US 20060188746A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0188746 A1**

Iou (43) **Pub. Date: Aug. 24, 2006**

(54) **ORGANIC ELECTROLUMINESCENT DEVICES AND DISPLAY UTILIZING THE SAME**

(75) Inventor: **Chung-Yeh Iou**, Wuci Township (TW)

Correspondence Address:
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948 (US)

(73) Assignee: **AU Optronics Corp.**

(21) Appl. No.: **11/285,563**

(22) Filed: **Nov. 21, 2005**

(30) **Foreign Application Priority Data**

Feb. 23, 2005 (TW)..... 94105399

Publication Classification

(51) **Int. Cl.**
H01L 51/54 (2006.01)
H01L 51/52 (2006.01)
H05B 33/14 (2006.01)

(52) **U.S. Cl.** **428/690**; 428/917; 428/212; 313/504; 313/506; 257/101; 257/E51

(57) **ABSTRACT**

An organic electroluminescent device (OELD) comprises a substrate, an first electrode, a second electrode opposite to the first electrode disposed over the substrate, a hole-transport layer disposed between the first electrode and the second electrode, an electron-transport layer disposed between the second electrode and the hole-transport layer, and an emissive layer disposed between the hole-transport layer and the electron-transport layer. The emissive layer comprises a plurality of sub-layers. One or more dopants dispersed gradually in the plurality of sub-layers having the substantially identical host material.

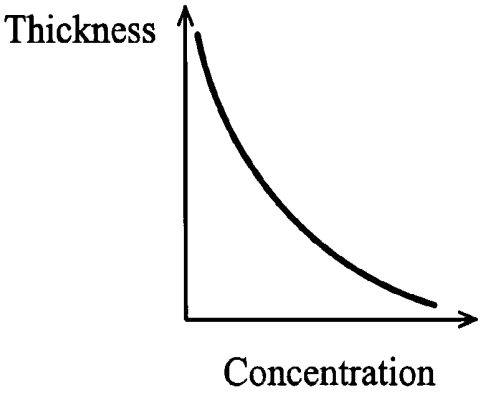

FIG. 1

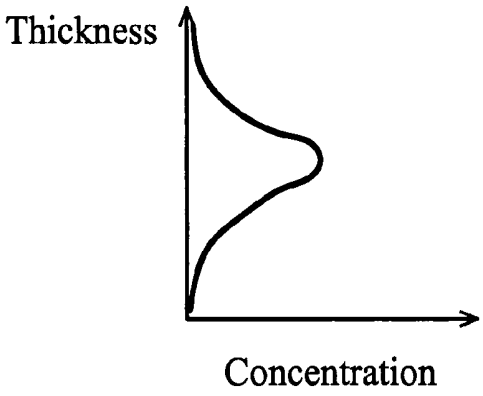

FIG. 2

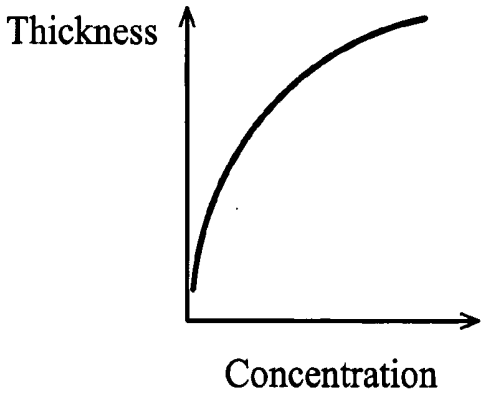

FIG. 3

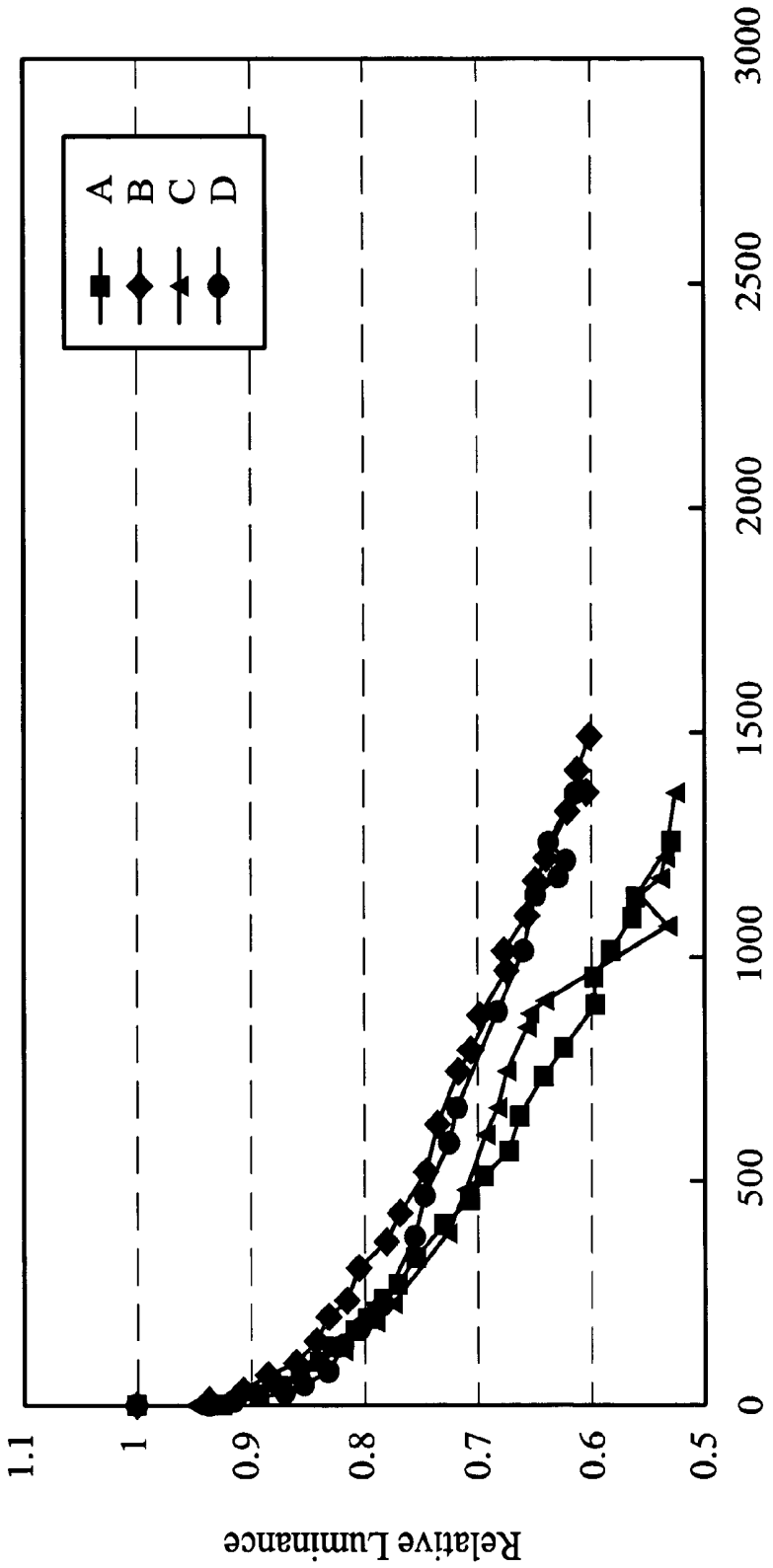
A
B
C
D
1.1
1
0.9
0.8
0.7
0.6
0.5
Relative Luminance
0
500
1000
1500
2000
2500
3000
Operation Time

FIG. 4

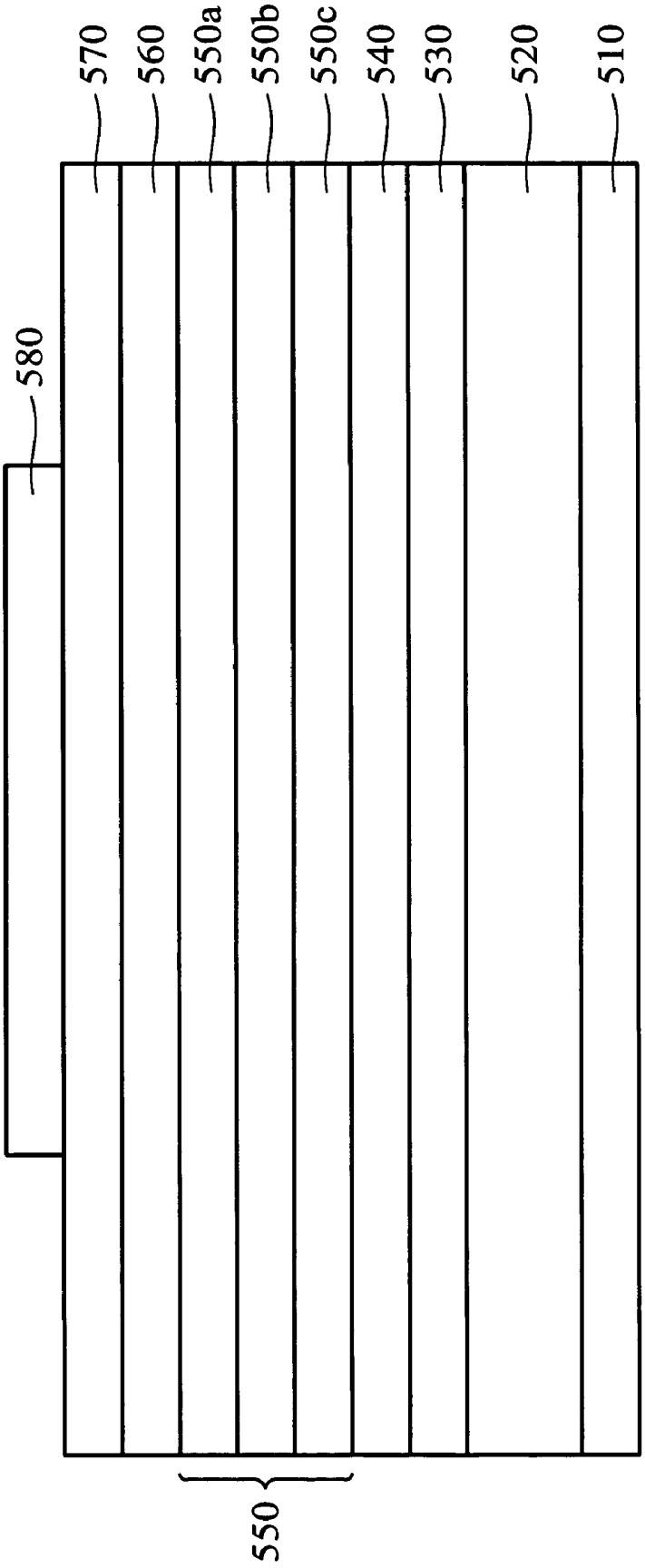

FIG. 5

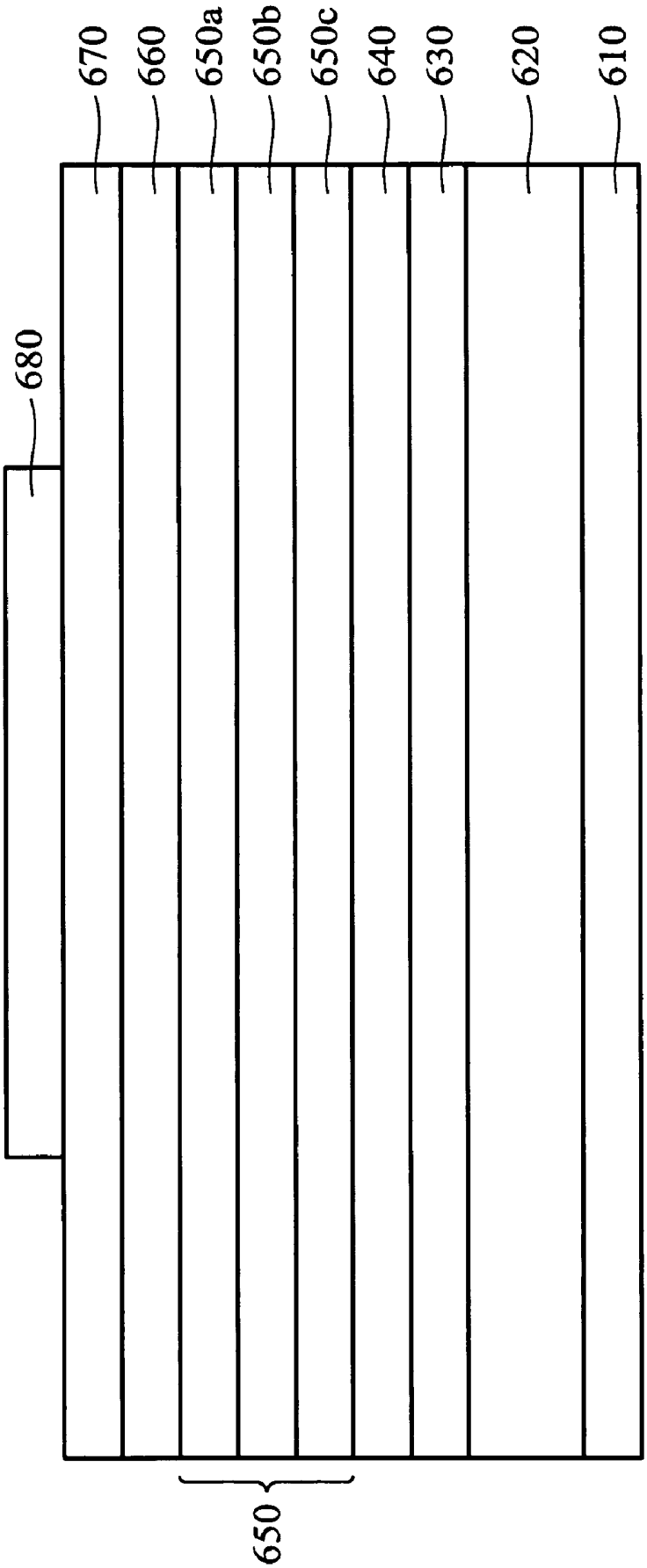

FIG. 6

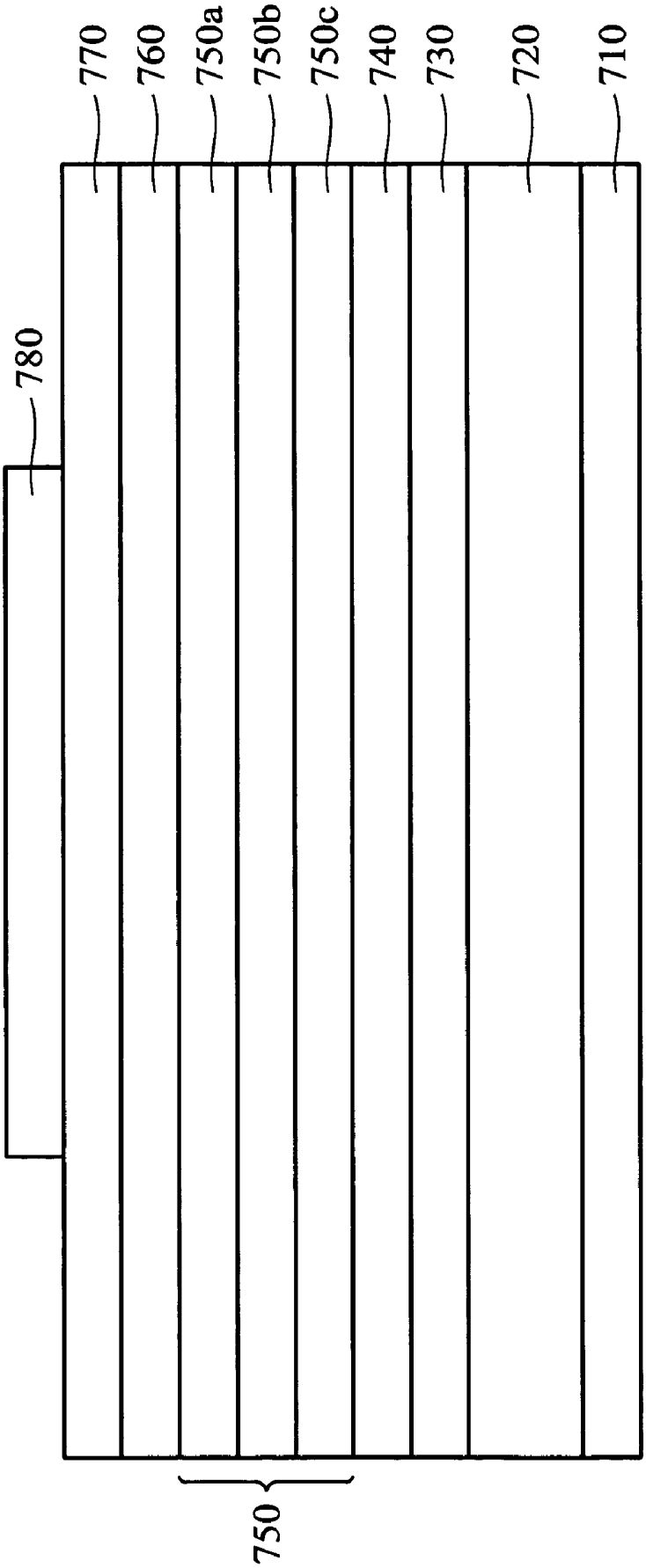

FIG. 7

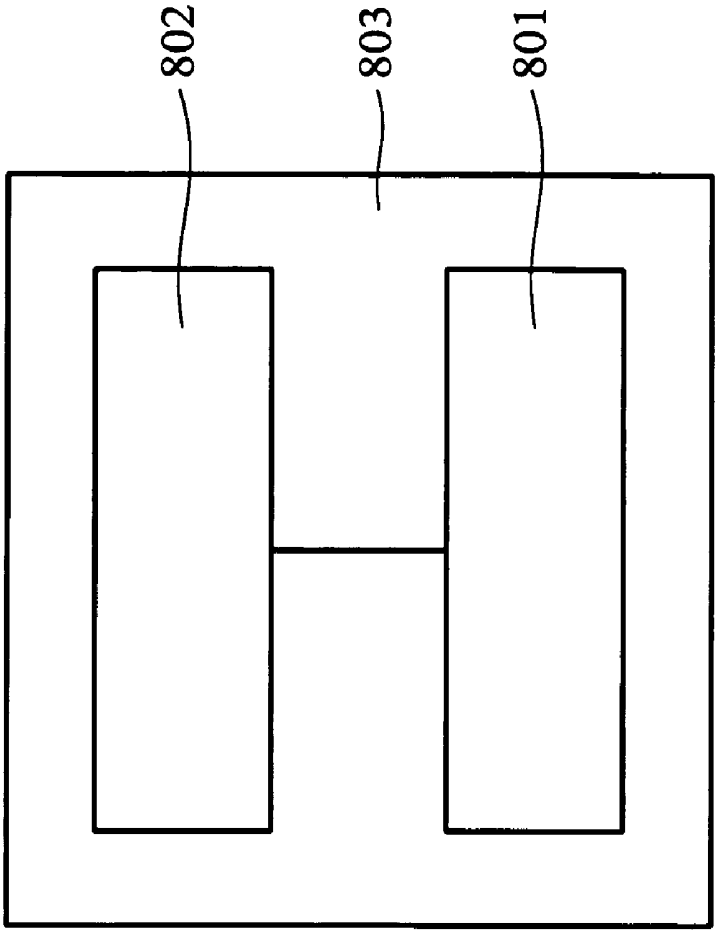

FIG. 8

ORGANIC ELECTROLUMINESCENT DEVICES AND DISPLAY UTILIZING THE SAME

BACKGROUND

[0001] The present invention relates generally to an organic electroluminescent device and, more particularly, to an emissive layer having one or more dopants dispersed therein with a concentration gradient.

[0002] Current density, luminance efficiency, and chromaticity of CIE coordinates for an organic electroluminescent device (OELD) have been significantly improved.

[0003] However, operational lifetime of an OELD, especially a blue OELD, has yet to be improved. Typically, a blue OELD has a half-life of about 1500 hours at a luminance of 1000 nits. Such a device require enhancement when applied in a display panel.

[0004] A typical OELD comprises an anode of indium tin oxide (ITO), a hole-injection layer (HIL), a hole-transport layer (HTL), an emissive layer doped with dopants having uniform concentration, an electron-transport layer (ETL), an electron-injection layer (EIL), and a cathode.

[0005] When electrical potential difference is applied between the anode and the cathode, electrons and holes are injected into the emissive layer from the cathode and the anode, respectively. The injected electrons and holes are then recombined to produce excitons. Excitons excite the dopants, thereby releasing energy as light.

[0006] However, distribution of excitons is confined to a certain region due to difference between hole mobility and electron mobility.

[0007] In other words, excitons only exit a certain region of the emissive layer. Thus, dopants may remain in some regions where no excitons exist. Moreover, excitons may not be completely exhausted due to insufficient dopant, producing radiation and heat, thereby significantly reducing operational lifetime of the device.

[0008] Accordingly, an OELD capable of solving problems such as shortened operational lifetime due to remaining dopants and excitons is required.

SUMMARY

[0009] The first aspect of the present invention is to enhance current density of driving current, luminance, and stability of an OELD.

[0010] The second aspect of the present invention is to completely exhaust excitons formed by recombination of electrons and holes.

[0011] To achieve the described aspect, one or more dopants are gradually doped into the emissive layer with a concentration gradient, depending on location. Therefore, the one or more dopants and excitons are completely exhausted, enhancing luminescent efficiency and stability.

[0012] According to the present invention, an OELD comprises a substrate, an first electrode, a second electrode opposite to the first electrode disposed over the substrate, a hole-transport layer disposed between the first electrode and the second electrode, an electron-transport layer disposed between the second electrode and the hole-transport layer, and an emissive layer disposed between the hole-transport layer and the electron-transport layer. Moreover, the emissive layer comprises a plurality of sub-layers having the substantially identical host materials, and each of the sub-layers is being doped with a substantially different concentration of one or more dopants.

[0013] The OELD of the present invention further comprises a hole-injection layer disposed between the first electrode and the hole-transport layer, and an electron-injection layer disposed between the second electrode and the electron-transport layer.

[0014] According to the present invention, the emissive layer is doped in several ways as follows:

[0015] First, as shown in **FIG. 1**, the one or more dopants concentration gradient decreases gradually along the increased thickness direction of the emissive layer.

[0016] Second, as shown in **FIG. 2**, the one or more dopants concentration gradient initially increases gradually along the increased thickness direction of the emissive layer, and then decreases. In other embodiments, the one or more dopants concentration gradient initially decreases gradually along the increased thickness direction of the emissive layer, and then increases.

[0017] Third, as shown in **FIG. 3**, the one or more dopants concentration gradient increases gradually along the thickness of increased direction of the emissive layer.

[0018] The concentration of the one or more dopants ranges from about 0.1 vol % to about 99 vol %. The thickness of the emissive layer ranges from about 50 Å to about 2000 Å. The thickness of the hole-injection layer ranges from about 50 Åto about 5000 Å. The thickness of the hole-transport layer ranges from about 50 Å to about 5000 Å. The thickness of the electron-transport layer ranges from about 50 Å to about 5000 Å. The thickness of the electron-injection layer ranges from about 1 Å to about 50 Å. The thickness of the second electrode ranges from about 500 Å to about 5000 Å.

[0019] The hole-transport layer comprises one or more diamine derivatives, for example, N,N'-diphenyl-N,N'-bis(1-naphthyl)-(1,1'-bisphenyl)-4,4'-diamine (NPB), N,N1-diphenyl-N,N'-bis(3-methylphenyl)-(1,1'-bisphenyl)-4,4'-diamine (TPD), 4,4',4"-tris(N-(1-naphtyl)-N-phenyl-amino)-trisphenyl-amine (1T-NATA), or 4,4',4"-tris(N-(2-naphtyl)-N-phenyl-amino)-trisphenyl-amine (2T-NATA).

[0020] The electron-transport layer comprises one or more metal quinolinate derivatives. The electron-injection layer comprises a metal fluoride, an alkali metal derivative, an alkaline metal derivative, or an alkaline-earth metal derivative. In other embodiments, the metal fluoride comprises lithium fluoride (LiF), cesium fluoride (CsF), or sodium fluoride (NaF).

[0021] The one or more dopants comprise singlets or triplets, for example, 10-(2-benzothiazolyl)-1,1,7,7-tetramethyl-2,3,6,7-tetrahydro-1H,5H,11H(1)benzopyrano(6,7,8-ij) quinolizin-11-one (C545T), 2-(1,1-dimethylethyl)-6(2-(2,3,6,7-tetrahydro-1,1,7,7-tetramethyl-1H,5H-benzo(ij) quinolizin-9-yl)ethyl)-4H-pyran-4-ylidene)propanedinitrile (DCJTB), or 2,5,8,11-tetrakis(1,1-dimethylethyl)perylene (TBP). In other embodiments, green dopants such as (3-(2'-benzothiazolyl)-7-diethylaminocoumarin(coumarin-6)), or

the one or more dopants comprise singlets or triplets capable of emitting three primary colors. In other embodiments, the one or more dopants may be dye.

[0022] Moreover, a display utilizing the OELD of the present invention is provided.

DESCRIPTION OF THE DRAWINGS

[0023] The present invention will become more fully understood from the detailed description given herein below and the accompanying drawings, given by way of illustration only and thus not intended to be limitative of the present invention.

[0024] **FIG. 1** shows distribution of dopants in the emissive layer of an OELD according to the present invention.

[0025] **FIG. 2** shows distribution of dopants in the emissive layer of an OELD according to the present invention.

[0026] **FIG. 3** shows distribution of dopants in the emissive layer of an OELD according to the present invention.

[0027] **FIG. 4** is a graph of the relative luminance as a function of operating time for OELDs of several embodiments and a comparative example.

[0028] **FIG. 5** is a cross-section of an embodiment of an OELD of the present invention.

[0029] **FIG. 6** is a cross-section of another embodiment of an OELD of the present invention.

[0030] **FIG. 7** is a cross-section of another embodiment of an OELD of the present invention.

[0031] **FIG. 8** is a cross-section of a display apparatus comprising the OELD of the present invention.

DETAILED DESCRIPTION

Comparative example

[0032] "Concentration", herein below described, is defined as a ratio of volume of the dopants and the emission layer.

[0033] A conventional OELD and a method for forming are described in greater detail in the following.

[0034] A conventional OELD comprises an anode, a thickness of a hole-injection layer (HIL) about 150 nm, a thickness of a hole-transport layer (HTL) about 20 nm, a thickness of a emissive layer about 40 nm, a thickness of a electron-transport layer (ETL) about 20 nm, an electron-injection layer (EIL), and a cathode. Moreover, the emissive layer, having a blue host material, is doped with blue dopants having a concentration of 2.5 vol %.

[0035] UV-ozone treatment is performed on a substrate having an anode thereon. The anode is indium tin oxide (ITO).

[0036] The 150 nm hole-injection layer is formed on the processed substrate by vacuum deposition.

[0037] The hole-transport layer is formed on the hole-injection layer by vacuum deposition.

[0038] The emissive layer is formed on the hole-transport layer by vacuum deposition.

[0039] The electron-transport layer and an electron-injection layer are formed on the emissive layer by vacuum deposition.

[0040] The cathode is formed on the electron-injection layer by vacuum deposition. The cathode comprises a layer of LiF about 1 nm and a layer of Al about 100 nm.

[0041] **FIG. 4** is a graph of relative luminance as a function of operating time for OELD of a comparative example (see curve-A). The relative luminance is defined as a ratio of initial luminance to luminance. At the same point in operating time, the increased value of relative luminance indicates luminance of the device decaying fast. **FIG. 4** illustrates measurement of operating time for a device at initial luminance of 1000 nits.

[0042] As shown in Table 1, column 2 shows current density, driving voltage, luminance, luminance efficiency, and CIE coordinates for a device of a comparative example.

TABLE 1

	comparative example (A)	First Embodiment (B)	Second Embodiment (C)	Third Embodiment (D)
current density (mA/cm^2)	31.2	21.3	21.55	40.85
driving voltage (V)	7	7	7	7
luminance (cd/m^2)	1392	893.5	1029	1906
luminance efficiency (cd/A)	4.47	4.2	4.77	4.67
CIEx	0.146	0.162	0.146	0.145
CIEy	0.185	0.21	0.205	0.188

First Embodiment

[0043] A top emissive type OELD and method for fabricating are provided. In other embodiments, the OELD may be bottom emissive type, or dual emissive type.

[0044] As shown in **FIG. 5**, the OELD comprises a first electrode such as an anode, the thickness of the hole-injection layer (HIL) substantially about 150 nm, the thickness of the hole-transport layer (HTL) substantially about 20 nm, the thickness of the emissive layer substantially about 40 nm, the thickness of the electron-transport layer (ETL) substantially about 20 nm, the thickness of the electron-injection layer (EIL) substantially about 1 nm, and a second electrode such as a cathode.

[0045] UV-ozone treatment is performed on a substrate **510** having an anode formed thereon. The anode **520** is indium tin oxide (ITO). In other embodiments, the anode **520** can be indium zinc oxide (IZO), cadmium tin oxide (CTO), or the like.

[0046] The thickness of the hole-injection layer **530** ranges from about 50 Å to about 5000 Å, preferably 150 nm, is formed on the processed substrate **510** by vacuum deposition.

[0047] The thickness of the hole-transport layer **540** ranges from about 50 Å to about 5000 Å, preferably 20 nm, is formed on the hole-injection layer **530** by vacuum depo-

sition. The hole-transport layer **540** comprise one or more diamine derivatives such as N,N'-diphenyl-N,N'-bis(1-naphthyl)-(1,1'-bisphenyl)-4,4'-diamine (NPB), N,N'-diphenyl-N,N'-bis(3-methylphenyl)-(1,1'-bisphenyl)-4,4'-diamine (TPD), 4,4',4"-tris(N-(1-naphtyl)-N-phenyl-amino)-trisphenyl-amine (1T-NATA) or 4,4',4"-tris(N-(2-naphtyl)-N-phenyl-amino)-trisphenyl-amine (2T-NATA).

[**0048**] The thickness of the emissive layer **550** ranges from about 50 Å to about 2000 Å, preferably 40 nm, is formed on the hole-transport layer **540** by vacuum deposition.

[**0049**] The electron-transport layer **560** ranges from about 50 Åto about 5000 Å and The electron-injection layer **570** ranges from about 1 Å to about 50 Å are formed on the emissive layer **550** by vacuum deposition. The electron-transport layer **560** comprises Tris-(8-hydroxyquinolinate) aluminum (III) (Alq3), Tris-(8-hydroxyquinolinate)gallium(III) (Gaq3), or Tris-(8-hydroxyquinolinate) Indium (III) (Inq3). The electron-injection layer **570** comprises a metal fluoride, an alkali metal derivative, an alkaline metal derivative, or an alkaline-earth metal derivative. Moreover, the metal fluoride comprises LiF, CsF, or NaF.

[**0050**] The thickness of the cathode **580** ranges from about 500 Å to about 5000 Å is formed on the electron-injection layer **570** by vacuum deposition. The cathode **580** comprises a layer of LiF substantially about 1 nm and a layer of Al substantially about 100 nm.

[**0051**] Moreover, the emissive layer **550**, having blue host materials, comprises sub-layers **550***a*, **550***b*, and **550***c*. The thickness of the sub-layer **550***a* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 8 vol %. The thickness of the sub-layer **550***b* can be substantially about 100 nm, doped with the concentration of the one or more blue dopants can be substantially about 5 vol %. The thickness of the sub-layer **550***c* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 2.5 vol %. The one or more dopants comprise 10-(2-benzothiazolyl)-1,1,7,7-tetramethyl-2,3,6,7-tetrahydro-1H,5H,11H(1)benzopyrano(6,7,8-ij) quinolizin-11-one (C545T), 2-(1,1-dimethylethyl)-6(2-(2,3,6,7-tetrahydro-1,1,7,7-tetramethyl-1H,5H-benzo(ij) quinolizin-9-yl)ethyl)-4H-pyran-4-ylidene)propanedinitrile (DCJTB), or 2,5,8,11-tetrakis(1,1-dimethylethyl)perylene (TBP). In other embodiments, the one or more dopants comprise one or more green dopants such as 3-(2'-benzothiazolyl)-7-diethylaminocoumarin(coumarin-6). In other embodiments, the one or more dopants comprise singlets or triplets capable of emitting three primary colors. In other embodiments, the one or more dopants may be dye.

[**0052**] **FIG. 4** is a graph of the relative luminance as a function of operating time for OELD of a first embodiment (see curve-B).

[**0053**] As shown in Table 1, column 3 shows current density, driving voltage, luminance, luminance efficiency, and CIE coordinates for the device of first embodiment.

Second Embodiment

[**0054**] As shown in **FIG. 6**, an OELD comprises a first electrode such as an anode, the thickness of the hole-injection layer (HIL) substantially about 150 nm, the thickness of the hole-transport layer (HTL) substantially about 20 nm, the thickness of the emissive layer substantially about 40 nm, the thickness of the electron-transport layer (ETL) substantially about 20 nm, the thickness of the electron-injection layer (EIL) substantially about 1 nm, and a second electrode such as a cathode.

[**0055**] UV-ozone treatment is performed on a substrate **610** having an anode formed thereon. The anode **620** is indium tin oxide (ITO). In other embodiments, the anode **620** can be indium zinc oxide (IZO), cadmium tin oxide (CTO), or the like.

[**0056**] The thickness of the hole-injection layer **630** ranges from about 50 Å to about 5000 Å, preferably 150 nm, is formed on the processed substrate **610** by vacuum deposition.

[**0057**] The thickness of the hole-transport layer **640** ranges from about 50 Å to about 5000 Å, preferably 20 nm, is formed on the hole-injection layer **630** by vacuum deposition. The hole-transport layer **640** comprise one or more diamine derivatives such as N,N'-diphenyl-N,N'-bis(1-naphthyl)-(1,1'-bisphenyl)-4,4'-diamine (NPB), N,N'-diphenyl-N,N1-bis(3-methylphenyl)-(1,1'-bisphenyl)-4,4'-diamine (TPD), 4,4',4"-tris(N-(1-naphtyl)-N-phenyl-amino)-trisphenyl-amine (1T-NATA) or 4,4',4"-tris(N-(2-naphtyl)-N-phenyl-amino)-trisphenyl-amine (2T-NATA).

[**0058**] The thickness of the emissive layer **650** ranges from about 50 Å to about 2000 Å, preferably 40 nm, is formed on the hole-transport layer **640** by vacuum deposition.

[**0059**] The thickness of the electron-transport layer **660** ranges from about 50 Å to about 5000 Å and The thickness of the electron-injection layer **670** ranges from about 1 Å to about 50 Å are formed on the emissive layer **650** by vacuum deposition. The electron-transport layer **660** comprises Tris-(8-hydroxyquinolinate) aluminum (III) (Alq3), Tris-(8-hydroxyquinolinate)gallium(III) (Gaq3), or Tris-(8-hydroxyquinolinate) Indium (III) (Inq3). The electron-injection layer **670** comprises a metal fluoride, an alkali metal derivative, alkaline metal derivative, or an alkaline-earth metal derivative. Moreover, the metal fluoride comprises LiF, CsF, or NaF.

[**0060**] The thickness of the cathode **680** ranges from about 500 Å to about 5000 Å is formed on the electron-injection layer **670** by vacuum deposition. The cathode **680** comprises a layer of LiF substantially about 1 nm and a layer of Al substantially about 100 nm.

[**0061**] Moreover, the emissive layer **650**, having blue host materials, comprises sub-layers **650***a*, **650***b*, **650***c* and **650***d*. The thickness of the sub-layer **650***a* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 10 vol %. The thickness of the sub-layer **650***b* can be substantially about 100 nm, doped with the concentration of the blue one or more dopants can be substantially about 7.5 vol %. The thickness of the sub-layer **650***c* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 5 vol %. The thickness of the sub-layer **650***d* can be substantially about 100 nm, and is doped with the one or more blue dopants at a concentration of 2.5 vol %. The one or more dopants

comprise 10-(2-benzothiazolyl)-1,1,7,7-tetramethyl-2,3,6,7-tetrahydro-1H,5H,11H(1)benzopyrano(6,7,8-ij) quinolizin-11-one (C545T), 2-(1,1-dimethylethyl)-6(2-(2,3,6,7-tetrahydro-1,1,7,7-tetramethyl-1H,5H-benzo(ij) quinolizin-9-yl)ethyl)-4H-pyran-4-ylidene)propanedinitrile (DCJTB), or 2,5,8,11-tetrakis(1,1-dimethylethyl)perylene (TBP). In other embodiments, the one or more dopants can comprise green dopants such as 3-(2'-benzothiazolyl)-7-diethylaminocoumarin(coumarin-6), or singlets or triplets capable of emitting three primary colors. In other embodiments, the one or more dopants may be dye.

[0062] **FIG. 4** is a graph of the relative luminance as a function of operating time for the OELD of a second embodiment (see curve-C).

[0063] As shown in Table 1, column 4 shows current density, driving voltage, luminance, luminance efficiency, and CIE coordinates for the device of second embodiment.

Third Embodiment

[0064] As shown in **FIG. 7**, the OELD comprises a first electrode such as an anode, the thickness of the hole-injection layer (HIL) substantially about 150 nm, the thickness of the hole-transport layer (HTL) substantially about 20 nm, the thickness of the emissive layer substantially about 40 nm, the thickness of the electron-transport layer (ETL) substantially about 20 nm, the thickness of the electron-injection layer (EIL) substantially about 1 nm, and a second electrode such as a cathode.

[0065] UV-ozone treatment is performed on a substrate **710** having the anode formed thereon. The anode **720** is indium tin oxide (ITO). In other embodiments, the anode **720** can be indium zinc oxide (IZO), cadmium tin oxide (CTO), or the like.

[0066] The thickness of the hole-injection layer **730** ranges from about 50 Å to about 5000 Å, preferably 150 nm, is formed on the processed substrate **710** by vacuum deposition.

[0067] The thickness of the hole-transport layer **740** ranges from about 50 Å to about 5000 Å, preferably 20 nm, is formed on the hole-injection layer **730** by vacuum deposition. The hole-transport layer **740** comprise one or more diamine derivatives such as N,N1-diphenyl-N,N1-bis(1-naphthyl)-(1,1'-bisphenyl)-4,4'-diamine (NPB), N,N'-diphenyl-N,N'-bis(3-methylphenyl)-(1,1'-bisphenyl)-4,4'-diamine (TPD), 4,4',4"-tris(N-(1-naphtyl)-N-phenyl-amino)-trisphenyl-amine (1T-NATA) or 4,4',4"-tris(N-(2-naphtyl)-N-phenyl-amino)-trisphenyl-amine (2T-NATA).

[0068] The thickness of the emissive layer **750** ranges from about 50 Å to about 2000 Å, preferably 40 nm, is formed on the hole-transport layer **740** by vacuum deposition.

[0069] The thickness of the electron-transport layer **760** ranges from about 50 Å to about 5000 Å and The thickness of the electron-injection layer **770** ranges from about 1 Å to about 50 Å are formed on the emission layer **750** by vacuum deposition. The electron-transport layer **760** comprises Tris-(8-hydroxyquinolinate) aluminum (III) (Alq3), Tris-(8-hydroxyquinolinate)gallium(III) (Gaq3), or Tris-(8-hydroxyquinolinate) Indium (III) (Inq3). The electron-injection layer **770** comprises a metal fluoride, an alkali metal derivative, an alkaline metal derivative, or an alkaline-earth metal derivative. Moreover, the metal fluoride comprises LiF, CsF, or NaF.

[0070] The thickness of the cathode **780** ranges from about 500 Å to about 5000 Å is formed on the electron-injection layer **770** by vacuum deposition. The cathode **780** comprises a layer of LiF substantially about 1 nm and a layer of Al substantially about 100 nm.

[0071] The emissive layer **750**, having blue host materials, comprises sub-layers **750***a*, **750***b*, **750***c* and **750***d*. The thickness of the sub-layer **750***a* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 15 vol %. The thickness of the sub-layer **750***b* can be substantially about 100 nm, doped with the concentration of the one or more blue dopants can be substantially about 10 vol %. The thickness of the sub-layer **750***c* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 5 vol %. The thickness of the sub-layer **750***d* can be substantially about 100 nm, and is doped with the concentration of the one or more blue dopants can be substantially about 2.5 vol %. The one or more dopants comprise 10-(2-benzothiazolyl)-1,1,7,7-tetramethyl-2,3,6,7-tetrahydro-1H,5H,11H(1)benzopyrano(6,7,8-ij) quinolizin-11-one (C545T), 2-(1,1-dimethylethyl)-6(2-(2,3,6,7-tetrahydro-1,1,7,7-tetramethyl-1H,5H-benzo(ij) quinolizin-9-yl)ethyl)-4H-pyran-4-ylidene)propanedinitrile (DCJTB), or 2,5,8,11-tetrakis(1,1-dimethylethyl)perylene (TBP). In other embodiments, the one or more dopants comprise one or more green dopants such as 3-(2'-benzothiazolyl)-7-diethylaminocoumarin(coumarin-6), or singlets or triplets capable of emitting three primary colors. In other embodiments, the one or more dopants may be dye.

[0072] **FIG. 4** is a graph of relative luminance as a function of operating time for OELD of a third embodiment (see curve-D).

[0073] As shown in Table 1, column 5 shows current density, driving voltage, luminance, luminance efficiency, and CIE coordinates for the device of third embodiment.

[0074] In other embodiments of the present invention, a display **803** comprising the described OELD **802** and a driving circuit **801** can also be provided. The OELD **802** is coupled with the driving circuit **801**, as shown in **FIG. 8**.

[0075] While the present invention has been described by way of example and in terms of preferred embodiment, it is to be understood that the present invention is not limited thereto. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation to encompass all such modifications and similar arrangements.

What is claimed is:

1. An organic electroluminescent device (OELD), comprising:

a substrate;

a first electrode and a second electrode opposite to the first electrode disposed over the substrate;

a hole-transport layer disposed between the first electrode and the second electrode;

an electron-transport layer disposed between the second electrode and the hole-transport layer; and

an emissive layer disposed between the hole-transport layer and the electron-transport layer,

wherein the emissive layer comprising a plurality of sub-layers having a substantially identical host material, and each of the sub-layers being doped with a substantially different concentration of one or more dopants.

2. The OELD of claim 1, further comprising:

a hole-injection layer disposed between the first electrode and the hole-transport layer; and

an electron-injection layer disposed between the second electrode and the electron-transport layer.

3. The OLED of claim 1, wherein the thickness of the emissive layer ranges from about 50 Å to about 2000 Å.

4. The OLED of claim 1, wherein the concentration of the one or more dopants ranges from about 0.1 vol % to about 99 vol %.

5. The OLED of claim 4, wherein the concentration of the one or more dopants within each of the sub-layers decreases along the increased direction of the thickness of the emissive layer.

6. The OLED of claim 4, wherein the concentration of the one or more dopants within each of the sub-layers increases along the increased direction of the thickness of the emissive layer.

7. The OLED of claim 4, wherein the concentration of the one or more dopants within each of the sub-layers initially increases gradually along the increased direction of the thickness of the emissive layer, and then decreases gradually.

8. The OLED of claim 4, wherein the concentration of the one or more dopants within each of the sub-layers initially decreases gradually along the increased direction of the thickness of the emissive layer, and then increases gradually.

9. The OLED of claim 2, wherein the thickness of the hole-injection layer ranges from about 50 Å to about 5000 Å.

10. The device of claim 1, wherein the hole-transport layer comprises one or more diamine derivatives.

11. The OLED of claim 10, wherein the one or more diamine derivatives comprise N,N'-diphenyl-N,N'-bis(1-naphthyl)-(1,1'-bisphenyl)-4,4'-diamine (NPB), N,N1-diphenyl-N,N'-bis(3-methylphenyl)-(1,1'-bisphenyl)-4,4'-diamine (TPD), 4,4',4"-tris(N-(1-naphtyl)-N-phenyl-amino)trisphenyl-amine (1T-NATA), or 4,4',4"-tris(N-(2-naphtyl)-N-phenyl-amino)-trisphenyl-amine (2T-NATA).

12. The OLED of claim 1, wherein the thickness of the hole-transport layer ranges from about 50 Å to about 5000 Å.

13. The OLED of claim 1, wherein the electron-transport layer comprises one or more metal chelate derivatives.

14. The OLED of claim 1, wherein the thickness of the electron-transport layer ranges from about 50 Å to about 5000 Å.

15. The OLED of claim 2, wherein the electron-injection layer comprises a metal fluoride, an alkali metal derivative, an alkaline metal derivative, or an alkaline-earth metal derivative.

16. The OLED of claim 15, wherein the metal fluoride comprise LiF, CsF, or NaF.

17. The OLED of claim 2, wherein the thickness of the electron-injection layer ranges from about 1 Å to about 50 Å.

18. The OLED of claim 1, wherein the thickness of the second electrode ranges from about 500 Å about 5000 Å.

19. The OLED of claim 1, wherein the one or more dopants comprise singlets or triplets.

20. The OLED of claim 1, wherein the one or more dopants comprise 10-(2-benzothiazolyl)-1,1,7,7-tetramethyl-2,3,6,7-tetrahydro-1H,5H,11H(1)benzopyrano(6,7,8-ij) quinolizin-11-one (C545T), 2-(1,1-dimethylethyl)-6(2-(2,3,6,7-tetrahydro-1,1,7,7-tetramethyl-1H,5H-benzo(ij) quinolizin-9-yl)ethyl)-4H-pyran-4-ylidene)propanedinitrile (DCJTB), or 2,5,8,11-tetrakis(1,1-dimethylethyl)perylene (TBP).

21. A display comprising an organic electroluminescent device of claim 1.

* * * * *

专利名称(译)	有机电致发光器件和利用其的显示器		
公开(公告)号	US20060188746A1	公开(公告)日	2006-08-24
申请号	US11/285563	申请日	2005-11-21
[标]申请(专利权)人(译)	友达光电股份有限公司		
申请(专利权)人(译)	友达光电.		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	IOU CHUNG YEH		
发明人	IOU, CHUNG-YEH		
IPC分类号	H01L51/54 H01L51/52 H05B33/14		
CPC分类号	H01L51/001 H01L51/0052 H01L51/0059 Y10T428/24942 H01L51/0081 H01L51/5012 H01L51/0062		
优先权	094105399 2005-02-23 TW		
外部链接	Espacenet USPTO		

摘要(译)

有机电致发光器件（OELD）包括基板，第一电极，与设置在基板上方的第一电极相对的第二电极，设置在第一电极和第二电极之间的空穴传输层，设置在第一电极和第二电极之间的电子传输层第二电极和空穴传输层，以及设置在空穴传输层和电子传输层之间的发光层。发光层包括多个子层。一种或多种掺杂剂逐渐分散在具有基本相同的主体材料的多个子层中。

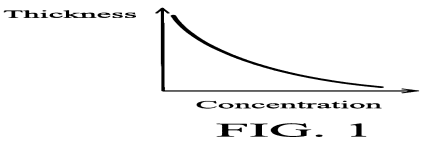

FIG. 1

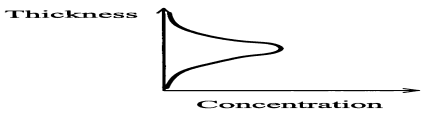

FIG. 2

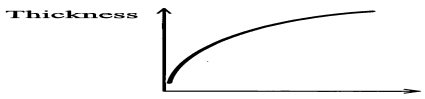

FIG. 3