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

(11) **EP 3 340 330 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
22.09.2021 Bulletin 2021/38

(21) Application number: **15894512.1**

(22) Date of filing: **11.12.2015**

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

(86) International application number:
PCT/CN2015/097123

(87) International publication number:
WO 2017/028412 (23.02.2017 Gazette 2017/08)

(54) **ORGANIC LIGHT-EMITTING DIODE DEVICE, MANUFACTURING METHOD, AND DISPLAY APPARATUS**

ORGANISCHE LICHTEMITTIERENDE VORRICHTUNG, HERSTELLUNGSVERFAHREN DAFÜR UND ANZEIGEVORRICHTUNG

DISPOSITIF À DIODE ÉLECTROLUMINESCENTE ORGANIQUE, PROCÉDÉ DE FABRICATION ET APPAREIL D'AFFICHAGE

(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

(30) Priority: **20.08.2015 CN 201510516240**

(43) Date of publication of application:
27.06.2018 Bulletin 2018/26

(73) Proprietors:
- **BOE Technology Group Co., Ltd.**
  Beijing 100015 (CN)
- **Hefei BOE Optoelectronics Technology Co., Ltd.**
  Hefei, Anhui 230012 (CN)

(72) Inventors:
- **LI, Rui**
  Beijing 100176 (CN)
- **XU, Dezhi**
  Beijing 100176 (CN)

(74) Representative: **Klunker IP**
Patentanwälte PartG mbB
Destouchesstraße 68
80796 München (DE)

(56) References cited:
EP-A2- 2 348 789
CN-A- 103 545 463
CN-A- 103 887 446
CN-A- 103 887 446
CN-A- 104 300 091
CN-A- 105 140 417
US-A1- 2010 019 664
US-A1- 2012 256 202
US-A1- 2012 256 202

EP 3 340 330 B1

Description

TECHNICAL FIELD

[0001] The present invention relates to an organic light-emitting diode (OLED) display device, a manufacturing method thereof and a display device.

BACKGROUND

[0002] The OLED display technology has become the next generation of display technology with broad prospect for development due to the advantages of light weight, thin profile, wide viewing angle, autoluminescence, continuous and adjustable luminous color, low cost, rapid response speed, low power consumption, low driving voltage, wide operating temperature range, simple manufacturing technique, high luminous efficiency, flexible display, etc.

[0003] Researches have indicated that components such as moisture and oxygen in the air have large influence on the service life of OLED devices in OLED displays. The reasons include that: in the operating process of an OLED device, electrons must be injected from a cathode; the work function of the cathode is required to be the lower the better; but the cathode is generally made from a metallic material such as aluminum, magnesium or calcium, has active chemical properties, and tends to react with penetrated moisture and oxygen; in addition, moisture and oxygen also tends to undergo chemical reaction with a hole transport layer (HTL) and an electron transport layer (ETL) of the OLED device, and the reactions will result in the failure of the OLED device. Therefore, if the OLED device is effectively encapsulated, so that functional layers of the OLED device can be fully isolated from the components such as moisture and oxygen in the air, and hence the service life of the OLED device can be greatly prolonged, and consequently the service life of the OLED display can be prolonged.

[0004] Accordingly, there is a need to improve the moisture and oxygen resistance of the OLED device.

[0005] EP 2348789A2 describes a barrier film composite including a film with an undulating surface and at least one decoupling layer disposed on the undulating surface of the film.

[0006] CN 103887446A describes an encapsulation structure including a buffer layer between a device substrate and an adhesive film, wherein one side, in contact with the adhesive film, of the buffer layer is provided with an uneven surface.

[0007] US 2010/0019664 A1 describes an OLED panel including an inorganic layer on the OLED device, wherein the inorganic layer comprises a concave-convex structure at an outermost surface on a light extraction side.

[0008] US 2012/0256202 A1 describes an OLED display including an encapsulation layer which comprises an organic layer and an inorganic layer.

SUMMARY

[0009] It is an objective of the present invention to provide an OELD device, a manufacturing method thereof and a display device, so as to reduce the damage of moisture and oxygen in the air on the OLED device and improve the moisture and oxygen resistance of the OLED device.

[0010] The object is achieved by the features of the respective independent claims. Further embodiments are defined in the corresponding dependent claims.

[0011] Embodiments of the present disclosure provide an OLED device, a manufacturing method thereof and a display device as described in respective claims 1, 8, 10.

[0012] As the concave-convex structure is provided on the surface of the encapsulation layer, the concave-convex structure on the surface of an inorganic layer will increase the surface area of the inorganic layer and hence improve the moisture and oxygen resistance; the concave-convex structure on the surface of an organic layer will increase the contact area between the organic layer and the inorganic layer, improve the bonding effect, and meanwhile improve the water resistance of the organic layer as the organic layer has water absorption. Therefore, compared with the state of art, the proposal can reduce the damage caused by moisture and oxygen in the air on the OLED device and improve the moisture and oxygen resistance of the OLED device.

[0013] In some embodiments, the at least two encapsulation layers include an organic layer and an inorganic layer which are alternately arranged.

[0014] The alternative design of the organic layer and the inorganic layer fully utilizes the superior moisture and oxygen resistance of the inorganic layer, and the organic layer therein has water absorption and can have good bonding effect between the OLED device and the inorganic layer.

[0015] The design of one organic layer and one inorganic layer can achieve good waterproof effect. The superimposition of a plurality of layers can satisfy high waterproof requirement in the case of long-term use in harsh and humid environment, but will result in transmittance loss. As the organic layer does not require etching process and hence there is no risk of damaging the OLED in the forming process, the organic layer makes direct contact with the OLED.

[0016] In some embodiments, the thickness of the organic layer is 1 - 2μm, and the thickness of the inorganic layer is 0.1 - 1 μm.

[0017] An overly thin inorganic layer may suffer from the risk of being etched through in the process of etching the concave-convex structure, and an overly thick inorganic layer will waste materials. The thickness of the inorganic layer must be adjusted according to product requirements in specific product design processes.

[0018] In some embodiments, the organic layer includes a polyacrylate organic layer.

[0019] In some embodiments, the inorganic layer in-

cludes a silicon nitride inorganic layer or a silicon oxynitride inorganic layer.

[0020] In some embodiments, the bonding layer is a thermosetting material bonding layer. In some embodiments, the thermosetting material bonding layer includes a thermosetting phenolic resin bonding layer or an ultraviolet (UV) curing adhesive bonding layer.

[0021] In some embodiments, the polyacrylate organic layer is made from negative polyacrylate materials. Thermosetting phenolic resin materials can be gradually hardened and molded by chemical reaction after heating and cannot be softened after secondary heating. UV curing adhesive can absorb UV energy under UV irradiation and generate active free radicals or cations, so that the bonding layer can be finally cured after a series of chemical reactions.

[0022] In some embodiments, the first substrate and/or the second substrate are flexible substrates. In some embodiments, the flexible substrate includes a polybutylene terephthalate (PBT) substrate or a polyethylene terephthalate (PET) substrate.

[0023] The substrate may be a flexible substrate and is applied to a flexible display device. The material of the flexible substrate is not limited and, for instance, may include at least one selected from the group consisting of polyimide, polycarbonate, polyacrylate, polyetherimide, polyether sulfone, PET or polyethylene naphthalate (PEN). In addition, the substrate may also be a common rigid substrate, e.g., a glass substrate and a resin substrate.

[0024] The concave-convex structure can increase the contact area between the encapsulation layers and between the encapsulation layer and the bonding layer, and can improve the moisture and oxygen resistance and enhance the bonding effect.

[0025] The embodiment of the present disclosure further provides a method for manufacturing an OLED device as described in claim 8.

[0026] In the technical proposal of the method embodiment, as the concave-convex structure is formed on the surface of the encapsulation layer, the concave-convex structure on the surface of an inorganic layer will increase the surface area of the inorganic layer and hence improve the moisture and oxygen resistance; the concave-convex structure on the surface of an organic layer will increase the contact area between the organic layer and the inorganic layer, improve the bonding effect, and meanwhile improve the water resistance of the organic layer as the organic layer has water absorption. Therefore, compared with the state of art, the proposal can reduce the damage of moisture and oxygen in the air on the OLED device and improve the moisture and oxygen resistance of the OLED dcvice.

[0027] The alternative design of the organic layer and the inorganic layer can fully utilize the superior moisture and oxygen resistance of the inorganic layer, and the organic layer therein has water absorption and can have good bonding function between the OLED device and the inorganic layer.

[0028] The embodiment of the present disclosure further provides a display device as described in claim 10. As the moisture and oxygen resistance of the OLED device is improved, the display device has good product quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In order to clearly illustrate the technical solution of the embodiments of the disclosure, the drawings of the embodiments will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the disclosure and thus are not limitative of the disclosure.

FIG. 1 is a schematic diagram of an OLED device provided by an embodiment of the present disclosure;

FIG. 2 is a flowchart of a method for manufacturing an OLED device provided by an embodiment of the present disclosure; and

FIG. 3 is a flowchart of a process for forming a concave-convex structure of an encapsulation layer of the OLED device provided by the embodiment of the present disclosure.

DETAILED DESCRIPTION

[0030] In order to make objects, technical details and advantages of the embodiments of the disclosure apparent, the technical solutions of the embodiments will be described in a clearly and fully understandable way in connection with the drawings related to the embodiments of the disclosure. Apparently, the described embodiments are just a part but not all of the embodiments of the disclosure. Based on the described embodiments herein, those skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the disclosure.

[0031] In order to improve the moisture and oxygen resistance of an OLED device, embodiments of the present disclosure provide an OLED device, a manufacturing method thereof and a display device. In the technical proposal of the embodiment of the present disclosure, as a concave-convex structure is designed on the surface of the encapsulation layer, the concave-convex structure on a surface of an inorganic layer will increase the surface area of the inorganic layer and hence improve the moisture and oxygen resistance; the concave-convex structure on the surface of an organic layer will increase the contact area between the organic layer and the inorganic layer, improve the bonding effect, and also improve the water resistance of the organic layer as the organic layer has water absorption. Therefore, compared with the related art, the proposal can reduce the damage of moisture and oxygen in the air on the OLED device and improve the moisture and oxygen resistance of the OLED

device.

[0032] Further detailed description will be given below to the present disclosure with reference to the following embodiments for more clear understanding of the objective, the technical proposals and the advantages of the present disclosure.

[0033] As illustrated in FIG. 1, the embodiment of the present disclosure provides an OLED device, which comprises: a first substrate 1, an OLED 2 disposed on the first substrate 1, an encapsulation layer disposed on the OLED 2, a bonding layer 5 disposed on the encapsulation layer, and a second substrate 6 disposed on the bonding layer 5; a concave-convex structure is formed on at least one surface of the encapsulation layer.

[0034] As illustrated in FIG. 1, in the technical proposal of the embodiment of the present disclosure, the encapsulation layer includes an organic layer 3 and an inorganic layer 4. But in actual application, the encapsulation layer may include, in an example not forming part of the claimed invention, the organic layer only or the inorganic layer only or may also include, in an embodiment of the claimed invention, a plurality of layers formed by the alternative design of the organic layers and the inorganic layers. The alternative design of the organic layers and the inorganic layers fully utilizes the superior moisture and oxygen resistance of the inorganic layer, and the organic layer therein has capability of water absorption and can have good bonding function between the OLED device and the inorganic layer.

[0035] As illustrated in FIG. 1, the encapsulation layer of the OLED device includes an organic layer 3 disposed on the OLED and an inorganic layer 4 disposed on the organic layer 3; a concave-convex structure is formed on the upper surface of the organic layer 3; a concave-convex structure is formed on both the upper surface and the lower surface of the inorganic layer 4; and the concave-convex structure on the upper surface of the organic layer is engaged or coupled with the concave-convex structure on the lower surface of the inorganic layer. As the inorganic layer is directly formed on the organic layer, the concave-convex structure engaged with the upper surface of the organic layer will be formed on the lower surface of the inorganic layer.

[0036] The design of one organic layer plus one inorganic layer can achieve good waterproof effect. The stack of a plurality of layers can satisfy high waterproof requirement in the case of long-term use in harsh and humid environment, but may bring about transmittance loss. As the organic layer does not require etching process and there is no risk of damaging the OLED in the forming process, the organic layer makes direct contact with the OLEDs.

[0037] In the technical proposal of the embodiment of the present disclosure, the thickness of the organic layer is 1 μm - 2 μm, and the thickness of the inorganic layer is 0.1 μm - 1 μm.

[0038] An overly thin organic or inorganic layer may suffer from the risk in the process of etching the concave-convex structure that the layer is etched through, while an overly thick organic or inorganic layer may bring about waste of raw material. The thickness of the organic or inorganic layer must be adjusted according to product requirements in a specific product design processes.

[0039] In the technical proposal of the embodiment of the present disclosure, the material of the organic layer may be polyacrylate series. In one embodiment, the material of the organic layer may be negative type polyacrylate series.

[0040] In the technical proposal of the embodiment of the present disclosure, the inorganic layer may be made from silicon nitride or silicon oxynitride materials.

[0041] In the technical proposal of the embodiment of the present disclosure, the bonding layer adopts a thermosetting material bonding layer which includes a thermosetting phenolic resin bonding layer or a UV curing adhesive bonding layer.

[0042] Thermosetting phenolic resin materials can be gradually hardened and molded by chemical reaction after heating and cannot be softened after secondary heating. UV curing adhesive can absorb UV energy under UV irradiation and generate active free radicals or cations, so that the bonding layer can be finally cured after a series of chemical reactions.

[0043] The first substrate and/or the second substrate may be flexible substrates and are applied in a flexible display device. The material of the flexible substrate is not limited herein and, for instance, may include at least one selected from the group consisting of polyimide, polycarbonate, polyacrylate, polyetherimide, polyether sulfone, PET or PEN. In the embodiment of the present disclosure, the material of the flexible substrate may adopt a PBT substrate or a PET substrate. In addition, the first substrate and the second substrate may also be a common rigid substrate, e.g., a glass substrate or a resin substrate. The materials of the first substrate and the second substrate are not limited. For instance, in some embodiments, the first substrate may be a flexible substrate and the second substrate is a rigid substrate; or in some embodiments, the first substrate is a rigid substrate and the second substrate is a flexible substrate; or in some embodiments, both the first substrate and the second substrate are flexible substrates or rigid substrates.

[0044] As illustrated in FIG. 1, the concave-convex structure formed on the encapsulation layer is a square sectional concave-convex structure, but is not limited thereto in practical conditions. The concave-convex structure may also be, in an example not forming part of the claimed invention, a wavy sectional concave-convex structure, or, according to an embodiment of the claimed invention, a zigzag sectional concave-convex structure. The concave-convex structure can increase the contact area between the encapsulation layers and between the encapsulation layer and the bonding layer and can improve the moisture and oxygen resistance and enhance the bonding effect.

[0045] The embodiment further provides a method for

manufacturing an OLED device, which, as shown in FIG. 2, comprises the following steps:

S101: forming OLEDs on a first substrate;
S102: forming at least one encapsulation layer on the OLEDs, in which a concave-convex structure is formed on at least one surface of the encapsulation layer;
S103 : forming a bonding layer on the at least one encapsulation layer; and
S104: bonding the second substrate with the bonding layer.

[0046] In the technical proposal of the embodiment of the present disclosure, the process of manufacturing the OLED device as shown in FIG. 1 must include the following steps: firstly, forming the organic layer by coating an organic film on the OLEDs, and forming the concave-convex structure on the organic layer; secondly, depositing one layer of inorganic substances on the surface of the organic layer by plasma enhanced chemical vapor deposition (PECVD), and forming the concave-convex structure on the upper surface of the inorganic layer; and finally, coating one layer of adhesive film (bonding layer) on the inorganic layer and bonding the first substrate and the second substrate after the curing of the adhesive film.

[0047] In some embodiments, the step of forming the at least one encapsulation layer on the OLEDs includes: forming a concave-convex structure on an upper surface of the encapsulation layer.

[0048] In the technical proposal of the embodiment of the present disclosure, the required concave-convex structure is obtained after performing soft baking, exposure and development processes on the OLED device coated with the organic film. The process of forming the concave-convex structure on the surface of the inorganic layer must include the following steps: firstly, coating photoresist on the surface of the inorganic layer and performing exposure and development; and secondly, etching the inorganic layer not covered by the photoresist by a dry etching process. Of course, the process of forming the concave-convex structure may also adopt other patterning processes such as a laser engraving process.

[0049] In some embodiments, the step of forming the concave-convex structure on the upper surface of the encapsulation layer specifically includes the following steps (as shown in FIG. 3):

S105: forming an organic layer on the OLEDs;
S106: forming a concave-convex structure on an upper surface of the organic layer by exposure and development processes;
S107: forming an inorganic layer on a surface of the organic layer; and
S108: forming a concave-convex structure on an upper surface of the inorganic layer by etching process.

[0050] In the technical proposal of the embodiment of the present disclosure, as a concave-convex structure is formed on the surface of the encapsulation layer, the concave-convex structure on a surface of an inorganic layer will increase the surface area of the inorganic layer and hence improve the moisture and oxygen resistance; the concave-convex structure formed on the surface of an organic layer will increase the contact area between the organic layer and the inorganic layer, improve the bonding effect, and meanwhile improve the water resistance of the organic layer as the organic layer has water absorption. Therefore, compared with the state of art, the proposal can reduce the damage caused by moisture and oxygen in the air on the OLED device and improve the moisture and oxygen resistance of the OLED device.

[0051] The embodiment of the present disclosure further provides a display device, which comprises the OLED device provided by any foregoing technical proposal. As the moisture and oxygen resistance of the OLED device is improved, the display device has good product quality. The type of the display device is not limited. The display device may be a common flat panel display device and may also be a flexible display device. The specific type of the display device may be a display, e-paper, a tablet PC, a TV, an intelligent display label, an intelligent display card, etc.

Claims

1. An organic light-emitting diode, OLED, device, comprising:

a first substrate (1);
an OLED (2) disposed on the first substrate (1);
at least two encapsulation layers disposed on the OLED (2);
a bonding layer (5) disposed on the at least two encapsulation layers; and
a second substrate (6) disposed on the bonding layer (5),
wherein the at least two encapsulation layers comprise an organic layer (3) disposed on the OLED (2) and an inorganic layer (4) disposed on the organic layer (3),
characterized in that
an upper surface of the organic layer (3), an upper surface and a lower surface of the inorganic layer (4) respectively comprise a concave-convex structure, and the organic layer (3) is in direct contact with the OLED (2);
the concave-convex structure of the upper surface of the organic layer (3) is coupled with the concave-convex structure on the lower surface of the inorganic layer (4); and
the concave-convex structure comprises a square sectional concave-convex structure or a zigzag sectional concave-convex structure.

2. The OLED device according to claim 1, wherein the at least two encapsulation layers comprise organic layers and inorganic layers which are alternately arranged.

3. The OLED device according to claim 1 or 2, wherein a thickness of the organic layer (3) is 1 - 2 μm, and a thickness of the inorganic layer (4) is 0.1-1 μm.

4. The OLED device according to claim 2 or 3, wherein the organic layer (3) includes a polyacrylate organic layer.

5. The OLED device according to any one of claims 2 to 4, wherein the inorganic layer (4) includes a silicon nitride inorganic layer or a silicon oxynitride inorganic layer.

6. The OLED device according to any one of claims 1 to 5, wherein the bonding layer (5) is a thermosetting material bonding layer which includes a thermosetting phenolic resin bonding layer or an ultraviolet, UV, curing adhesive bonding layer.

7. The OLED device according to any one of claims 1 to 6, wherein the first substrate (1) and/or the second substrate (6) is a flexible substrate which includes a polybutylene terephthalate, PBT, substrate or a polyethylene terephthalate, PET, substrate.

8. A method for manufacturing an organic light-emitting diode, OLED, device, comprising:

forming (S101) an OLED (2) on a first substrate (1);
forming at least two encapsulation layers on the OLED, comprising: forming (S105) an organic layer (3) disposed on the OLED and forming (S107) an inorganic layer (4) disposed on the organic layer (3);
forming (S103) a bonding layer (5) on the at least two encapsulation layers; and
bonding (S104) a second substrate (6) with the bonding layer (5),
characterized in that,
an upper surface of the organic layer (3), an upper surface and a lower surface of the inorganic layer (4) respectively comprise a concave-convex structure, and the organic layer (3) is in direct contact with the OLED (2);
the concave-convex structure of the upper surface of the organic layer (3) is coupled with the concave-convex structure of the lower surface of the inorganic layer (4); and
the concave-convex structure comprises a square sectional concave-convex structure or a zigzag sectional concave-convex structure.

9. The method for manufacturing the OLED device according to claim 8, wherein

the concave-convex structure of the upper surface of the organic layer (3) is formed by exposure and development processes; and
the concave-convex structure of the upper surface of the inorganic layer (4) is formed by etching process.

10. A display device, comprising the OLED device according to any one of claims 1 to 7.

Patentansprüche

1. Vorrichtung mit einer organischen lichtemittierenden Diode, OLED, aufweisend:

ein erstes Substrat (1);
eine OLED (2), die auf dem ersten Substrat (1) angeordnet ist;
mindestens zwei Verkapselungsschichten, die auf der OLED (2) angeordnet sind;
eine Verbindungsschicht (5), die auf den mindestens zwei Verkapselungsschichten angeordnet ist; und
ein zweites Substrat (6), das auf der Bindungsschicht (5) angeordnet ist,
wobei die mindestens zwei Verkapselungsschichten eine organische Schicht (3), die auf der OLED (2) angeordnet ist, und eine anorganische Schicht (4), die auf der organischen Schicht (3) angeordnet ist, aufweisen,
dadurch gekennzeichnet, dass
eine obere Fläche der organischen Schicht (3), eine obere Fläche und eine untere Fläche der anorganischen Schicht (4) jeweils eine konkav-konvexe Struktur aufweisen, und die organische Schicht (3) in direktem Kontakt mit der OLED (2) steht;
die konkav-konvexe Struktur der oberen Oberfläche der organischen Schicht (3) mit der konkav-konvexen Struktur auf der unteren Oberfläche der anorganischen Schicht (4) gekoppelt ist; und
die konkav-konvexe Struktur eine konkav-konvexe Struktur mit quadratischem Querschnitt oder eine konkav-konvexe Struktur mit zickzackförmigem Querschnitt aufweist.

2. OLED-Vorrichtung nach Anspruch 1, wobei die mindestens zwei Verkapselungsschichten organische Schichten und anorganische Schichten aufweisen, die abwechselnd angeordnet sind.

3. OLED-Vorrichtung nach Anspruch 1 oder 2, wobei die Dicke der organischen Schicht (3) 1 - 2 μm und

die Dicke der anorganischen Schicht (4) 0,1 - 1 μm beträgt.

4. OLED-Vorrichtung nach Anspruch 2 oder 3, wobei die organische Schicht (3) eine organische Polyacrylat-Schicht aufweist.

5. OLED-Vorrichtung nach einem der Ansprüche 2 bis 4, wobei die anorganische Schicht (4) eine anorganische Siliziumnitrid-Schicht oder eine anorganische Siliziumoxynitrid-Schicht aufweist.

6. OLED-Vorrichtung nach einem der Ansprüche 1 bis 5, wobei die Bindungsschicht (5) eine Bindungsschicht aus wärmehärtendem Material ist, die eine wärmehärtende Phenolharz-Bindungsschicht oder eine ultraviolett-, UV-, härtende Klebstoff-Bindungsschicht aufweist.

7. OLED-Vorrichtung nach einem der Ansprüche 1 bis 6, wobei das erste Substrat (1) und/oder das zweite Substrat (6) ein flexibles Substrat ist, das ein Polybutylenterephthalat (PBT)-Substrat oder ein Polyethylenterephthalat (PET)-Substrat aufweist.

8. Verfahren zur Herstellung einer organischen lichtemittierenden Diode (OLED), aufweisend:

Bilden (S101) einer OLED (2) auf einem ersten Substrat (1);
Bilden von mindestens zwei Verkapselungsschichten auf der OLED, aufweisend: Bilden (S105) einer organischen Schicht (3), die auf der OLED angeordnet ist, und Bilden (S107) einer anorganischen Schicht (4), die auf der organischen Schicht (3) angeordnet ist;
Bilden (S103) einer Verbindungsschicht (5) auf den mindestens zwei Verkapselungsschichten; und
Verbinden (S104) eines zweiten Substrats (6) mit der Verbindungsschicht (5),
dadurch gekennzeichnet, dass
eine obere Fläche der organischen Schicht (3), eine obere Fläche und eine untere Fläche der anorganischen Schicht (4) jeweils eine konkav-konvexe Struktur aufweisen, und die organische Schicht (3) in direktem Kontakt mit der OLED (2) steht;
die konkav-konvexe Struktur der oberen Oberfläche der organischen Schicht (3) mit der konkav-konvexen Struktur der unteren Oberfläche der anorganischen Schicht (4) gekoppelt ist; und
die konkav-konvexe Struktur eine konkav-konvexe Struktur mit quadratischem Querschnitt oder eine konkav-konvexe Struktur mit zickzackförmigem Querschnitt aufweist.

9. Verfahren zur Herstellung der OLED-Vorrichtung nach Anspruch 8, wobei

die konkav-konvexe Struktur der oberen Oberfläche der organischen Schicht (3) durch Belichtungs- und Entwicklungsprozesse gebildet wird; und
die konkav-konvexe Struktur der oberen Oberfläche der anorganischen Schicht (4) durch einen Ätzprozess gebildet wird.

10. Anzeigevorrichtung, aufweisend die OLED-Vorrichtung nach einem der Ansprüche 1 bis 7.

Revendications

1. Dispositif à diode électroluminescente organique, OLED, comprenant :

un premier substrat (1) ;
une OLED (2) qui est disposée sur le premier substrat (1) ;
au moins deux couches d'encapsulation qui sont disposées sur l'OLED (2) ;
une couche de liaison (5) qui est disposée sur les au moins deux couches d'encapsulation ; et un second substrat (6) qui est disposé sur la couche de liaison (5),
dans lequel les au moins deux couches d'encapsulation comprennent une couche organique (3) qui est disposée sur l'OLED (2) et une couche inorganique (4) qui est disposée sur la couche organique (3),
caractérisé en ce que :

une surface supérieure de la couche organique (3), une surface supérieure et une surface inférieure de la couche inorganique (4) comprennent respectivement une structure concave - convexe, et la couche organique (3) est en contact direct avec l'OLED (2) ;
la structure concave - convexe de la surface supérieure de la couche organique (3) est couplée avec la structure concave - convexe de la surface inférieure de la couche inorganique (4) ; et
la structure concave - convexe comprend une structure concave - convexe présentant une section en coupe carrée ou une structure concave - convexe présentant une section en coupe en zigzag.

2. Dispositif à OLED selon la revendication 1, dans lequel les au moins deux couches d'encapsulation comprennent des couches organiques et des couches inorganiques qui sont agencées en alternance

3. Dispositif à OLED selon la revendication 1 ou 2, dans lequel une épaisseur de la couche organique (3) est comprise entre 1 et 2 μm, et une épaisseur de la couche inorganique (4) est comprise entre 0,1 et 1 μm.

4. Dispositif à OLED selon la revendication 2 ou 3, dans lequel la couche organique (3) inclut une couche organique en polyacrylate.

5. Dispositif à OLED selon l'une quelconque des revendications 2 à 4, dans lequel la couche inorganique (4) inclut une couche inorganique en nitrure de silicium ou une couche inorganique en oxynitrure de silicium.

6. Dispositif à OLED selon l'une quelconque des revendications 1 à 5, dans lequel la couche de liaison (5) est une couche de liaison en un matériau thermodurcissable, laquelle couche inclut une couche de liaison en une résine phénolique thermodurcissable ou une couche de liaison en un adhésif durcissable aux ultraviolets, UV.

7. Dispositif à OLED selon l'une quelconque des revendications 1 à 6, dans lequel le premier substrat (1) et/ou le second substrat (6) sont/est un substrat souple, lequel substrat inclut un substrat en téréphtalate de polybutylène, PBT, ou un substrat en téréphtalate de polyéthylène, PET.

8. Procédé pour fabriquer un dispositif à diode électroluminescente organique, OLED, comprenant :

la formation (S101) d'une OLED (2) sur un premier substrat (1) ;
la formation d'au moins deux couches d'encapsulation sur l'OLED, comprenant : la formation (S105) d'une couche organique (3) qui est disposée sur l'OLED et la formation (S107) d'une couche inorganique (4) qui est disposée sur la couche organique (3) ;
la formation (S103) d'une couche de liaison (5) sur les au moins deux couches d'encapsulation ; et
la liaison (S104) d'un second substrat (6) avec la couche de liaison (5),
caractérisé en ce que :

une surface supérieure de la couche organique (3), une surface supérieure et une surface inférieure de la couche inorganique (4) comprennent respectivement une structure concave - convexe, et la couche organique (3) est en contact direct avec l'OLED (2) ;
la structure concave - convexe de la surface supérieure de la couche organique (3) est couplée avec la structure concave - convexe de la surface inférieure de la couche inorganique (4) ; et
la structure concave - convexe comprend une structure concave - convexe présentant une section en coupe carrée ou une structure concave - convexe présentant une section en coupe en zigzag.

9. Procédé pour fabriquer le dispositif à OLED selon la revendication 8, dans lequel :

la structure concave - convexe de la surface supérieure de la couche organique (3) est formée au moyen de processus d'exposition et de développement ; et
la structure concave - convexe de la surface supérieure de la couche inorganique (4) est formée au moyen d'un processus de gravure.

10. Dispositif d'affichage, comprenant le dispositif à OLED selon l'une quelconque des revendications 1 à 7.

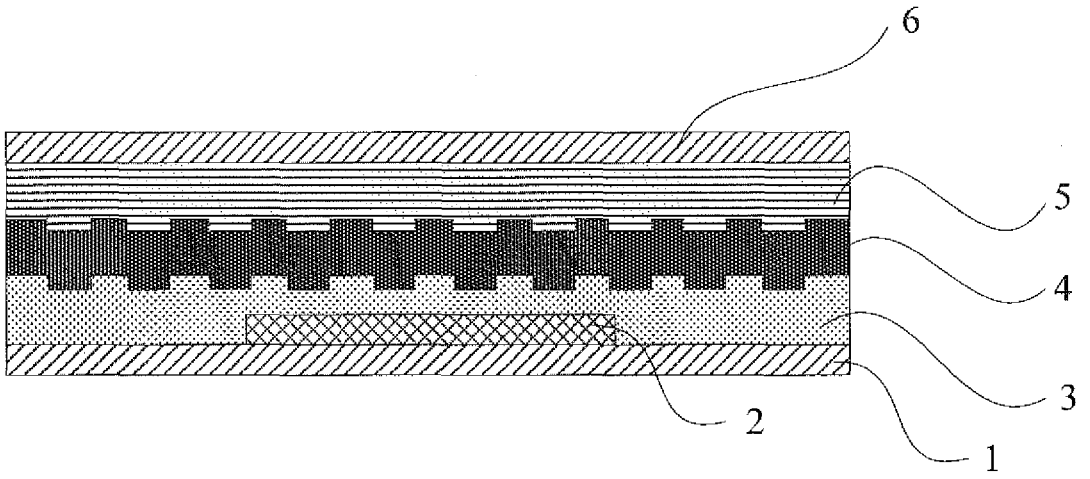
6
5
4
3
2
1

FIG. 1

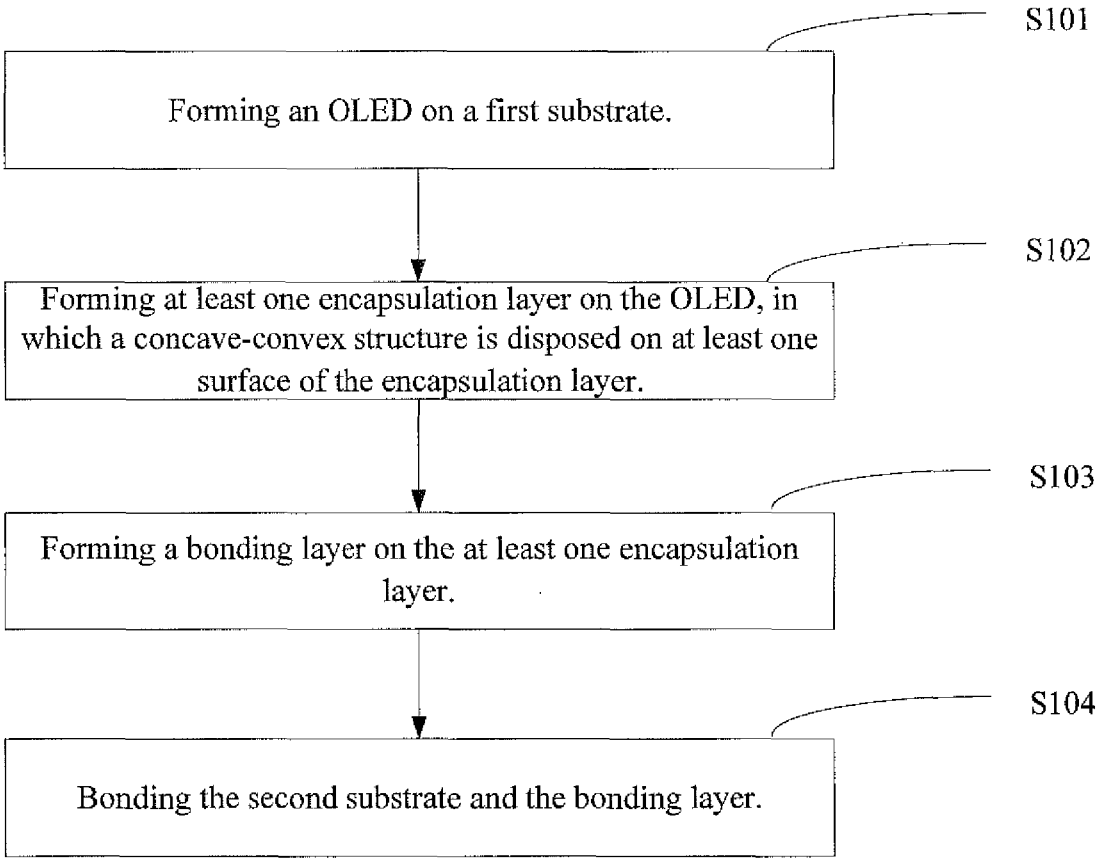
S101
Forming an OLED on a first substrate.
S102
Forming at least one encapsulation layer on the OLED, in which a concave-convex structure is disposed on at least one surface of the encapsulation layer.
S103
Forming a bonding layer on the at least one encapsulation layer.
S104
Bonding the second substrate and the bonding layer.

FIG. 2

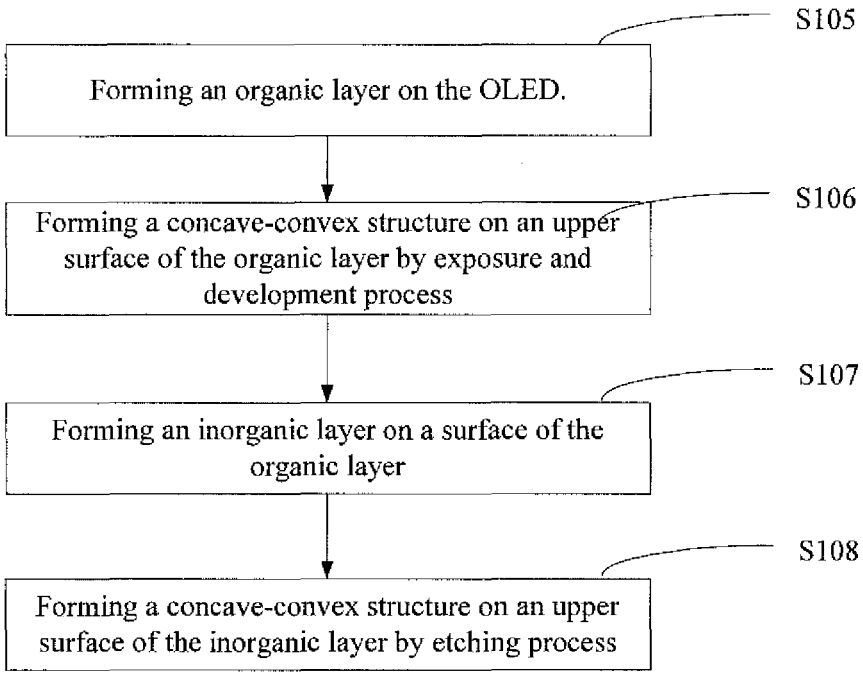
S105
Forming an organic layer on the OLED.
S106
Forming a concave-convex structure on an upper surface of the organic layer by exposure and development process
S107
Forming an inorganic layer on a surface of the organic layer
S108
Forming a concave-convex structure on an upper surface of the inorganic layer by etching process

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2348789 A2 **[0005]**
- CN 103887446 A **[0006]**
- US 20100019664 A1 **[0007]**
- US 20120256202 A1 **[0008]**