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(54) **ORGANIC LIGHT-EMITTING DISPLAY PANEL AND DEVICE**

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H01L 51/50 (2006.01)
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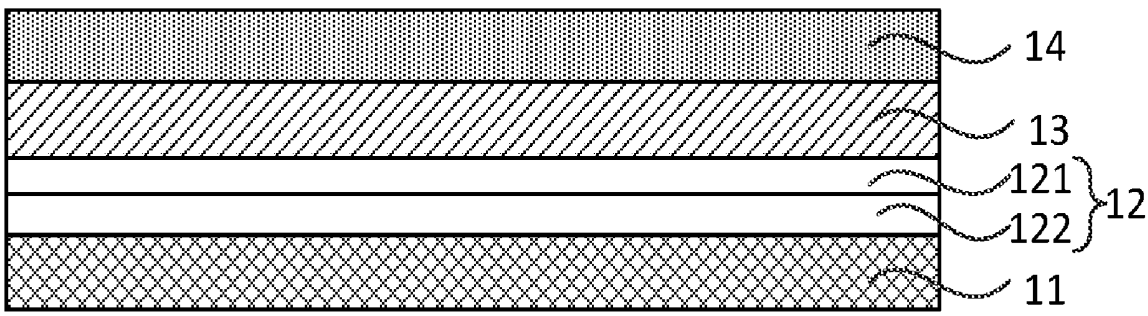
(57) **ABSTRACT**

Embodiments of the present invention disclose an organic light-emitting display panel and an organic light-emitting display device. The organic light-emitting display panel includes: a first electrode, a hole injection layer, a light-emitting layer and a second electrode that are stacked in turn; wherein, the material of the hole injection layer includes an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer.



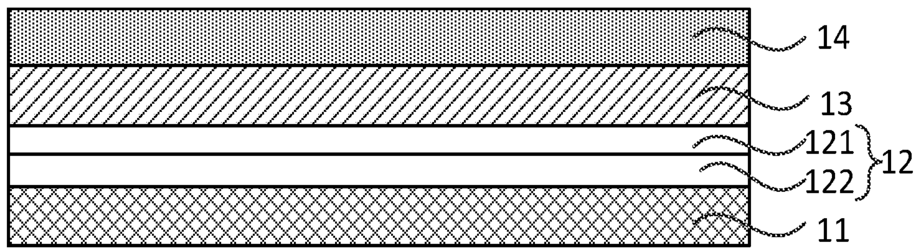


FIG. 1A

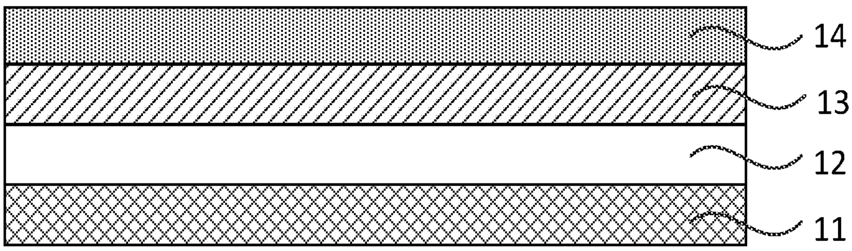


FIG. 1B

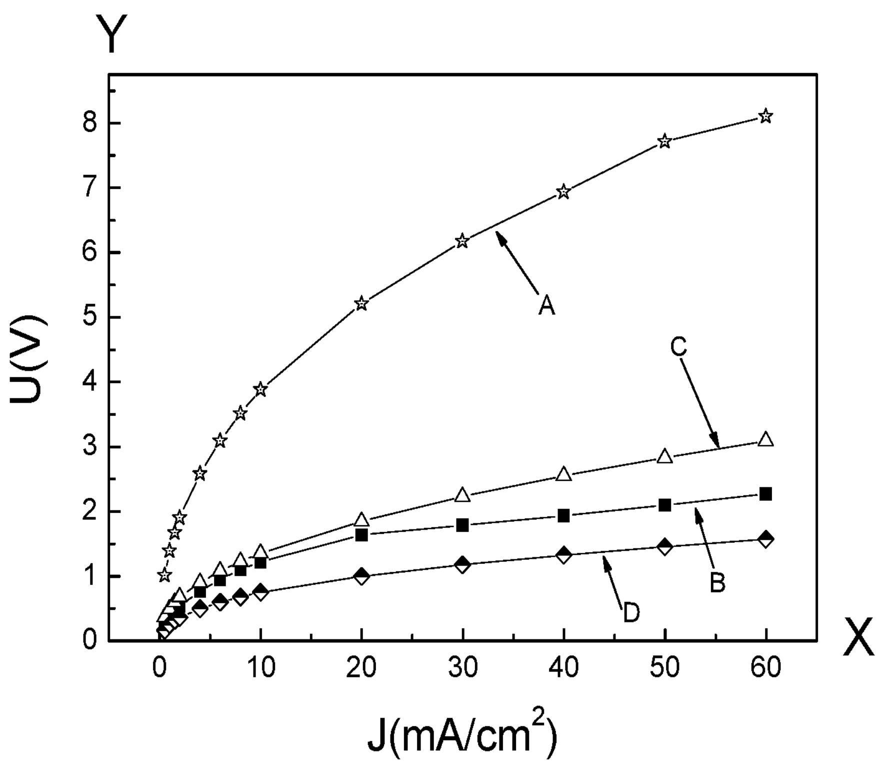


FIG. 2

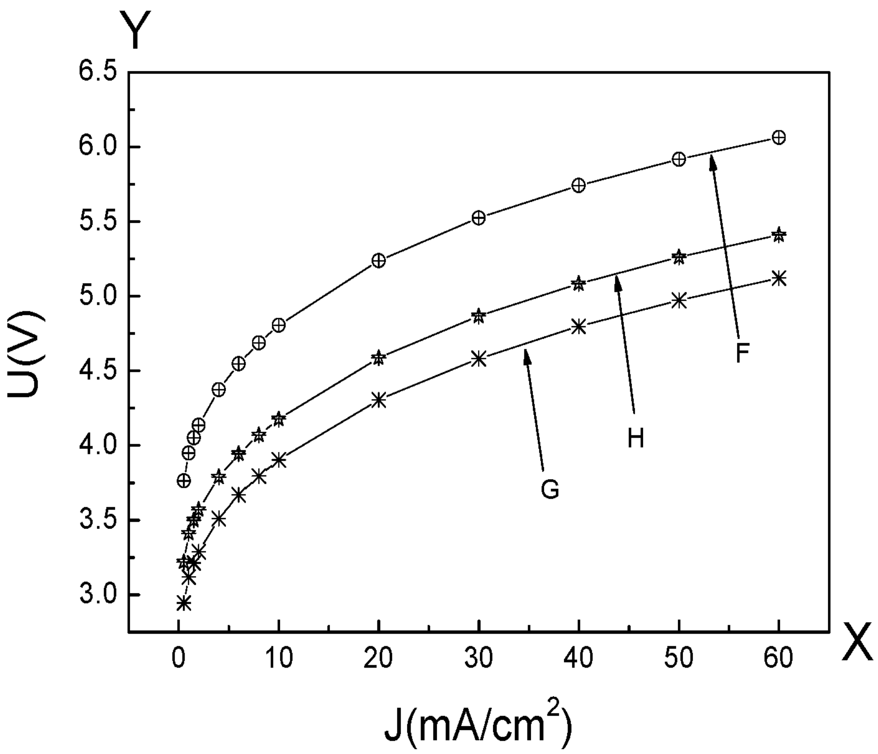


FIG. 3A

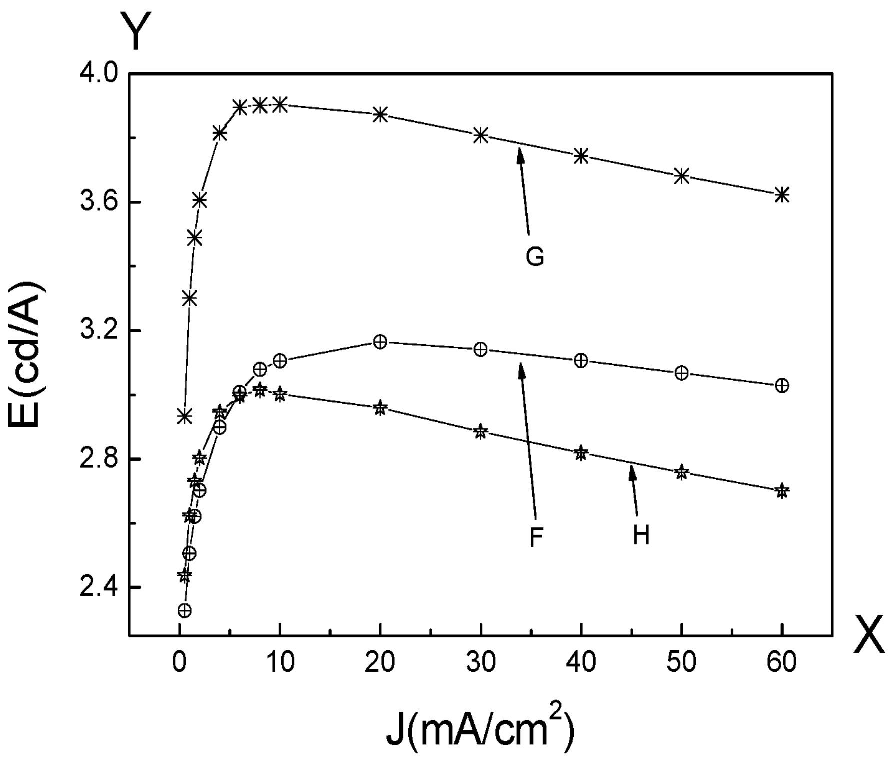


FIG. 3B

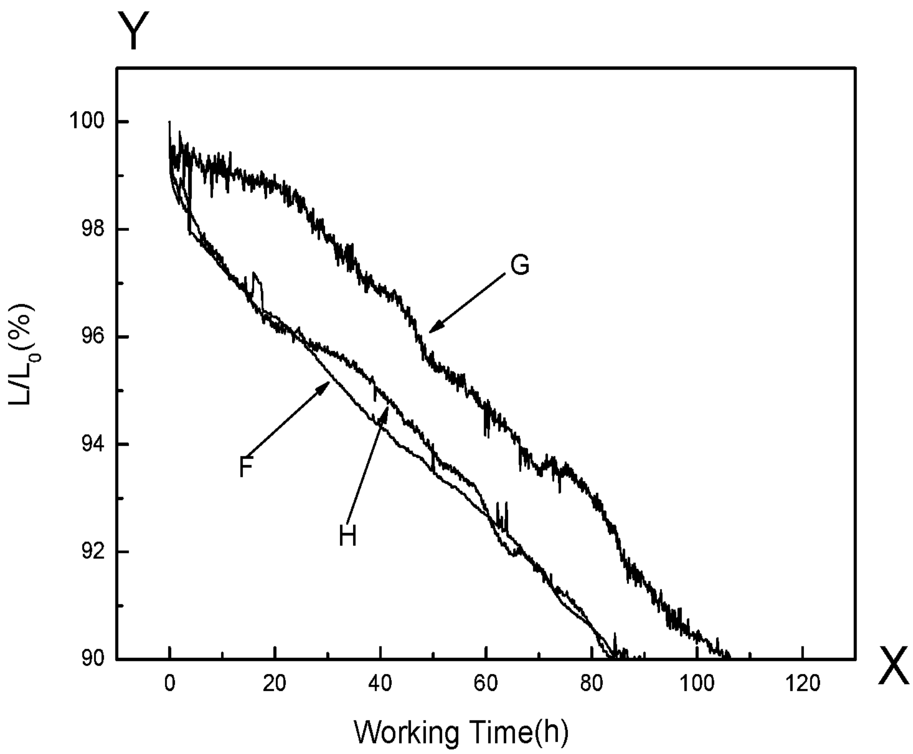


FIG. 3C

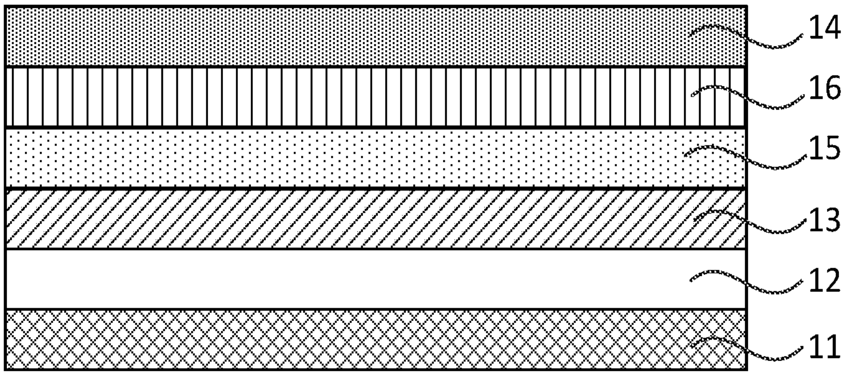


FIG. 4

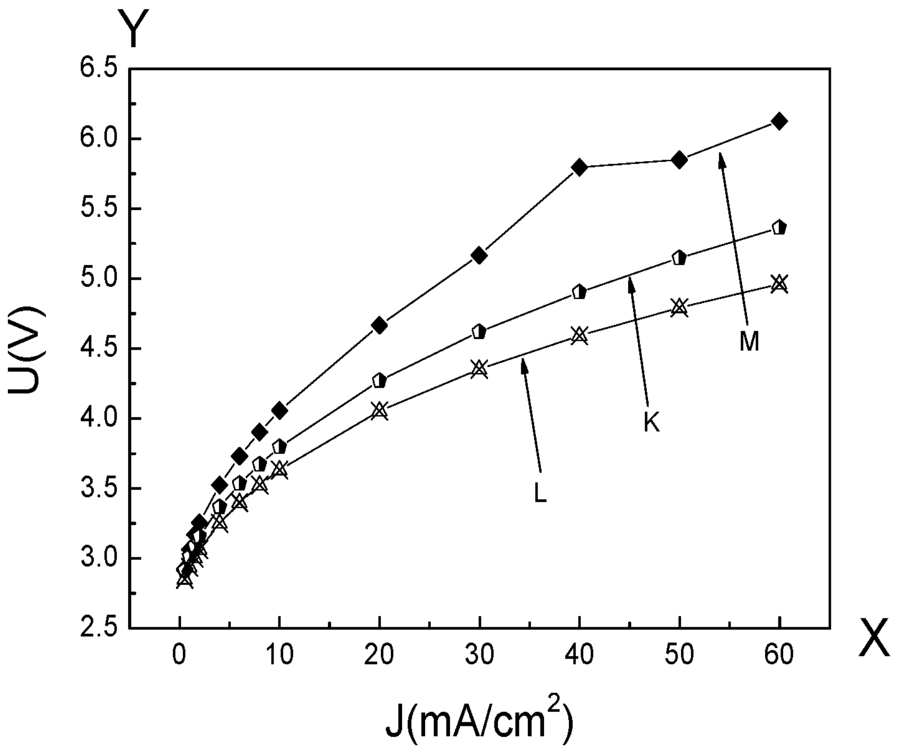


FIG. 5A

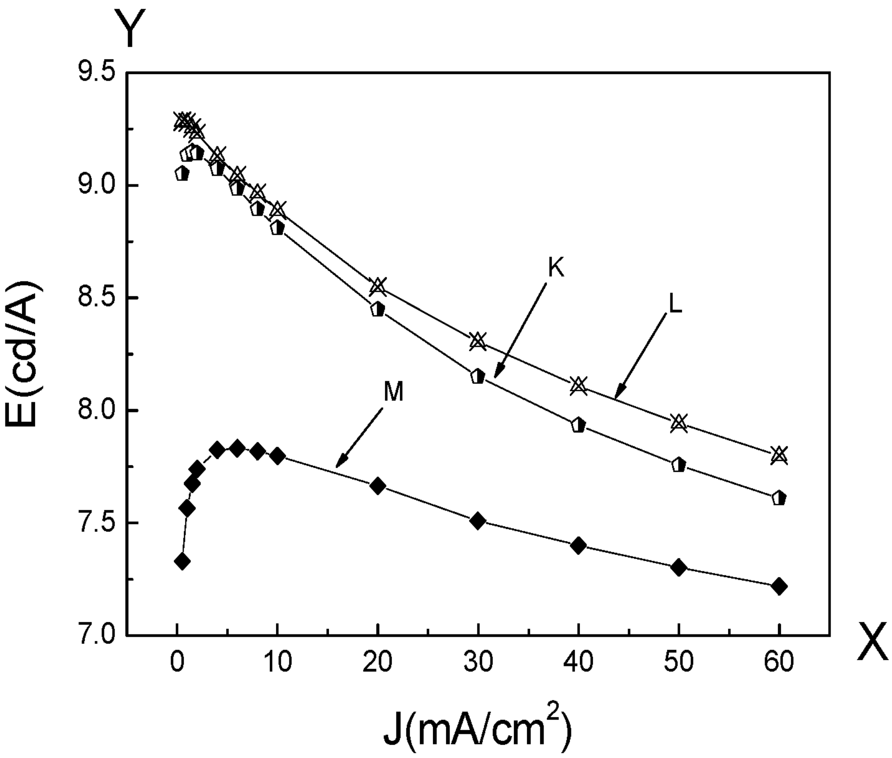


FIG. 5B

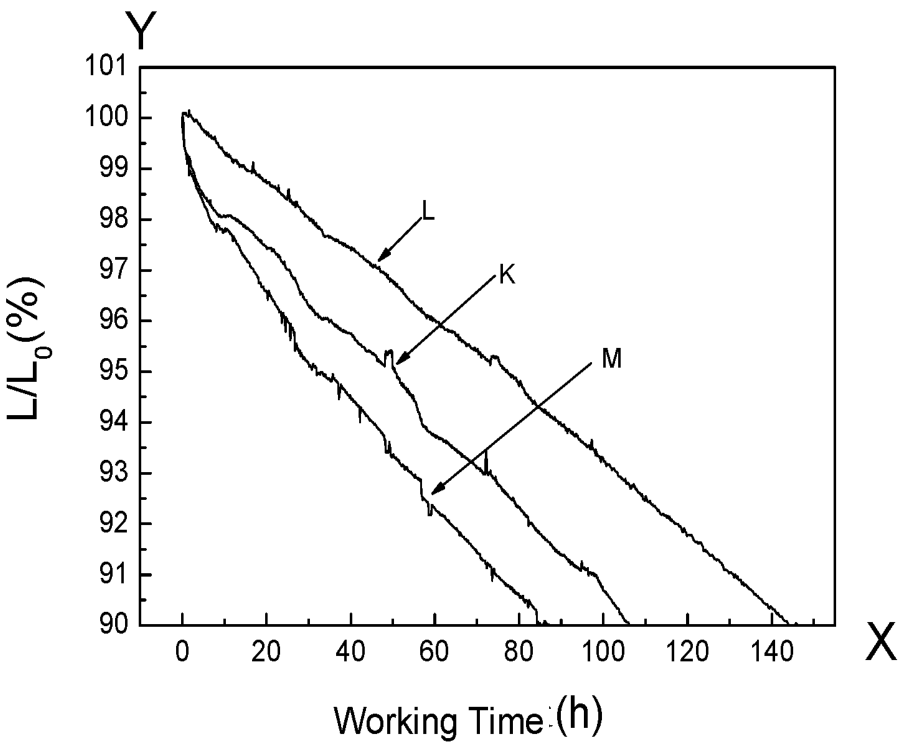

Y
101
100
99
98
97
96
95
94
93
92
91
90
L/L0(%)
L
K
M
0
20
40
60
80
100
120
140
X
Working Time (h)

FIG. 5C

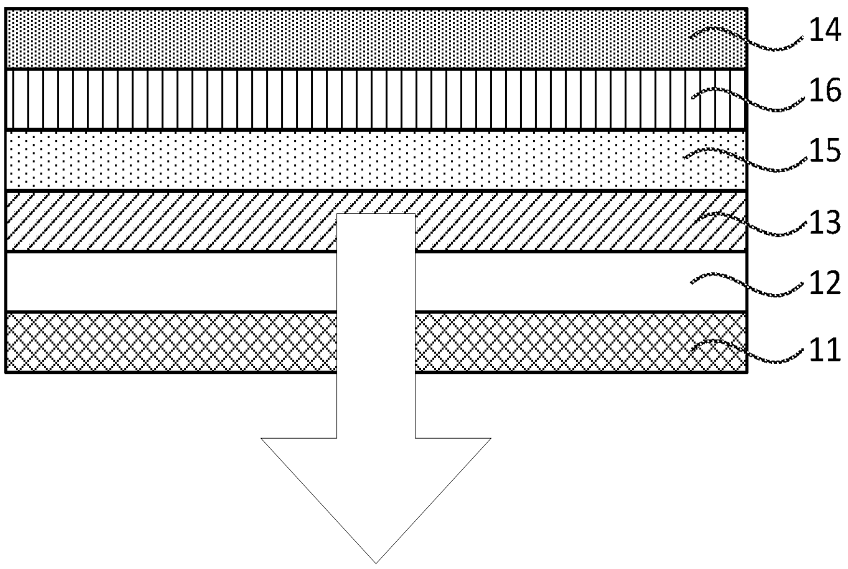


FIG. 6

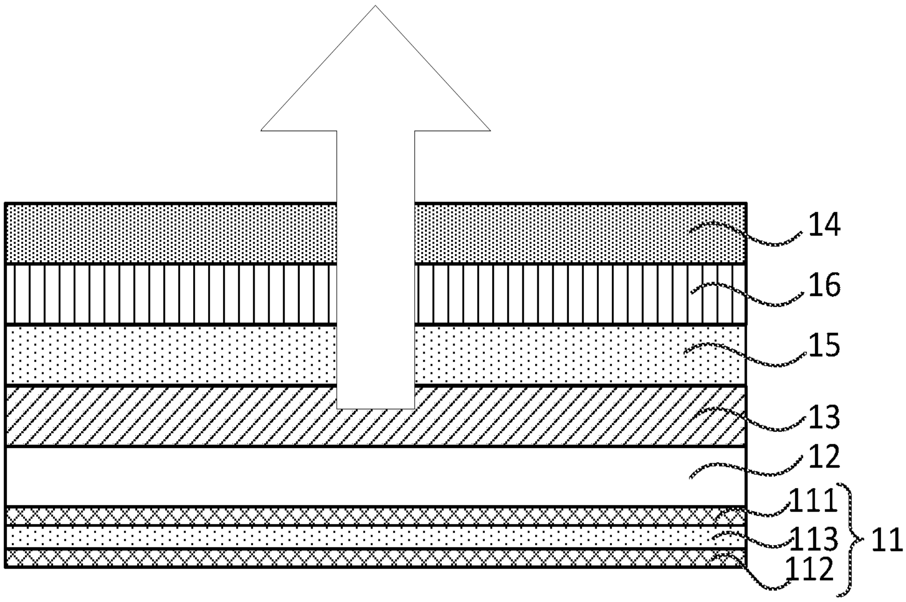


FIG. 7

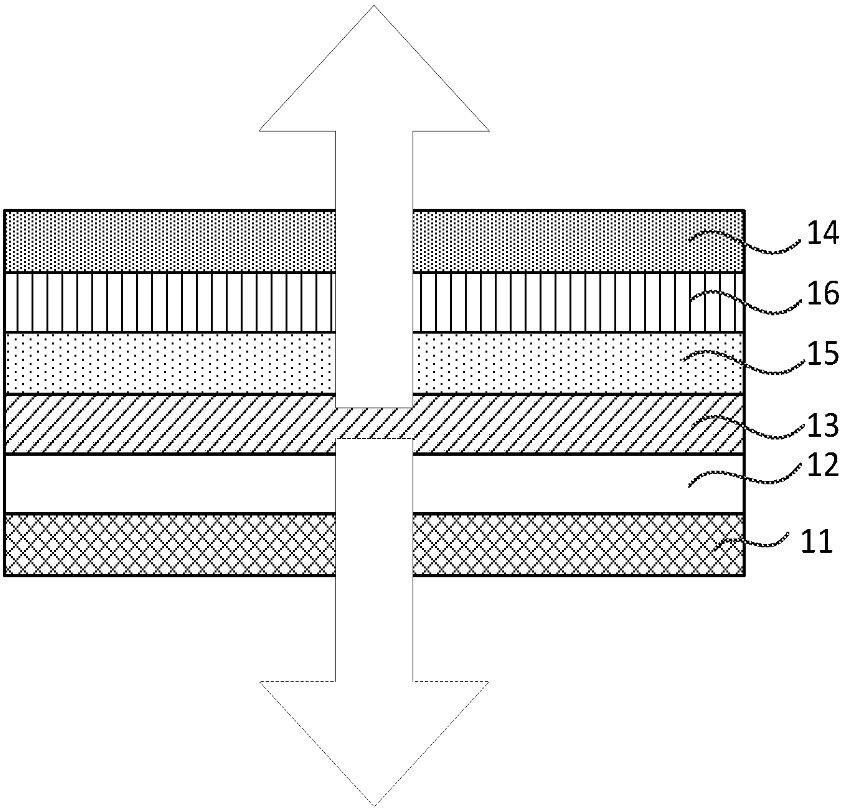


FIG. 8

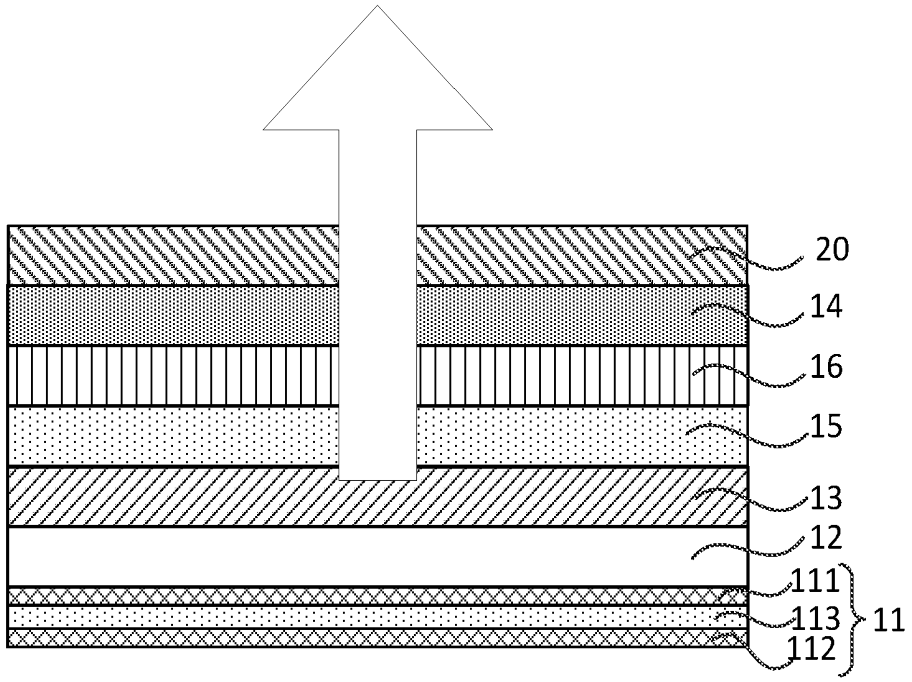


FIG. 9

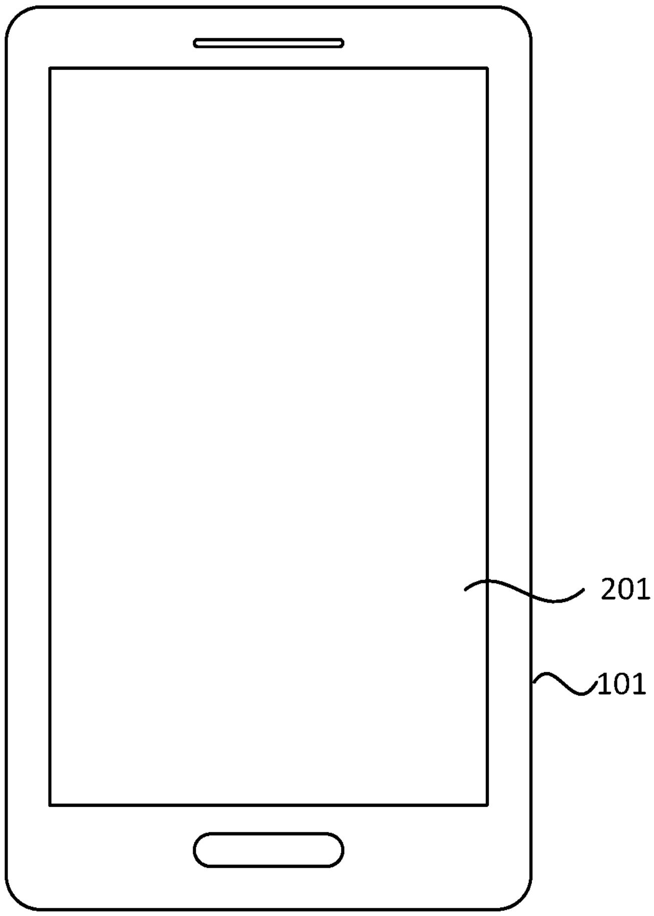


FIG. 10

ORGANIC LIGHT-EMITTING DISPLAY PANEL AND DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 201611236780.5, filed on Dec. 28, 2016 and entitled "ORGANIC LIGHT-EMITTING DISPLAY PANEL AND DEVICE", the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of the present invention relate to organic light-emitting display technologies, and in particular, to an organic light-emitting display panel and an organic light-emitting display device.

BACKGROUND

[0003] Due to the technical advantages of no backlight source, high contrast, small thickness, large visual angle and fast reaction speed, etc., Organic Light-Emitting Display has become one of the important development directions of the display industries.

[0004] The existing organic light-emitting display panel includes: a cathode, an electron transport layer, a light-emitting layer, a hole transport layer, an anode and a substrate. During operation, a bias voltage is applied between the anode and the cathode of the organic light-emitting display panel, so that holes and electrons can break through the interfacial energy barrier and migrate respectively from the hole transport layer and the electron transport layer to the light-emitting layer, and on the light-emitting layer, electrons and holes are recombined to generate excitons. The excitons are unstable, and energy can be released. The energy is transferred to the molecules of the organic light-emitting material in the light-emitting layer, so that the molecules transit from a ground state to an excited state. The excited state is very unstable, and thus the excited molecules return to the ground state from the excited state, so that a light emitting phenomenon appears due to radiative transition. In the organic light-emitting display panel, the number of injected carriers as well as the lightness and efficiency of the organic light-emitting display panel are determined by the interfacial energy barrier between the organic material and the electrodes. However, in the existing organic light-emitting display panel, due to the too high interfacial energy barrier between the hole injection layer and the anode, the injection capacity of holes is small, which will cause the poor performance of the organic light-emitting display panel.

SUMMARY

[0005] Embodiments can provide an organic light-emitting display panel and an organic light-emitting display device, in order to lower the interfacial energy barrier between the hole injection layer and the anode and hence improve the performance of the organic light-emitting display panel

[0006] In a first aspect, embodiments of the application provide an organic light-emitting display panel, which includes:

[0007] a first electrode, a hole injection layer, a light-emitting layer and a second electrode that are stacked in turn;

[0008] wherein, the material of the hole injection layer includes an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer.

[0009] In a second aspect, embodiments of the present invention further provide an organic light-emitting display device, which includes any of the organic light-emitting display panels according to the embodiments of the present invention.

[0010] In the embodiments of the present invention, by setting that the material of the hole injection layer includes an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer, it can solve the problems of the existing organic light-emitting display panels that the interfacial energy barrier between the hole injection layer and the anode is too high and the performance of the organic light-emitting display panel is low, thereby lowering the interfacial energy barrier between the hole injection layer and the anode of the organic light-emitting display panel and improving the hole injection capacity and the performance of the organic light-emitting display panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1A is a structural representation of an organic light-emitting display panel according to one embodiment of the present invention;

[0012] FIG. 1B is a structural representation of another organic light-emitting display panel according to one embodiment of the present invention;

[0013] FIG. 2 is a comparison diagram of the performance curves of single carrier devices according to the embodiments of the present invention;

[0014] FIG. 3A-FIG. 3C are comparison diagrams of the performance curves of different organic light-emitting display panels according to the embodiments of the present invention;

[0015] FIG. 4 is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention;

[0016] FIG. 5A-FIG. 5C are comparison diagrams of the performance curves of different organic light-emitting display panels according to the embodiments of the present invention;

[0017] FIG. 6 is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention;

[0018] FIG. 7 is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention;

[0019] FIG. 8 is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention;

[0020] FIG. 9 is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention; and

[0021] FIG. 10 is a structural representation of an organic light-emitting display device according to one embodiment of the present invention

DETAILED DESCRIPTION

[0022] The present invention will be further illustrated in detail in conjunction with the drawings and embodiments. It may be understood that, the specific embodiments described here are only for explaining, rather than limiting, the present invention. Additionally, it further needs to be noted that, for convenient description, the drawings only show the parts related to the disclosure, rather than the entire structure.

[0023] One embodiment of the present invention provides an organic light-emitting display panel. The organic light-emitting display panel includes: a first electrode, a hole injection layer, a light-emitting layer and a second electrode that are stacked in turn; where the material of the hole injection layer includes an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer.

[0024] It may be known according to Fowler-Nordheim (FN) tunneling model that, by setting that the material of the hole injection layer includes an organic material and a conductive metal oxide or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer, the interfacial energy barrier between the hole injection layer and the anode may be lowered, and hence the hole injection capacity and the performance of the organic light-emitting display panel may be improved.

[0025] FIG. **1**A is a structural representation of an organic light-emitting display panel according to one embodiment of the present invention. Referring to FIG. **1**A, the organic light-emitting display panel includes: a first electrode **11**, a hole injection layer **12**, a organic light-emitting layer **13** and a second electrode **14** that are stacked in turn. The hole injection layer **12** is formed by stacking an organic material film layer **121** and a conductive metal oxide film layer **122**. The first electrode **11** is an anode, and the second electrode **14** is a cathode. It should be noted that, in specific arrangement, the organic material film layer **121** may be provided between the first electrode **11** and the conductive metal oxide film layer **122**, or the conductive metal oxide film layer **122** may be provided between the first electrode **11** and the organic material film layer **121**.

[0026] FIG. **1**B is a structural representation of another organic light-emitting display panel according to one embodiment of the present invention. In comparison with FIG. **1**A, the material of the hole injection layer **12** includes an organic material and a conductive metal oxide in FIG. **1**B.

[0027] The selection of the organic material and the conductive metal oxide in the hole injection layer **12** may vary. During specific manufacturing, Such a selection needs to be determined according to the performance requirement of the organic light-emitting display panel to be manufactured. For example, the organic material may be 2,3,6,7,10,11-hexacyano-1,4,5,8,9,12-hexaazatriphenylene (HAT-CN), and the conductive metal oxide may be molybdenum trioxide (MnO_3).

[0028] Because the bias voltage required by the organic light-emitting display panel can reflect the injection condition of holes, in order to avoid the influence of the injection of electrons at the side of the second electrode **14** in the organic light-emitting display panel on the injection condition of holes, a research will be made on the influence of the material of the hole injection layer **12** on the hole injection capacity by manufacturing four single carrier devices to replace the organic light-emitting display panel. The four single carrier devices are respectively device A, device B, device C and device D. The device A includes a tin indium oxide layer, a first buffer layer, a hole transport layer and a magnesium-silver alloy layer that are stacked in turn. The device B, the device C and the device D further include a second buffer layer as compared with the device A. Specifically, each of the device B, the device C and the device D can include a tin indium oxide layer, a first buffer layer, a hole transport layer, a second buffer layer and a magnesium-silver alloy layer that are stacked in turn. Here, the second buffer layer is equivalent to the hole injection layer **12** of the organic light-emitting display panel. The material of the second buffer layer in B is HAT-CN, the material of the second buffer layer in C is molybdenum trioxide, and the materials of the second buffer layer in D are molybdenum trioxide and HAT-CN. A research will be made on the hole injection capacity of the above four devices, and the result thereof will be shown in FIG. **2**.

[0029] In FIG. **2**, the X axis represents the current density J of the device, with a unit of milliampere per square centimeter (mA/cm^2), and the Y axis represents the bias voltage U that needs to be applied to the device, with a unit of volt (V). Referring to FIG. **2**, under the same current density J, the bias voltage U required for the device (including the device B, the device C and the device D) having the second buffer layer (which is equivalent to the hole injection layer **12** of the organic light-emitting display panel) is much lower than the bias voltage required for the device A without such the second buffer layer. This indicates that the arrangement of the second buffer layer positively helps to lower the interfacial energy barrier, and hence facilitates the injection of holes. Additionally, under the same current density J, the bias voltage U required for the device D is lower than the bias voltage U required for the device B; and also, the bias voltage U required for the device B is lower than the bias voltage U required for the device C. Thus, the ordering according to the hole injection capacities in the organic light-emitting display panel from large to small is as follows: the device D>the device B>the device C>the device A. This indicates that, the arrangement in which the material of the second buffer layer includes an organic material and a conductive metal oxide positively indeed helps to further lower the interfacial energy barrier, and hence facilitates the injection of more holes and the lowering of the working voltage (i.e., the bias voltage U) of the device.

[0030] A research shows that, if the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is changed, the performance parameter of the organic light-emitting display panel will be changed. In specific arrangement, appropriate volume ratio of molybdenum trioxide to HAT-CN may be selected according to the performance requirement of the organic light-emitting display panel to be manufactured, which will not be limited in this application. Exemplarily, the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** may be in the range of 1:2 to 2:1.

[0031] FIG. **3**A-FIG. **3**C are comparison diagrams of the performance curves of different organic light-emitting display panels according to the embodiments of the present invention. In FIG. **3**A-FIG. **3**C, F represents an organic light-emitting display panel in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 2:1, G represents an organic light-emitting display panel in which the volume ratio of molybdenum trioxide to

HAT-CN in the hole injection layer **12** is 1:1, and H represents an organic light-emitting display panel in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:2.

[0032] In FIG. **3**A, X axis represents the current density J of the organic light-emitting display panel, with a unit of milliampere per square centimeter (mA/cm^2), and Y axis represents the bias voltage U that needs to be applied to the organic light-emitting display panel, with a unit of volt (V). As shown in FIG. **3**A, under the same current density J, the ordering according to the bias voltage U required by the organic light-emitting display panel from small to large is as follows: the organic light-emitting display panel G<the organic light-emitting display panel H<the organic light-emitting display panel F. This indicates that, in comparison with the organic light-emitting display panel F in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 2:1 and the organic light-emitting display panel H in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:2, the interfacial energy barrier of the organic light-emitting display panel G in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:1 is lower, which is more favorable for injecting more holes from the first electrode **11** and facilitates the carrier balance in the organic light-emitting display panel, thereby lowering the working voltage (i.e., the bias voltage U) of the organic light-emitting display panel.

[0033] In FIG. **3**B, X axis represents the current density J of the organic light-emitting display panel, with a unit of milliampere per square centimeter (mA/cm^2), and Y axis represents the light-emitting efficiency E of the organic light-emitting display panel, with a unit of candela per ampere (cd/A). Referring to FIG. **3**B, under the same current density J, the ordering according to the light-emitting efficiency of the organic light-emitting display panel from large to small is as follows: the organic light-emitting display panel G>the organic light-emitting display panel F>the organic light-emitting display panel H. This indicates that, in comparison with the organic light-emitting display panel F in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 2:1 and the organic light-emitting display panel H in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:2, the light-emitting efficiency of the organic light-emitting display panel G in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:1 is higher.

[0034] In FIG. **3**C, the X axis represents the working time of the organic light-emitting display panel, with a unit of hour (h), and Y axis represents a ratio of the light-emitting lightness L to the initial lightness L_0 of the organic light-emitting display panel. Referring to FIG. **3**C, during the process in which the lightness L of the organic light-emitting display panel attenuates from the initial lightness L_0 (corresponding to the vertical coordinate of 100) to 90% of the initial lightness L_0 (corresponding to the vertical coordinate of 90), the working time of the improved organic light-emitting display panel G is larger than the working time of the organic light-emitting display panel F, and the working time of the organic light-emitting display panel G is larger than the working time of the organic light-emitting display panel H. This indicates that, in comparison with the organic light-emitting display panel F in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 2:1 and the organic light-emitting display panel H in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:2, the lifetime of the organic light-emitting display panel G in which the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:1 is longer.

[0035] In conclusion, in specific arrangement, optionally, the volume ratio of molybdenum trioxide to HAT-CN in the hole injection layer **12** is 1:1.

[0036] FIG. **4** is a structural representation of another organic light-emitting display panel according to one embodiment of the present invention. In comparison with FIG. **1**, the organic light-emitting display panel further includes an electron transport layer **15** and an electron injection layer **16**. Specifically, referring to FIG. **4**, the electron transport layer **15** is located between the second electrode **14** and the organic light-emitting layer **13**. The electron injection layer **16** is located between the second electrode **14** and the electron transport layer **15**. Moreover, in order to improve the electron injection capacity of the organic light-emitting display panel, optionally, at least one of the electron transport layer **15**, the electron injection layer **16** and the second electrode **14** is doped with at least one of an alkali metal, an alkaline earth metal and a rare earth metal. For example, at least one of the electron transport layer **15**, the electron injection layer **16** and the second electrode **14** is doped with at least one of cesium, lithium, rubidium, calcium, magnesium, barium, ytterbium and samarium.

[0037] Next, a research will be made on the performance of the doped organic light-emitting display panel by an example in which the electron transport layer **15** of an organic light-emitting display panel is doped with at least one of an alkali metal, an alkaline earth metal and a rare earth metal. FIG. **5**A-FIG. **5**C are comparison diagrams of the performance curves of different organic light-emitting display panels according to the embodiments of the present invention. In FIG. **5**A-FIG. **5**C, M represents an organic light-emitting display panel in which the electron transport layer **15** is not doped with an alkali metal, an alkaline earth metal or a rare earth metal, K represents an organic light-emitting display panel in which the electron transport layer **15** is doped with 8-hydroxyquinolinolato-lithium, and L represents an organic light-emitting display panel in which the electron transport layer **15** is doped with ytterbium. It should be noted that, the material of the hole injection layer **12** in the organic light-emitting display panel M, the organic light-emitting display panel K and the organic light-emitting display panel L includes molybdenum trioxide and HAT-CN, and the volume ratio of molybdenum trioxide to HAT-CN is 1:1.

[0038] In FIG. **5**A, X axis represents the current density J of the organic light-emitting display panel, with a unit of milliampere per square centimeter (mA/cm^2), and Y axis represents the bias voltage U that needs to be applied to the organic light-emitting display panel, with a unit of volt (V). As shown in FIG. **5**A, under the same current density J, the ordering according to the bias voltage U required by the organic light-emitting display panel from small to large is as follows: the organic light-emitting display panel L<the organic light-emitting display panel K<the organic light-emitting display panel M. This indicates that doping the electron injection layer **16** with at least one of an alkali

metal, an alkaline earth metal and a rare earth metal positively facilitates improving the injection capacity of electrons and facilitates the carrier balance in the organic light-emitting display panel, thereby lowering the working voltage (i.e., the bias voltage U) of the organic light-emitting display panel. Moreover, in comparison with the organic light-emitting display panel K in which the electron transport layer **15** is doped with 8-hydroxyquinolinolato-lithium, the injection capacity of electrons of the organic light-emitting display panel L in which the electron transport layer **15** is doped with ytterbium is higher.

[0039] In FIG. **5**B, X axis represents the current density J of the organic light-emitting display panel, with a unit of milliampere per square centimeter (mA/cm^2), and Y axis represents the light-emitting efficiency E of the organic light-emitting display panel, with a unit of candela per ampere (cd/A). Referring to FIG. **5**B, under the same current density J, the ordering according to the light-emitting efficiency of the organic light-emitting display panel from large to small is as follows: the organic light-emitting display panel L>the organic light-emitting display panel K>the organic light-emitting display panel M. This indicates that doping the electron transport layer **15** with at least one of an alkali metal, an alkaline earth metal and a rare earth metal positively facilitates improving the light-emitting efficiency of the organic light-emitting display panel. Moreover, in comparison with the organic light-emitting display panel K in which the electron transport layer **15** is doped with 8-hydroxyquinolinolato-lithium, the organic light-emitting display panel L in which the electron transport layer **15** is doped with ytterbium has a higher light-emitting efficiency.

[0040] In FIG. **5**C, the X axis represents the working time of the organic light-emitting display panel, with a unit of hour (h), and Y axis represents a ratio of the light-emitting lightness L to the initial lightness L_0 of the organic light-emitting display panel. Referring to FIG. **5**C, during the process in which the lightness L of the organic light-emitting display panel attenuates from the initial lightness L_0 (corresponding to the vertical coordinate of 100) to 90% of the initial lightness L_0 (corresponding to the vertical coordinate of 9), the working time of the organic light-emitting display panel L>the working time of the organic light-emitting display panel K>the working time of the organic light-emitting display panel M. This indicates that doping the electron transport layer **15** with at least one of an alkali metal, an alkaline earth metal and a rare earth metal positively facilitates prolonging the lifetime of the organic light-emitting display panel. In comparison with the organic light-emitting display panel K in which the electron transport layer **15** is doped with 8-hydroxyquinolinolato-lithium, the organic light-emitting display panel L in which the electron transport layer **15** is doped with ytterbium is more favorable for prolonging the lifetime of the organic light-emitting display panel.

[0041] In conjunction with FIGS. **3**A-**3**C and FIGS. **5**A-**5**B, it may be found that, when the material of the hole injection layer **12** in the organic light-emitting display panel includes molybdenum trioxide and HAT-CN with the volume ratio of molybdenum trioxide to HAT-CN being 1:1 and the electron transport layer **15** is doped with ytterbium, the overall performance of the organic light-emitting display panel will be excellent. Such organic light-emitting display panel has main advantages such as a low bias voltage required in operation, a high light-emitting efficiency and a long lifetime.

[0042] Based on each of the above technical solutions, optionally, the first electrode **11** and/or the second electrode **14** may be set as a light exit side electrode of organic light-emitting display panel. If only the first electrode **11** is the light exit side electrode of the organic light-emitting display panel or only the second electrode **14** is the light exit side electrode of the organic light-emitting display panel, the organic light-emitting display panel will be a unilateral light-emitting type organic light-emitting display panel. If the first electrode **11** and the second electrode **14** are both the light exit side electrodes of organic light-emitting display panel, the organic light-emitting display panel will be a bilateral light-emitting type organic light-emitting display panel.

[0043] FIG. **6** is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention. Referring to FIG. **6**, in the organic light-emitting display panel, the first electrode **11** functions as a light exit side electrode of organic light-emitting display panel, and after being formed on the organic light-emitting layer **13**, the light is emitted out via the first electrode **11**. Specifically, the material of the first electrode **11** is a conductive transparent material, and the material of the second electrode **14** may be silver or an alloy containing silver. Optionally, during specific design, the material and thickness of the first electrode **11** may vary, so long as it can guarantee that the first electrode **11** has a good hole injection capacity and a good light transmittance. For example, the material for forming the conductive transparent film of the first electrode **11** may be tin indium oxide, zinc indium oxide or a mixture of aluminium oxide and zinc oxide. The thickness of the second electrode **14** may vary, so long as it can guarantee that the second electrode **14** has a good electron injection capacity and a good reflection effect. For example, the material of the second electrode **14** may be an alloy containing silver, where the volume percent of silver is greater than or equal to 80%, and the thickness of the second electrode **14** may be 50 nm-150 nm. In this thickness range, the light formed on the organic light-emitting layer **13** may be emitted out from the first electrode **11** after being reflected.

[0044] FIG. **7** is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention. Referring to FIG. **7**, in the organic light-emitting display panel, the second electrode **14** functions as a light exit side electrode of organic light-emitting display panel, and after being formed on the organic light-emitting layer **13**, the light is emitted out via the second electrode **14**. The material of the second electrode **14** is silver or an alloy containing silver. The material and thickness of the second electrode **14** may vary, so long as it can guarantee that the second electrode **14** has a good electron injection capacity and a good light transmittance. For example, the material of the second electrode **14** may be an alloy containing silver, where the volume percent of silver is greater than or equal to 80%, and the thickness of the second electrode **14** may be 10 nm-20 nm. In this thickness range, the second electrode **14** has a certain transparency, and hence the light formed on the organic light-emitting layer **13** may be transmitted through the second electrode **14**. The first electrode **11** may include a first conductive transparent film **111**, a second conductive transparent film **112** and a reflective film **113** that is located between the first conductive transparent film **111** and the second conductive transparent film **112**. During specific design, the material and thickness of each film layer of the first electrode **11** may vary, so long as it can guarantee the first electrode **11** has a good hole injection capacity and a good reflection effect. For example, the material of the first conductive transparent film **111** and the second conductive transparent film **112** in the first electrode **11** may be tin indium oxide, zinc indium oxide or a mixture of aluminium oxide and zinc oxide, the material of the reflective film **113** may be silver or an alloy containing silver, and the thickness of the reflective film **113** may be 50 nm-150 nm.

[0045] FIG. **8** is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention. Referring to FIG. **8**, in the organic light-emitting display panel, the first electrode **11** and the second electrode **14** both function as a light exit side electrode. After being formed on the organic light-emitting layer **13**, one part of the light is emitted out via the first electrode **11**, and the other part of the light is emitted out via the second electrode **14**. Specifically, the material of the first electrode **11** is a conductive transparent material. Optionally, during specific design, the material and thickness of the first electrode **11** may vary, so long as it can guarantee that the first electrode **11** has a good hole injection capacity and a good light transmittance. For example, the material for forming the conductive transparent film of the first electrode **11** may be tin indium oxide, zinc indium oxide or a mixture of aluminium oxide and zinc oxide. The material of the second electrode **14** is silver or an alloy containing silver. The material and thickness of the second electrode **14** may vary, so long as it can guarantee that the second electrode **14** has a good electron injection capacity and a good light transmittance. For example, the material of the second electrode **14** may be an alloy containing silver, where the volume percent of silver is greater than or equal to 80%, and the thickness of the second electrode **14** may be 10 nm-20 nm. In this thickness range, the second electrode **14** has a certain transparency, and hence the light formed on the organic light-emitting layer **13** may be transmitted through the second electrode **14**.

[0046] FIG. **9** is a structural representation of yet another organic light-emitting display panel according to one embodiment of the present invention. Optionally, as shown in FIG. **9**, the organic light-emitting display panel may further include an optical coupling layer **20**. The optical coupling layer **20** is located on one side of the light exit side electrode (the second electrode **14**) of the organic light-emitting display panel away from the organic light-emitting layer **13**. If the organic light-emitting display panel does not include the optical coupling layer **20**, the process in which the light is emitted from the light exit side electrode (the second electrode **14**) into the air will essentially be a process in which the light is emitted from an optically denser medium into an optically thinner medium. The light tends to be reflected at the interface between the light exit side electrode (the second electrode **14**) and the air, and hence the light transmittance will be low. In the technical solutions of this application, the essence of providing the optical coupling layer **20** is to change the refractive index of the contact surface between the light exit side of the organic light-emitting display panel and the air so as to suppress the reflection of light, thereby improving the light transmittance. Moreover, the transmittance of the light exit side electrode is 30%-50%, and the total transmittance of the light exit side electrode (the second electrode **14**) and the optical coupling layer **20** is greater than or equal to 65%.

[0047] It should be noted that, during the manufacturing process of each organic light-emitting display panel provided in this application, the first electrode **11** may be first formed on the substrate, then the film layers located between the first electrode **11** and the second electrode **14** may be formed in turn, and finally the second electrode **14** is formed; or, the second electrode **14** may be first formed on the substrate, then the film layers located between the first electrode **11** and the second electrode **14** may be formed in turn, and finally the first electrode **11** is formed. That is, the organic light-emitting display panel may have an upright structure, or it may have an inverted structure.

[0048] Embodiments of the present invention further provide an organic light-emitting display device. FIG. **10** is a structural representation of an organic light-emitting display device according to one embodiment of the present invention. Referring to FIG. **10**, the organic light-emitting display device **101** includes any of the organic light-emitting display panels **201** according to the embodiments of the present invention. Specifically, the organic light-emitting display device may be a mobile phone, a notebook computer, an intelligent wearable device and an information inquiry machine in a public hall.

[0049] In the embodiments of the present invention, by setting that the material of the hole injection layer includes an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer, it can solve the problems of the existing organic light-emitting display panels that the interfacial energy barrier between the hole injection layer and the anode is too high and the performance of the organic light-emitting display panel is low, thereby lowering the interfacial energy barrier between the hole injection layer and the anode of the organic light-emitting display panel and hence improving the hole injection capacity and the performance of the organic light-emitting display panel.

[0050] It should be noted that the embodiments of the present invention and the technical principles used therein are described as above. It should be appreciated that the invention is not limited to the particular embodiments described herein, and any apparent alterations, modification and substitutions can be made without departing from the scope of protection of the invention. Accordingly, while the invention is described in detail through the above embodiments, the invention is not limited to the above embodiments and can further include other additional embodiments without departing from the concept of the invention.

What is claimed is:

1. An organic light-emitting display panel, comprising:

a first electrode, a hole injection layer, a light-emitting layer and a second electrode that are stacked in turn; and, wherein

a material of the hole injection layer comprises an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer.

2. The organic light-emitting display panel according to claim **1**, wherein the material of the hole injection layer comprises molybdenum trioxide and 2,3,6,7,10,11-hexacyano-1,4,5,8,9,12-hexaazatriphenylene (HAT-CN).

3. The organic light-emitting display panel according to claim **2**, wherein, a volume ratio of the molybdenum trioxide to the HAT-CN in the hole injection layer is in a range of 1:2 to 2:1.

4. The organic light-emitting display panel according to claim **3**, wherein, the volume ratio of the molybdenum trioxide to the HAT-CN in the hole injection layer is 1:1.

5. The organic light-emitting display panel according to claim **1**, wherein

the organic light-emitting display panel further comprises an electron transport layer and an electron injection layer;

the electron transport layer is located between the second electrode and the light-emitting layer; and

the electron injection layer is located between the second electrode and the electron transport layer.

6. The organic light-emitting display panel according to claim **5**, wherein

at least one of the electron transport layer, the electron injection layer and the second electrode is doped with at least one of an alkali metal, an alkaline earth metal and a rare earth metal.

7. The organic light-emitting display panel according to claim **6**, wherein

the electron transport layer is doped with at least one of cesium, lithium, rubidium, calcium, magnesium, barium, ytterbium and samarium.

8. The organic light-emitting display panel according to claim **1**, wherein

at least one of the first electrode and the second electrode is a light exit side electrode of the organic light-emitting display panel.

9. The organic light-emitting display panel according to claim **8**, wherein

the first electrode is the light exit side electrode of the organic light-emitting display panel; and

a material of the first electrode is a conductive transparent material.

10. The organic light-emitting display panel according to claim **9**, wherein, a material of the second electrode is silver or an alloy containing silver.

11. The organic light-emitting display panel according to claim **8**, wherein

the second electrode is the light exit side electrode of the organic light-emitting display panel; and

a material of the second electrode is silver or an alloy containing silver.

12. The organic light-emitting display panel according to claim **11**, wherein

the material of the second electrode is an alloy containing silver, wherein a volume percent of silver is greater than or equal to 80%.

13. The organic light-emitting display panel according to claim **11**, wherein

a thickness of the second electrode is 10 nm-20 nm.

14. The organic light-emitting display panel according to claim **11**, wherein

the first electrode comprises a first conductive transparent film, a second conductive transparent film and a reflective film located between the first conductive transparent film and the second conductive transparent film.

15. The organic light-emitting display panel according to claim **14**, wherein

a material of the first conductive transparent film and the second conductive transparent film is tin indium oxide, zinc indium oxide or a mixture of aluminium oxide and zinc oxide, and the material of the reflective film is silver or an alloy containing silver.

16. The organic light-emitting display panel according to claim **15**, wherein

a thickness of the reflective film is 50 nm-150 nm.

17. The organic light-emitting display panel according to claim **11**, further comprising an optical coupling layer, wherein the optical coupling layer is located on a side of the light exit side electrode of the organic light-emitting display panel away from the light-emitting layer.

18. The organic light-emitting display panel according to claim **17**, wherein, a transmittance of the light exit side electrode is 30%-50%, and the total transmittance of the light exit side electrode and the optical coupling layer is greater than or equal to 65%.

19. An organic light-emitting display device, comprising an organic light-emitting display panel, wherein the organic light-emitting display panel comprises:

a first electrode, a hole injection layer, a light-emitting layer and a second electrode that are stacked in turn; and, wherein

a material of the hole injection layer comprises an organic material and a conductive metal oxide, or the hole injection layer is formed by stacking an organic material film layer and a conductive metal oxide film layer.

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摘要(译)

本发明的实施方式公开了有机发光显示面板和有机发光显示装置。有机发光显示面板包括：第一电极，空穴注入层，发光层和第二电极，依次堆叠;其中，空穴注入层的材料包括有机材料和导电金属氧化物，或者空穴注入层通过堆叠有机材料膜层和导电金属氧化物膜层形成。