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(54) ORGANIC LIGHT-EMITTING DEVICE INCLUDING FLUORINE-CONTAINING COMPOUND AND CARBON-BASED COMPOUND

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(57) **ABSTRACT**

An organic light-emitting device includes a substrate; a first electrode disposed on the substrate; a hole transport layer disposed on the first electrode; an emitting layer disposed on the hole transport layer; and a second electrode disposed on the emitting layer, wherein an organic layer is interposed between the first electrode and the hole transport layer, the organic layer including at least one fluorine-containing compound selected from the group consisting of a fluorine-substituted phthalocyanine derivative, an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF2_x, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, where y is an integer of 1 to 80, n is an integer of 0 to 80, and 6y−2n is a positive integer, and fluorinated fullerene. The organic light-emitting device can show high efficiency, a low driving voltage, high brightness, and a long lifetime.

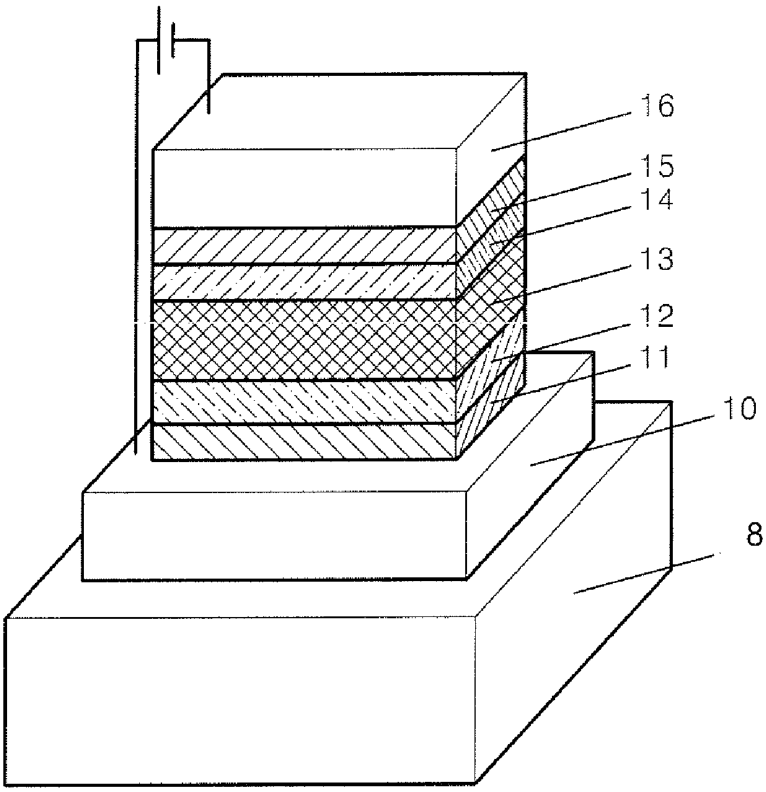


FIG. 1

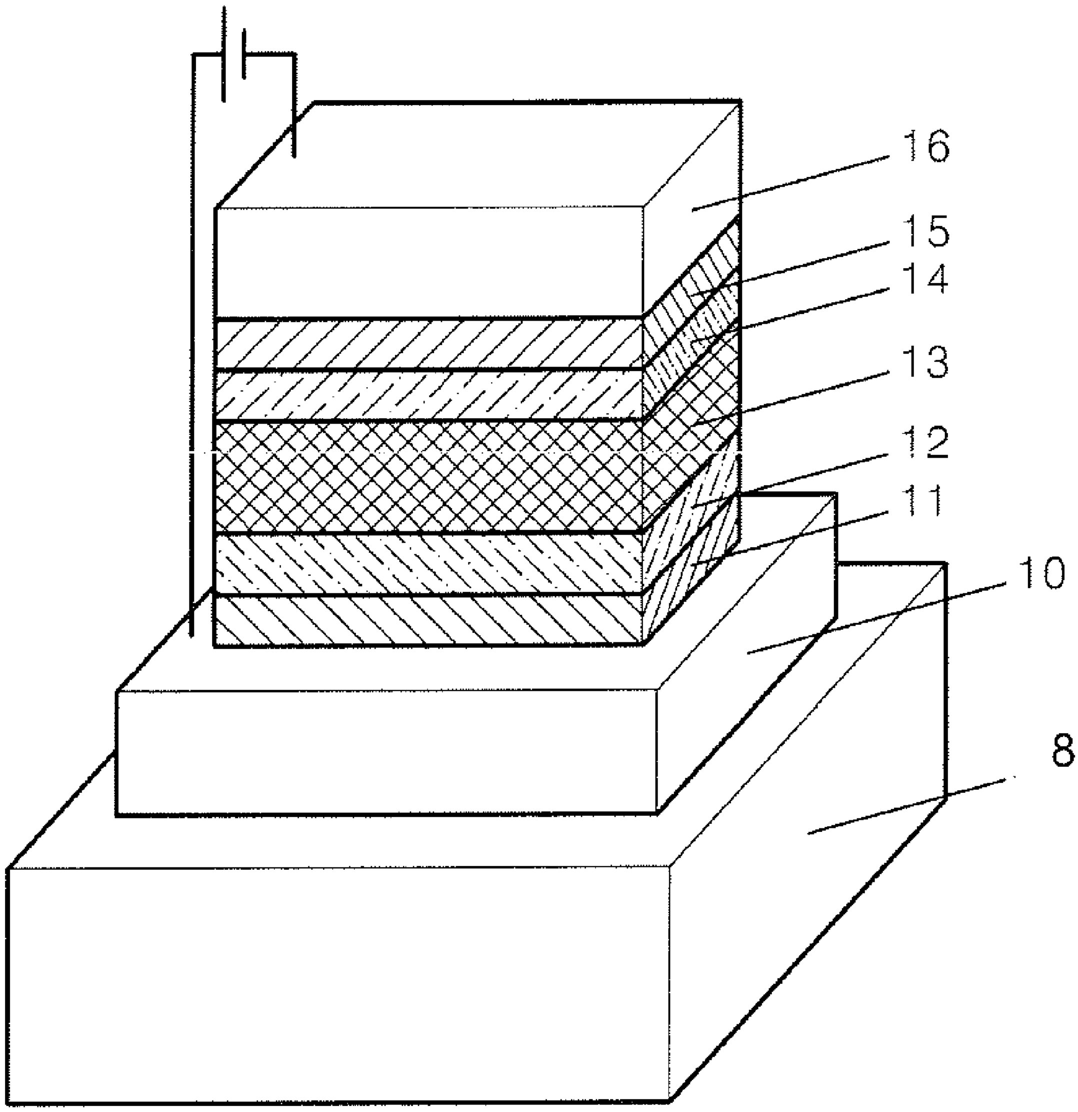


FIG. 2

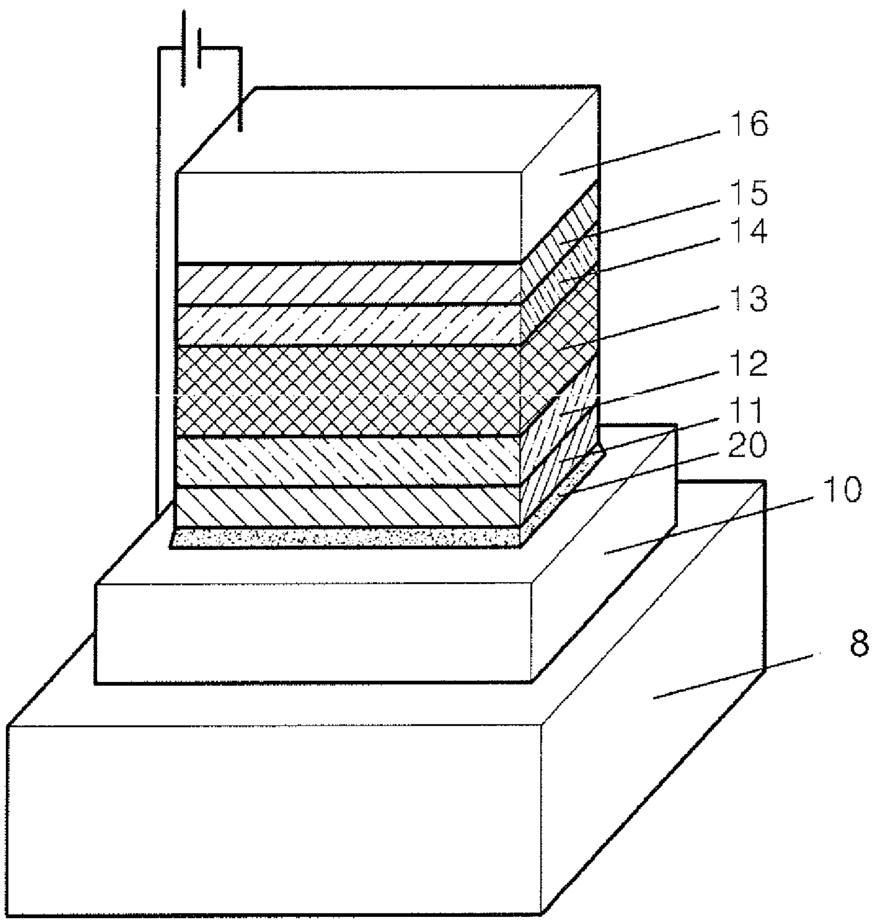
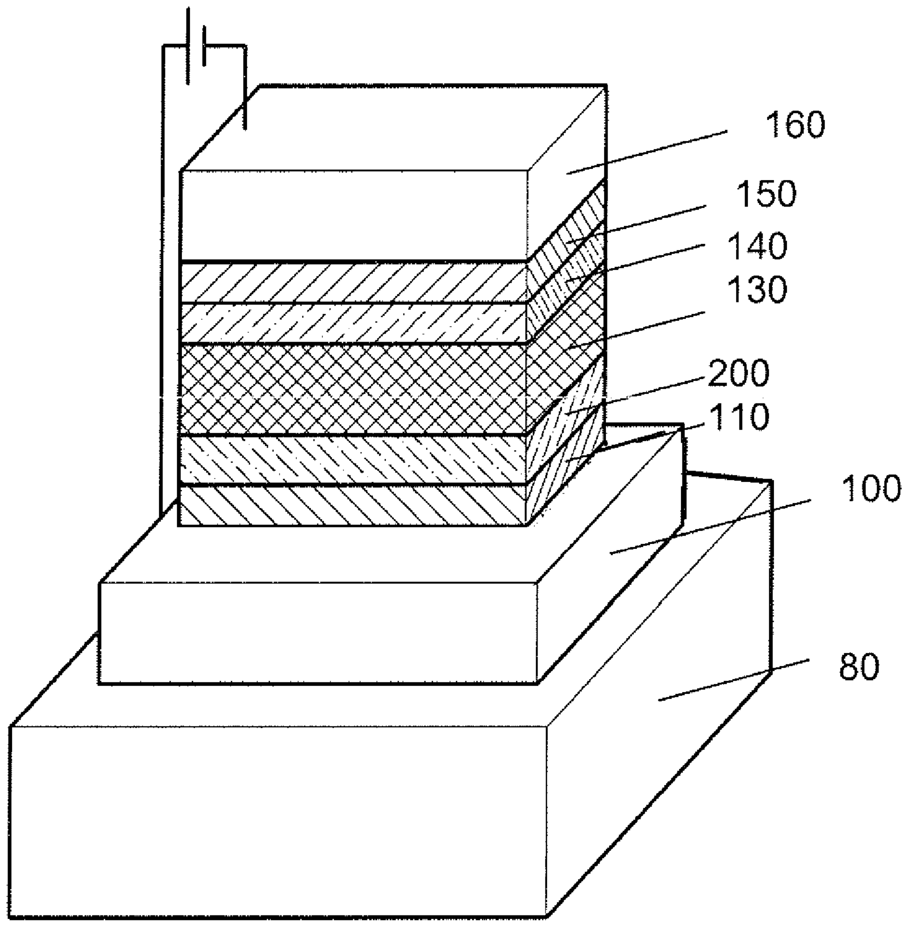


FIG. 3



ORGANIC LIGHT-EMITTING DEVICE INCLUDING FLUORINE-CONTAINING COMPOUND AND CARBON-BASED COMPOUND

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Application No. 2007-7627, filed Jan. 24, 2007, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] Aspects of the present invention relate to an organic light-emitting device, and more particularly, to an organic light-emitting device with improved brightness, lifetime, and power consumption characteristics.

[0004] 2. Description of the Related Art

[0005] Organic light-emitting devices are devices that emit light by recombination of electrons and holes in an organic layer interposed between two electrodes when a current is supplied to the organic layer. A typical organic light-emitting device is illustrated in FIG. **1**. Organic light-emitting devices have advantages such as high image quality, a rapid response speed, and a wide viewing angle, and thus, can embody light-weight and thin information display apparatuses. By virtue of such advantages, the organic light-emitting device technology has started to grow rapidly. Recently, the application field of organic light-emitting devices has expanded beyond mobile phones to other high-quality information display apparatuses.

[0006] With the rapid development of organic light-emitting devices, organic light-emitting devices should inevitably compete with other information display devices, such as TFT-LCDs, in terms of science and industrial applications. Conventional display devices are now facing technical limitations in terms of efficiency, lifetime, and power consumption of the devices that significantly affect the quantitative and qualitative growth of the devices.

SUMMARY OF THE INVENTION

[0007] Aspects of the present invention provide an organic light-emitting device capable of enhancing lifetime, brightness, and power consumption efficiency.

[0008] According to an aspect of the present invention, there is provided an organic light-emitting device including: a substrate; a first electrode disposed on the substrate; a hole transport layer disposed on the first electrode; an emitting layer disposed on the hole transport layer; and a second electrode disposed on the emitting layer, wherein an organic layer is interposed between the first electrode and the hole transport layer, the organic layer including at least one fluorine-containing compound selected from the group consisting of a fluorine-substituted phthalocyanine derivative, an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, where y is an integer of 1 to 80, n is an integer of 0 to 80 and 6y−2n is a positive integer, and a fluorinated fullerene.

[0009] According to another aspect of the present invention, there is provided an organic light-emitting device including: a substrate; a first electrode disposed on the substrate; a hole injection layer disposed on the first electrode; an emitting layer disposed on the hole injection layer; and a second electrode disposed on the emitting layer, wherein an organic layer is interposed between the hole injection layer and the emitting layer, the organic layer including at least one fluorine-containing compound selected from the group consisting of a fluorine-substituted phthalocyanine derivative, an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, where y is an integer of 1 to 80, n is an integer of 0 to 80 and 6y−2n is a positive integer, and fluorinated fullerene.

[0010] A buffer layer made of a carbon-based compound may be further disposed on at least one surface of the organic layer that includes the fluorine-containing compound.

[0011] Organic light-emitting devices according to aspects of the present invention can show high efficiency, a low driving voltage, high brightness, and a long lifetime.

[0012] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

[0014] FIG. **1** is a schematic view illustrating a conventional organic light-emitting device;

[0015] FIG. **2** is a schematic view illustrating an organic light-emitting device according to an example embodiment of the present invention; and

[0016] FIG. **3** is a schematic view illustrating an organic light-emitting device according to another example embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0017] Reference will now be made in detail to the present embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0018] According to aspects of the present invention, in order to adjust an interface between layers constituting an organic light-emitting device, a thin film including a fluorine-containing compound is interposed between an anode and a hole injection layer (or a hole transport layer) to thereby produce an organic light-emitting device with a low power consumption together with a drop in the driving voltage.

[0019] Aspects of the present invention provide an organic light-emitting device including: a substrate; a first electrode disposed on the substrate; a hole transport layer disposed on the first electrode; an emitting layer disposed on the hole transport layer; and a second electrode disposed on the emitting layer, wherein an organic layer is interposed between the first electrode and the hole transport layer, the organic layer including at least one fluorine-containing compound selected from the group consisting of a fluorine-substituted phthalocyanine derivative, an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, where y is an integer of 1 to 80, n is an integer of 0 to 80 and 6y−2n is a positive integer, and a fluorinated fullerene.

[0020] Herein, in general, when it is mentioned that one layer or material is formed on or disposed on a second layer or a second material, it is to be understood that the terms "formed on" and "disposed on" are not limited to the one layer being formed directly on the second layer, but may include instances wherein there is an intervening layer or material between the one layer and the second layer. Likewise, when it is mention that a third layer is interposed between a first and second layer, it is to be understood that other layers may be present between the one layer and the second layer.

[0021] The fluorine-substituted phthalocyanine derivative is divalent metal phthalocyanate containing a central metal such as Cr, Fe, Co, Ni, Cu, or Zn, and which is substituted by at least one fluorine. As a non-limiting example, the central metal may be copper.

[0022] The aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x} may be C_4F_{10}, C_5F_{12}, C_6F_{14}, C_7F_{16}, C_3F_4, C_4F_6, C_2F_4, C_3F_6, C_4F_8, C_5F_{10}, C_6F_{12}, C_7F_{14}, or the like. The aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$ may be C_6F_6, $C_{12}F_{10}$, $C_{18}F_{14}$, $C_{24}F_{18}$, $C_{42}F_{30}$, or the like. For example, the aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$ may be a compound wherein n=y−1.

[0023] The fluorinated fullerene is a fullerene-based compound containing at least one fluorine. Fullerene, which is also called "bucky ball", is formed through the binding of carbons that are separated from a surface of a graphite target when strong laser is irradiated onto the graphite target in a vacuum system. That is, fullerene is a carbon allotrope, and preferably, may be a carbon material having 20-500 carbon atoms. A representative example of a fullerene molecule is C60 which is made up of 60 carbon atoms. In addition, there are C70, C76, C84, etc. A reaction between a fullerene molecule and a fluorine atom produces fluorinated fullerene, e.g., $C_{60}F_{41}$, $C_{60}F_{42}$, $C_{60}F_{43}$, $C_{60}F_{48}$, or $C_{74}F_{38}$. As a non-limiting example, $C_{60}F_{42}$ may be used herein as the fluorinated fullerene.

[0024] As a non-limiting example, the organic light-emitting device according to aspects of the present invention may further include a buffer layer made of a carbon-based compound. The buffer layer may be disposed on a surface or on both surfaces of the organic layer that includes the fluorine-containing compound.

[0025] As a non-limiting example, the carbon-based compound may be at least one selected from the group consisting of fullerene, a metal-containing fullerene-based complex, a carbon nanotube, a carbon fiber, a carbon black, graphite, carbine, MgC60, CaC60, and SrC60.

[0026] The carbon-based compound is not particularly limited, but may include a metal-containing carbon-based compound (i.e., carbon complex) that is a carbon allotrope, and at the same time, a carbon material having 20-500 carbon atoms. As used herein, the carbon-based compound is at least one selected from the group consisting of fullerene, a metal-containing fullerene-based complex, a carbon nanotube, a carbon fiber, a carbon black, graphite, carbine, MgC60, CaC60, and SrC60. As a non-limiting example, the carbon-based compound may be a fullerene.

[0027] As described above, according to aspects of the present invention, when the buffer layer made of the carbon-based compound is disposed on the organic layer that includes the fluorine-containing compound, a driving voltage can be further lowered, thereby improving efficiency and lifetime characteristics.

[0028] The organic light-emitting device according to aspects of the present invention may further include a hole injection layer on the organic layer or on the buffer layer, if present.

[0029] The organic light-emitting device according to aspects of the present invention may further include at least one selected from a hole blocking layer, an electron injection layer, and an electron transport layer between the emitting layer and the second electrode.

[0030] Aspects of the present invention also provide an organic light-emitting device including: a substrate; a first electrode disposed on the substrate; a hole injection layer disposed on the first electrode; an emitting layer disposed on the hole injection layer; and a second electrode disposed on the emitting layer, wherein an organic layer is interposed between the hole injection layer and the emitting layer, the organic layer including at least one fluorine-containing compound selected from the group consisting of a fluorine-substituted phthalocyanine derivative, an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, y is an integer of 1 to 80, and n is an integer of 0 to 80, and a fluorinated fullerene.

[0031] The organic light-emitting device includes a hole injection layer, unlike the above-described organic light-emitting device.

[0032] The organic light-emitting device according to the present invention may further include a hole transport layer on the hole injection layer, the organic layer, or a buffer layer that may be further disposed on the organic layer.

[0033] The fluorine-substituted phthalocyanine derivative, the aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, the aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$ (x is an integer of 1 to 500, y is an integer of 1 to 80, and n is an integer of 0 to 80), and the fluorinated fullerene are as described above.

[0034] As a non-limiting example, the organic light-emitting device according to aspects of the present invention may further include a buffer layer including a carbon-based compound on a surface or both surfaces of the organic layer including the fluorine-containing compound.

[0035] The carbon-based compound may be a carbon-based compound as described with respect to the buffer layer in the embodiment discussed above.

[0036] The organic light-emitting device according to aspects of the present invention may further include a hole transport layer on the organic layer or on the buffer layer, if present.

[0037] The organic light-emitting device according to aspects of the present invention may further include at least one selected from a hole blocking layer, an electron injection layer, and an electron transport layer between the emitting layer and the second electrode.

[0038] An organic layer included in an organic light-emitting device according to aspects of the present invention includes a fluorine-containing compound, thereby improving the deposition and interface characteristics of layers constituting the organic light-emitting device. As described above, an organic layer including a fluorine-containing compound resists morphological changes in a thin film state, and the fluorine-containing compound does not affect the color coordinates characteristics of an organic light-emitting device. At this time, when changing an interfacial energy band gap between indium tin oxide (ITO) used in an anode and a hole injection layer or a hole transport layer, the injection of holes from ITO into the organic layer can be further facilitated, thereby lowering a driving voltage. Moreover, the organic layer including the fluorine-containing compound can serve as a stable buffer layer at an interface between ITO used in the anode and the hole injection layer, thereby increasing the lifetime of an organic light-emitting device.

[0039] An organic light-emitting device according to aspects of the present invention includes an organic layer including a fluorine-containing compound, and may further include a buffer layer including a carbon-based compound. Still further, in order to further adjust the interfacial characteristics of layers constituting an organic light-emitting device according to aspects of the present invention, at least one selected from a hole injection layer, a hole transport layer, an emitting layer, a hole blocking layer, an electron transport layer, and an electron injection layer may be doped with a carbon-based compound such as fullerene. Here, the carbon-based compound is as described above with respect to the carbon-based compound used in the buffer layer.

[0040] The content of the carbon-based compound may be 0.005 to 99.95 parts by weight based on the total weight (100 parts by weight) of each of the hole injection layer, the hole transport layer, the emitting layer, the hole blocking layer, the electron transport layer, and the electron injection layer. If the content of the carbon-based compound is outside the range, an organic light-emitting device may have unsatisfactory characteristics.

[0041] In an organic light-emitting device according to aspects of the present invention, an organic layer including a fluorine-containing compound may be formed by a method such as deposition, Langmuir Blodgett (LB) method, e-beam, sputtering, or spin-coating, as non-limiting examples. The thickness of the organic layer may be 1 to 500 Å. If the thickness of the organic layer is less than 1 Å, it may be difficult to control the thickness and to reproduce film characteristics. On the other hand, if the thickness of the organic layer exceeds 500 Å, a driving voltage may be increased.

[0042] In an organic light-emitting device according to aspects of the present invention, a buffer layer including a carbon-based compound may be formed by a method such as deposition, as a non-limiting example. The thickness of the buffer layer may be 20 to 100 Å. As a non-limiting example, the thickness of the buffer layer may be 20 to 30 Å. If the thickness of the buffer layer is less than 20 Å, an improvement in characteristics of an organic light-emitting device may be insignificant. On the other hand, if the thickness of the buffer layer exceeds 100 Å, the characteristics of an organic light-emitting device, e.g., lifetime, contrast, or pixel short (in a PM type) may be improved, but a further reduction in driving voltage may not be achieved or a voltage gain width may be reduced.

[0043] FIG. **1** illustrates a conventional organic light-emitting device. Referring to FIG. **1**, a conventional organic light-emitting device includes a substrate **8**, a first electrode **10**, a hole injection layer **11** is on the first electrode **10**, and a hole transport layer **12**, an emitting layer **13**, an electron transport layer **14**, an electron injection layer **15**, and a second electrode **16** sequentially stacked on the hole injection layer **11**.

[0044] FIG. **2** and FIG. **3** are schematic views illustrating organic light-emitting devices according to example embodiments of the present invention. In the organic light-emitting device illustrated in FIG. **2**, an organic light-emitting device according to an example embodiment includes a substrate **8**, a first electrode **10**, a hole injection layer **11** disposed on a first electrode **10** and a hole transport layer **12**, an emitting layer **13**, an electron transport layer **14**, an electron injection layer **15**, and a second electrode **16** sequentially stacked on the hole injection layer **11**. An organic layer **20** including a fluorine-containing compound is interposed between the first electrode **10** and the hole injection layer **11**. A buffer layer (not shown) may be further disposed on the organic layer **20**. The hole injection layer **11** may be omitted.

[0045] Although not shown in FIG. **2**, a hole blocking layer may be further disposed. In addition, it is possible to further form intermediate layers for improving interlayer interfacial characteristics. Moreover, as described above, the hole injection layer **11**, the hole transport layer **12**, the emitting layer **13**, the electron transport layer **14**, or the electron injection layer **15** may be doped with a carbon-based compound.

[0046] Referring to the organic light-emitting device illustrated in FIG. **3**, an organic light-emitting device according to an example embodiment includes a substrate **80**, a first electrode, **100**, a hole injection layer **110** disposed on a first electrode **100** and an emitting layer **130**, an electron transport layer **140**, an electron injection layer **150**, and a second electrode **160** are sequentially stacked on the hole injection layer **110**. An organic layer **200** including a fluorine-containing compound is interposed between the hole injection layer **110** and the emitting layer **130**. A buffer layer (not shown) may be further disposed on the organic layer **20**.

[0047] Hereinafter, a method of manufacturing an organic light-emitting device according to the example embodiments shown in FIGS. **2** and **3** will be described. For the sake of convenience, a method of manufacturing an organic light-emitting device according to an example embodiment of the present invention will be described with reference to FIG. **2**.

[0048] First, a first electrode **10** is patterned on a substrate. Here, the substrate may be a substrate commonly used in organic light-emitting devices. As a non-limiting example, the substrate may be a glass or transparent plastic substrate that is excellent in transparency, surface smoothness, handling property, and water repellency. The thickness of the substrate may be 0.3 to 1.1 mm.

[0049] A material for forming the first electrode **10** may be a conductive metal facilitating hole injection or an oxide of a conductive metal. Non-limiting examples of a material for forming the first electrode include indium tin oxide (ITO), indium zinc oxide (IZO), nickel (Ni), platinum (Pt), gold (Au), or iridium (Ir).

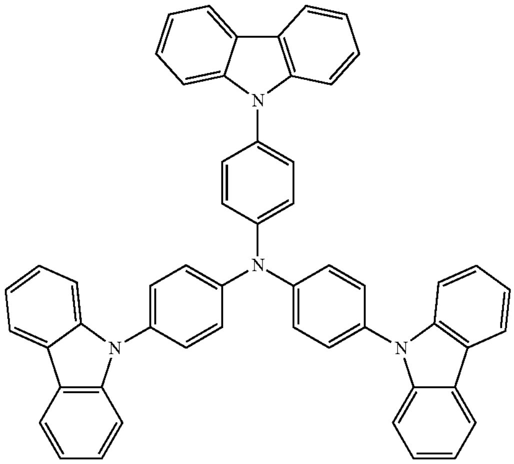
[0050] The substrate on which the first electrode **10** is formed is cleaned and then treated with UV/ozone. At this time, the cleaning may be performed using an organic solvent such as isopropanol (IPA) or acetone.

[0051] After the cleaning, a fluorine-containing compound is deposited on the first electrode **10** to form an organic layer **20** to a thickness of 1 to 500 Å.

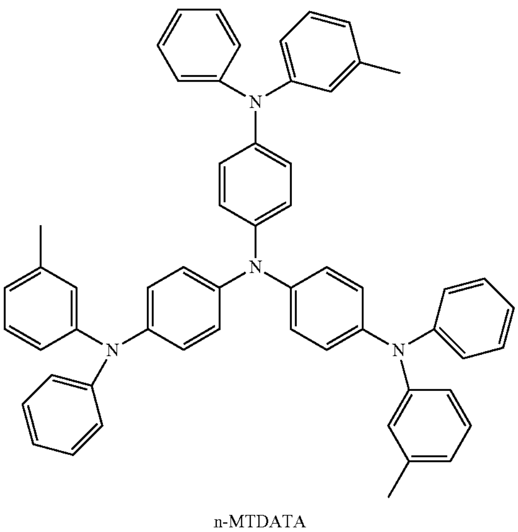
[0052] Next, a hole injection material is applied onto the organic layer **20** using vacuum thermal evaporation or spin coating to form a hole injection layer **11**. As such, when the hole injection layer **11** is formed, a contact resistance between the first electrode **10** and an emitting layer **13** is reduced, and at the same time, hole transport capability of the first electrode **10** toward the emitting layer **13** is enhanced, thereby improving the driving voltage and lifetime characteristics of a device.

[0053] The thickness of the hole injection layer **11** may be 300 to 1500 Å. If the thickness of the hole injection layer **11** is less than 300 Å, the lifetime and reliability of an organic light-emitting device may be lowered. In particular, in a passive matrix (PM) organic light-emitting device, a pixel short may occur. On the other hand, if the thickness of the hole injection layer **11** exceeds 1500 Å, a driving voltage may be increased.

[0054] The hole injection material is not particularly limited and may be copper phthalocyanine (CuPc) or a starburst-type amines such as TCTA, m-MTDATA, or IDE406 (Idemitsu), as non-limiting examples.

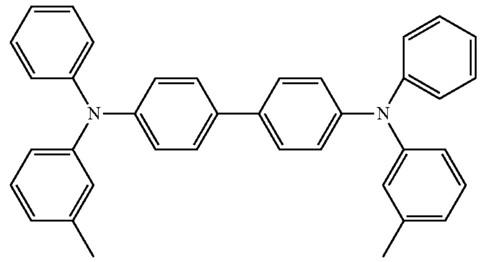


TCTA

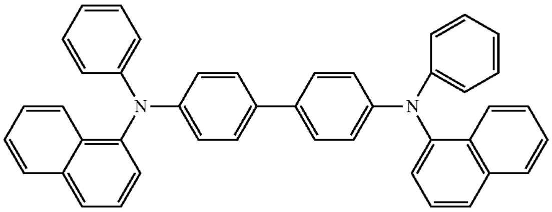


m-MTDATA

[0055] A hole transport material is applied onto the hole injection layer **11** using vacuum thermal evaporation or spin coating to form a hole transport layer **12**. The hole transport material is not particularly limited and may be N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4' diamine (TPD), N,N'-di(naphthalene-1-yl)-N,N'-diphenylbenzidine, N,N'-di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (α-NPD), IDE320 (Idemitsu), or the like. The thickness of the hole transport layer **12** may be 100 to 400 Å. If the thickness of the hole transport layer **12** is less than 100 Å, hole transport capability may be lowered due to insufficient thickness. On the other hand, if the thickness of the hole transport layer **12** exceeds 400 Å, a driving voltage may be increased.



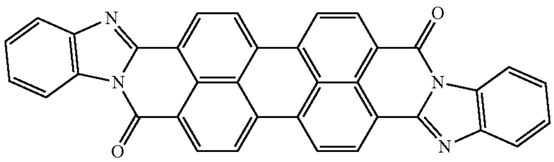
TPD



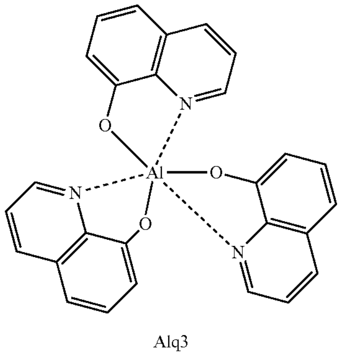
alpha-NPD

[0056] Next, the emitting layer **13** is formed on the hole transport layer **12**.

[0057] An emitting layer material is not particularly limited and thus may be selected from emitting materials commonly known in the art. For example, the emitting layer material may be an aluminum complex (e.g.: Alq3 (tris(8-quinolinolato)-aluminum), BAlq, SAlq, Almq3), a gallium complex (e.g.: Gaq'_2OPiv, Gaq'_2OAc, $2(Gaq'_2)$), a fluorene-based polymer, polyparaphenylene vinylene or its derivative, a biphenyl derivative, a spiropolyfluorene-based polymer, or the like.



Perylene-based compound



Alq3

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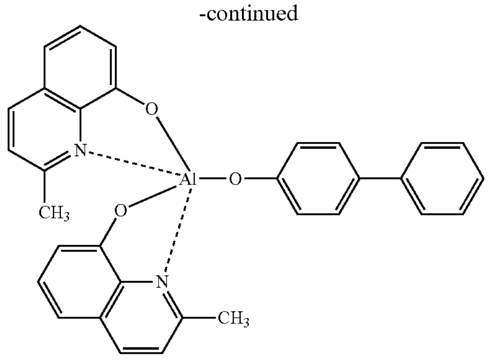
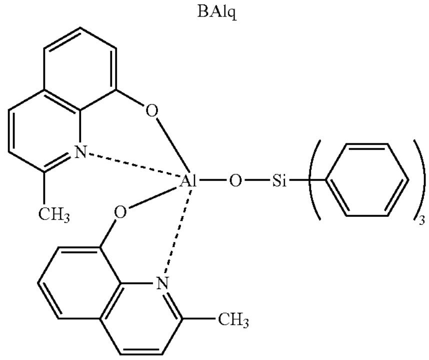
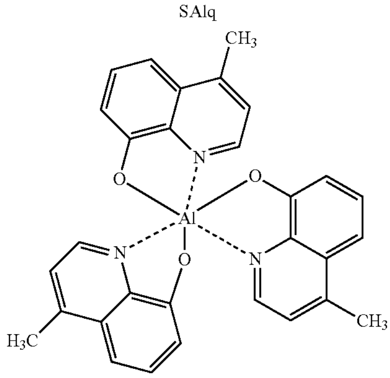


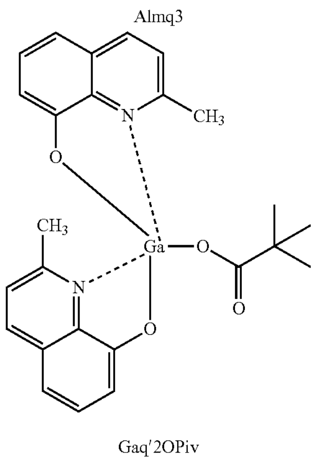
BAlq



SAlq



Almq3



Gaq'2OPiv

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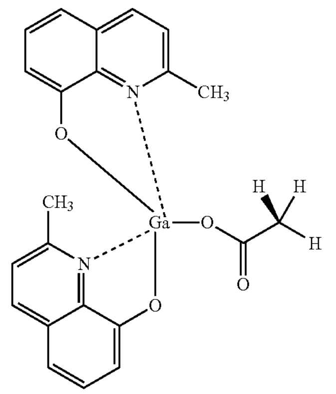
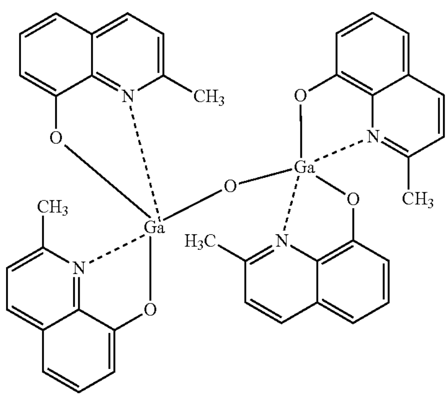


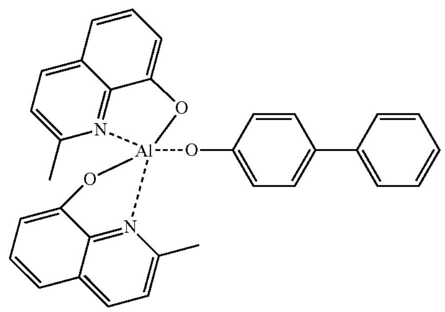
Gaq'2Oac



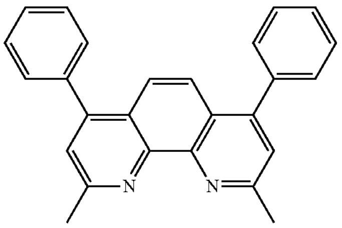
2(Gaq'2)

[0058] The thickness of the emitting layer **13** may be 300 to 500 Å. As a non-limiting example, the thickness of the emitting layer **13** is 150 to 600 Å. As the thickness of the emitting layer **13** increases, a driving voltage increases. In this regard, it is difficult to apply an emitting layer having a thickness more than 600 Å.

[0059] Although not shown in FIG. **2**, a hole blocking layer may be selectively formed on the emitting layer **13** by vacuum deposition or spin coating using a hole blocking material. The hole blocking material is not particularly limited but may be a material having electron transport capability and a higher ionization potential than an emitting compound. Non-limiting examples of the hole blocking material include Balq, BCP, or TPBI. The thickness of the hole blocking layer may be 30 to 70 Å. If the thickness of the hole blocking layer is less than 30 Å, hole blocking characteristics may not be realized efficiently. On the other hand, if the thickness of the hole blocking layer exceeds 70 Å, a driving voltage may be increased.



Balq



BCP

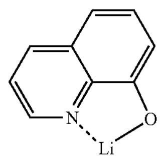
[0060] An electron transport material is applied onto the hole blocking layer, or onto the emitting layer if the hole blocking layer is not present, using vacuum deposition or spin coating to form an electron transport layer **14**. The electron transport material is not particularly limited and may be Alq3.

[0061] According to aspects of the present invention, the organic layer **20** including the fluorine-containing compound and/or a buffer layer including a carbon-based compound are/is interposed between the first electrode **10** and the hole injection layer **11**. The hole injection layer **11**, the hole transport layer **12**, the emitting layer **13**, the electron transport layer **14**, or an electron injection layer **15** may be doped with a carbon-based compound.

[0062] That is, the organic layer **20** including the fluorine-containing compound and/or the buffer layer including the carbon-based compound are/is interposed between the first electrode **10** and the hole injection layer **11**, and when forming at least one of the hole injection layer **11**, the hole transport layer **12**, the emitting layer **13**, the electron transport layer **14**, and the electron injection layer **15**, a carbon-based compound may be co-deposited with a hole injection material, a hole transport material, or the like, using vacuum thermal evaporation. Here, the content of the carbon-based compound may be 0.005 to 99.95 parts by weight based on the total weight (100 parts by weight) of each of the hole injection layer **11**, the hole transport layer **12**, the emitting layer **13**, the electron transport layer **14**, and the electron injection layer **15**. If the content of the carbon-based compound is less than 0.005 parts by weight, the characteristics of an organic light-emitting device may not be improved significantly.

[0063] The thickness of the electron transport layer **14** may be 150 to 600 Å. If the thickness of the electron transport layer **14** is less than 150 Å, electron transport capability may be lowered. On the other hand, if the thickness of the electron transport layer **14** exceeds 600 Å, a driving voltage may be increased.

[0064] The electron injection layer **15** is formed on the electron transport layer **14**. A material for forming the electron injection layer **15** may be LiF, NaCl, CsF, Li_2O, BaO, Liq, or the like. The thickness of the electron injection layer **15** may be 5 to 20 Å. If the thickness of the electron injection layer **15** is less than 5 Å, a function as an electron injection layer may not be performed. On the other hand, if the thickness of the electron injection layer **15** exceeds 20 Å, a driving voltage may be increased.



Liq

[0065] Next, a cathode metal is thermally vacuum-deposited on the electron injection layer **15** to form a second electrode **16**, thereby completing the manufacture of an organic light-emitting device.

[0066] The cathode metal may be lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), magnesium-silver (Mg—Ag), or the like.

[0067] An organic light-emitting device according to aspects of the present invention may further include one or two intermediate layers between the anode, the hole injection layer, the hole transport layer, the emitting layer, the electron transport layer, the electron injection layer, and the cathode, when needed. In addition, when needed, an electron blocking layer may also be formed.

[0068] Hereinafter, aspects of the present invention will be described more specifically with reference to the following working examples. However, the following working examples are for illustrative purposes only and are not intended to limit the scope of the invention.

Comparative Example

[0069] A 15 Ω/cm^2 ITO glass substrate (Corning, 1,200 Å) was cut into pieces of 50 mm×50 mm×0.7 mm in size, followed by ultrasonic cleaning in isopropyl alcohol and pure water (5 minutes for each), UV/ozone cleaning (30 minutes), and then plasma treatment under vacuum of 0.1 mtorr or less (9 minutes) to thereby form anodes. Then, m-MTDATA was vacuum-deposited on the anodes to form hole injection layers with a thickness of about 600 Å.

[0070] A green light-emitting material was thermally vacuum-deposited to a thickness of about 350 Å on the hole transport layers to form green light-emitting layers. Then, an electron transport material, Alq3 was deposited on the green light-emitting layers to form electron transport layers with a thickness of about 250 Å.

[0071] LiF (electron injection layers) and Al (cathodes) were sequentially thermally vacuum-deposited to thicknesses of about 10 Å and about 800 Å, respectively, on the electron transport layers to form LiF/Al electrodes, thereby completing organic green light-emitting devices as illustrated in FIG. **1**.

Example

[0072] Organic light-emitting devices as illustrated in FIG. **2** were manufactured in the same manner as in the Comparative Example except that a fluorine-containing compound, F16CuPc, was deposited on the anodes to form organic layers before the m-MTDATA was deposited to form the hole injection layers.

[0073] The characteristics (efficiency, driving voltage) of the organic light-emitting devices including the organic layers with thicknesses of 5 Å and 10 Å (hereinafter, referred to as "samples 1 and 2", respectively) were evaluated.

Evaluation Example

[0074] The brightness and driving voltage of the organic light-emitting devices were evaluated using a BM-5A (TOPCON) photometer and a 238 HIGH CURRENT SOURCE MEASURE UNIT (KEITHLEY). For each of the organic light-emitting devices manufactured in Comparative Example and Example, direct current (DC) was applied at intervals of 10 mA/cm^2 from 10 mA/cm^2 until the current reached 100 mA/cm^2 to thereby obtain nine or more different data values. The DC-based initial characteristics of the organic light-emitting devices are presented in Table 1 below.

TABLE 1

	Comparative Example	Sample 1	Sample 2
ITO (ohm)	15	15	15
Driving voltage (V)	8.4	6.8	7.0
Efficiency (cd/A)	9.0	9.3	9.2

* Initial characteristics: evaluation at DC 100 mA/cm^2

[0075] Referring to Table 1, the organic light-emitting devices according to the embodiments of the present invention exhibited a driving voltage that was reduced to 75% or less of the driving voltage of the conventional organic light-emitting devices, without affecting the color coordinates.

[0076] That is, a driving voltage of the organic light-emitting devices according to the present invention was lowered 1V or more relative to that of the conventional organic light-emitting devices.

[0077] An organic light-emitting device according to aspects of the present invention can show high efficiency, a low driving voltage, high brightness, and a long lifetime.

[0078] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the and their equivalents.

1. An organic light-emitting device comprising:

a substrate;

a first electrode disposed on the substrate;

a hole transport layer disposed on the first electrode;

an emitting layer disposed on the hole transport layer; and

a second electrode disposed on the emitting layer,

wherein an organic layer is interposed between the first electrode and the hole transport layer, the organic layer comprising at least one fluorine-containing compound selected from the group consisting of an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, where y is an integer of 1 to 80, n is an integer of 0 to 80 and 6y−2n is a positive integer, and a fluorinated fullerene.

2. The organic light-emitting device of claim **1**, further comprising a buffer layer made of a carbon-based compound disposed on at least one surface of the organic layer.

3. The organic light-emitting device of claim **1** further comprising a hole injection layer disposed on the organic layer.

4. The organic light-emitting device of claim **2**, further comprising a hole injection layer disposed on the buffer layer.

5. The organic light-emitting device of claim **3**, further comprising at least one selected from a hole blocking layer, an electron injection layer, and an electron transport layer, disposed between the emitting layer and the second electrode.

6. The organic light-emitting device of claim **1**, wherein the thickness of the organic layer is 1 to 500 Å.

7. The organic light-emitting device of claim **2**, wherein the thickness of the buffer layer is 20 to 100 Å.

8. (canceled)

9. The organic light-emitting device of claim **1**, wherein the fluorine-containing compound is an aliphatic fluorocarbon compound represented by C_4F_{10}, C_5F_{12}, C_6F_{14}, C_7F_{16}, C_3F_4, C_4F_6, C_2F_4, C_3F_6, C_4F_8, C_5F_{10}, C_6F_{12}, or C_7F_{14}.

10. The organic light-emitting device of claim **1**, wherein the fluorine-containing compound is aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, wherein y is an integer of 1 to 80, and n is an integer of 0 to 80, and n=y−1.

11. The organic light-emitting device of claim **1**, wherein the fluorine-containing compound is aromatic fluorocarbon compound represented by C_6F_6, $C_{12}F_{10}$, $C_{18}F_{14}$, $C_{24}F_{18}$, or $C_{42}F_{30}$.

12. The organic light-emitting device of claim **1**, wherein the fluorine-containing compound is a fluorinated fullerene represented by $C_{60}F_{41}$, $C_{60}F_{42}$, $C_{60}F_{43}$, $C_{60}F_{48}$, or $C_{74}F_{38}$.

13. (canceled)

14. The organic light-emitting device of claim **2**, wherein the carbon-based compound is at least one selected from the group consisting of fullerene, a metal-containing fullerene-based complex, carbon nanotube, carbon fiber, carbon black, graphite, carbine, MgC60, CaC60, and SrC60.

15. The organic light-emitting device of claim **1**, wherein at least one selected from the group consisting of the hole transport layer and the emitting layer, comprises a carbon-based compound.

16. The organic light-emitting device of claim **5**, wherein at east one selected from the group consisting of the hole injection layer, the hole transport layer, the emitting layer, the hole blocking layer, the electron transport layer, and the electron injection layer comprises a carbon-based compound.

17. The organic light-emitting device of claim **16**, wherein the content of the carbon-based compound is 0.005 to 99.95 parts by weight based on 100 parts by weight of each of the hole injection layer, the hole transport layer, the emitting layer, the hole blocking layer, the electron transport layer, and the electron injection layer.

18. An organic light-emitting device comprising:

a substrate;

a first electrode disposed on the substrate;

a hole injection layer disposed on the first electrode;

an emitting layer disposed on the hole injection layer; and

a second electrode disposed on the emitting layer,

wherein an organic layer is interposed between the hole injection layer and the emitting layer, the organic layer comprising at least one fluorine-containing compound selected from the group consisting of an aliphatic fluorocarbon compound represented by $C_xF_{(2x+2)}$, $C_xF_{(2x-2)}$, or C_xF_{2x}, where x is an integer of 1 to 500, an aromatic fluorocarbon compound represented by $C_{6y}F_{6y-2n}$, where y is an integer of 1 to 80, n is an integer of 0 to 80 and 6y−2n is a positive integer, and a fluorinated fullerene.

19. (canceled)

20. The organic light-emitting device of claim **18**, further comprising a buffer layer made of a carbon-based compound disposed on at least one surface of the organic layer.

21. (canceled)

22. The organic light-emitting device of claim **20**, further comprising a hole transport layer disposed on the buffer layer.

23. The organic light-emitting device of claim **21**, further comprising at least one selected from a hole blocking layer, an electron injection layer, and an electron transport layer, between the emitting layer and the second electrode.

24. (canceled)

25. (canceled)

26. The organic light-emitting device of claim **25**, wherein the content of the carbon-based compound is 0.005 to 99.95 parts by weight based on 100 parts by weight of each of the hole injection layer, the hole transport layer, the emitting layer, the hole blocking layer, the electron transport layer, and the electron injection layer.

* * * * *

patsnap

专利名称(译)	有机发光装置包括含氟化合物和碳基化合物		
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申请(专利权)人(译)	三星移动显示器有限公司.		
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摘要(译)

有机发光装置包括基板;第一电极设置在基板上;空穴传输层，设置在第一电极上;发光层，设置在空穴传输层上;和设置在发光层上的第二电极，其中有机层插入在第一电极和空穴传输层之间，有机层包括至少一种选自氟取代的酞菁衍生物的含氟化合物，由CxF（2x＋2），CxF（2x-2）或CxF2x表示的脂族碳氟化合物，其中x是1至500的整数，由C 6 F 6 y-2 n表示的芳族碳氟化合物，其中y是1的整数对于80，n是0至80的整数，并且6y-2n是正整数，并且是氟化富勒烯。有机发光器件可以显示出高效率，低驱动电压，高亮度和长寿命。