(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 531 454 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.08.2019 Bulletin 2019/35

(21) Application number: **16919480.0**

(22) Date of filing: **13.12.2016**

(51) Int Cl.:
H01L 27/32 *(2006.01)* ***H01L 51/52*** *(2006.01)*
H01L 51/56 *(2006.01)*

(86) International application number:
PCT/CN2016/109572

(87) International publication number:
WO 2018/072283 (26.04.2018 Gazette 2018/17)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **20.10.2016 CN 201610914584**

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(54) **OLED DISPLAY DEVICE AND METHOD FOR MANUFACTURING SAME**

(57) Provided are an organic light-emitting diode (OLED) display device and a method for manufacturing the same. The OLED display device comprises an OLED substrate (101) and a thin-film packaging layer disposed on the OLED substrate (101), wherein the thin-film packaging layer comprises a patterned highly thermal conductive layer (301), and a plurality of openings (3011) having a one-to-one correspondence with a plurality of sub-pixel regions on the OLED substrate (101) are provided on the highly thermal conductive layer (301), which prevents light absorption by the highly thermal conductive layer, and avoids the limitation of a top transmitting device only being capable of using a material provided with high transmittance. As a result, heat generated by the OLED device during operation may be effectively transferred without the light-emitting efficiency of the device being lowered, thereby reducing thermal decomposition of the material of the OLED device, ensuring the device is sufficiently isolated from external moisture and oxygen, and extending the life of the device.

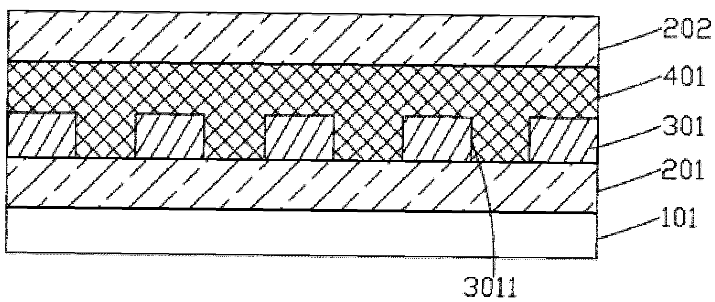

Fig. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to the field of flat panel display technology and more particular to an organic light-emitting diode (OLED) display and a manufacturing method thereof.

2. The Related Arts

[0002] OLED displays possess advantages, such as being self-luminous, high brightness, wide view angle, high contrast, being flexible, and low power consumption, and thus attract much attention as a new generation of displaying solution that gradually takes the place of traditional liquid crystal displays. It is now a symbol of being high tech by adopting an OLED display panel from small size ones used in mobile phone display screens to large size ones used in high definition flat panel televisions.

[0003] The OLED based display technology is different from the traditional liquid crystal display technology in that no backlighting is necessary and an extremely thin organic material coating layer and a glass substrate are involved so that when an electrical current is conducted therethrough, the organic material emits light. However, the organic material is susceptible to reaction with moisture and oxygen and thus, a display based that is based on the organic material is subject to extremely severe requirement for packaging of an OLED display panel. Consequently, packaging an OLED device to improve sealing of the interior of the device and to achieve isolation from the external environment to the greatest extent would be indispensable to stable emission of light of the OLED device.

[0004] The most commonly adopted processes of packaging existing OLED device involve ultraviolet curable resin in combination with a rigid package plate (such as glass or metal) to cover the packaging. Such processes are not fit for flexible devices. Thus, technical solutions that are based on thin film encapsulation (TFE) that uses stacked films to package an OLED device have also been proposed and the related thin film encapsulation art is considered vital for flexible displaying is regarded as a mainstream technique in the future. On the other hand, massive results of study and research reveal deterioration of the performance of an OLED device is closely related to material degradation resulting from heat generated by the device itself. Thus, to effectively isolate external moisture and oxygen and to reduce heat-induced decomposition caused by the heat generated by a device are imperative factors for extension of the service life of the device.

[0005] Currently, the most widely used TFE techniques generally adopt an inorganic/organic/inorganic alternate structure, such as a thin film encapsulation structure disclosed in US Patent No. 8,569,951, this thin film encapsulation structure adopting a cyclically alternating arrangement of organics and inorganics, in which the inorganic layers function to block external moisture and oxygen, while the organic layers function for relief of stress and planarization covering of particulate substances. Soon afterwards, Samsung massively reported a series of secondary type TFE techniques, such as US2009/0252975, US2015/0188084, US2015/0153779, and US 2015/0079707. However, it is known that such packaging techniques involve inorganic metal oxides and organic materials, of which thermal conductivity is generally poor, making it hard to conduct away heat generated by a device.

[0006] Korean institute of industrial research discloses in *Organic Electrics* an OLED device structure, in which a TFE structure comprises a multiple-layer structure including alternate polymer layers and aluminum oxide (Al_2O_3) layers and the TFE structure is finally provided, on a topmost layer, with a copper (Cu) heat dissipation plate. The OLED device that comprises the copper heat dissipation plate exhibits an operation temperature that is lower than that of a device having no such a copper heat dissipation plate. In addition, with the advance of operation time, the device with the copper heat dissipation plate shows a temperature increase trend that is significantly suppressed. Such a technique provides a better guidance solution for heat transfer of an OLED device. However, the transmission rate of Cu is not high enough, and, particularly for application in a top emission device in the display field, such a technique is subjected great limitation.

[0007] Korea Institute of Science and Technology reported in Journal of Information Display a thin film encapsulation technique involving a silver inlay layer. This thin film encapsulation technique uses a polymer that contains nanometer particulates of silicon as organic layers and aluminum oxide (Al_2O_3) as inorganic layers, with an extremely thin layer of silver (Ag) interposed between two Al_2O_3 inorganic layers and an additional layer of Ag placed on the topmost layer. A thin film encapsulation structure adopting such a technique would reduce water vapor transmission rate (WVPR) of the thin film to $10^{-5}g/m^2/d$. Also, the addition of Ag helps effectively transfer heat generated in the interior of the device so as to improve the stability of the device. However, covering Ag on an entire surface of the thin film in a top emission device would reduce outward emission of light so that such a heat conducting material suffers certain limitations.

SUMMARY OF THE INVENTION

[0008] An objective of the present invention is to provide an organic light-emitting diode (OLED) display, which allows for effective transfer of heat generated during an operation of an OLED device, reduces thermal decomposition of a material of the OLED device, and extends the service life of the device while ensuring sufficient capability of the device in blocking external moisture and oxygen.

[0009] Another objective of the present invention is to provide a manufacturing method of an OLED display, which includes a patterned layer of high thermal conductivity in a thin film encapsulation structure to provide effective transfer of heat generated during an operation of an OLED device, reduce thermal decomposition of a material of the OLED device, and extend the service life of the device while ensuring sufficient capability of the device in blocking external moisture and oxygen.

[0010] To achieve the above objectives, the present invention provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate;

the thin film encapsulation layer comprising a first inorganic passivation layer disposed on the OLED substrate, a high thermal conductivity layer disposed on the first inorganic passivation layer, a first organic buffer layer disposed on the first inorganic passivation layer and the high thermal conductivity layer, and a second inorganic passivation layer disposed on the first organic buffer layer;

the OLED substrate comprising a plurality of pixel units arranged in an array, each of the pixel units comprising a plurality of sub-pixel areas arranged in an array;

the high thermal conductivity layer comprising a plurality of openings formed therein to correspond, in a one to one manner, to the plurality the sub-pixel areas of the plurality of pixel units, the first organic buffer layer completely filling up the plurality of openings formed in the high thermal conductivity layer.

[0011] The high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, the high thermal conductivity layer having a thickness of 1-1000 nm.

[0012] The thin film encapsulation layer further comprises a second organic buffer layer disposed on the second inorganic passivation layer and a third inorganic passivation layer disposed on the second organic buffer layer.

[0013] The first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx, the first, second, and third inorganic passivation layers each having a thickness of 0.5-1 μm;

the first and second organic buffer layers each comprising a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene, the first and second organic buffer layers each having a thickness of 4-8 μm.

[0014] Each of the pixel units comprises four sub-pixel areas arranged in a 2$\times$2 array, the four sub-pixel areas being respectively white, red, blue, and green sub-pixel areas.

[0015] The present invention also provides a manufacturing method of an OLED display, which comprises the following steps:

Step 1: providing an OLED substrate, wherein the OLED substrate comprises a plurality of pixel units arranged in an array and each of the pixel units comprises a plurality of sub-pixel areas arranged in an array; and

Step 2: forming a thin film encapsulation layer on the OLED substrate to provide an OLED display; wherein the thin film encapsulation layer is formed with a process that comprises the following steps:

Step 21: depositing and forming a first inorganic passivation layer on the OLED substrate;

Step 22: forming a high thermal conductivity layer on the first inorganic passivation layer, the high thermal conductivity layer comprising a plurality of openings that correspond, in a one to one manner, the plurality of sub-pixel areas of the plurality of pixel units;

Step 23: form a first organic buffer layer on the first inorganic passivation layer and the high thermal conductivity layer such that the first organic buffer layer completely fills up the plurality of openings formed in the high thermal conductivity layer; and

Step 24: depositing and forming a second inorganic passivation layer on the first organic buffer layer.

[0016] Step 22 comprises applying vacuum deposition with a mask plate to direct form the high thermal conductivity layer that comprises the plurality of openings; or alternatively,

applying plasma enhanced chemical vapor deposition (PECVD), atomic layer deposition (ALD), pulsed laser deposition (PLD), or sputtering to first deposit a thermally conductive layer and then, subjecting the thermally conductive film to treatment through photoengraving so as to form the plurality of openings in the thermally conductive film to thus provide the high thermal conductivity layer;

wherein the high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, and the high thermal conductivity layer has a thickness of 1-1000 nm.

[0017] The process with which the thin film encapsulation layer is formed further comprises:

Step 25: forming a second organic buffer layer on the second inorganic passivation layer; and

Step 26: depositing and forming a third inorganic passivation layer on the second organic buffer layer.

[0018] The first, second, and third inorganic passivation layers are each formed with PECVD, ALD, PLD, or sputtering; the first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the first, second, and third inorganic passivation layers each have a thickness of 0.5-1μm;
wherein the first and second organic buffer layers are each formed with ink jet printing (IJP), PECVD, screen printing, or slot coating; the first and second organic buffer layers each comprise a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the first and second organic buffer layers each have a thickness of 4-8μm.

[0019] In the OLED substrate provided in Step 1, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array and the four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas.

[0020] The present invention further provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate;
the thin film encapsulation layer comprising a first inorganic passivation layer disposed on the OLED substrate, a high thermal conductivity layer disposed on the first inorganic passivation layer, a first organic buffer layer disposed on the first inorganic passivation layer and the high thermal conductivity layer, and a second inorganic passivation layer disposed on the first organic buffer layer;
the OLED substrate comprising a plurality of pixel units arranged in an array, each of the pixel units comprising a plurality of sub-pixel areas arranged in an array;
the high thermal conductivity layer comprising a plurality of openings formed therein to correspond, in a one to one manner, to the plurality the sub-pixel areas of the plurality of pixel units, the first organic buffer layer completely filling up the plurality of openings formed in the high thermal conductivity layer;
wherein the high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, the high thermal conductivity layer having a thickness of 1-1000 nm; and
wherein each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array, the four sub-pixel areas being respectively white, red, blue, and green sub-pixel areas.

[0021] The efficacy of the present invention is that the present invention provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate, wherein the thin film encapsulation layer comprises a patterned the high thermal conductivity layer and the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device; and the present invention provides a manufacturing method of an OLED display, which adopts thin film encapsulation to package an OLED device and adds a patterned high thermal conductivity layer in the thin film encapsulation structure, wherein the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0022] For better understanding of the features and technical contents of the present invention, reference will be made to the following detailed description of the present invention and the attached drawings. However, the drawings are provided only for reference and illustration and are not intended to limit the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The technical solution, as well as other beneficial advantages, of the present invention will become apparent from the following detailed description of embodiments of the present invention, with reference to the attached drawings.

[0024] In the drawings:

FIG. 1 is a schematic view showing the structure of a first embodiment of an organic light-emitting diode (OLED) display according to the present invention.

FIG. 2 is a schematic view showing the structure of a second embodiment of the OLED display according to the present invention.

FIG. 3 is a flow chart illustrating a manufacturing method of an OLED display according to the present invention;

FIG. 4 is a schematic view illustrating Step 21 of the manufacturing method of the OLED display according to the present invention;

FIG. 5 is a schematic view illustrating Step 22 of the manufacturing method of the OLED display according to the present invention;

FIG. 6 is a schematic view illustrating Step 23 of the manufacturing method of the OLED display according to the present invention; and

FIG. 7 is a schematic view illustrating Step 25 of a second embodiment of the manufacturing method of the OLED display according to the present invention;

DETAILED DESCRIPTOIN OF THE PREFERRED EMBODIMENTS

[0025] To further expound the technical solution adopted in the present invention and the advantages thereof, a detailed description will be given with reference to the preferred embodiments of the present invention and the drawings thereof.

[0026] Referring to FIG. 1, which is a schematic view showing the structure of a first embodiment of an organic light-emitting diode (OLED) display according to the present invention, in the instant embodiment, the OLED display comprises an OLED substrate 101 and a thin film encapsulation layer disposed on the OLED substrate 101.

[0027] The thin film encapsulation layer comprises a first inorganic passivation layer 201 disposed on the OLED substrate 101, a high thermal conductivity layer 301 disposed on the first inorganic passivation layer 201, a first organic buffer layer 401 disposed on the first inorganic passivation layer 201 and the high thermal conductivity layer 301, and a second inorganic passivation layer 202 disposed on the first organic buffer layer 401.

[0028] The OLED substrate 101 comprises a plurality of pixel units arranged in an array. Each of the pixel units comprises a plurality of sub-pixel areas arranged in an array.

[0029] The high thermal conductivity layer 301 is provided with a plurality of openings 3011 formed therein to correspond, in a one to one manner, to the plurality the sub-pixel areas of the plurality of pixel units. The first organic buffer layer 401 completely filling up the plurality of openings 3011 formed in the high thermal conductivity layer 301.

[0030] Specifically, in the present invention, the plurality of openings 3011 of the high thermal conductivity layer 301 are arranged in a manner identical to the arrangement of the plurality of sub-pixel areas of the plurality of pixel units and each of the openings 3011 has a size consistent with a size of the corresponding one of the sub-pixel areas so as to prevent the high thermal conductivity layer 301 from absorbing light emitting from the sub-pixel areas and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0031] Specifically, in the instant embodiment, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array. The four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas. Each of the openings 3011 that corresponds to the white sub-pixel area has a size consistent with a size of the white sub-pixel area; and similarly, the openings 3011 that correspond to the red, blue, and green sub-pixel areas have sizes respectively consistent with sizes of the red, blue, and green sub-pixel areas.

[0032] Specifically, the high thermal conductivity layer 301 comprises a material that is a metallic or non-metal high thermal conductivity material, such as diamond-like carbon (DLC), silver, aluminum (Al), aluminum nitride (AlN), graphene, and copper.

[0033] Specifically, the high thermal conductivity layer 301 has a thickness of 1-1000 nm.

[0034] Specifically, the first and second inorganic passivation layers 201, 202 comprise a material that is a material for blocking external moisture and oxygen, such as Al_2O_3, titanium oxide (TiO_2), silicon nitride (SiNx), silicon carbon nitride (SiCNx), and silicon oxide (SiOx).

[0035] Specifically, the first and second inorganic passivation layers 201, 202 each have a thickness of 0.5-1 μm.

[0036] Specifically, the first organic buffer layer 401 comprises a material that is a material for stress relief and covering particulates, such as hexamethyldisiloxane (HMDSO), polyacrylate polymers (such as acrylic), polycarbonate polymers, and polystyrene.

[0037] Specifically, the first organic buffer layer 401 has a thickness of 4-8μm.

[0038] Referring to FIG. 2, which is a schematic view showing a structure of a second embodiment of an OLED display according to the present invention, compared to the first embodiment described above, the thin film encapsulation layer further comprises a second organic buffer layer 402 disposed on the second inorganic passivation layer 202 and a third inorganic passivation layer 203 disposed on the second organic buffer layer 402. In this embodiment, the second organic buffer layer 402 and the first organic buffer layer 401 comprise a material comprising hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the second organic buffer layer 402 and the first organic buffer layer 401 each have a thickness of 4-8μm. The third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 comprise a material comprising Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 each have a thickness of 0.5-1μm. The remaining is the same as those of the first embodiment described above and thus, repeated description is omitted herein.

[0039] Based on the OLED display described above, reference being had to FIG. 3, the present invention further provides a manufacturing method of an OLED display, of which a first example specifically comprises the following steps:

Step 1: providing an OLED substrate 101, wherein the OLED substrate 101 comprises a plurality of pixel units arranged in an array and each of the pixel units comprises a plurality of sub-pixel areas arranged in an array.

Step 2: forming a thin film encapsulation layer on the OLED substrate 101 to provide an OLED display; wherein the thin film encapsulation layer is formed through a process that comprises the following steps:
Step 21: as shown in FIG. 4, applying plasma enhanced chemical vapor deposition (PECVD), atomic layer deposition (ALD), pulsed laser deposition (PLD), or sputtering to deposit and form a first inorganic passivation layer 201 on the OLED substrate 101.

[0040] Specifically, the first inorganic passivation layer 201 comprises a material that is a material for blocking external moisture and oxygen, such as Al_2O_3, TiO_2, SiNx, SiCNx, and SiOx.

[0041] Specifically, the first inorganic passivation layer 201 has a thickness of 0.5-1μm .

[0042] Step 22: as shown in FIG. 5, forming a high thermal conductivity layer 301 on the first inorganic passivation layer 201, the high thermal conductivity layer 301 comprising a plurality of openings 3011 that correspond, in a one to one manner, the plurality of sub-pixel areas of the plurality of pixel units.

[0043] Specifically, Step 22 comprises applying vacuum deposition with a mask plate to direct form the high thermal conductivity layer 301 that comprises the plurality of openings 3011; or alternatively,
applying various metal or non-metal deposition processes, such as PECVD, ALD, PLD, and sputtering, to first deposit a thermally conductive layer and then, subjecting the thermally conductive film to treatment through photoengraving so as to form the plurality of openings 3011 in the thermally conductive film to thus provide the high thermal conductivity layer 301.

[0044] Specifically, in the present invention, the plurality of openings 3011 of the high thermal conductivity layer 301 are arranged in a manner identical to the arrangement of the plurality of sub-pixel areas of the plurality of pixel units and each of the openings 3011 has a size consistent with a size of the corresponding one of the sub-pixel areas so as to prevent the high thermal conductivity layer 301 from absorbing light emitting from the sub-pixel areas and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0045] Specifically, in the instant embodiment, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array. The four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas. Each of the openings 3011 that corresponds to the white sub-pixel area has a size consistent with a size of the white sub-pixel area; and similarly, the openings 3011 that correspond to the red, blue, and green sub-pixel areas have sizes respectively consistent with sizes of the red, blue, and green sub-pixel areas.

[0046] Specifically, the high thermal conductivity layer 301 comprises a material that is a metallic or non-metal high thermal conductivity material, such as diamond-like carbon, silver, aluminum, aluminum nitride, graphene, and copper.

[0047] Specifically, the high thermal conductivity layer 301 has a thickness of 1-1000 nm.

[0048] Step 23, as shown in FIG. 6, applying ink jet printing (IJP), PECVD, screen printing, or slot coating to form a first organic buffer layer 401 on the first inorganic passivation layer 201 and the high thermal conductivity layer 301 such that the first organic buffer layer 401 completely fills up the plurality of openings 3011 formed in the high thermal conductivity layer 301.

[0049] Specifically, the first organic buffer layer 401 comprises a material that is a material for stress relief and covering particulates, such as hexamethyldisiloxane, polyacrylate polymers (such as acrylic), polycarbonate polymers, and polystyrene.

[0050] Specifically, the first organic buffer layer 401 has a thickness of 4-8μm.

[0051] Step 24: applying PECVD, ALD, PLD, or sputtering to deposit and form a second inorganic passivation layer 202 on the first organic buffer layer 401 so as to provide an OLED display shown in FIG. 1.

[0052] Specifically, the second inorganic passivation layer 202 comprises a material that is a material for blocking external moisture and oxygen, such as Al_2O_3, TiO_2, SiNx, SiCNx, and SiOx; and the second inorganic passivation layer 202 has a thickness of 0.5-1μm.

[0053] A second example of the manufacturing method of an OLED display according to the present invention, when compared to the first example described above, involves a process of forming the thin film encapsulation layer that further comprises:

Step 25: as shown in FIG. 7, coating and forming a second organic buffer layer 402 on the second inorganic passivation layer 202.

[0054] Specifically, the second organic buffer layer 402 and the first organic buffer layer 401 are each formed with IJP, PECVD, screen printing, or slot coating; the second organic buffer layer 402 and the first organic buffer layer 401 comprises a material comprising hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the second organic buffer layer 402 and the first organic buffer layer 401 each have a thickness of 4-8μm.

[0055] Step 26: coating and forming a third inorganic passivation layer 203 on the second organic buffer layer 402 so as to provide an OLED display as shown in FIG. 2.

[0056] Specifically, the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 are each formed with PECVD, ALD, PLD, or sputtering; the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 each comprise a material that comprising Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 each have a thickness of 0.5-1μm.

[0057] In summary, the present invention provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate, wherein the thin film encapsulation layer comprises a patterned the high thermal conductivity layer and the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device; and the present invention provides a manufacturing method of an OLED display, which adopts thin film encapsulation to package an OLED device and adds a patterned high thermal conductivity layer in the thin film encapsulation structure, wherein the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0058] Based on the description given above, those having ordinary skills in the art may easily contemplate various changes and modifications of he technical solution and the technical ideas of the present invention. All these changes and modifications are considered belonging to the protection scope of the present invention as defined in the appended claims.

Claims

1. An organic light-emitting diode (OLED) display, comprising an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate;

   the thin film encapsulation layer comprising a first inorganic passivation layer disposed on the OLED substrate, a high thermal conductivity layer disposed on the first inorganic passivation layer, a first organic buffer layer disposed on the first inorganic passivation layer and the high thermal conductivity layer, and a second inorganic passivation layer disposed on the first organic buffer layer;

   the OLED substrate comprising a plurality of pixel units arranged in an array, each of the pixel units comprising a plurality of sub-pixel areas arranged in an array;

   the high thermal conductivity layer comprising a plurality of openings formed therein to correspond, in a one to one manner, to the plurality the sub-pixel areas of the plurality of pixel units, the first organic buffer layer completely filling up the plurality of openings formed in the high thermal conductivity layer

2. The OLED display as claimed in Claim 1, wherein the high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, the high thermal conductivity layer having a thickness of 1-1000 nm.

3. The OLED display as claimed in Claim 1, wherein the thin film encapsulation layer further comprises a second organic buffer layer disposed on the second inorganic passivation layer and a third inorganic passivation layer disposed on the second organic buffer layer.

4. The OLED display as claimed in Claim 3, wherein the first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3,

TiO_2, SiNx, SiCNx, or SiOx, the first, second, and third inorganic passivation layers each having a thickness of 0.5-1 μm;
the first and second organic buffer layers each comprising a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene, the first and second organic buffer layers each having a thickness of 4-8μm.

5. The OLED display as claimed in Claim **1**, wherein each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array, the four sub-pixel areas being respectively white, red, blue, and green sub-pixel areas.

6. A manufacturing method of an organic light-emitting diode (OLED) display, comprising the following steps:

Step 1: providing an OLED substrate, wherein the OLED substrate comprises a plurality of pixel units arranged in an array and each of the pixel units comprises a plurality of sub-pixel areas arranged in an array; and
Step 2: forming a thin film encapsulation layer on the OLED substrate to provide an OLED display;
wherein the thin film encapsulation layer is formed with a process that comprises the following steps:

Step 21: depositing and forming a first inorganic passivation layer on the OLED substrate;
Step 22: forming a high thermal conductivity layer on the first inorganic passivation layer, the high thermal conductivity layer comprising a plurality of openings that correspond, in a one to one manner, the plurality of sub-pixel areas of the plurality of pixel units;
Step 23: form a first organic buffer layer on the first inorganic passivation layer and the high thermal conductivity layer such that the first organic buffer layer completely fills up the plurality of openings formed in the high thermal conductivity layer; and
Step 24: depositing and forming a second inorganic passivation layer on the first organic buffer layer.

7. The manufacturing method of the OLED display as claimed in Claim 6, wherein Step 22 comprises applying vacuum deposition with a mask plate to direct form the high thermal conductivity layer that comprises the plurality of openings; or alternatively,

applying plasma enhanced chemical vapor deposition (PECVD), atomic layer deposition (ALD), pulsed laser deposition (PLD), or sputtering to first deposit a thermally conductive layer and then, subjecting the thermally conductive film to treatment through photoengraving so as to form the plurality of openings in the thermally conductive film to thus provide the high thermal conductivity layer;
wherein the high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, and the high thermal conductivity layer has a thickness of 1-1000 nm.

8. The manufacturing method of the OLED display as claimed in Claim 6, wherein the process with which the thin film encapsulation layer is formed further comprises:

Step 25: forming a second organic buffer layer on the second inorganic passivation layer; and
Step 26: depositing and forming a third inorganic passivation layer on the second organic buffer layer.

9. The manufacturing method of the OLED display as claimed in Claim 8, wherein the first, second, and third inorganic passivation layers are each formed with PECVD, ALD, PLD, or sputtering; the first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the first, second, and third inorganic passivation layers each have a thickness of 0.5-1μm;
wherein the first and second organic buffer layers are each formed with ink jet printing (IJP), PECVD, screen printing, or slot coating; the first and second organic buffer layers each comprise a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the first and second organic buffer layers each have a thickness of 4-8 μm.

10. The manufacturing method of the OLED display as claimed in Claim 6, wherein in the OLED substrate provided in Step 1, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array and the four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas.

11. An organic light-emitting diode (OLED) display, comprising an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate;

the thin film encapsulation layer comprising a first inorganic passivation layer disposed on the OLED substrate, a high thermal conductivity layer disposed on the first inorganic passivation layer, a first organic buffer layer disposed on the

first inorganic passivation layer and the high thermal conductivity layer, and a second inorganic passivation layer disposed on the first organic buffer layer;
the OLED substrate comprising a plurality of pixel units arranged in an array, each of the pixel units comprising a plurality of sub-pixel areas arranged in an array;
the high thermal conductivity layer comprising a plurality of openings formed therein to correspond, in a one to one manner, to the plurality the sub-pixel areas of the plurality of pixel units, the first organic buffer layer completely filling up the plurality of openings formed in the high thermal conductivity layer;
wherein the high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, the high thermal conductivity layer having a thickness of 1-1000 nm; and wherein each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array, the four sub-pixel areas being respectively white, red, blue, and green sub-pixel areas.

12. The OLED display as claimed in Claim 11, wherein the thin film encapsulation layer further comprises a second organic buffer layer disposed on the second inorganic passivation layer and a third inorganic passivation layer disposed on the second organic buffer layer.

13. The OLED display as claimed in Claim **12**, wherein the first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx, the first, second, and third inorganic passivation layers each having a thickness of 0.5-1 μm;
the first and second organic buffer layers each comprising a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene, the first and second organic buffer layers each having a thickness of 4-8μm.

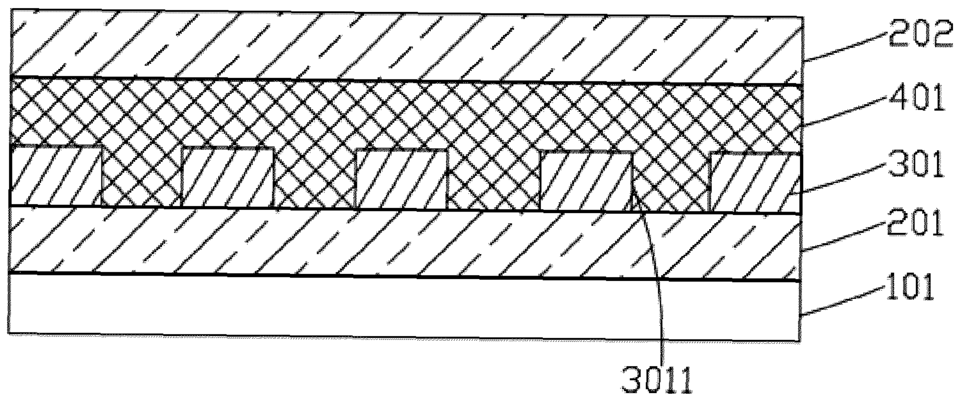

Fig. 1

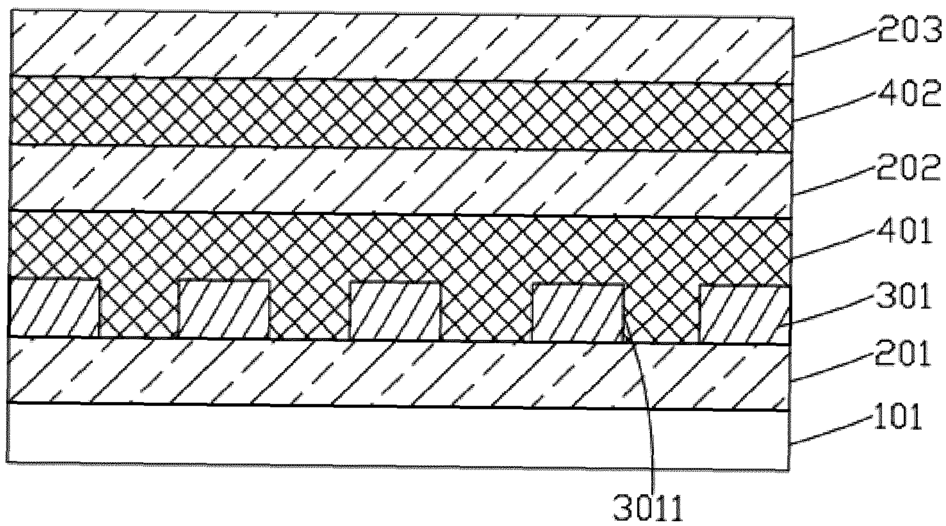

Fig. 2

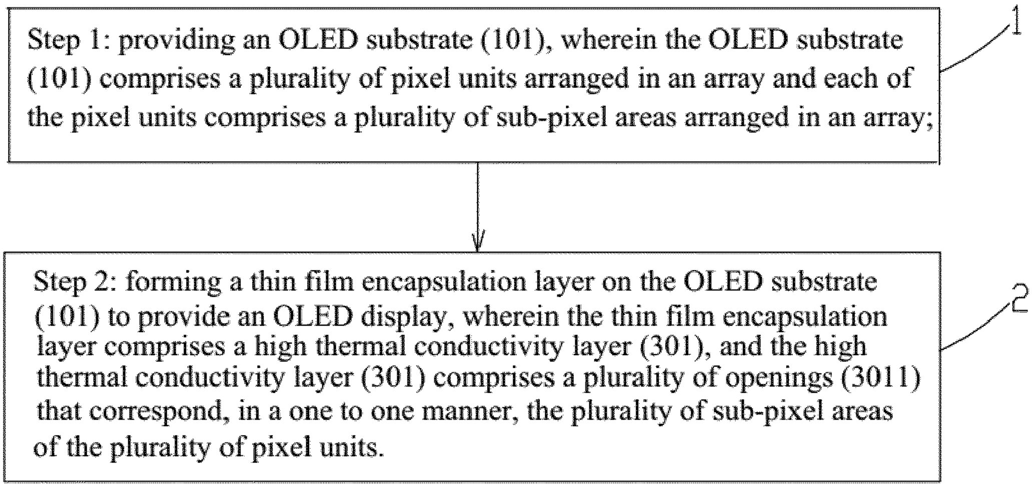

Fig. 3

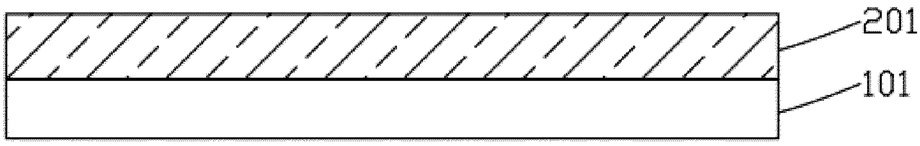

Fig. 4

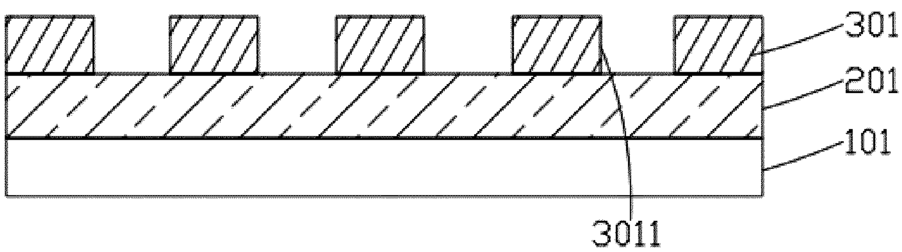

Fig. 5

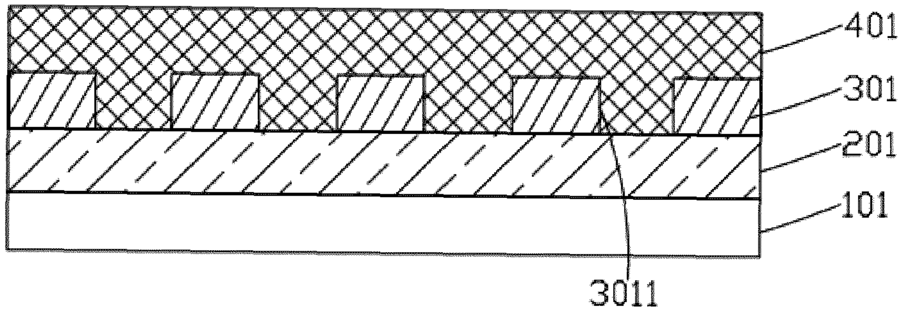

Fig. 6

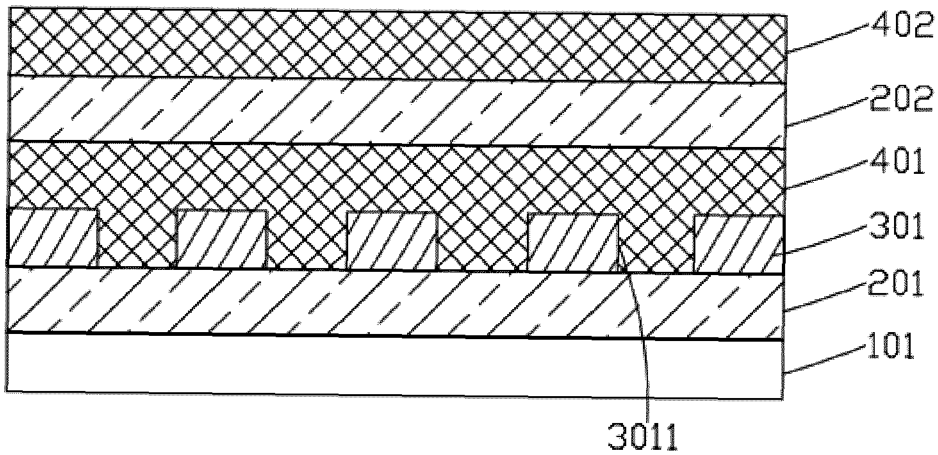

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/109572

A. CLASSIFICATION OF SUBJECT MATTER

H01L 27/32 (2006.01) i; H01L 51/52 (2006.01) i; H01L 51/56 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CPRSABS; DWPI; CNKI; BAIDU SCHOLAR: 导热, 传热, 热传导, 热导, 散热, 热散失, 热释放, 放热, 层, 膜, 口, 窗, 孔, 图案化, 镂空, 沟, 槽, 洞, 像素, OLED, 显示, 封装, 囊封, 包封, 密封, TFE, heat, thermal, dispers+, dissipat+, abstract+, emission, emit+, radiat+, eliminat+, remov+, discharg+, releas+, diffus +, spread+, conduct+, layer, film, sheet, trench+, groov+, opening, openings, aperture, apertures, hole, holes, concave?, hollow, recess+, window?, cavities, cavity, pattern+, pixel?, display, envelop+, encapsulat+, packag+, seal+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 202003622 U (SHIJIAZHUANG JINGHUA ELECTRONIC INDUSTRIAL CO., LTD.), 05 October 2011 (05.10.2011), entire document	1-13
A	CN 101562192 A (SHANGHAI UNIVERSITY), 21 October 2009 (21.10.2009), entire document	1-13
A	CN 105470409 A (BOE TECHNOLOGY GROUP CO., LTD. et al.), 06 April 2016 (06.04.2016), entire document	1-13
A	US 2003218421 A1 (PENG), 27 November 2003 (27.11.2003), entire document	1-13
A	JP 2007165735 A (DRILL CENT KK), 28 June 2007 (28.06.2007), entire document	1-13

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 June 2017	29 June 2017

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/109572

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JEONG, H.K. et al., "Metal-Containing Thin-1m Encapsulation with Exibility and Heat Transfer." Journal of Information Display., 09 June 2015 (09.06.2015), 16(2), pages 123-128	1-13

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/109572

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 202003622 U	05 October 2011	None	
CN 101562192 A	21 October 2009	None	
CN 105470409 A	06 April 2016	None	
US 2003218421 A1	27 November 2003	US 6833671 B2	21 December 2004
		JP 2004127705 A	22 April 2004
JP 2007165735 A	28 June 2007	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- US 20150188084 A **[0005]**
- US 20150153779 A **[0005]**
- US 20150079707 A **[0005]**

Non-patent literature cited in the description

- Journal of Information Display. Korea Institute of Science and Technology **[0007]**

patsnap

专利名称(译)	OLED显示装置及其制造过程		
公开(公告)号	[EP3531454A4]	公开(公告)日	2020-07-29
申请号	EP2016919480	申请日	2016-12-13
[标]申请(专利权)人(译)	武汉华星光电技术有限公司		
申请(专利权)人(译)	中国武汉恒星光电科技有限公司.		
当前申请(专利权)人(译)	中国武汉恒星光电科技有限公司.		
[标]发明人	JIN JIANGJIANG		
发明人	JIN, JIANGJIANG		
IPC分类号	H01L27/32 H01L51/52 H01L51/56		
CPC分类号	H01L27/32 H01L27/3246 H01L51/5237 H01L51/5253 H01L51/5256 H01L51/56 H01L27/1248 H01L27/1259 H01L27/3213 H01L51/529 H01L2251/30 H01L25/0753 H01L27/1214 H01L27/1251 H01L51/5296		
优先权	201610914584.2 2016-10-20 CN		
其他公开文献	EP3531454A1		
外部链接	Espacenet		

摘要(译)

提供了一种有机发光二极管(OLED)显示装置及其制造方法。 OLED显示装置包括OLED基板(101)和设置在OLED基板(101)上的薄膜封装层,其中薄膜封装层包括图案化的高导热层(301)和多个开口 (3011)在高导热层(301)上提供与OLED基板(101)上的多个子像素区域一一对应的结构,防止高导热层吸收光; 避免了仅能够使用具有高透射率的材料的顶部透射装置的限制。 结果,在不降低装置的发光效率的情况下,可以有效地传递由OLED装置在操作期间产生的热量,从而减少了OLED装置的材料的热分解,从而确保了该装置与外界湿气充分隔离。 氧气,并延长了设备的使用寿命。