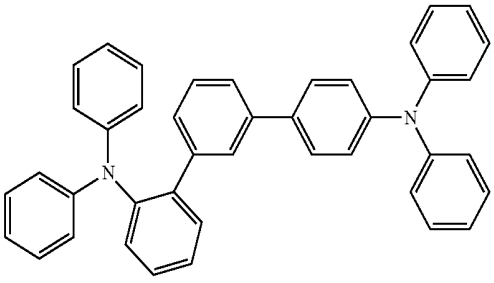

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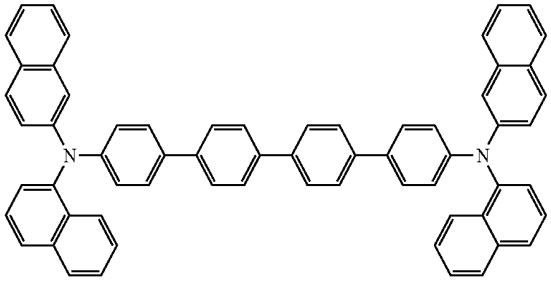
(1-7)



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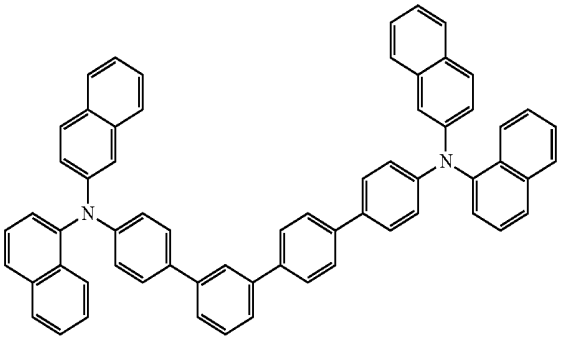

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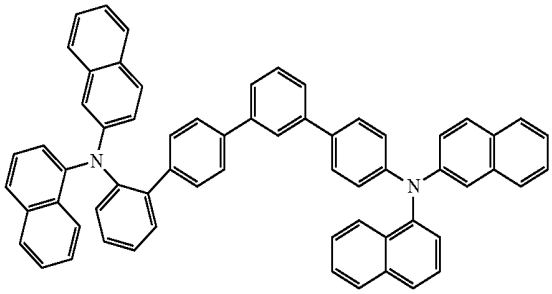

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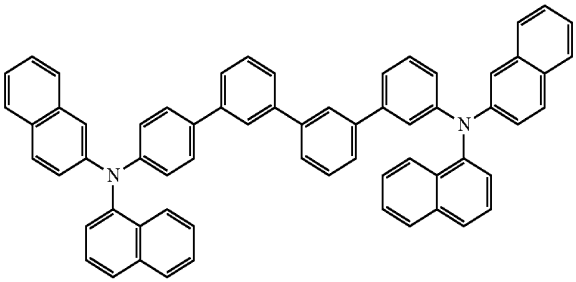

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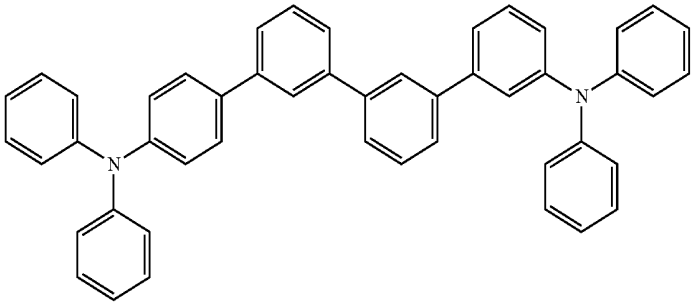

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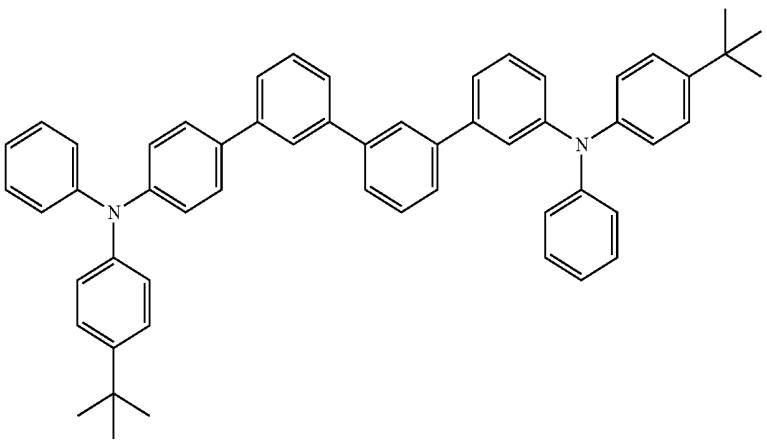

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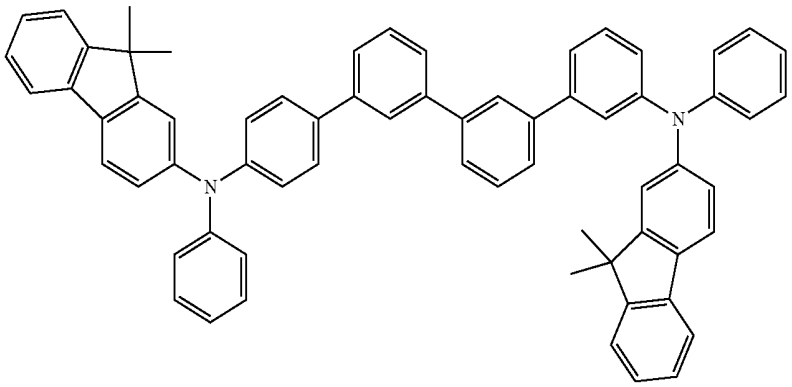
(1-13)



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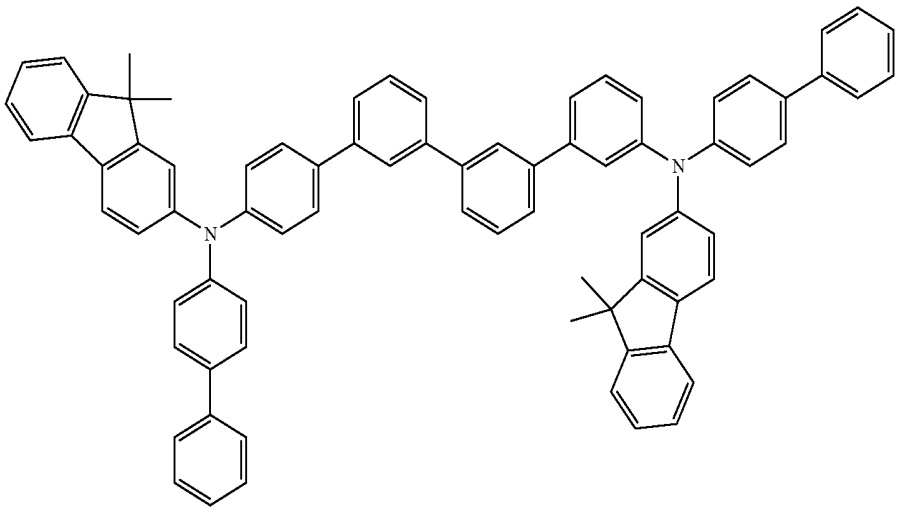

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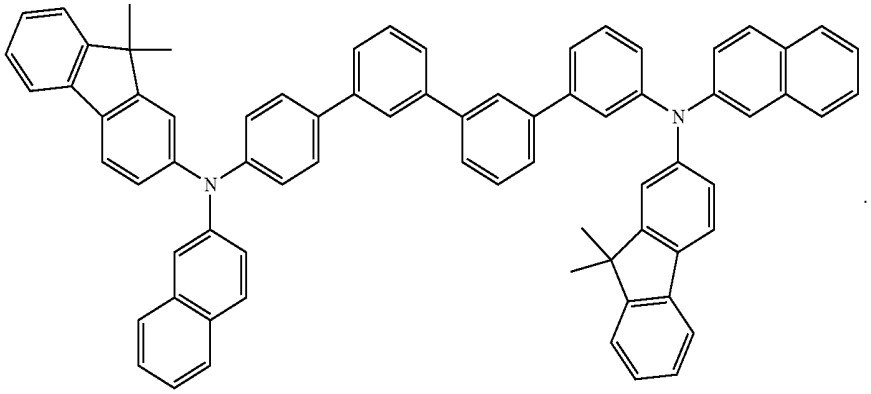
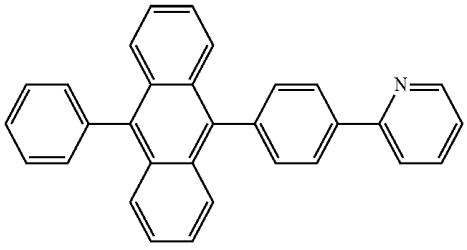


The second compound represented by Formula 2 may be represented by one of Formula 2-1 to Formula 2-9:

-continued

(2-1)



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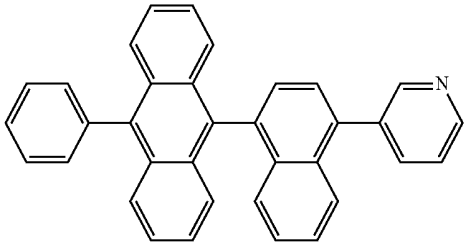

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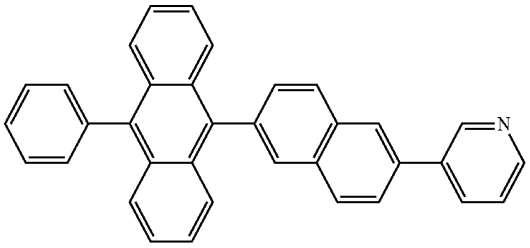

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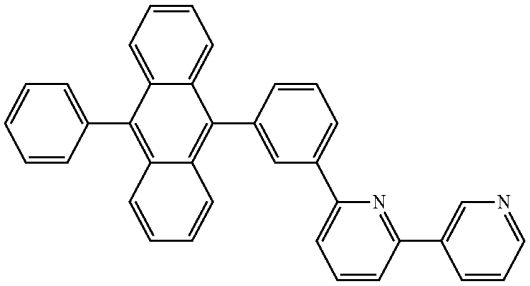

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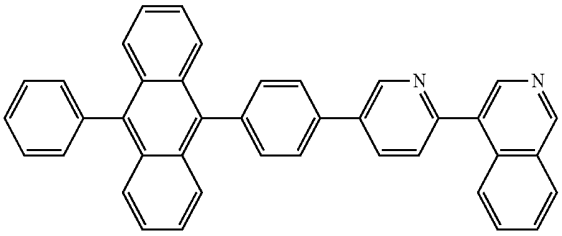

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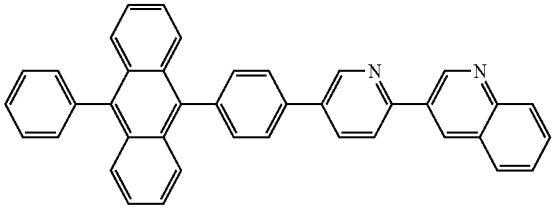

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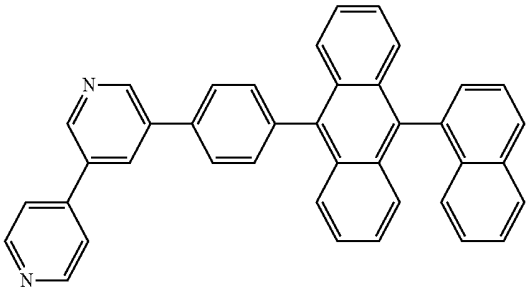

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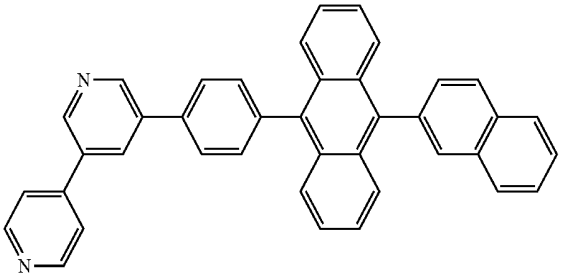

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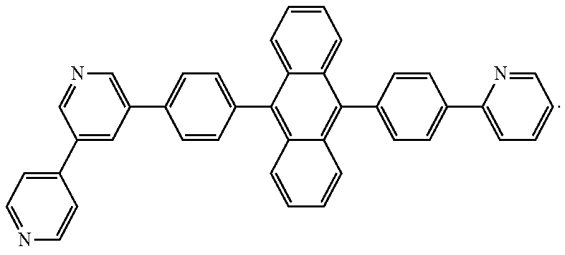
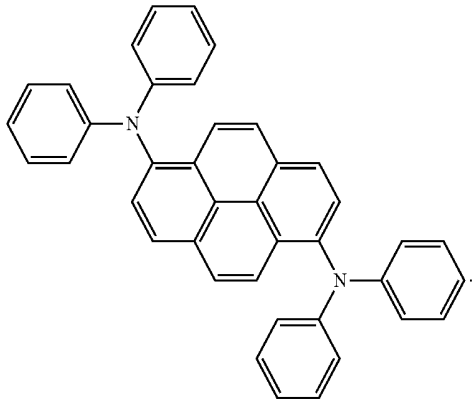
(2-9)



The emission layer may include at least one of tris(8-quinolinolate)aluminum (Alq3), 2-methyl-9,10-di(2-naphthyl)anthracene (MADN), 4,4'-N,N'-dicarbazol-biphenyl (CBP), or poly(n-vinylcarbazole) (PVK).

The emission layer may be doped with a third compound represented by the following Formula 3:

[Formula 3]



The third compound may be included in the emission layer in an amount of about 5 wt % or less, based on a total weight of the emission layer.

The hole transport layer may include at least one of 4,4",4""-tris[(3-methylphenyl(phenyl)amino)]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDATB), copper phthalocyanine (CuPc), N-phenylcarbazole, polyvinylcarbazole, N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl benzidine (α-NPD), or 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPB).

The electron transport layer may include at least one of Alq3, TAZ, Balq, or Bebq2.

BRIEF DESCRIPTION OF THE DRAWINGS

Features will be apparent to those of skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. **1** illustrates a configuration of an organic light emitting diode according to an exemplary embodiment.

FIG. **2** illustrates a layout view of an organic light emitting device according to an exemplary embodiment.

FIG. **3** illustrates a cross-sectional view of the organic light emitting device of FIG. **2** taken along a line III-III.

FIG. **4** illustrates a cross-sectional view of the organic light emitting device of FIG. **2** taken along a line IV-IV.

DETAILED DESCRIPTION

Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. Like reference numerals refer to like elements throughout.

It will be understood that when an element such as a layer, film, region, or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

In the present specification, the term "substituted", unless separately defined otherwise, means a substitution of at least one hydrogen atom with a substituent selected from a group consisting of deuterium, C1 to C30 alkyl groups, C6 to C36 aryl groups, C2 to C30 heteroaryl groups, C1 to C30 alkoxy groups, C2 to C30 alkenyl groups, C6 to C30 aryloxy groups, C3 to C30 silyloxy groups, C1 to C30 acyl groups, C2 to C30 acyloxy groups, C2 to C30 heteroacyloxy groups, C1 to C30 sulfonyl groups, C1 to C30 alkylthiol groups, C6 to C30 arylthiol groups, C1 to C30 heterocyclothiol groups, C1 to C30 phosphoric acid amide groups, C3 to C40 silyl groups, NR"R'" (here, R" and R'" are respectively substituents selected from a group consisting of a hydrogen atom, C1 to C30 alkyl groups, and C6 to C30 aryl groups), a carboxylic acid group, a halogen group, a cyano group, a nitro group, an azo group, a fluorene group, and a hydroxyl group.

As used herein, the term "hetero," unless separately defined otherwise, means that a single ring contains one to three heteroatoms selected from the group consisting of B, N, O, S, P, Si, and P(=0), and carbon atoms as the remainder.

Further, among groups used in chemical formulae of the present specification, definition of a representative group is as follows. (The number of carbons that limits substituents is not restrictive, and does not limit characteristics of the constituents).

An unsubstituted C1 to C20 alkyl group may be a linear type or a branched type, and nonrestrictive examples of the unsubstituted C1 to C30 alkyl may be methyl, ethyl, propyl, iso-propyl, sec-butyl, hexyl, iso-amyl, hexyl, heptyl, octyl, nonanyl, dodecyl, and the like.

An unsubstituted C1 to C20 alkoxy group indicates a group having a structure of —OA (wherein A is an unsubstituted C1 to C20 alkyl group as described above). Non-limiting examples of the unsubstituted C1 to C30 include a methoxy group, an ethoxy group, a propoxy group, an isopropyloxy group, a butoxy group, and a pentoxy group.

An unsubstituted C6 to C30 aryl group indicates a carbocyclic aromatic system containing at least one ring. At least two rings may be fused to each other or linked to each other by a single bond. The term aryl refers to an aromatic system, such as phenyl, naphthyl, or anthracenyl. Examples of the unsubstituted C6 to C30 aryl group may be selected from a group consisting of a phenyl group, a tolyl group, a biphenyl group, a naphthyl group, an anthracenyl group, a terphenyl group, a fluorenyl group, a phenanthrenyl group, a pyrenyl group, a diphenylanthracenyl group, a dinaphthylanthracenyl group, a pentacenyl group, a bromophenyl group, a hydroxyphenyl group, a stilbene group, an azobenzenyl group, and a ferrocenyl group.

An unsubstituted C2 to C30 heteroaryl group includes one, two, or three heteroatoms selected from a group consisting of B, N, O, S, P, Si, and P(=0), and at least two rings may be fused to each other or linked to each other by a single bond. An example of the unsubstituted C2 to C30 heteroaryl group includes a pyrazolyl group, an imidazolyl group, an oxazolyl group, a triazolyl group, a triazinyl group, a triazolyl group, a tetrazolyl group, an oxadiazole group, a thiadiazole group, a pyridinyl group, a pyridazinyl group, a pyrimidinyl group, a triazinyl group, a carbazole group, an N-phenylcarbazole group, an indolyl group, a quinolyl group, an isoquinolyl group, a thiophene group, a dibenzothiophene group, a dibenzofuran group, and a benzimidazolyl group.

An organic light emitting diode according to an exemplary embodiment will now be described in detail. FIG. **1** and FIG. **2** illustrate views of an organic light emitting diode according to an exemplary embodiment.

Referring to FIG. **1**, the organic light emitting diode may include, e.g., an anode **10**, a cathode **20** facing the anode **10**, an emission layer **70** between the anode **10** and the cathode **20**, a hole transport layer **30** between the anode **10** and the emission layer **70**, an electron transport layer **40** between the cathode **20** and the emission layer **70**, an electron blocking layer **50** between the hole transport layer **30** and the emission layer **70**, and a hole blocking layer **60** between the electron transport layer **40** and the emission layer **70**.

A substrate (not shown) may be disposed on a side of the anode **10** or the cathode **20**. The substrate may be made of, e.g., an inorganic material such as glass, an organic material such as polycarbonate, (PC), polymethylmethacrylate (PMMA), polyethylene terephthalate (PET), polyamide (PA), polyethersulfone (PES), or a combination thereof, a silicon wafer, or the like.

The anode **10** may be a transparent or non-transparent electrode. The transparent electrode may be made of a conductive oxide, e.g., indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), zinc oxide (ZnO), or a combination thereof, or a metal such as aluminum, silver, or magnesium, having a thin thickness. The non-transparent electrode may be made of, e.g., a metal, e.g., aluminum, silver, or magnesium.

In an implementation, regarding the anode **10** of the organic light emitting diode device according to an exemplary embodiment, a reflective layer may be formed with silver (Ag), aluminum (Al), chromium (Cr), molybdenum (Mo), tungsten (W), titanium (Ti), gold (Au), palladium (Pd), or an alloy thereof, and transparent electrode materials such as ITO, IZO, or ZnO may be stacked as the reflective layer.

The anode **10** may be formed by using, e.g., a sputtering method, a vapor phase deposition method, an ion beam deposition method, an electron beam deposition method, or a laser abrasion method.

The cathode **20** may contain a substance with a small work function to facilitate electron injection. An example of the substance may include a metal such as magnesium, calcium, sodium, potassium, titanium, indium, yttrium, lithium, gadolinium, aluminum, silver, tin, lead, cesium, barium, or an alloy thereof, or a multilayer structure substance such as LiF/Al, LiO_2/Al, LiF/Ca, LiF/Al, or BaF_2/Ca. In an implementation, the electrode of a metal such as aluminum or the like may be employed as the cathode.

In an implementation, magnesium, calcium, tin, lead, titanium, yttrium, lithium, ruthenium, manganese, alumi-

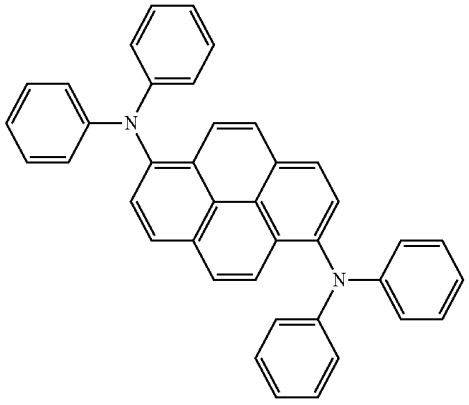
num, lithium fluoride, and their alloys may be usable for a conductive material used in the cathode **20** according to an exemplary embodiment, e.g., magnesium/silver, magnesium/indium, or lithium/aluminum may be used for the alloy. An alloy ratio of the alloys may be controlled according to a temperature of a deposition source, an atmosphere, and a vacuum degree, and may be selected to have a suitable ratio value.

In an implementation, the anode **10** and the cathode **20** may be configured to have a plurality of layers.

The emission layer **70** may include a blue, red, or green emission material, and the emission layer **70** may include a host and a dopant. The host of the emission layer may include, e.g., at least one material selected from a group including tris(8-quinolinolate)aluminum (Alq3), 2-methyl-9,10-di(2-naphthyl) anthracene (MADN), 4,4'-N,N'-dicarbazol-biphenyl (CBP), or poly(n-vinylcarbazole) (PVK).

The emission layer **50** may be doped with a third compound represented by Formula 3.

[Formula 3]



A weight ratio of the host of the emission layer to the third compound may be, e.g., 95:5.

The emission layer **70** may additionally include another dopant material. In the case of the dopant material, IDE102 or IDE105 that may be purchased from Idemitsu Company and C545T that may be bought from Hayashibara Company may be usable for a fluorescent dopant, and a PtOEP red phosphorescent dopant, RD 61 made by UDC Company, an $Ir(PPy)_3$ (PPy=2-phenylpyridine) green phosphorescent dopant, an F_2Irpic blue phosphorescent dopant, and an RD 61 red phosphorescent dopant made by UDC Company may be usable for a phosphorescent dopant.

In an implementation, $Ir(ppy)_3$, $Ir(ppy)_2acac$, $(piq)_2Ir(acac)$, and Pt(OEP) may be used for the dopant of the emission layer **70**.

In an implementation, a content of the dopant may be about 0.01 to 15 parts by weight, based on 100 parts by weight of the host. In an implementation, the dopant may be included in the emission layer in an amount of about 5 wt % or less, based on a total weight of the emission layer.

The emission layer may be 100 Å to 1,000 Å thick, e.g. 200 Å to 600 Å. Maintaining the thickness of the emission layer at about 100 Å or greater may help prevent deterioration in an emission characteristic. Maintaining the thickness of the emission layer at about 1,000 Å or less may help prevent an increase in driving voltage and may help prevent deterioration in efficiency and service life.

The emission layer **70** may be formed by using various methods, e.g., a vacuum deposition method, a spin coating method, a cast method, or an LB method.

When an organic layer such as the emission layer **70** is formed by using the vacuum deposition method, deposition conditions depend on a compound used as a material of the organic layer, and a configuration and a thermal characteristic of the target organic layer, and in general, a deposition temperature can be selected between 100 and 500° C., the vacuum degree can be selected between 10^{-8} and 10^{-3} torr, and the deposition speed can be selected between 0.01 and 100 Å/sec.

When an organic layer such as the emission layer **70** is formed by using the spin coating method, coating conditions depend on a compound used as a material of the organic layer and a configuration and a thermal characteristic of the target organic layer, and a coating speed can be selected between 2,000 to 5,000 rpm and a heat treatment temperature for removing a solvent after a coating process can be selected within an 80 to 200° C. temperature range.

The hole transport layer **30** may include a suitable hole transport material, e.g., an arylene diamine derivative, a starburst compound, a biphenyl diamine derivative including a spiro group, or a ladder-type compound. In an implementation, the hole transport material may include, e.g., 4,4",4""-tris[(3-methylphenyl(phenyl)amino)]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDATB), and copper phthalocyanine (CuPc), a carbazole derivative such as N-phenylcarbazole or polyvinylcarbazole, or an amine derivative including an aromatic condensed ring such as N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD) or N,N'-di(naphthalene-1-yl)-N,N'-diphenyl benzidine (α-NPD).

The hole transport layer **30** may be about 50 to 2,000 Å thick, e.g., 500 to 1500 Å thick. When the thickness of the hole transport layer **30** satisfies the above-noted range, an excellent hole transport characteristic may be obtainable without a substantial increase of the driving voltage.

The hole transport layer **30** may further include an auxiliary material to help improve conductivity of the layer. When the hole transport layer **30** includes the auxiliary material, the auxiliary material may be modifiable with numerous variations, e.g., it may be uniformly or non-uniformly spread to the layers.

The hole transport layer may be formed by using various methods such as a vacuum deposition method, a spin coating method, a cast method, or an LB method. When the hole transport layer is formed by the vacuum deposition method and the spin coating method, the deposition conditions and the coating conditions may be different according to the compound used.

In an implementation, a hole injection layer (not shown) that is a material for facilitating injection of holes from the anode may be stacked between the hole transport layer **30** and the anode.

The material of the hole injection layer may be a suitable hole injection material including, e.g., TCTA, m-MTDATA, m-MTDAPB, polyaniline/dodecylbenzenesulfonic acid (Pani/DBSA) which is a soluble conductive polymer, or poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (Pani/CSA), or polyaniline/poly(4-styrenesulfonate) (PANI/PSS).

The hole injection layer may be formed by using various methods such as the vacuum deposition method, the spin coating method, the cast method, or the LB method. When the hole injection layer is formed according to the vacuum

deposition method, the deposition conditions may depend on a compound used for a material of the hole injection layer, and a configuration and a thermal characteristic of the target hole injection layer, and in general, it may be desirable to appropriately select a deposition temperature between 100 and 500° C., a vacuum degree between 10^{-8} and 10^{-3} torr, a deposition speed between 0.01 and 100 Å/sec, and a layer thickness between 10 Å and 5 μm.

When the hole injection layer is formed by using the spin coating method, coating conditions may depend on a compound used as a material of the hole injection layer, and a configuration and a thermal characteristic of the target hole injection layer, and it may be desirable to appropriately select a coating speed substantially between 2,000 and 5,000 rpm and a heat treatment temperature for removing a solvent after a coating process substantially between 80 and 200° C.

The deposition conditions and the coating conditions of the hole injection layer may be similarly applicable to formation of the hole transport layer.

The electron transport layer **40** may include a quinoline derivative, e.g., at least one compound selected from a group including tris(8-quinolinolate)aluminum (Alq3), TAZ, Balq, and Bebq2.

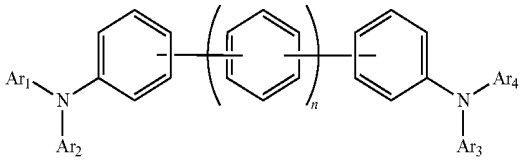
The electron transport layer may be about 100 to 1,000 Å thick, e.g. 200 to 500 Å. Maintaining the thickness of electron transport layer at about 100 Å of greater may help prevent deterioration of electron transport characteristics. Maintaining the thickness of the electron transport layer at about 1,000 Å or less may help prevent an increase in the driving voltage.

The electron transport layer **40** may be formed by using various methods such as the vacuum deposition method, the spin coating method, or the cast method. When the electron transport layer **40** is formed by using the vacuum deposition method and the spin coating method, the conditions may be changeable according to the compound.

An electron injection layer (not shown) that is a material for facilitating injection of electrons from the cathode may be stacked between the electron transport layer and the cathode. The material may include, e.g., LiF, NaCl, CsF, Li_2O, or BaO. The deposition conditions of the electron injection layer may follow the compound used, and may generally be selected from among almost the same condition range as formation of the hole injection layer.

In an implementation, the electron blocking layer **50** may include a first compound represented by the following Formula 1.

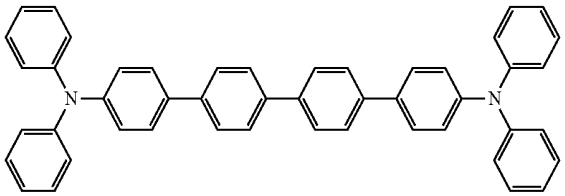
[Formula 1]



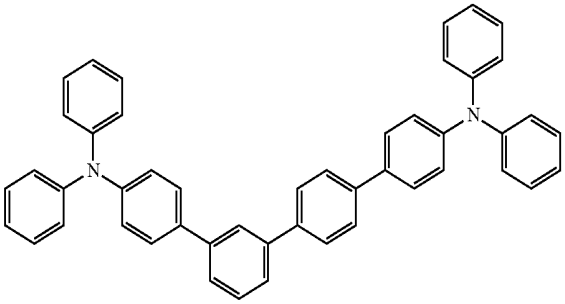
In Formula 1, Ar_1 to Ar_4 may each independently be, e.g., a substituted or unsubstituted aromatic hydrocarbon group (e.g., an aryl group), a substituted or unsubstituted aromatic heterocyclic group (e.g., a heteroaryl group), or a substituted or unsubstituted condensed polycyclic aromatic group. n may be an integer of 2 to 4, e.g., may be 2, 3, or 4.

The first compound represented by Formula 1 may be represented by one of Formula 1-1 to Formula 1-15.

(1-1)



(1-2)



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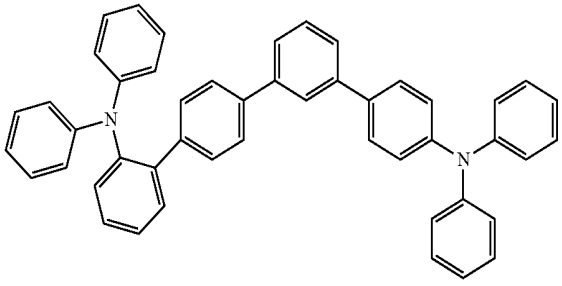
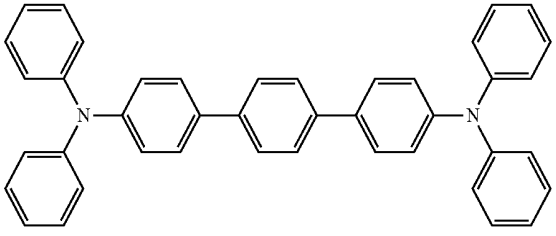


(1-4)



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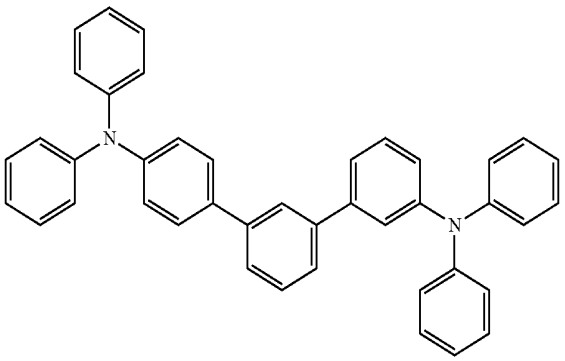
(1-5)



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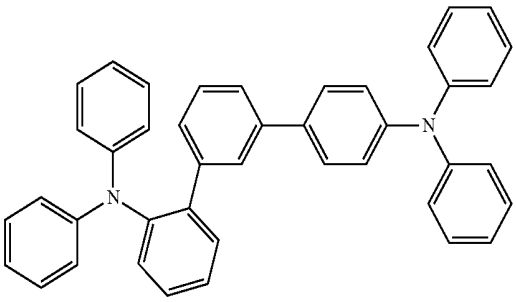
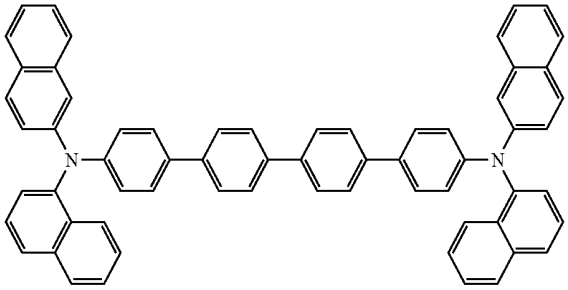
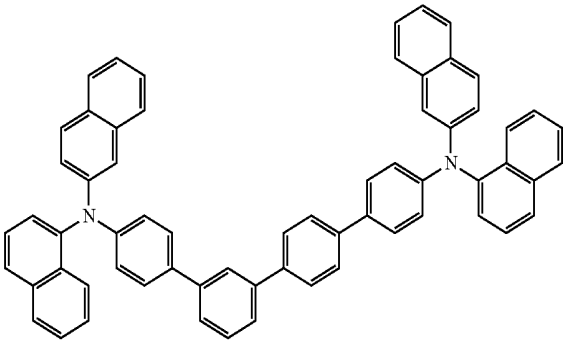


(1-7)



(1-8)



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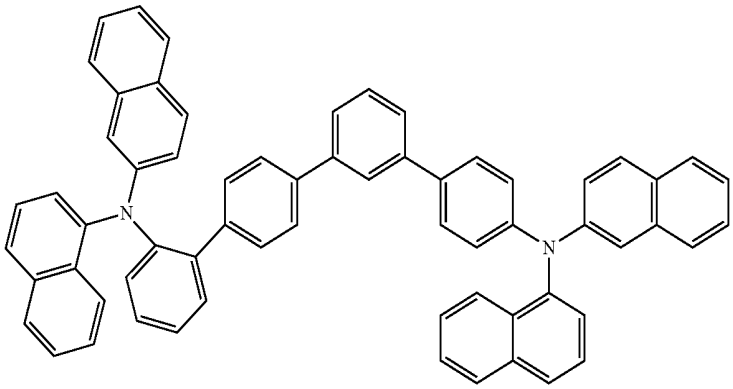
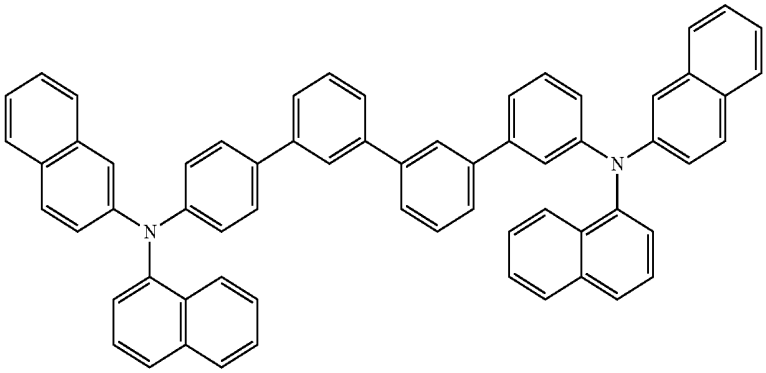


(1-10)



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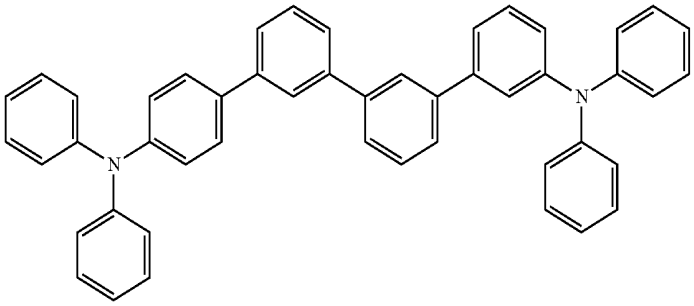
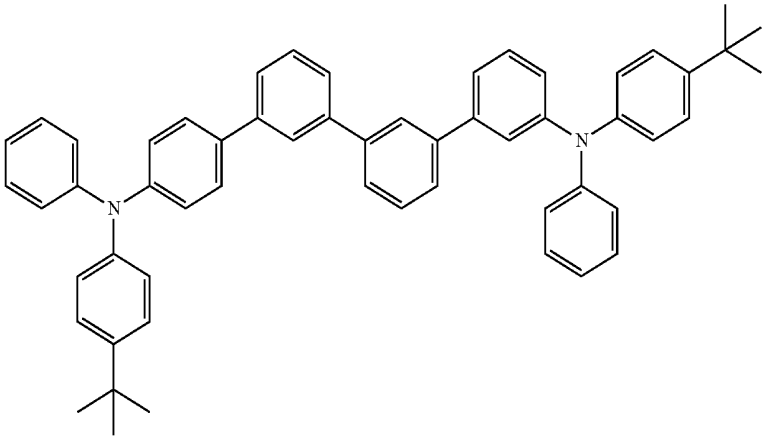
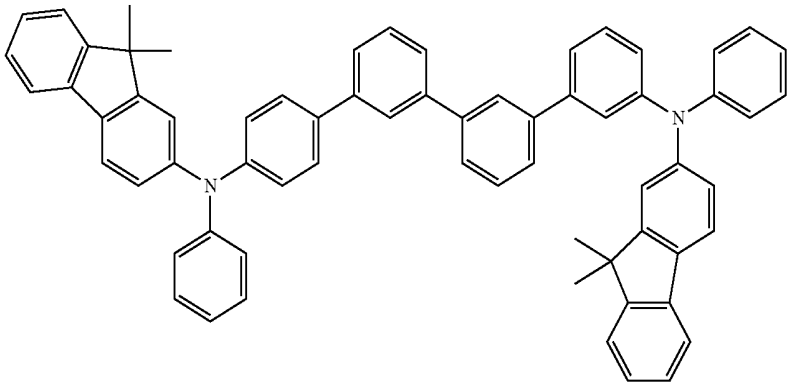
(1-11)



(1-12)



(1-13)



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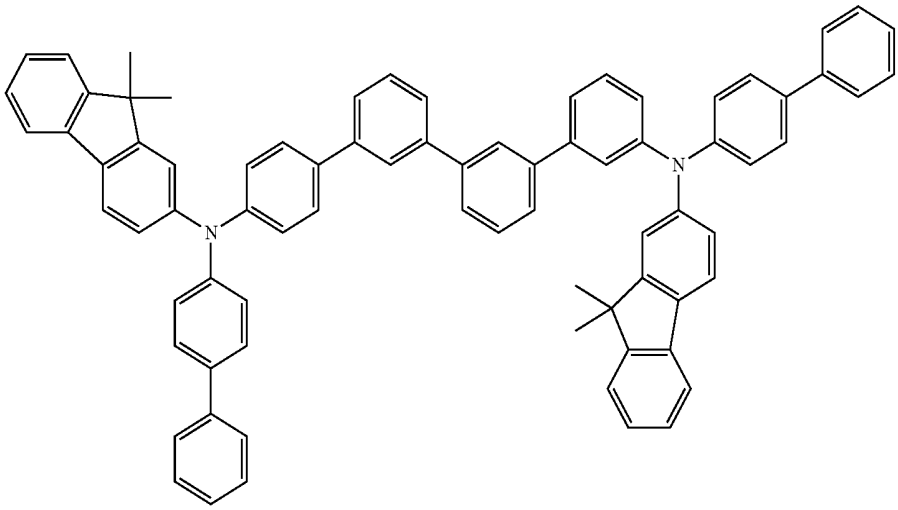

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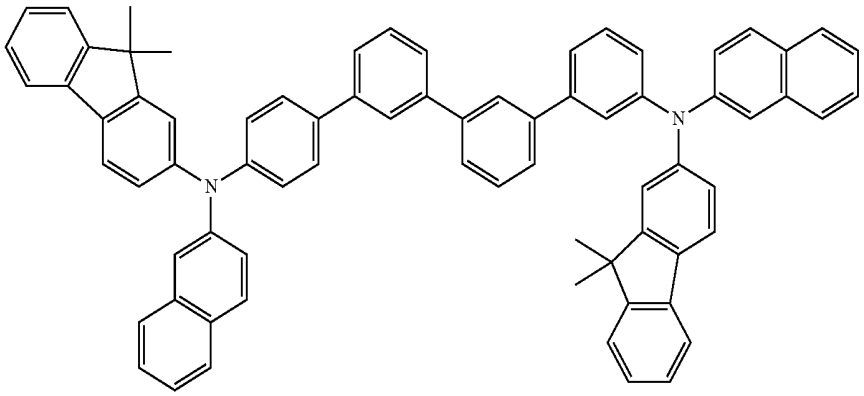
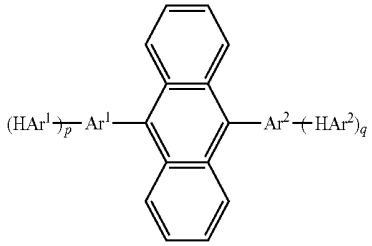
(1-15)



The electron blocking layer **50** may have a thickness of about 50 Å to about 1,000 Å, e.g., about 100 Å to about 300 Å. Maintaining the thickness of the electron blocking layer **50** at about 50 Å or greater may help prevent deterioration of electron blocking properties. Maintaining the thickness of the electron blocking layer **50** at about 1,000 Å or less may help prevent an increase in the driving voltage.

In an implementation, the hole blocking layer **60** may include a second compound represented by Formula 2.

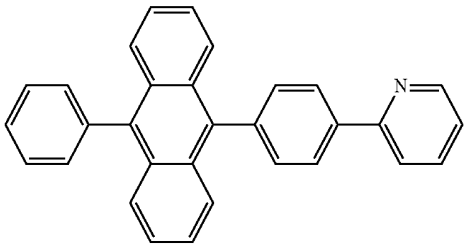
[Formula 2]



In Formula 2, Ar^1 may be, e.g., a substituted or unsubstituted phenylene group, Ar^2 may be, e.g., a substituted or unsubstituted phenylene group or a substituted or unsubstituted naphthylene group, and HAr^1 and HAr^2 may each independently be, e.g., a substituted or unsubstituted pyridine group, a quinoline group, or an isoquinoline group. p and q may each independently be integers of 0 to 3, e.g., may each independently be 0, 1, 2, or 3. In an implementation, when p or q is 2 or greater, each HAr^1 or HAr^2 may be the same as or different from each other. In an implementation, a sum of p and q may be 1 or greater, e.g., may be an integer of 1 to 6.

The second compound represented by Formula 2 may be represented by one of Formula 2-1 to Formula 2-9.

(2-1)



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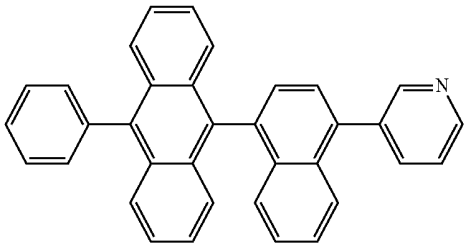
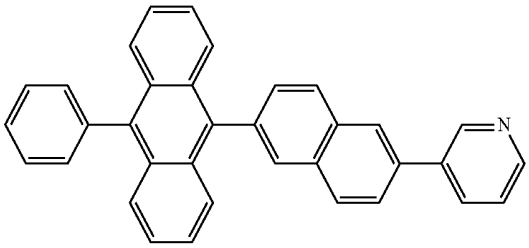
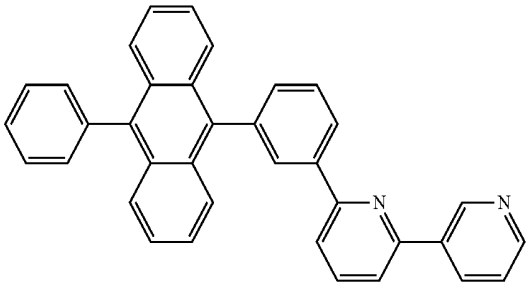
(2-2)



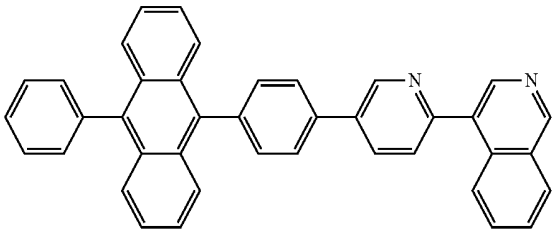
(2-3)



(2-4)



(2-5)



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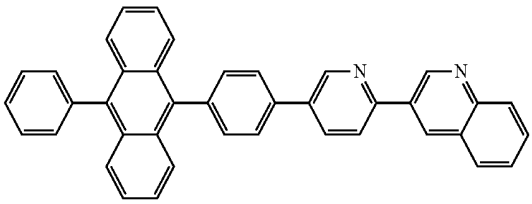
(2-6)



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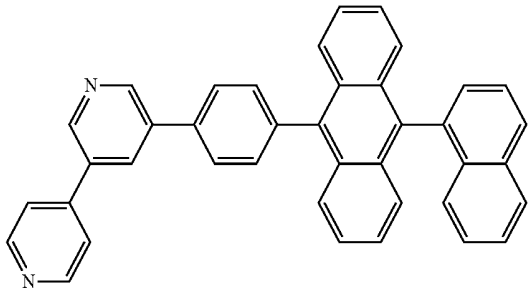
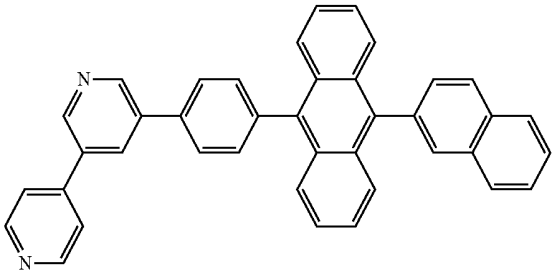
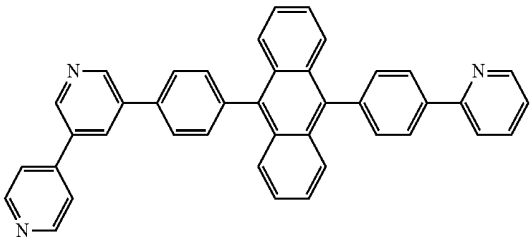


(2-8)



(2-9)



The hole blocking layer may have a thickness of about 10 Å to 1,000 Å. Maintaining the thickness of the hole blocking layer at about 10 Å or greater may help prevent deterioration of hole blocking characteristics. Maintaining the thickness of the hole blocking layer at about 1,000 Å or less may help prevent an increase in the driving voltage.

The organic light emitting diode according to the an embodiment may include the phenyl-based (e.g., phenyl-containing) compound represented by Formula 1 in the electron blocking layer and may simultaneously include the anthracene-based (e.g., anthracene-containing) compound represented by Formula 2 in the hole blocking layer. Thus, efficiency and lifespan of the diode may be improved.

An organic light emitting device including an organic light emitting diode according to an embodiment will now be described with reference to FIG. **2** to FIG. **4**.

FIG. **2** illustrates a layout view of an organic light emitting device according to an exemplary embodiment. FIG. **3** illustrates a cross-sectional view of the organic light emitting device of FIG. **2** with respect to a line III-III. FIG. **4** illustrates a cross-sectional view of the organic light emitting device of FIG. **2** with respect to a line IV-IV.

A blocking or buffer layer **111** (made of a silicon oxide or a silicon nitride) may be formed on a substrate **110** (made of transparent glass). The blocking or buffer layer **111** may have a dual-layer structure.

A plurality of pairs of first and second semiconductor islands or layers **151***a* and **151***b* (made of polysilicon) may be formed on the blocking or buffer layer **111**. The semiconductor islands or layers **151***a* and **151***b* may respectively include a plurality of extrinsic regions including an n- or p-type conductive impurity, and at least one intrinsic region substantially not including a conductive impurity.

Regarding the first semiconductor layer **151***a*, the extrinsic region may include first source and drain regions **153***a* and **155***a* and an intermediate region **1535**, and they may be doped with an n-type impurity and are separated from each other. The intrinsic region may include a pair of first channel regions (**154***a***1**, **154***a***2**) provided between the extrinsic regions **153***a*, **1535**, and **155***a*.

Regarding the second semiconductor layer **151***b*, the extrinsic region may include second source and drain regions **153***b* and **155***b*, and they may be doped with a p-type impurity and are separated from each other. The intrinsic region may include a second channel region **154***b* provided between the second source and drain regions **153***b* and **155***b* and a storage region **157** extended upwardly from the second source region **153***b*.

The extrinsic region may further include a lightly doped region (not shown) between the channel regions (**154***a***1**, **154***a***2**, and **154***b*) and the source and drain regions (**153***a*, **155***a*, **153***b*, and **155***b*). The lightly doped region may be replaced with an offset region substantially not including an impurity.

In contrast, the extrinsic regions **153***a* and **155***a* of the first semiconductor layer **151***a* may be doped with a p-type impurity, or the extrinsic regions **153***b* and **155***b* of the second semiconductor layer **151***b* may be doped with an n-type impurity. The p-type conductive impurity may include, e.g., boron (B) and gallium (Ga), and the n-type conductive impurity may include, e.g., phosphorus (P) and arsenic (As).

A gate insulating layer **140** (formed with a silicon oxide or a silicon nitride) may be formed on the semiconductor layers **151***a* and **151***b* and the blocking or buffer layer **111**.

A plurality of gate lines **121** (including a first control electrode **124***a* and a plurality of gate conductors including a plurality of second control electrodes **124***b*) may be formed on the gate insulating layer **140**.

The gate line **121** may transmit a gate signal and may extend in a horizontal direction. The first control electrode **124***a* may be extended upward from the gate line **121**, may cross the first semiconductor layer **151***a*, and may overlap the first channel regions (**154***a***1** and **154***a***2**). Each gate line **121** may include a wide end portion for accessing another layer or an external driving circuit. When a gate driving circuit for generating a gate signal is integrated on the substrate **110**, the gate line **121** may be extended to be connected to the gate driving circuit.

The second control electrode **124***b* may be separated from the gate line **121** and may overlap the second channel region **154***b* of the second semiconductor layer **151***b*.

The second control electrode **124***b* may be extended to configure a storage electrode **127**, and the storage electrode **127** may overlap the storage region **157** of the second semiconductor **151***b*.

The gate conductors **121** and **124***b* may be made of an aluminum-based metal such as aluminum (Al) or an aluminum alloy, a silver-based metal such as silver (Ag) or a silver

alloy, a copper-based metal such as copper (Cu) or a copper alloy, a molybdenum-based metal such as molybdenum (Mo) or a molybdenum alloy, chromium (Cr), tantalum (Ta), titanium (Ti), or the like. In an implementation, they may have a multilayer structure including at least two conductive layers with different physical properties. One of the conductive layers may be formed using a metal having low resistivity, such as an aluminum-based metal, a silver-based metal, or a copper-based metal, in order to help reduce signal delay or voltage drop. Another conductive layer may be formed using a material having good physical, chemical, and electrical contact characteristics particularly with indium tin oxide (ITO) and indium zinc oxide (IZO), such as a molybdenum-based metal, chromium, tantalum, titanium, or the like. Examples of the combination may include a lower chromium film and an upper aluminum (alloy) film, and a lower aluminum (alloy) film and an upper molybdenum (alloy) film. In an implementation, the gate conductors **121** and **124***b* may be made of various metals or conductors.

Sides of the gate conductors **121** and **124***b* may be slanted with respect to the surface of the substrate **110** by, e.g., an angle of about 30 to 80°.

An interlayer insulating layer **160** may be formed on the gate conductors **121** and **124***b*. The interlayer insulating layer **160** may be made of an inorganic insulator such as a silicon nitride or silicon oxide, an organic insulator, and a low dielectric insulator. A dielectric constant of the low dielectric insulator may be, e.g., less than 4.0, and a-Si:C:O and a-Si:O:F formed by plasma enhanced chemical vapor deposition (PECVD) may be examples thereof. The interlayer insulating layer **160** may be made of an organic insulator having photosensitivity, and may have a flat surface.

A plurality of contact holes **164** for exposing the second control electrode **124***b* may be formed on the interlayer insulating layer **160**. A plurality of contact holes **163***a*, **163***b*, **165***a*, and **165***b* for exposing the source and drain regions **153***a*, **153***b*, **155***a*, and **155***b* may be formed on the interlayer insulating layer **160** and the gate insulating layer **140**.

A plurality of data conductors (including a data line **171**, a driving voltage line **172**, and first and second output electrodes **175***a* and **175***b*) may be formed on the interlayer insulating layer **160**.

The data line **171** may transmit a data signal, it may be mainly extended in a longitudinal direction, and may cross the gate line **121**. Each data line **171** may include a plurality of first input electrodes **173***a* connected to the first source region **153***a* through the contact hole **163***a*, and may include a wide end portion for accessing another layer or an external driving circuit. When a data driving circuit for generating a data signal is integrated on the substrate **110**, the data line **171** may be extended to be connected to the data driving circuit.

The driving voltage line **172** may transmit a driving voltage, may be mainly extended in the perpendicular direction, and may cross the gate line **121**. Each driving voltage line **172** may include a plurality of second input electrodes **173***b* connected to the second source region **153***b* through the contact hole **163***b*. The driving voltage line **172** may overlap the storage electrode **127** and may be connected to the same.

The first output electrode **175***a* may be separated from the data line **171** and the driving voltage line **172**. The first output electrode **175***a* may be connected to the first drain region **155***a* through the contact hole **165***a*, and may be connected to the second control electrode **124***b* through the contact hole **164**.

The second output electrode **175***b* may be separated from the data line **171**, the driving voltage line **172**, and the first output electrode **175***a*, and may be connected to the second drain region **155***b* through the contact hole **165***b*.

The data conductors **171**, **172**, **175***a*, and **175***b* may be made of, e.g., a refractory metal such as molybdenum, chromium, tantalum, titanium, or an alloy thereof, and they may have a multilayer structure including a refractory metal layer (not shown) and a low resistance conductive layer (not shown). Examples of the multilayer structure may include a double layer including a chromium or molybdenum (alloy) lower layer and an aluminum (alloy) upper layer, and a triple layer including a molybdenum (alloy) lower layer, an aluminum (alloy) intermediate layer, and a molybdenum (alloy) upper layer. In an implementation, the data conductors **171**, **172**, **175***a*, and **175***b* may be made of various kinds of metals and conductors.

In a like manner of the gate conductors **121** and **121***b*, sides of the data conductors **171**, **172**, **175***a*, and **175***b* may be slanted with respect to the surface of the substrate **110** by an angle of, e.g., about 30 to 80°.

A passivation layer **180** may be formed on the data conductors **171**, **172**, **175***a*, and **175***b*. The passivation layer **180** may be formed with an inorganic material, an organic material, or a low dielectric insulating material.

A plurality of contact holes **185** for exposing the second output electrode **175***b* may be formed on the passivation layer **180**. A plurality of contact holes (not shown) for exposing an end portion of the data line **171** may be formed on the passivation layer **180**, and a plurality of contact holes (not shown) for exposing an end portion of the gate line **121** may be formed on the passivation layer **180** and the interlayer insulating layer **160**.

A plurality of pixel electrodes **190** may be formed on the passivation layer **180**. The pixel electrode **190** may be physically and electrically connected to the second output electrode **175***b* through the contact hole **185**, and it may be made of a transparent conductive material such as ITO or IZO or a reflective metal such as aluminum, silver, or alloys thereof.

A plurality of contact assistants (not shown) or connecting members (not shown) may be formed on the passivation layer **180**, and may be connected to the exposed end portions of the gate line **121** and the data line **171**.

A partition or pixel defining layer **361** may be formed on the passivation layer **180**. The partition **361** may define an opening by wrapping edges of the pixel electrodes **190** like a bank, and may be made of an organic insulator or an inorganic insulator. The partition **361** may be made of a photoresist including black pigments, and it may function as a light blocking member in this case thereby simplifying the manufacturing process.

An organic emission layer **370** may be formed on the pixel electrode **190**, and a common electrode **270** may be formed on the organic emission layer **370**. As described, the organic light emitting diode including the pixel electrode **190**, the organic emission layer **370**, and the common electrode **270** may be formed.

A description on the organic light emitting diode corresponds to the previous description. In an implementation, the organic light emitting diode may have a stacked configuration of, e.g., anode/hole transport layer/electron blocking layer/emission layer/hole blocking layer/electron transport layer/cathode or anode/hole injection layer/hole transport layer/electron blocking layer/emission layer/hole blocking layer/electron transport layer/electron injection layer/cathode.

For example, the pixel electrode **190** may be an anode that is a hole injection electrode, and the common electrode **270** may be a cathode that is an electron injection electrode. In an implementation, the pixel electrode **190** may be a cathode and the common electrode **270** may be an anode according to a method for driving an organic light emitting device. Holes and electrons may be injected from the pixel electrode **190** and the common electrode **270** into the organic light emitting layer **370**, and when excitons formed as the holes and electrons injected into the organic light emitting layer **370** are combined change from an excited state to a ground state, the organic light emitting layer **370** may emit light.

The common electrode **270** may receive a common voltage and may be made of a reflective metal such as calcium (Ca), barium (Ba), magnesium (Mg), aluminum, silver, or the like, or a transparent conductive material such as ITO or IZO.

Compositions of the electron blocking layer and the hole blocking layer of the organic light emitting diode correspond to the previous description. For example, a first compound (e.g., a phenyl-based compound) may be included in the electron blocking layer of the organic light emitting diode, and simultaneously a second compound (e.g., an anthracene-based compound) may be included in the hole blocking layer.

In the organic light emitting device, the first semiconductor layer **151***a*, the first control electrode **124***a* connected to the gate line **121**, the first input electrode **173***a* connected to the data line **171**, and the first output electrode **175***a* may configure a switching thin film transistor (TFT) Qs, and a channel of the switching thin film transistor Qs may be formed in channel regions **154***a***1** and **154***a***2** of the first semiconductor layer **151***a*. The second semiconductor layer **151***b*, the second control electrode **124***b* connected to the first output electrode **175***a*, the second input electrode **173***b* connected to the driving voltage line **172**, and the second output electrode **175***b* connected to the pixel electrode **190** may configure a driving thin film transistor (TFT) Qd, and a channel of the driving thin film transistor Qd may be formed in the channel region **154***b* of the second semiconductor layer **151***b*. The pixel electrode **190**, the organic light emitting member **370**, and the common electrode **270** may configure an organic light emitting diode, and the pixel electrode **190** may be and anode and the common electrode **270** may be a cathode, or the pixel electrode **190** may be a cathode and the common electrode **270** may be an anode. The overlapping storage electrode **127**, the driving voltage line **172**, and the storage region **157** may configure a storage capacitor (Cst).

The switching thin film transistor Qs may transmit a data signal of the data line **171** in response to the gate signal of the gate line **121**. Upon receiving a data signal, the driving thin film transistor Qd may supply a current that follows a voltage difference between the second control electrode **124***b* and the second input electrode **173***b*. A voltage difference between the second control electrode **124***b* and the second input electrode **173***b* may be charged in the storage capacitor Cst and may be maintained when the switching thin film transistor Qs is turned off. The organic light emitting diode may display an image by changing intensity according to the current supplied by the driving thin film transistor Qd and emitting light.

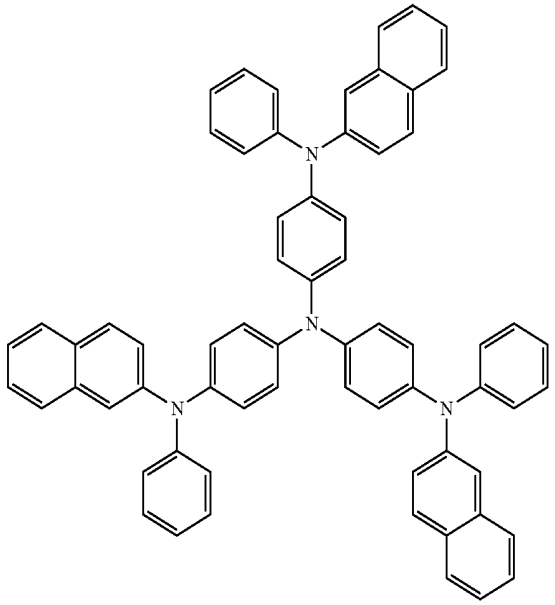
The following Examples and Comparative Examples are provided in order to highlight characteristics of one or more embodiments, but it will be understood that the Examples and Comparative Examples are not to be construed as limiting the scope of the embodiments, nor are the Comparative Examples to be construed as being outside the scope of the embodiments. Further, it will be understood that the embodiments are not limited to the particular details described in the Examples and Comparative Examples.

EXAMPLE 1

As the anode, a 15 Ω/cm^2 500 Å ITO glass substrate (manufactured by Corning) was cut to the size of 50 mm×50 mm×0.5 mm, an ultrasonic wave cleaning process was performed for ten minutes using isopropyl alcohol and pure water, ultraviolet rays were irradiated thereto for ten minutes, they were exposed to ozone to be cleaned, and the glass substrate is was in a vacuum deposition device.

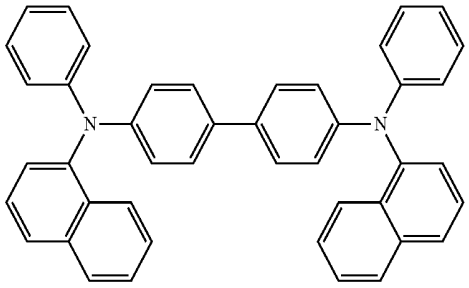
A fourth compound (2-TNATA) represented by Formula 4 was vacuum-deposited as a 600 Å-thick hole injection layer on the glass substrate.

[Formula 4]



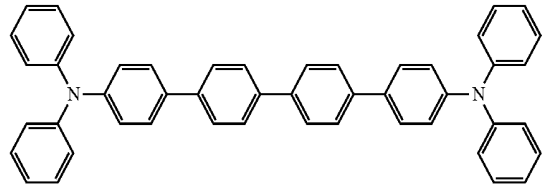
A fifth compound (4,4'-bis[N-(1-naphthyl)-N-phenyl-amino]biphenyl (NPB)) represented by Formula 5 was formed to be a 300 Å thick hole transport layer.

[Formula 5]



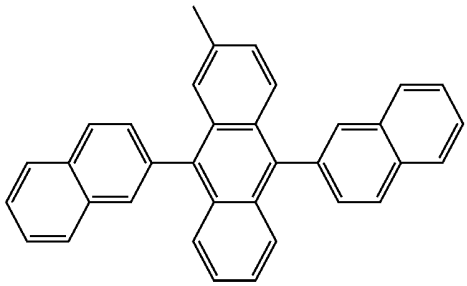
A compound represented by Formula 1-1 was vacuum-deposited to a thickness of 100 Å as an electron blocking layer on an upper portion of the hole transport layer.

[Formula 1-1]

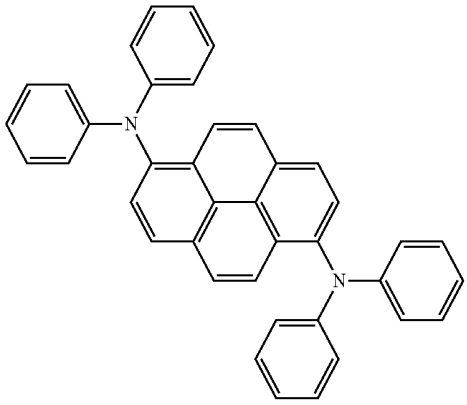


A 300 Å-thick emission layer was formed on an upper portion of the electron blocking layer by doping 5 wt % of a third compound represented by Formula 3 (as a dopant of the emission layer) into a sixth compound (MADN) represented by Formula 6 (as a host of the emission layer).

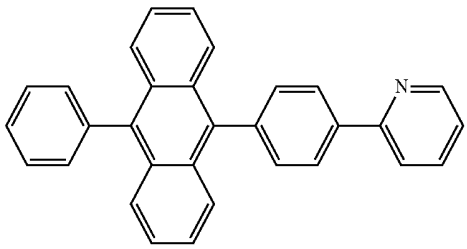
[Formula 6]



[Formula 3]



A compound represented by Formula 2-1 was formed to a thickness of 50 Å as the hole blocking layer on an upper portion of the emission layer.



Alq3 was deposited to a thickness of 300 Å as an electron transport layer on the hole blocking layer, and Al was vacuum-deposited to a thickness of 1,200 Å to form an Al electrode (cathode electrode), and accordingly manufacture an organic electroluminescence element.

Element performance (=current efficiency, Cd/A) when driving the manufactured organic light emitting diode was measured with a current density of 10 mA/cm^2, and a time (=lifespan) when initial luminance was reduced to be 80% of initial luminance with the current density 50 mA/cm^2 was determined.

For Examples 2 to 15 and Comparative Examples 2 to 5, a diode was manufactured under the same conditions as in Example 1, except for using the materials outlined in Table 1, below, in the electron blocking layer or the hole blocking layer, or omitting the electron blocking layer or hole blocking layer, and performance and lifespan thereof were measured.

For Comparative Example 1, a diode was manufactured under the same conditions, except for not including the electron blocking layer and the hole blocking layer, and efficiency and lifespan were evaluated.

Measurement results are shown in Table 1.

TABLE 1

	Electron blocking layer	Hole blocking layer	Efficiency (cd/A)	Lifespan (h)
Example 1	Formula 1-1	Formula 2-1	5.2	130
Example 2	Formula 1-2	Formula 2-1	5	120
Example 3	Formula 1-3	Formula 2-1	5.1	120
Example 4	Formula 1-8	Formula 2-1	5.6	110
Example 5	Formula 1-9	Formula 2-1	5.5	130
Example 6	Formula 1-13	Formula 2-1	5.4	110
Example 7	Formula 1-14	Formula 2-1	5.5	120
Example 8	Formula 1-15	Formula 2-1	5.6	130
Example 9	Formula 1-2	Formula 2-2	5.4	120
Example 10	Formula 1-8	Formula 2-2	5.3	130
Example 11	Formula 1-13	Formula 2-2	5.1	100
Example 12	Formula 1-15	Formula 2-2	5.2	110
Example 13	Formula 1-14	Formula 2-5	5.3	110
Example 14	Formula 1-15	Formula 2-8	5.4	140
Example 15	Formula 1-14	Formula 2-9	5.5	120
Comparative Example 1	—	—	3.7	55
Comparative Example 2	Formula 1-1	—	4.6	47
Comparative Example 3	—	Formula 2-1	4.5	35
Comparative Example 4	Formula 1-15	—	4.4	50
Comparative Example 5	—	Formula 2-2	4.7	60

As may be seen in Table 1, when the compound of Formula 1 was included in an electron blocking layer and the compound of Formula 2 was included in a hole blocking layer, efficiency and lifespan were substantially improved, compared to Comparative Example 1 in which the electron blocking layer and the hole blocking layer were not included.

Further, compared to the case of selectively including the electron blocking layer or the hole blocking layer, as in Comparative Examples 2 to 4, the Examples acquired a substantial effect in the viewpoint of efficiency and lifespan.

By way of summation and review, an organic light emitting diode device may require a high driving voltage, may exhibit low light emission luminance or efficiency, and may have a short light emission lifespan.

The organic light emitting diode according to an embodiment may have improved efficiency and lifespan by including the phenyl-based compound represented by Formula 1 as an electron blocking layer and simultaneously including the anthracene-based compound represented by Formula 2 as a hole blocking layer.

The embodiments may provide an organic light emitting diode having high efficiency and a long lifespan.

The organic light emitting diode according to an embodiment may include the phenyl-based compound in the electron blocking layer of the organic light emitting diode and the anthracene-based compound in the hole blocking layer of the organic light emitting diode to help improve efficiency and lifespan of the organic light emitting diode.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

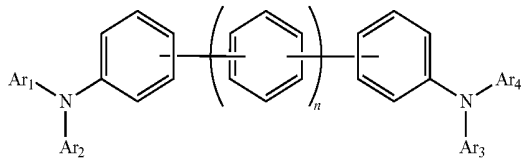
What is claimed is:

1. An organic light emitting diode, comprising:

a first compound represented by the following Formula 1; and

a second compound represented by the following Formula 2,

[Formula 1]

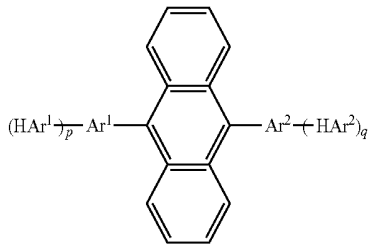


wherein, in Formula 1,

Ar_1 to Ar_4 are each independently a substituted or unsubstituted aromatic hydrocarbon group, a substituted or unsubstituted aromatic heterocyclic group, or a substituted or unsubstituted condensed polycyclic aromatic group, and

n is an integer of 2 to 4,

[Formula 2]



wherein, in Formula 2,

Ar^1 is a substituted or unsubstituted phenylene group,

Ar^2 is a substituted or unsubstituted phenylene group or a substituted or unsubstituted naphthylene group,

HAr^1 and HAr^2 are each independently a substituted or unsubstituted pyridine group, a quinoline group, or an isoquinoline group,

p and q are each independently integers of 0 to 3, and

when p or q is 2 or greater, each HAr^1 is the same as or different from each other or each HAr^2 is the same as or different from each other; wherein at least one of p and q are independently integers of 1 to 3.

2. The organic light emitting diode as claimed in claim **1**, wherein:

the organic light emitting diode includes:

an anode,

a cathode facing the anode,

an emission layer between the anode and the cathode,

a hole transport layer between the anode and the emission layer,

an electron blocking layer between the emission layer and the hole transport layer,

an electron transport layer between the cathode and the emission layer, and

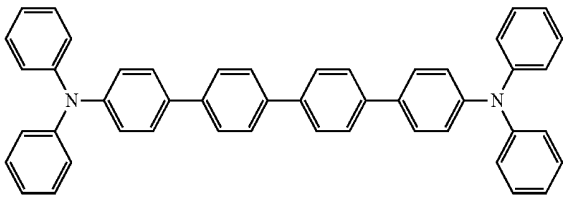
a hole blocking layer between the emission layer and the electron transport layer,

the electron blocking layer includes the first compound, and

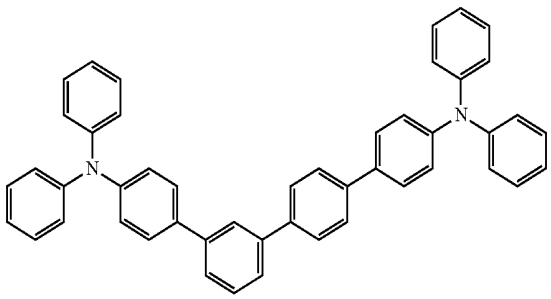
the hole blocking layer includes the second compound.

3. The organic light emitting diode as claimed in claim **1**, wherein the first compound represented by Formula 1 is represented by one of Formula 1-1 to Formula 1-15:

(1-1)



(1-2)



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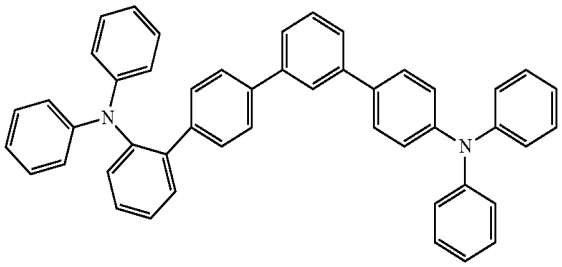
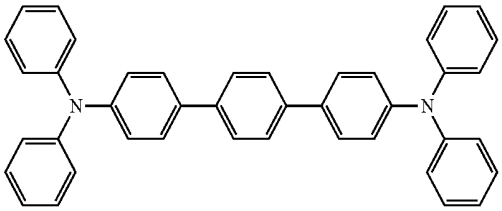
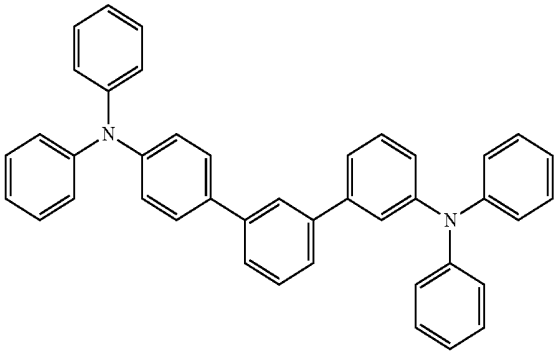
(1-3)



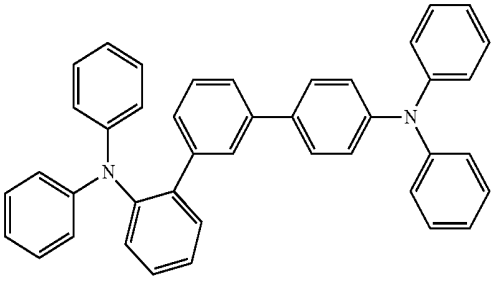
(1-4)



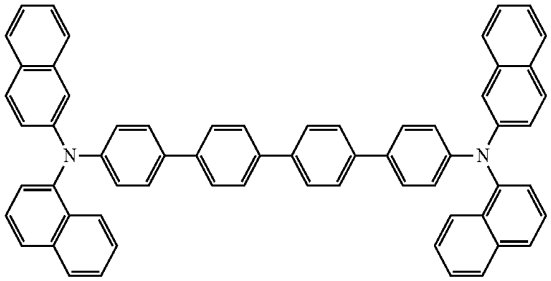
(1-5)



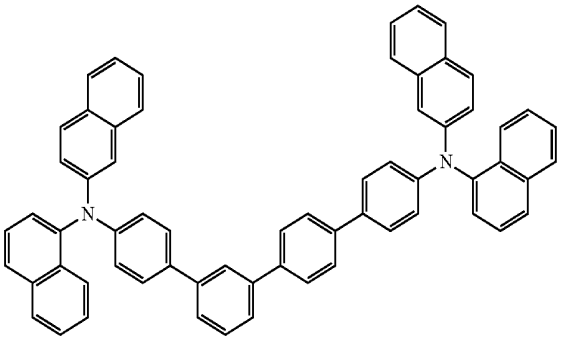
(1-6)



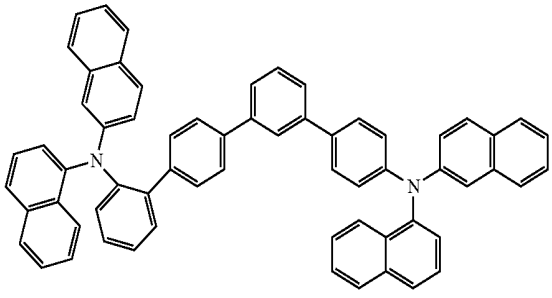
(1-7)



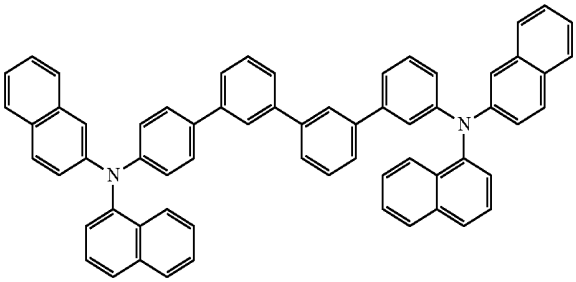
(1-8)



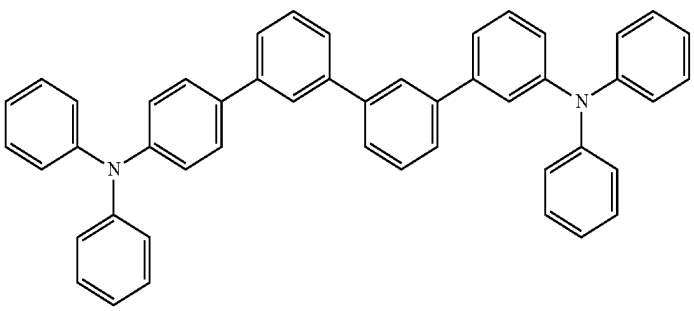
(1-9)



(1-10)



(1-11)



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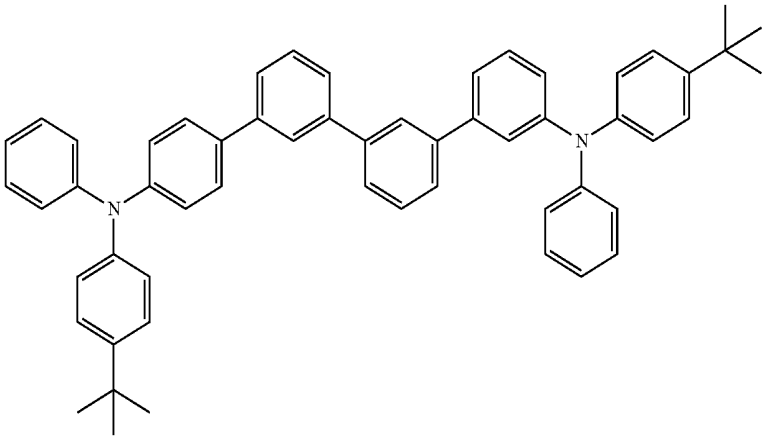
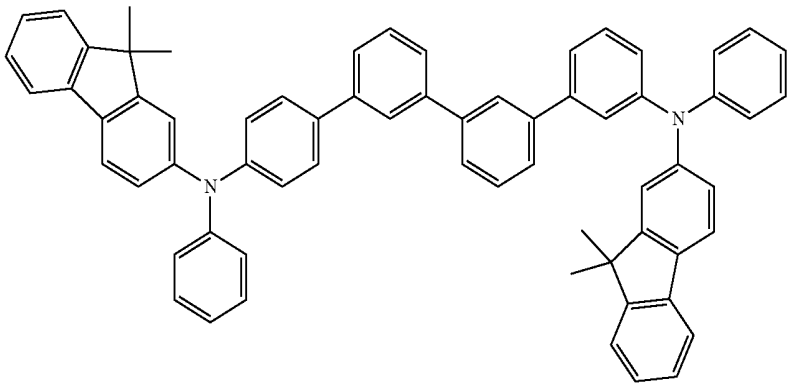
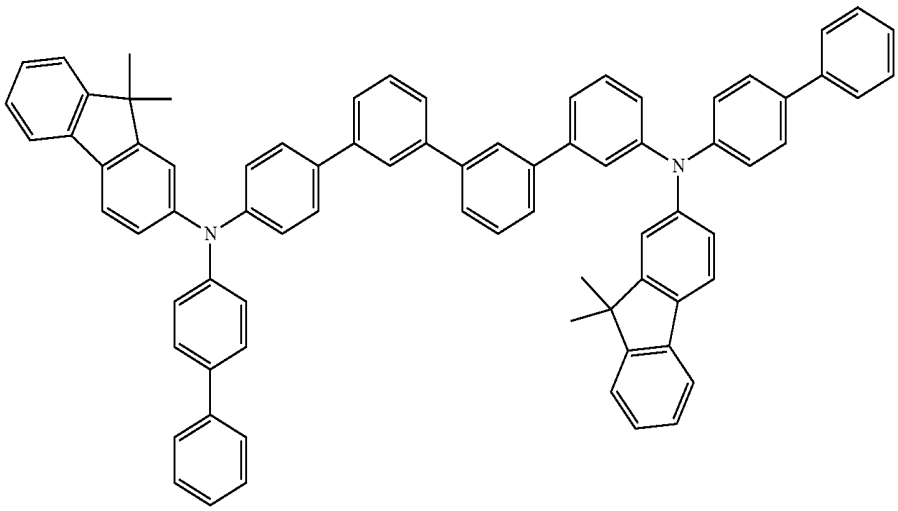
(1-12)



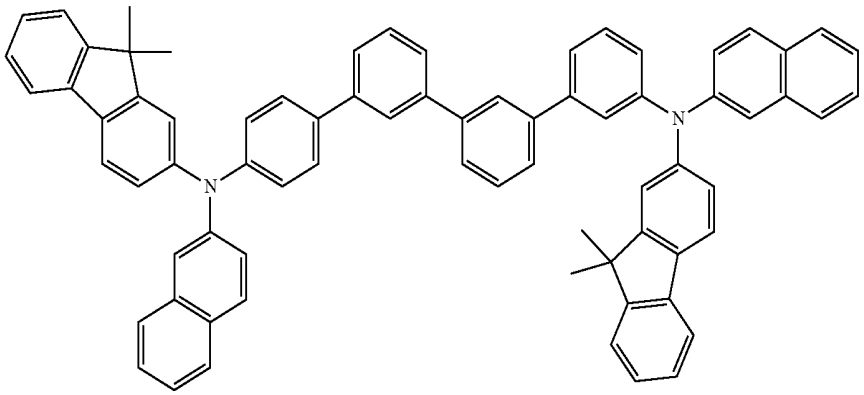
(1-13)



(1-14)

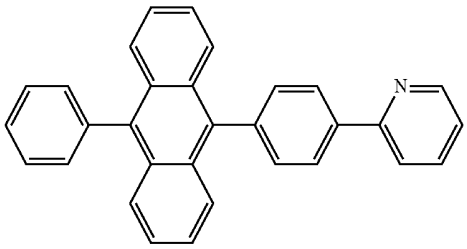


(1-15)

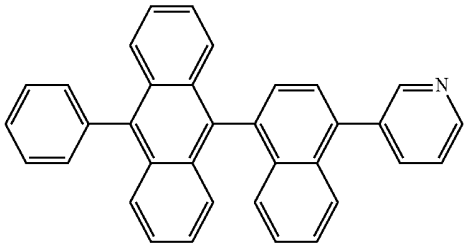


4. The organic light emitting diode as claimed in claim 1, wherein the second compound represented by Formula 2 is represented by one of Formula 2-1 to Formula 2-9:

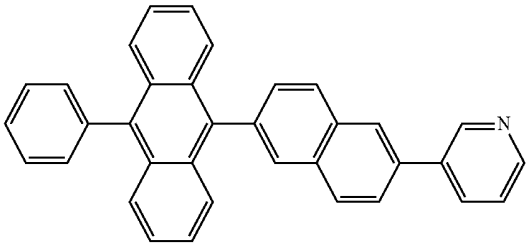
(2-1)



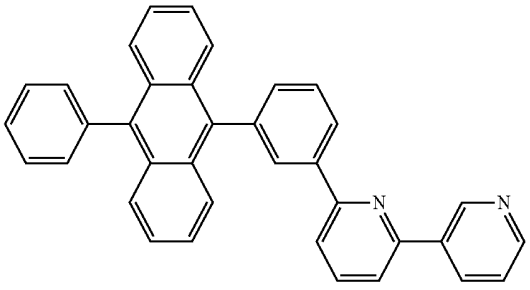
(2-2)



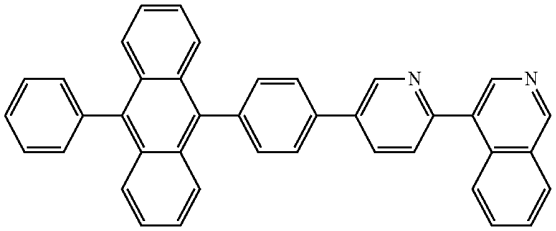
(2-3)



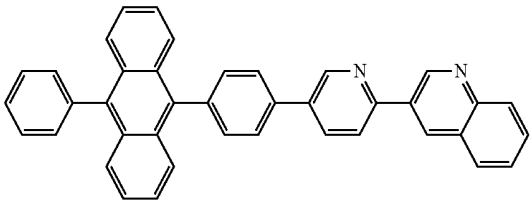
(2-4)



(2-5)



(2-6)



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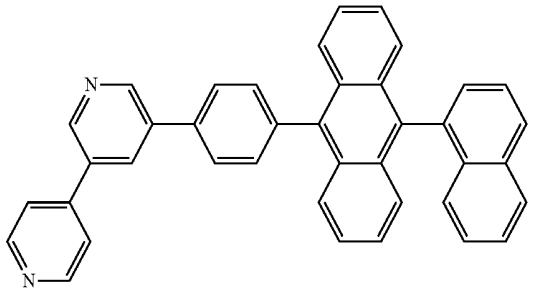
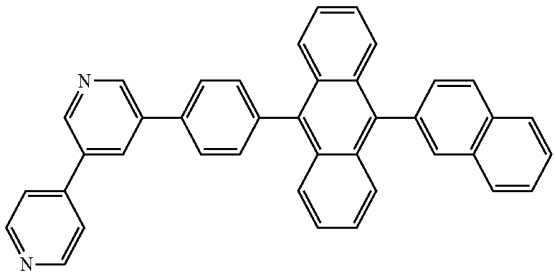
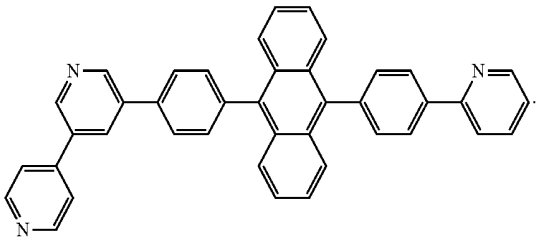
(2-7)



(2-8)



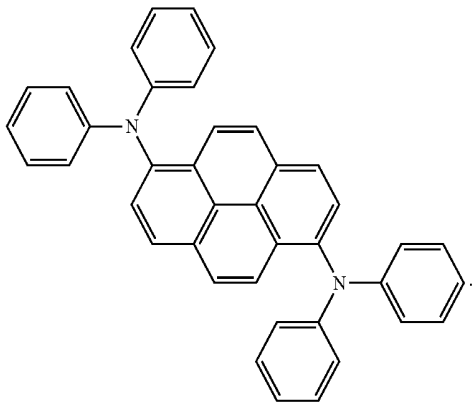
(2-9)



5. The organic light emitting diode as claimed in claim 2, wherein the emission layer includes at least one of tris(8-quinolinolate)aluminum (Alq3), 2-methyl-9,10-di(2-naphthyl) anthracene (MADN), 4,4'-N,N'-dicarbazol-biphenyl (CBP), or poly(n-vinylcarbazole) (PVK).

6. The organic light emitting diode as claimed in claim 5, wherein the emission layer is doped with a third compound represented by the following Formula 3:

[Formula 3]



7. The organic light emitting diode as claimed in claim 6, wherein the third compound is included in the emission layer in an amount of about 5 wt % or less, based on a total weight of the emission layer.

8. The organic light emitting diode as claimed in claim 2, wherein the hole transport layer includes at least one of 4,4",4""-tris[(3-methylphenyl(phenyl)amino)]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDATB), copper phthalocyanine (CuPc), N-phenylcarbazole, polyvinylcarbazole, N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl benzidine (α-NPD), or 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPB).

9. The organic light emitting diode as claimed in claim 2, wherein the electron transport layer includes at least one of Alq3, TAZ, Balq, or Bebq2.

10. An organic light emitting device, comprising:

a substrate;

a gate line on the substrate;

a data line and a driving voltage line crossing the gate line;

a switching thin film transistor connected to the gate line and the data line;

a driving thin film transistor connected to the switching thin film transistor and the driving voltage line; and

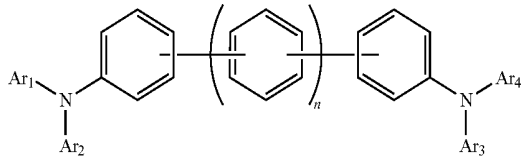
an organic light emitting diode connected to the driving thin film transistor,

wherein the organic light emitting diode includes:

a first compound represented by the following Formula 1, and

a second compound represented by the following Formula 2:

[Formula 1]

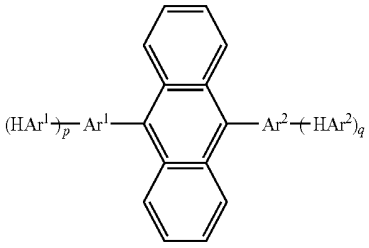


wherein, in Formula 1,

Ar_1 to Ar_4 are each independently a substituted or unsubstituted aromatic hydrocarbon group, a substituted or unsubstituted aromatic heterocyclic group, or a substituted or unsubstituted condensed polycyclic aromatic group, and

n is an integer of 2 to 4,

[Formula 2]



wherein, in Formula 2,

Ar^1 is a substituted or unsubstituted phenylene group,

Ar^2 is a substituted or unsubstituted phenylene group or a substituted or unsubstituted naphthylene group,

HAr^1 and HAr^2 are each independently a substituted or unsubstituted pyridine group, a quinoline group, or an isoquinoline group,

p and q are each independently integers of 0 to 3, and

when p or q is 2 or greater, each HAr^1 is the same as or different from each other or each HAr^2 is the same as or different from each other.

11. The organic light emitting device as claimed in claim 10, wherein:

the organic light emitting diode includes:

an anode,

a cathode facing the anode,

an emission layer between the anode and the cathode,

a hole transport layer between the anode and the emission layer,

an electron blocking layer between the emission layer and the hole transport layer,

an electron transport layer between the cathode and the emission layer, and

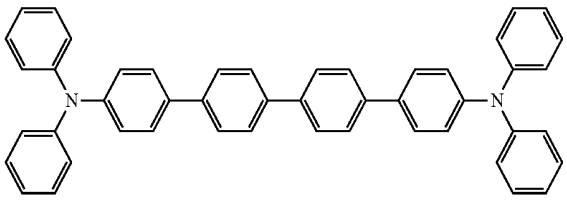
a hole blocking layer between the emission layer and the electron transport layer,

the electron blocking layer includes the first compound, and

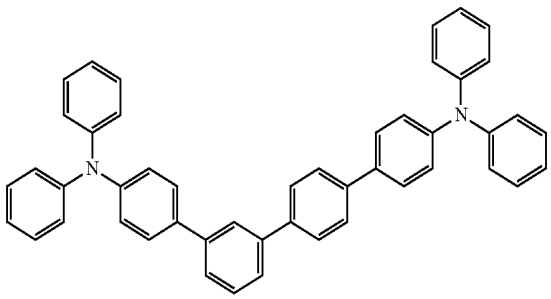
the hole blocking layer includes the second compound.

12. The organic light emitting device as claimed in claim 10, wherein the first compound represented by Formula 1 is represented by one of Formula 1-1 to Formula 1-15:

(1-1)



(1-2)



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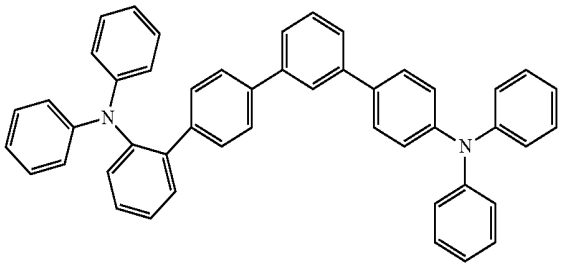
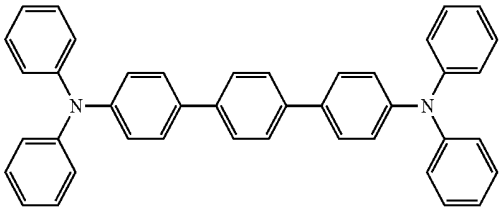
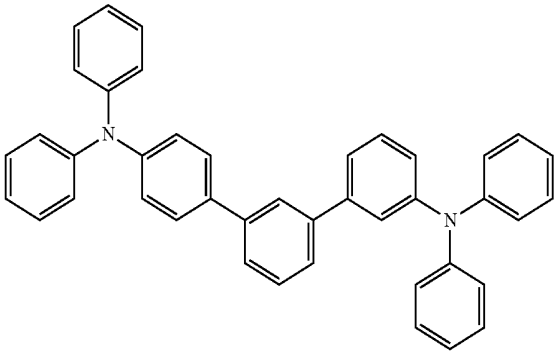
(1-3)



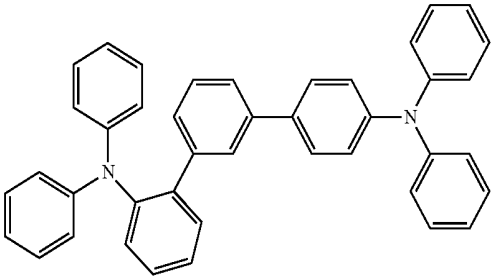
(1-4)



(1-5)



(1-6)



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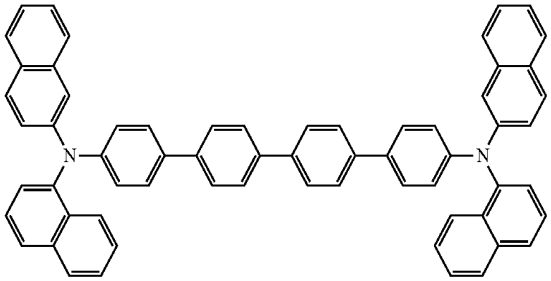

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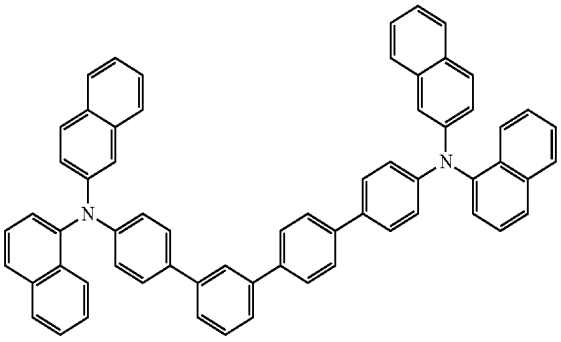

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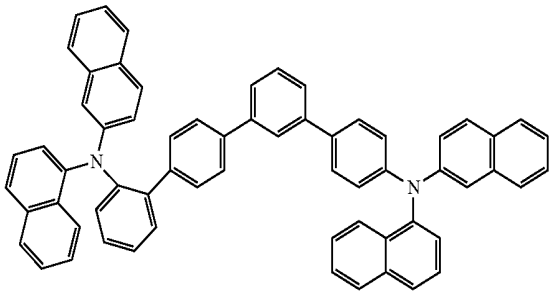

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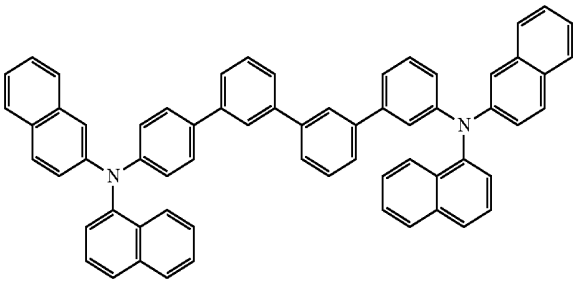

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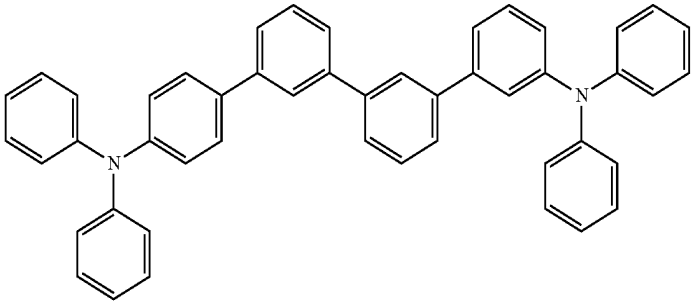

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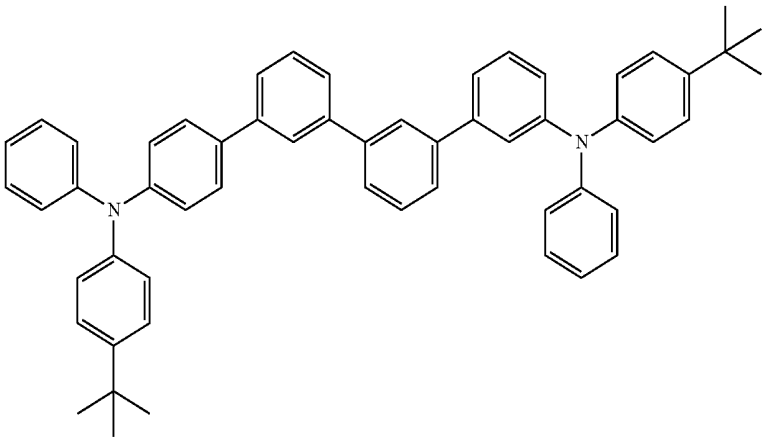
(1-12)



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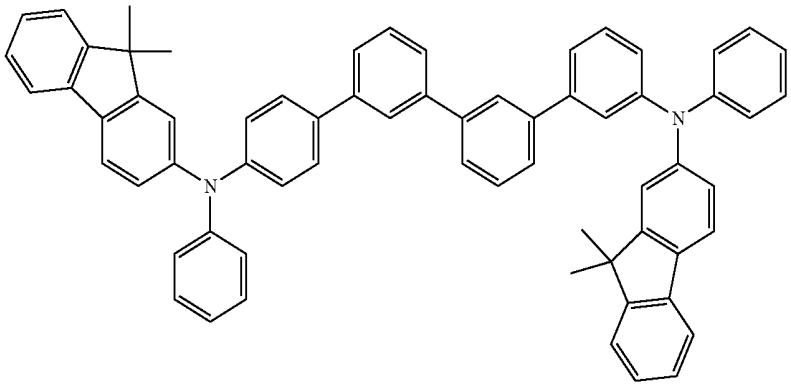
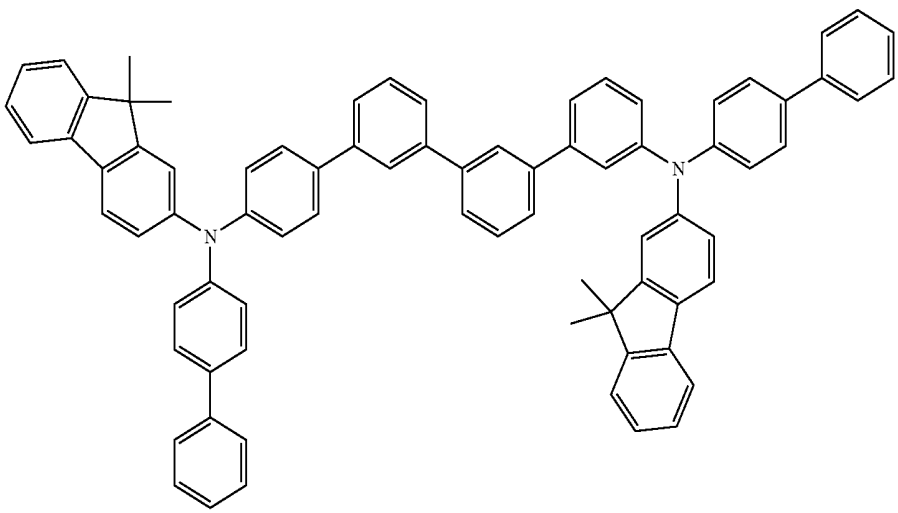


(1-14)



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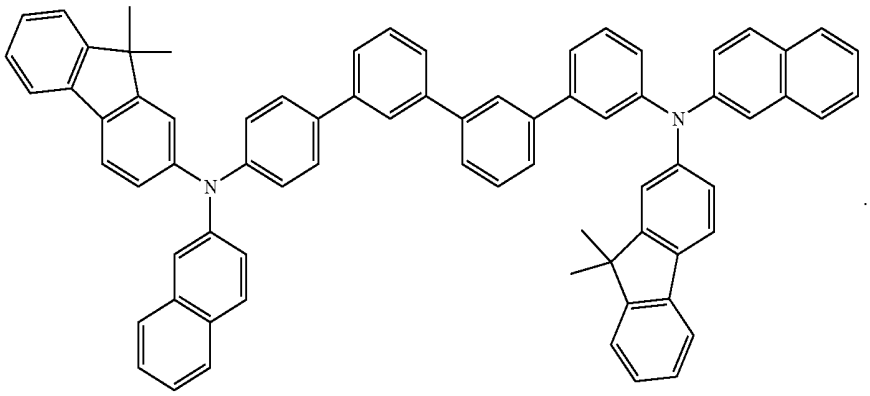
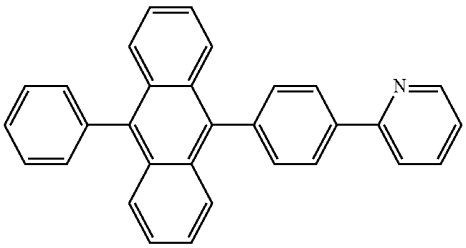
(1-15)

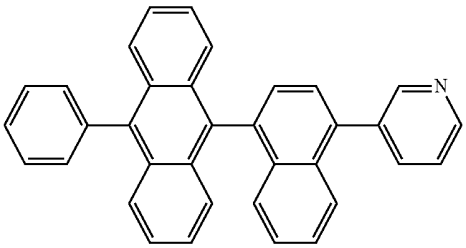


13. The organic light emitting device as claimed in claim 10, wherein the second compound represented by Formula 2 is represented by one of Formula 2-1 to Formula 2-9:

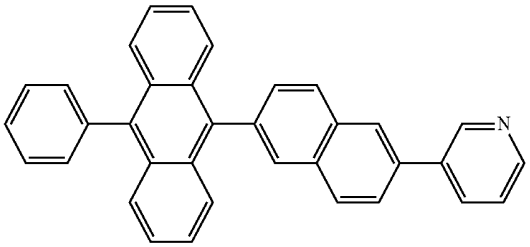
(2-1)



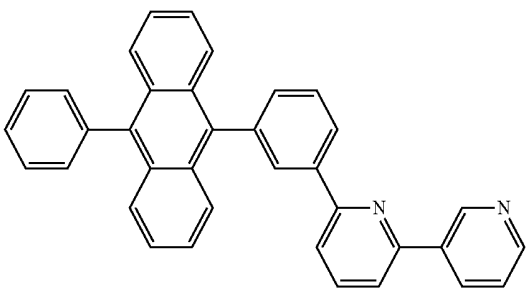
(2-2)



(2-3)



(2-4)



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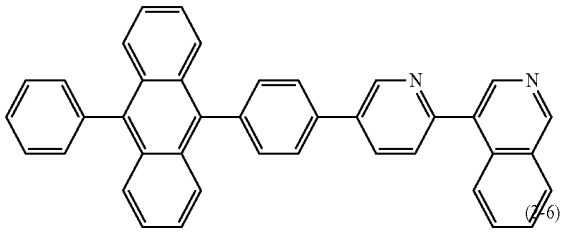
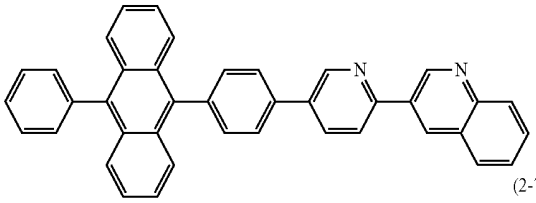
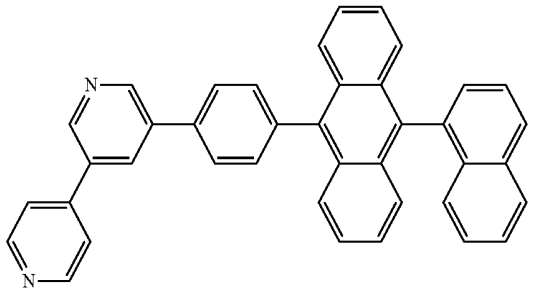
(2-5)



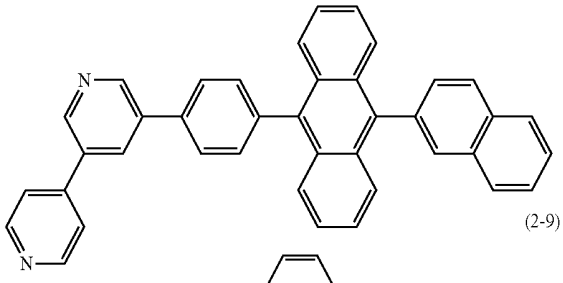
(2-6)



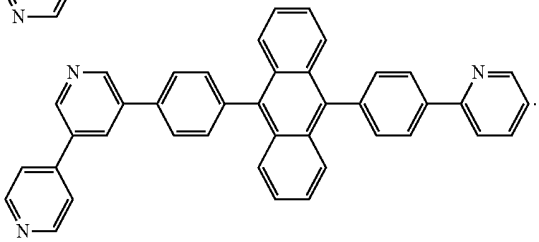
(2-7)



(2-8)



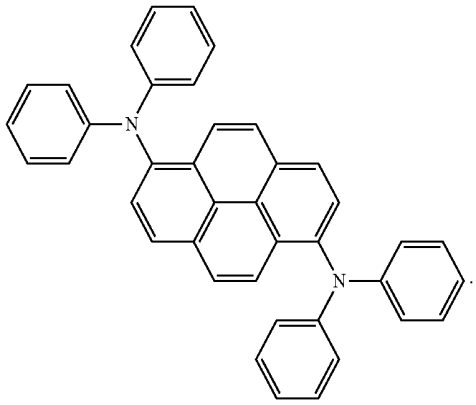
(2-9)



14. The organic light emitting device as claimed in claim **11**, wherein the emission layer includes at least one of tris(8-quinolinolate)aluminum (Alq3), 2-methyl-9,10-di(2-naphthyl)anthracene (MADN), 4,4'-N,N'-dicarbazol-biphenyl (CBP), or poly(n-vinylcarbazole) (PVK).

15. The organic light emitting device as claimed in claim **14**, wherein the emission layer is doped with a third compound represented by the following Formula 3:

[Formula 3]



16. The organic light emitting device as claimed in claim **15**, wherein the third compound is included in the emission layer in an amount of about 5 wt % or less, based on a total weight of the emission layer.

17. The organic light emitting device as claimed in claim **11**, wherein the hole transport layer includes at least one of 4,4",4""-tris[(3-methylphenyl(phenyl)amino)]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDATB), copper phthalocyanine (CuPc), N-phenylcarbazole, polyvinylcarbazole, N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl benzidine (α-NPD), or 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (NPB).

18. The organic light emitting device as claimed in claim **11**, wherein the electron transport layer includes at least one of Alq3, TAZ, Balq, or Bebq2.

* * * * *

专利名称(译)	有机发光二极管和包括其的有机发光显示装置		
公开(公告)号	US9680109	公开(公告)日	2017-06-13
申请号	US14/743690	申请日	2015-06-18
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	LEE JUNG SUB KIM SEUL ONG KIM YOUN SUN SHIN DONG WOO ITO NAOYUKI		
发明人	LEE, JUNG SUB KIM, SEUL ONG KIM, YOUN SUN SHIN, DONG WOO ITO, NAOYUKI		
IPC分类号	H01L51/50 H01L51/00		
CPC分类号	H01L51/0059 H01L51/006 H01L51/0052 H01L51/0058 H01L51/0067 H01L51/0054 H01L51/0081 H01L51/5096 H01L2227/323		
审查员(译)	CLARK，GREGORY		
优先权	1020140107647 2014-08-19 KR		
其他公开文献	US20160056386A1		
外部链接	Espacenet USPTO		

摘要(译)

有机发光二极管和有机发光器件，所述有机发光二极管包括由下式1表示的第一化合物;和由下式2表示的第二化合物，