United States Patent Application Publication	20250261546
Kind Code	A1
Publication Date	August 14, 2025
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DISPLAY PANEL AND DISPLAY DEVICE

Abstract

An embodiment of the present application provides a display panel, including: a substrate; a first film layer arranged on one side of the substrate and defining at least one pixel opening in an enclosing manner, the pixel opening including a bottom portion and a side wall arranged on a peripheral side of the bottom portion; a first electrode layer located at the bottom portion of the pixel opening; a reflective layer located on a side of the first film layer away from the substrate and covering at least the side wall; a light-emitting functional layer arranged on a side of the first electrode layer away from the substrate; and a second electrode layer arranged on a side of the light-emitting functional layer away from the substrate.

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Appl. No.: **19/193889**

Filed: **April 29, 2025**

Foreign Application Priority Data

CN	202410740606.2	Jun. 07, 2024

Publication Classification

Int. Cl.: **H10K59/80** (20230101); **H10K59/122** (20230101)

U.S. Cl.:

CPC **H10K59/879** (20230201); **H10K59/122** (20230201);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to Chinese Patent Application No. 202410740606.2, filed on Jun. 7, 2024 and entitled “DISPLAY PANEL AND DISPLAY DEVICE”, the disclosure of which is incorporated herein by reference in its entirety.

FIELD

[0002] The present application relates to the field of display, and in particular to a display panel and a display device.

BACKGROUND

[0003] In a display device, an organic light emitting diode (OLED) device is a device that uses a multi-layer organic thin film structure to generate electroluminescence, and has the advantages of light weight, high brightness, low power consumption, fast response, large angle of view, etc. With the wide application of OLED devices, the requirements for display of the OLED devices are increasingly high. However, there are still some problems with the display of OLED devices.

SUMMARY

[0004] In view of this, embodiments of the present application provide a display panel and a display device, in order to improve the light extraction efficiency.

[0005] In a first aspect, an embodiment of the present application provides a display panel, including: a substrate; a first film layer arranged on one side of the substrate and defining at least one pixel opening in an enclosing manner, the pixel opening including a bottom portion and a side wall arranged on a peripheral side of the bottom portion; a first electrode layer located at the bottom portion of the pixel opening; a reflective layer located on a side of the first film layer away from the substrate and covering at least the side wall; a light-emitting functional layer arranged on a side of the first electrode layer away from the substrate; and a second electrode layer arranged on a side of the light-emitting functional layer away from the substrate.

[0006] In a second aspect, an embodiment of the present application provides a display device, including: a display panel described above.

[0007] In the above embodiments, a reflective layer is provided on the side wall, so that when large-angle light emitted by the light-emitting functional layer directly irradiates the side wall or is reflected and then irradiates the side wall, the reflective layer located on the side wall can reflect the light irradiating the side wall to change the angle of the light so as to convert the large-angle light into small-angle light that can be emitted smoothly when irradiating an encapsulation layer, thereby improving the light extraction efficiency.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a structural schematic diagram of a display panel according to an embodiment of the present application.

[0009] FIG. **2** is a top view of a first film layer of the display panel shown in FIG. **1**.

[0010] FIG. **3** is a structural schematic diagram of a display panel according to another embodiment of the present application.

[0011] FIG. **4** is a structural schematic diagram of a display panel according to yet another

embodiment of the present application.
[0012] FIG. **5** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0013] FIG. **6** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0014] FIG. **7** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0015] FIGS. **8**A and **8**B are structural schematic diagrams of a display panel according to yet another embodiment of the present application, respectively.
[0016] FIG. **9** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0017] FIG. **10** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0018] FIG. **11** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0019] FIG. **12** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0020] FIG. **13** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0021] FIG. **14** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0022] FIG. **15** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0023] FIG. **16** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0024] FIG. **17** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0025] FIG. **18** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0026] FIG. **19** is a structural schematic diagram of a display panel according to yet another embodiment of the present application.
[0027] FIG. **20** is a flowchart of a method for preparing a display panel according to an embodiment of the present application.
[0028] FIG. **21** is a flowchart of a method for preparing a display panel according to yet another embodiment of the present application.
[0029] FIG. **22** is a structural schematic diagram of a display device according to yet another embodiment of the present application.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0030] A display panel has a film layer arrangement including a light-emitting device layer, an encapsulation layer, a touch layer, a protective layer, a polarizer and a cover plate. The light-emitting device layer includes an anode, a light-emitting functional layer and a cathode which are sequentially stacked. The light-emitting functional layer includes a hole injection layer (HIL), a hole transport layer (HTL), an electron block layer (EBL), an emission layer (EML), a hole block layer (HBL), an electron transport layer (ETL) and an electron injection layer (EIL) which are sequentially stacked. The encapsulation layer includes a first inorganic layer, an organic layer and a second inorganic layer. The first inorganic layer and the second inorganic layer are formed by a chemical vapor deposition (CVD) process, and the organic layer is formed by an ink jet printing (IJP) process. The first inorganic layer is made of a high-refractive index material, the organic layer is made of a low-refractive index material, a refractive index of the organic layer is less than a refractive index of the first inorganic layer, and most of the light ray emitted by the light-emitting device layer is subjected to total reflection at an interface between the first inorganic layer and the organic layer and is thus confined in a waveguide mode, resulting in a low light extraction efficiency.

[0031] Embodiments of the present application provide a display panel and a method for preparing same, and a display device, which can extract most of the light emitted by the light-emitting device layer, thereby improving the light extraction efficiency.

[0032] FIG. **1** is a structural schematic diagram of a display panel according to an embodiment of the present application. As shown in FIG. **1**, the display panel includes a substrate **70**, a first film layer **110**, a reflective layer **30**, a first electrode layer **201**, a light-emitting functional layer **202** and a second electrode layer **203**.

[0033] FIG. **2** is a top view of a first film layer of the display panel shown in FIG. **1**. As shown in FIGS. **1** and **2**, the first film layer **110** is arranged on one side of the substrate **70**, the first film layer **110** defines at least one pixel opening in an enclosing manner, and a pixel opening includes a bottom portion **112** and a side wall **111** arranged on a peripheral side of the bottom portion **112**. In one embodiment, the side wall **111** is a straight line or an arc in a cross section along a direction perpendicular to the substrate. For reasons of processes, with respect to the cross section along the direction perpendicular to the substrate, it is impossible to ensure the side wall **111** to be completely straight, and the side wall **111** is usually an arc (as shown in FIG. **8**B). Regardless of whether the side wall is a straight line or an arc, an angle α between the bottom portion **112** and the side wall **111** is an obtuse angle. In this case, when light irradiates the side wall **111**, an emergence angle of the light irradiating the side wall **111** can be changed.

[0034] In the case of the side wall being straight, the obtuse angle is greater than or equal to 135° and less than or equal to 145°. For example, the obtuse angle may be any one of 135°, 138°, 140°, 142° and 145°. Since the angle α between the bottom portion **112** and the side wall **111** is an obtuse angle, the emergence angle of the light irradiating the side wall **111** can be changed.

[0035] The first film layer **110** includes a first region L**1** located between the side wall **111** and the substrate **70** and a second region L**2** surrounding the pixel opening, an orthographic projection of the first region L**1** on the substrate **70** overlapping with an orthographic projection of the side wall **111** on the substrate **70**. In the embodiments of the present application, the first film layer **110** is a pixel defining layer. A maximum thickness of the first film layer **110** in the direction perpendicular to the substrate **70** is greater than or equal to 1 μm and less than or equal to 2 μm. For example, the maximum thickness of the first film layer **110** may be any one of 1 μm, 1.3 μm, 1.5 μm, 1.8 μm and 2 μm.

[0036] In one embodiment, as shown in FIG. **3**, the display panel further includes a sixth film layer **120** arranged on a side of the first film layer **110** close to the substrate **70**. The sixth film layer **120** is a planarization layer. The sum of the maximum thickness of the first film layer **110** and a maximum thickness of the sixth film layer **120** in the direction perpendicular to the substrate **70** is greater than or equal to 4 μm and less than or equal to 5 μm. For example, the sum of the maximum thickness of the first film layer **110** and the maximum thickness of the sixth film layer **120** may be any one of 4 μm, 4.2 μm, 4.5 μm, 4.8 μm and 5 μm. The first film layer **110** and the sixth film layer **120** in the figures are only for illustration and are not drawn to scale.

[0037] The first film layer **110** and/or the sixth film layer **120** are/is made of an organic material. In one embodiment, the first film layer **110** and the sixth film layer **120** are made of the same material. In one embodiment, the first film layer **110** and the sixth film layer **120** are prepared synchronously. Specifically, a pixel opening is directly formed in the organic material layer, the organic material layer located at the bottom portion of the pixel opening is the sixth film layer **120** (i.e., the planarization layer), and the organic material layer surrounding the peripheral side of the pixel opening is the first film layer **110** (i.e., the pixel defining layer). In the embodiments of the present application, the pixel defining layer and the planarization layer are formed in one procedure, which simplifies the preparation process and reduces the number of masks required. In one embodiment, the pixel opening may be formed by laser etching, photoetching, chemical dry etching, halftone process, etc., which are not limited in the present application. For example, the organic material layer may be exposed for hole formation by means of a halftone process to form the pixel opening. The pixel opening is formed by forming a hole in the organic material layer, the sixth film layer **120** located at the bottom portion of the pixel opening is equivalent to a planarization layer, and the first film layer **110** surrounding the peripheral side of the pixel opening is equivalent to a pixel defining layer. The circular pixel opening in the embodiments of the present application is only exemplary. The shape of the pixel opening may be adjusted according to actual requirements. For example, the pixel opening may be square, elliptical, triangular, etc.

[0038] Still referring to FIGS. **1** and **3**, the first electrode layer **201** is located at the bottom portion **112** of the pixel opening. The first electrode layer **201** is electrically connected to a pixel circuit in an array film layer (not shown). In one embodiment, the first electrode layer **201** includes a reflective electrode material to reflect the light irradiating the bottom portion **112**, which ensures emission of light from above the pixel opening (i.e., top emission), thereby improving the light extraction efficiency. In one embodiment, the first electrode layer **201** may be a metal layer, and for example, the first electrode layer **201** may be prepared from silver, gold, platinum, etc.; or the first electrode layer **201** may be of a stacked structure that includes a metal and a conductive oxide. For example, the metal may be silver (Ag), and the conductive oxide may be indium tin oxide (ITO). In the embodiments of the present application, the stacked structure includes indium tin oxide/silver/indium tin oxide (ITO/Ag/ITO).

[0039] The reflective layer **30** is located on a side of the first film layer **110** away from the substrate **70**, and the reflective layer **30** covers at least the side wall **111**. The reflective layer **30** may be a metal layer. For example, the reflective layer **30** may be prepared from silver, gold, platinum, etc. In one embodiment, the reflective layer **30** may be of a stacked structure that includes metal and conductive oxide. In one embodiment, the stacked structure includes indium tin oxide/silver/indium tin oxide.

[0040] The light-emitting functional layer **202** is arranged on a side of the first electrode layer **201** away from the substrate **70**. The light-emitting functional layer **202** may include a hole injection layer, a hole transport layer, an electron block layer, an emission layer, a hole block layer, an electron transport layer and an electron injection layer, which are sequentially stacked. In the embodiments of the present application, the light-emitting functional layer **202** may be prepared by an evaporation process. In one embodiment, the light-emitting functional layer **202** covers the first electrode layer **201** and the first region L**1** and the second region L**2** of the first film layer **10**, that is, the light-emitting functional layer **202** may be prepared integrally, thereby simplifying the preparation process.

[0041] The second electrode layer **203** is arranged on a side of the light-emitting functional layer **202** away from the substrate **70**. In the embodiments of the present application, the first electrode layer **201** is an anode, and the second electrode layer **203** is a cathode; or the first electrode layer **201** is a cathode, and the second electrode layer **203** is an anode. In one embodiment, the second electrode layer **203** covers the first electrode layer **201** and the first region L**1** and the second region L**2** of the first film layer **10**, that is, the second electrode layer **203** may be prepared integrally, thereby simplifying the preparation process.

[0042] In the embodiments of the present application, the reflective layer **30** is arranged on the side wall **111**, and the angle α between the side wall **111** and the bottom portion **112** is the obtuse angle, so that when large-angle light emitted by the light-emitting functional layer **202** directly irradiates the side wall **111** or is reflected and then irradiates the side wall, the reflective layer **30** located on the side wall can reflect the light irradiating the side wall **111** to change the angle of light to convert the large-angle light into small-angle light that can be emitted smoothly when irradiating an encapsulation layer, thereby improving the light extraction efficiency. In addition, the first electrode layer **201** includes a reflective electrode material to reflect the light irradiating the bottom portion **112**, which ensures emission of light from above the pixel opening (i.e., top emission), thereby further improving the light extraction efficiency.

[0043] FIG. **4** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The difference between the display panel shown in FIG. **4** and the display panel shown in FIG. **3** lies in that the first electrode layer **201** includes a first sub-electrode layer **2011** and a second sub-electrode layer **2012** located on a side of the first sub-electrode layer **2011** away from the substrate **70**.

[0044] The first sub-electrode layer **2011** includes a reflective material, or the second sub-electrode layer **2012** includes a reflective material. The first sub-electrode layer **2011** may be a metal layer or a conductive oxide layer. The second sub-electrode layer **2012** may be a metal layer or of a stacked structure. In one embodiment, the first sub-electrode layer **2011** is made of a material including indium tin oxide; and the second sub-electrode layer **2012** is of a stacked structure that includes indium tin oxide/silver/indium tin oxide. A thickness of the first sub-electrode layer **2011** in the direction perpendicular to the substrate **70** is greater than or equal to 300 nm and less than or equal to 400 nm. For example, the thickness of the first sub-electrode layer **2011** may be any one of 300 nm, 330 nm, 350 nm, 370 nm and 400 nm. A thickness of the second sub-electrode layer **2012** in the direction perpendicular to the substrate **70** is greater than or equal to 120 nm and less than or equal to 130 nm. For example, the thickness of the second sub-electrode layer **2012** may be any one of 120 nm, 124 nm, 126 nm, 128 nm and 130 nm. In the embodiments of the present application, the light-emitting functional layer **202** may be prepared by an evaporation process. In one embodiment, the light-emitting functional layer **202** covers the second sub-electrode layer **2012** and the first region L**1** and the second region L**2** of the first film layer **10**, that is, the light-emitting functional layer **202** may be prepared integrally, thereby simplifying the preparation process. In one embodiment, the second electrode layer **203** covers the second sub-electrode layer **2012** and the first region L**1** and the second region L**2** of the first film layer **10**, that is, the second electrode layer **203** may be prepared integrally, thereby simplifying the preparation process.

[0045] Still referring to FIG. **4**, the display panel includes an array film layer **10** located between the substrate **70** and the first film layer **110** and the pixel opening, the sixth film layer **120** shown in FIG. **3** (i.e., the planarization layer) is part of the array film layer **10**, and specifically the sixth film layer **120** is the film layer in the array film layer **10** that is farthest from the substrate **70**. In the embodiments of the present application, an orthographic projection of the first sub-electrode layer **2011** on the substrate **70** covers an orthographic projection of the bottom portion of the pixel opening on the substrate **70**. The first sub-electrode layer **2011** is electrically connected to the pixel circuit in the array film layer **10**. For example, the first sub-electrode layer **2011** is electrically connected to a metal layer **101** (e.g., an M3 metal layer) in the array film layer **10**.

[0046] In the embodiments of the present application, during preparation of the first sub-electrode layer **2011**, holes are formed in the array film layer **10** above the metal layer **121**, a conductive layer is then prepared on a side of the sixth film layer **120** of the array film layer **10** away from the substrate **70** and can fill the holes, and then the conductive layer is patterned, so as to obtain the first sub-electrode layer **2011** in the embodiments of the present application. Providing the first sub-electrode layer **2011** can prevent the second sub-electrode layer **2012** from being directly electrically connected to the pixel circuit, so as to prevent formation of an uneven surface of the second sub-electrode layer **2012** caused by hole formation.

[0047] In one embodiment, the material of the second sub-electrode layer **2012** is the same as the material of the reflective layer **30**, and in this case the second sub-electrode layer **2012** may be prepared synchronously with the reflective layer **30**. The synchronous preparation of the second sub-electrode layer **2012** and the reflective layer **30** can simplify the preparation process and reduce the number of the masks used. However, since the second sub-electrode layer **2012** is connected to the pixel circuit by means of the first sub-electrode layer **2011**, the light-emitting functional layer **202** located at the bottom portion of the pixel opening emits light, so that the reflective layer **30** prepared synchronously with the second sub-electrode layer **2012** is also electrically connected to the pixel circuit, that is, the reflective layer **30** is also conductive, which causes the light-emitting functional layer **202** located on the side wall **111** to emit light to result in crosstalk of light. In order to reduce or avoid the crosstalk of light, the display panel in the embodiments of the present application further includes an insulation layer **40**.

[0048] The insulation layer **40** is located between the reflective layer **30** and the light-emitting functional layer **202** and covers at least the reflective layer **30**. The insulation layer **40** may cover the entire reflective layer **30**, or the insulation layer **40** may cover the reflective layer **30** and the surface, away from the substrate **70**, of the first film layer **110** that is not covered by the reflective layer **30**. In order to ensure that the light-emitting functional layer **202** located at the bottom portion **112** emits light normally, the insulation layer **40** should not cover the second sub-electrode layer **2012**. The insulation layer **40** is made of an inorganic insulation material. In one embodiment, the insulation layer **40** is made of a high-dielectric-constant inorganic insulation material. For example, the inorganic insulation material includes at least one of silicon dioxide, silicon nitride and silicon oxynitride. A thickness of the insulation layer **40** in the direction perpendicular to the substrate **70** is greater than or equal to 150 nm and less than or equal to 200 nm. For example, the thickness of the insulation layer **40** may be any one of 150 nm, 160 nm, 175 nm and 200 nm. On the one hand, using a high-dielectric-constant inorganic insulation material can better ensure the electric insulation capability of the insulation layer **40** to prevent the light-emitting functional layer **202** located on the side wall **111** from emitting light, thereby reducing the crosstalk of light. On the other hand, the insulation layer **40** and the light-emitting functional layer **202** form microcavities. On the basis of the principle of ultra-thin film thickness interference between the microcavities, the length of the microcavities is controlled by controlling the thickness of the insulation layer **40** to achieve constructive interference so as to adjust the reflectivity of the light at the side wall **102**, so that more light is reflected and then emitted from above the pixel opening, thereby further improving the light extraction efficiency. When the reflective layer **30** is not conductive, the insulation layer **40** may be omitted.

[0049] FIG. **5** is a structural schematic diagram of a display panel according to yet another exemplary embodiment of the present application. The difference between the display panel shown in FIG. **5** and the display panel shown in FIG. **4** lies in that the display panel shown in FIG. **5** further includes a second film layer **510**, a third film layer **520**, a fourth film layer **530** and a fifth film layer **540**, which are sequentially stacked on a side of the second electrode layer **203** away from the substrate **70**.

[0050] In one embodiment, a refractive index of the third film layer **520** is greater than or equal to a refractive index of the second film layer **510**, such that the light emitted by the light-emitting functional layer **202** will not be totally reflected at an interface between the second film layer **510** and the third film layer **520**, and the light can enter the third film layer **520** from the second film layer **510**. The third film layer **520** fills at least the entire pixel opening, such that more light can irradiate the side wall **111** after total reflection. In addition, filling the entire pixel openings with the third film layer **520** can simplify the preparation process of the third film layer **520**.

[0051] In one embodiment, a refractive index of the fourth film layer **530** is less than the refractive index of the third film layer **520**. The third film layer **520** fills at least the entire pixel opening, and in this case the large-angle light emitted by the light-emitting functional layer **202** is totally reflected at the interface between the third film layer **520** and the fourth film layer **530**, and the totally reflected light can irradiate the side wall **111**. The side wall **111** is provided with the reflective layer **30** and the insulation layer **40**, and the angle α between the bottom portion **112** and the side wall **111** is an obtuse angle, so that the reflective layer **30** and the insulation layer **40** can reflect the light irradiating the side wall **111** to change the angle of light to convert the large-angle light into small-angle light that can be emitted smoothly when irradiating the interface between the third film layer **520** and the fourth film layer **530** again, thereby improving the light extraction

efficiency.
[0052] FIG. **6** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The display panel in FIG. **6** shows an optical path diagram of large-angle light. As shown in FIG. **6**, the large-angle light emitted by the light-emitting functional layer **202** irradiates the side wall **111**, and the light irradiating the side wall **111** is reflected by the reflective layer **30** and the insulation layer **40** on the side wall **111**, sequentially passes through the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540**, and is then emitted. In the embodiments of the present application, the light is reflected once by the reflective layer **30** and the insulation layer **40**, so that the large-angle light emitted by the light-emitting functional layer **202** is converted into small-angle light which, when irradiating the interface between the third film layer **520** and the fourth film layer **530**, sequentially passes through the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** and is then emitted, instead of being totally reflected, thereby improving the light extraction efficiency.
[0053] FIG. **7** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The display panel in FIG. **7** shows an optical path diagram of large-angle light. As shown in FIG. **7**, the large-angle light emitted by the light-emitting functional layer **202** is totally reflected at the interface between the third film layer **520** and the fourth film layer **530**, the totally reflected light irradiates the side wall **111**, the light irradiating the side wall **111** is reflected by the reflective layer **30** and the insulation layer **40** on the side wall **111**, the reflected light irradiates the other side wall **111** again, and the light irradiating the side wall **111** is reflected again by the reflective layer **30** and the insulation layer **40** on the side wall **111**, then sequentially passes through the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540**, and is then emitted. In the embodiments of the present application, the light is reflected twice by the reflective layer **30** and the insulation layer **40**, so that the large-angle light emitted by the light-emitting functional layer **202** is converted into small-angle light which, when irradiating the interface between the third film layer **520** and the fourth film layer **530** again, sequentially passes through the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** and is then emitted, instead of being totally reflected, thereby improving the light extraction efficiency.
[0054] The light emitted by the light-emitting functional layer **202** may be reflected once or multiple times on the reflective layer **30**, so that the large-angle light is finally converted into small-angle light which, when irradiating the interface between the third film layer **520** and the fourth film layer **530** again, sequentially passes through the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** and is then emitted, instead of being totally reflected, thereby improving the light extraction efficiency.
[0055] In one embodiment, the second film layer **510** and the fifth film layer **540** are made of inorganic materials. In one embodiment, the third film layer **520** and the fourth film layer **530** are made of organic materials. In the embodiment of the present application, the specific materials of the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** are not limited, as long as the refractive index of the third film layer **520** is greater than or equal to the refractive index of the second film layer **510**, and the refractive index of the fourth film layer **530** is less than the refractive index of the third film layer **520**.
[0056] In the present application, the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** may be prepared by means of a conventional process, which is not limited in the present application. For example, the second film layer **510** and the fifth film layer **540** may be prepared by means of a chemical vapor deposition (CVD) process. For example, the third film layer **520** and the fourth film layer **530** may be prepared by means of an ink jet printing (IJP) process.
[0057] With the above embodiments, the second film layer **510** and the third film layer **520** are sequentially arranged on the side of the electrode layer **203** away from the substrate **70**, the

refractive index of the third film layer **520** being greater than or equal to the refractive index of the second film layer **510**, so that the light emitted by the light-emitting functional layer **202** will not be totally reflected at the interface between the second film layer **510** and the third film layer **520**, and the light emitted by the light-emitting functional layer **202** can enter the third film layer **520**. The fourth film layer **530** is arranged on a side of the third film layer **40** away from the substrate **70**, the refractive index of the fourth film layer **530** being less than the refractive index of the third film layer **520**, and the reflective layer **30** and the insulation layer **40** are also arranged on the side wall **111**, so that the large-angle light is totally reflected when irradiating the interface between the third film layer **520** and the fourth film layer **530**, the totally reflected light can irradiate the side wall **111**, the light irradiating the side wall **111** can be reflected by the reflective layer **30** and the insulation layer **40** located on the side wall **111** to change the angle of light, so that the light irradiating the side wall **111** due to total reflection is converted into small-angle light which, when irradiating the interface between the third film layer **520** and the fourth film layer **530** again, sequentially passes through the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** and is then emitted, instead of being totally reflected. In this way, the large-angle light emitted by the light-emitting functional layer **202** can also be extracted, thereby reducing the light loss and improving the light extraction efficiency. In addition, the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** are sequentially arranged on the side of the electrode layer **203** away from the substrate **70**, and the distances of the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** from the light-emitting functional layer **202** are not large, which does not cause the problem of serious reduction in brightness at a large angle of view, and the process for preparing the second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** is simple. In addition, the large-viewing-angle light is extracted by means of a combination of the reflective layer **30** (and the insulation layer **40**), the third film layer **520** and the fourth film layer **530**, so that there is no requirement for the large-viewing-angle light, and the success rate is high, thereby significantly improving the light extraction efficiency. Furthermore, in the embodiments of the present application, with the reasonable structural design, the light-emitting path of large-angle light is improved, so that as much light as possible can be extracted. The design concept is ingenious, and the effect is remarkable. In the embodiments of the present application, the third film layer **520** fills at least the pixel opening such that the interface where total reflection occurs shifts upward, the totally reflected light can irradiate the side wall **111** of the pixel opening, and the path of light is changed by the reflective layer **30** and the insulation layer **40** on the side wall, so as to maximize the coupling output of light trapped in the waveguide mode, which can achieve the advantages such as improving the light extraction efficiency without causing brightness attenuation at a large angle of view.

[0058] FIGS. **8**A and **8**B are structural schematic diagrams of a display panel according to yet another embodiment of the present application. The difference between the display panels shown in FIGS. **8**A and **8**B lies in that, in the display panel in FIG. **8**B, the side wall **111** is an arc with respect to the cross section along the direction perpendicular to the substrate **70**. with respect to the cross section along the direction perpendicular to the substrate **70**, regardless of whether the side wall **111** is a straight line or an arc, the light irradiating the side wall **111** can be reflected. The difference between the display panels shown in FIGS. **8**A and **8**B and the display panel shown in FIG. **5** lies in that the reflective layer **30** covers the side wall **111** and a surface, away from the substrate, of the second region L**2** of the first film layer **10**. When the reflective layer **30** and the second sub-electrode layer **2012** are made of the same material, the reflective layer **30** and the second sub-electrode layer **2012** can be prepared synchronously, and in this case, during preparation of the reflective layer **30** and the second sub-electrode layer **2012**, the second sub-electrode layer **2012** and the reflective layer **30** are directly prepared on the pixel opening and on the surface of the second region L**2** away from the substrate **70**, respectively. In this way, the preparation process can be simplified, and the number of the masks required can be reduced. In one embodiment, the reflective layer **30** may only cover the side wall **111**, or cover the side wall **111** and at least part of the surface of the second region L**2** away from the substrate **70**, which can ensure the transmittance of light in the second region L**2** to ensure implementation of other functions of the display panel.

[0059] Still referring to FIGS. **8**A and **8**B, since the second sub-electrode layer **2012** is electrically connected to the pixel circuit in the array film layer **10** by means of the first sub-electrode layer **2012**, that is, the second sub-electrode layer **2012** is conductive, the reflective layer **30** prepared synchronously with the second sub-electrode layer **2012** is also conductive, so that in order to prevent the light-emitting functional layer **202** from emitting light in a region other than the bottom portion of the pixel opening, the insulation layer **40** needs to cover at least the reflective layer **30**. During preparation of the insulation layer **40**, the insulation layer **40** is prepared on a side of the reflective layer **30** away from the substrate **70**. The insulation layer **40** covers the reflective layer **30**, which can better ensure the electric insulation capability of the insulation layer **40** to prevent the light-emitting functional layer **202** located on the side wall **111** from emitting light, thereby reducing the crosstalk of light. Also, the insulation layer **40** and the light-emitting functional layer **202** form microcavities to adjust the reflectivity of light at the side wall **102**, so that more light is reflected and then emitted from above the pixel opening, thereby further improving the light extraction efficiency. In the embodiments of the present application, the insulation layer **40** should not cover the second sub-electrode layer **2012** to avoid affecting light emission of the light-emitting functional layer **202**.

[0060] Still referring to FIG. **5**, the second film layer **510** includes a first section L**3** and a second section L**4** connected to the first section L**3**. The first section L**3** covers the side wall **111** and the bottom portion **112**, and the second section L**4** is located on the surface of the side of the second region L**2** away from the substrate **70**. Since the reflective layer **30**, the light-emitting functional layer **202** and the electrode layer **203** are arranged between the second film layer **510** and the first film layer **110**, an orthographic projection of the first section L**3** on the substrate **70** is less than an orthographic projection of the first region L**1** on the substrate **70**.

[0061] In the embodiments of the present application, the third film layer **520** fills at least the entire pixel opening, such that more light can irradiate the side wall **111** after total reflection. In addition, filling the entire pixel openings with the third film layer **40** can simplify the preparation process of the third film layer **520**.

[0062] In the direction perpendicular to the substrate **70**, a maximum thickness of the third film layer **520** is greater than or equal to the maximum distance between the first section L**3** and the second section L**4**. As shown in FIG. **5**, in the direction perpendicular to the substrate **70**, the maximum thickness of the third film layer **520** is H**1**, and the maximum distance between the first section L**3** and the second section L**4** is H**2**. The maximum distance between the first section L**3** and the second section L**4** may be the maximum distance between a surface of the first section L**3** away from the substrate **70** and a surface of the second section L**4** away from the substrate **70**, or the maximum distance between a surface of the first section L**3** close to the substrate **70** and a surface of the second section L**4** close to the substrate **70**. When the maximum thickness of the third film layer **520** is greater than or equal to the maximum distance between the first section L**3** and the second section L**4**, and the third film layer **520** may fill the entire pixel opening, which can ensure that the light totally reflected at the interface between the third film layer **520** and the fourth film layer **530** can be reflected by the reflective layer **30** and the insulation layer **40** which cover the side wall **111**, so as to change the angle of light, so that the light can be extracted, thereby improving the light extraction efficiency. In addition, filling the entire pixel openings with the third film layer **520** can simplify the preparation process of the third film layer **520**. In addition, when the maximum thickness of the third film layer **520** is greater than the maximum distance between the first section L**3** and the second section L**4**, the side of the third film layer **520** away from the substrate **70** protrudes out of the pixel opening, and with the design of the shape of the side of the third film layer **520** away from the substrate **70**, the light transmission path can be changed, which is conducive to extraction or convergence of light. In one embodiment, the maximum thickness of the third film layer **520** in the direction perpendicular to the substrate **70** is greater than or equal to 2 μm and less than or equal to 3 μm. For example, the maximum thickness of the third film layer **520** may be any one of 2 μm, 2.2 μm, 2.5 μm, 2.7 μm and 3 μm. Controlling the maximum thickness of the third film layer **520** to be within a suitable thickness range can improve the light extraction efficiency without causing brightness attenuation at a large angle of view.

[0063] FIG. **9** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The difference between the display panel shown in FIG. **9** and the display panel shown in FIG. **5** lies in that at least part of the region of the second section L**4** of the second film layer **510** overlaps with the fourth film layer **530**. As shown in FIG. **9**, the second film layer **510** includes a first section L**3** and a second section L**4** connected to the first section L**3**, the first section L**3** covers the side wall **111** and the bottom portion **112**, and the second section L**4** is located on a surface of a side of the second region L**2** away from the substrate **70**.

[0064] In the embodiments of the present application, the entire region of the second section L**4** of the second film layer **510** overlaps with the fourth film layer **50**, or part of the region of the second section L**4** of the second film layer **510** overlaps with the fourth film layer **50**.

[0065] In the embodiments of the present application, by means of at least part of the region of the second section L**4** of the second film layer **510** being overlapped with the fourth film layer **530**, it is possible to prevent part of light from reaching the interface between the third film layer **520** and the second film layer **510** after total reflection at the interface between the third film layer **510** and the fourth film layer **530** and then being refracted at the interface between the third film layer **520** and the second film layer **510**, so that the light cannot be emitted from a light-emitting side; or it is possible to prevent part of the light from being confined in a waveguide mode due to total reflection between the interface between the second film layer **510** and the third film layer **520** and the interface between the third film layer **520** and the fourth film layer **530**.

[0066] In one embodiment, the side of the third film layer **520** away from the substrate **70** covers at least the pixel opening. With the design of the shape of the side of the third film layer **520** away from the substrate **70**, the light transmission path can be changed, which is conducive to extraction or convergence of light.

[0067] Still referring to FIG. **9**, the surface of the third film layer **520** away from the substrate includes a first portion **521** and a second portion **522**. An orthographic projection of the first portion **521** on the substrate **70** covers at least the pixel opening, and the second portion **5222** surrounds the first portion **521** and is connected to the first portion **521**. In one embodiment, the orthographic projection of the first portion **521** on the substrate **70** just covers the pixel opening, or the orthographic projection of the first portion **521** on the substrate **70** covers the pixel opening and at least part of the second region L**2**. In one embodiment, the shape of a cross section of the second portion **522** in the direction perpendicular to the substrate is any one of: an arc, a straight segment perpendicular to the substrate, and a straight segment at a preset angle to the substrate. The shape of the cross section of the first portion **521** in the direction perpendicular to the substrate is an arc or is a straight segment parallel to the substrate. In the embodiments of the present application, both the first portion **521** and the second portion **522** of the side of the third film layer **520** away from the substrate can converge the light emitted by the light-emitting functional layer **202**, or one of the first portion **521** and the second portion **522** can converge the light emitted by the light-emitting functional layer **202**. In the embodiments of the present application, setting or changing the shape of the first portion **521** and/or the second portion **522** achieves different degrees of convergence of the light emitted from the light-emitting functional layer **202**.

[0068] As shown in FIG. **9**, the cross section of the first portion **521** in the direction perpendicular to the substrate **70** is a straight segment parallel to the substrate **70**, and the cross section of the second portion **522** in the direction perpendicular to the substrate **70** is a straight segment forming a preset angle with the substrate **70**. As shown in FIG. **10**, the cross section of the first portion **521** in the direction perpendicular to the substrate **70** is a straight segment parallel to the substrate **70**, and the cross section of the second portion **522** in the direction perpendicular to the substrate **70** is a straight segment perpendicular to the substrate **70**. As shown in FIG. **11**, the cross section of the first portion **521** in the direction perpendicular to the substrate **70** is a straight segment parallel to the substrate **70**, and the cross section of the second portion **522** in the direction perpendicular to the substrate **70** is an arc. As shown in FIG. **12**, the cross section of the first portion **521** in the direction perpendicular to the substrate **70** is an arc, and the cross section of the second portion **522** in the direction perpendicular to the substrate **70** is also an arc. In one embodiment, the first portion **521** and the second portion **522** are arc-shaped formed by the same circular arc. The shapes of the first portion **521** and the second portion **522** shown in the embodiments of the present application are only exemplary, and can be selected or adjusted in the art according to requirements.

[0069] FIG. **13** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The display panel in FIG. **13** shows an optical path diagram of large-angle light. The difference between the display panel shown in FIG. **13** and the display panel shown in FIG. **6** lies in the shape of the side of the third film layer **520** away from the substrate **70**. In FIG. **13**, since the side of the third film layer **520** away from the substrate **70** is arc-shaped, the direction of light irradiating the side of the third film layer **520** away from the substrate **70** can be changed such that the light is converged above the pixel opening. FIG. **14** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The display panel in FIG. **14** shows an optical path diagram of large-angle light. The difference between the display panel shown in FIG. **14** and the display panel shown in FIG. **7** lies in the shape of the side of the third film layer **520** away from the substrate **70**. In FIG. **14**, since the side of the third film layer **520** away from the substrate **70** is arc-shaped, the direction of light irradiating the side of the third film layer **520** away from the substrate **70** can be changed such that the light is converged above the pixel opening. FIGS. **13** and **14** are only illustrated with the shape of the third film layer **520** shown in FIG. **12** as an example. In the case of the third film layer **520** being in other shapes, the optical path diagram of large-angle light follows the same rule, which will not be repeated herein.

[0070] FIG. **15** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The difference between the display panel shown in FIG. **15** and the display panel shown in FIG. **5** lies in that the surface of the third film layer **520** away from the substrate **70** includes a patterned structure **525**. The patterned structure **525** is located on the side of the second region L**2** away from the substrate **70**. The patterned structure **525** includes at least one protrusion.

[0071] In the direction perpendicular to the substrate **70**, the cross section of the protrusion of the patterned structure **525** is a sawtooth protrusion (as shown in FIG. **15**), an arc-shaped protrusion (as shown in FIG. **16**), a trapezoidal protrusion, etc. The patterned structure **525** may include protrusions having the same cross-sectional shape or protrusions having different cross-sectional shapes. The depth H**3** of the protrusions may be determined according to the specific circumstances. Regardless of the shape of the protrusions, it is only required that at least one protrusion is included such that the interface between the second film layer **510** and the fourth film layer **530** in the second region L**2** is not a plane. Providing the patterned structure **525** can reduce the optical waveguide loss of lateral propagation. Specifically, providing the patterned structure **525** can change the light propagation path, thereby improving the light extraction efficiency.

[0072] FIG. **17** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The difference between the display panel shown in FIG. **17** and the display panel shown in FIG. **5** lies in that the first film layer **110** defines two pixel openings in the side thereof away from the substrate **70** in an enclosing manner, the adjacent pixel openings

being spaced apart from each other, and the second region L**2** being located between the plurality of pixel openings. As shown in FIG. **17**, the light-emitting functional layer **202** in the pixel opening extends along a surface of the second region L**2** and is connected to the light-emitting functional layer **202** in the adjacent pixel opening. That is, the light-emitting functional layer **202** is prepared integrally, which simplifies the preparation process of the light-emitting functional layer and reduces the number of masks used in the preparation process. The second electrode layer **203** in the pixel opening extends along the surface of the second region L**2** and is connected to the electrode layer **203** in the adjacent pixel openings. That is, the second electrode layer **203** is prepared integrally, which simplifies the preparation process of the electrode layer and reduces the number of the masks used in the preparation process.
[0073] FIG. **18** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The difference between the display panel shown in FIG. **18** and the display panel shown in FIG. **17** lies in that the reflective layer **30** and the insulation layer **40** cover the pixel openings and the surface, away from the substrate **70**, of the second region L**2** between the adjacent pixel openings. That is, the reflective layer **30** extends along the surface of the second region L**2** and is connected to the reflective layer **30** in the adjacent pixel opening. When the second sub-electrode layer **2012** and the reflective layer **30** are made of the same material, the reflective layer **30** and the second sub-electrode layer **2012** are prepared simultaneously, which simplifies the preparation process and reduces the number of the masks required. However, in this case, the reflective layer **30** is conductive, so that the insulation layer **40** needs to be provided to cover the reflective layer **30**. The insulation layer **40** extends along the surface of the second region L**2** and is connected to an insulation layer **40** in the adjacent pixel opening. That is, the insulation layer **40** covers the region of the first film layer **110** other than the bottom portion **112**, so as to cover the entire reflective layer **30**.
[0074] In the case of having two or more pixel openings, the shape of the side of the third film layer **520** away from the substrate **70** may also be the shape of the side of the third film layer **520** away from the substrate **70** shown in FIGS. **9** to **16**, which will not be repeated herein.
[0075] FIG. **19** is a structural schematic diagram of a display panel according to yet another embodiment of the present application. The difference between the display panel shown in FIG. **19** and the display panel shown in FIG. **5** lies in that the display panel shown in FIG. **19** further includes a protective layer **80** and a cover plate **90**. The second film layer **510**, the third film layer **520**, the fourth film layer **530** and the fifth film layer **540** constitute an encapsulation layer of the display panel. The protective layer **80** may be an optical clear adhesive (OCA). The cover plate **90** may be a glass cover plate.
[0076] The upstream products of the display panel provided in the embodiments of the present application may be high-refractive index materials and low-refractive index materials, and the downstream products may be mobile phones.
[0077] In a second aspect, an embodiment of the present application provides a method for preparing a display panel. The preparation method is used for preparing the display panel in the above embodiments.
[0078] FIG. **20** is a flowchart of a method for preparing a display panel according to an embodiment of the present application. As shown in FIG. **20**, the method includes the following steps.
[0079] At step S**2001**, a substrate is provided.
[0080] In the embodiments of the present application, the substrate is a glass substrate or a flexible substrate.
[0081] At step S**2002**, a first film layer is prepared on one side of the substrate. The first film layer defines at least two pixel openings spaced apart from each other in an enclosing manner.
[0082] In the embodiments of the present application, the first film layer is a pixel defining layer, a material of the first film layer is formed on one side of the substrate, and at least two pixel openings

spaced apart from each other are formed by a patterning process. In one embodiment, before preparation of the first film layer, an array film layer is prepared on one side of the substrate, and the array film layer includes a plurality of film layers.

[0083] In one embodiment, the first film layer and a sixth film layer are prepared on the same side of the substrate. The sixth film layer is part of the array film layer. The first film layer is a pixel defining layer, the sixth film layer is a planarization layer, and the first film layer and the sixth film layer are both made of organic materials and are made of the same organic material. An organic material layer is formed on one side of the substrate, and holes are formed in the organic material layer to form at least two pixel openings spaced apart from each other. In one embodiment, the pixel openings may be formed by means of laser etching, photoetching, chemical dry etching, halftone process, etc. For example, the organic material layer is exposed for hole formation by means of a halftone process to form the pixel openings. The first film layer and the sixth film layer are formed in one procedure, which simplifies the preparation process and reduces the number of the masks required. In the embodiments of the present application, each pixel opening includes a bottom portion and a side wall arranged on a peripheral side of the bottom portion. In one embodiment, the side wall is obliquely arranged on the peripheral side of the bottom portion.

[0084] At step S**2003**, a first electrode layer is prepared at the bottom portion of each pixel opening, and a reflective layer is prepared on the side wall of each pixel opening or prepared on the side wall of each pixel opening and a surface, away from the substrate, of the first film layer between the plurality of pixel openings.

[0085] In the embodiments of the present application, the first electrode layer includes a first sub-electrode layer and a second sub-electrode layer. The first sub-electrode layer is electrically connected to a metal layer in the sixth film layer. During preparation of the first sub-electrode layer, holes are formed in the sixth film layer above the metal layer of the sixth film layer, a conductive layer is then prepared on a side of the sixth film layer **120** away from the substrate **70**, the conductive layer can fill the holes, and the conductive layer is patterned to obtain the first sub-electrode layer.

[0086] In the embodiments of the present application, the second sub-electrode layer may be prepared synchronously with the reflective layer. That is, the conductive material is prepared at the bottom portion and the side wall of each pixel opening, or prepared at the bottom portion and the side wall of each pixel opening and the surface, away from the substrate, of the first film layer between the plurality of pixel openings. The conductive material layer at the bottom portions of the pixel openings is the second sub-electrode layer; and the conductive material layer located on the side wall of each pixel opening and on the surface, away from the substrate, of the first film layer between the plurality of pixel openings is the reflective layer.

[0087] At step S**2004**, an insulation layer is prepared on a surface of the reflective layer away from the substrate.

[0088] In the embodiments of the present application, the insulation layer covers at least the reflective layer, and the insulation layer should not cover the first electrode layer.

[0089] The specific working principle and benefits of the preparation method provided in the embodiments of the present application are similar to the specific working principle and benefits of the display panel provided in the embodiments of the present application, which will not be repeated herein.

[0090] FIG. **21** is a flowchart of a method for preparing a display panel according to yet another embodiment of the present application. The difference between the method shown in FIG. **21** and the method shown in FIG. **20** lies in that the method further includes the following steps.

[0091] At step S**2005**, a light-emitting functional layer and a second electrode layer are sequentially prepared on a side of the insulation layer and the first electrode layer away from the substrate.

[0092] In the embodiments of the present application, the light-emitting functional layer and the second electrode layer may be prepared integrally, which simplifies the preparation process and

reduces the number of the masks used in the preparation process. Since the insulation layer is arranged between the reflective layer and the light-emitting functional layer, only the light-emitting functional layer at the bottom portion of the pixel opening can emit light, thereby avoiding the crosstalk of light.
[0093] At step S**2006**, a second film layer, a third film layer, a fourth film layer and a fifth film layer are sequentially prepared on a side of the second electrode layer away from the substrate. The refractive index of the third film layer is greater than or equal to the refractive index of the second film layer. The refractive index of the fourth film layer is less than the refractive index of the third film layer.
[0094] In the embodiments of the present application, the second film layer and the fifth film layer are both made of inorganic materials, and may be prepared by means of a CVD process. The third film layer and the fourth film layer are both made of organic materials, and may be prepared by means of an IJP process. The second film layer, the third film layer, the fourth film layer and the fifth film layer may also be prepared by means of other conventional processes.
[0095] In one embodiment, the third film layer may be patterned. For example, the third film layer is patterned to form the shape of the third film layer as shown in FIGS. **9** to **16**. The present application does not limit the patterning method, as long as the patterned third film layer can be obtained.
[0096] The specific working principle and benefits of the preparation method provided in the embodiments of the present application are similar to the specific working principle and benefits of the display panel provided in the embodiments of the present application, which will not be repeated herein.
[0097] In a third aspect, an embodiment of the present application further provides a display device. The display device includes a display panel in the above embodiments.
[0098] FIG. **22** is a structural schematic diagram of a display device according to an embodiment of the present application. As shown in FIG. **22**, the display device **100** is a product having an image display function. For example, the display device **100** may be used to display static images, such as pictures or photos. The display device **100** may also be used to display dynamic images, such as videos.
[0099] The display device **100** may be a laptop computer, a mobile phone, a handheld or portable computer, a camera, a video camera, a vehicle-mounted intelligent central control screen, a calculator, a smart watch, a GPS navigator, an electronic photograph, electronic billboard or signboard, a projector, etc.
[0100] The display device **100** includes a display panel according to any one of the above embodiments. The display panel may be an organic light-emitting diode display panel or a quantum dot electroluminescent display panel.
[0101] In addition, the display device **100** may also have functions such as photographing, video recording, fingerprint recognition and face recognition. Accordingly, the display device **100** further includes at least one functional module for implementing the above functions, such as an under-display camera, or an under-display fingerprint recognition sensor.
[0102] The foregoing description has been presented for the purposes of illustration and description. Furthermore, this description is not intended to limit the embodiments of the present application to the forms disclosed herein. Although various exemplary aspects and embodiments have been discussed above, it is recognized that some variations, modifications, alterations, additions and sub-combinations thereof.

Claims

1. A display panel, comprising: a substrate; a first film layer arranged on one side of the substrate and defining at least one pixel opening in an enclosing manner, a pixel opening comprising a bottom portion and a side wall arranged on a peripheral side of the bottom portion; a first electrode layer located at the bottom portion of the pixel opening; a reflective layer located on a side of the first film layer away from the substrate and covering at least the side wall; a light-emitting functional layer located on a side of the first electrode layer away from the substrate; and a second electrode layer located on a side of the light-emitting functional layer away from the substrate.

2. The display panel according to claim 1, wherein the first electrode layer comprises a first sub-electrode layer and a second sub-electrode layer located on a side of the first sub-electrode layer away from the substrate; and the first sub-electrode layer comprises a reflective material, or the second sub-electrode layer comprises a reflective material.

3. The display panel according to claim 2, wherein the first sub-electrode layer is made of a material comprising indium tin oxide, and the second sub-electrode layer comprises a stacked structure of indium tin oxide/silver/indium tin oxide; and a thickness of the first sub-electrode layer in a direction perpendicular to the substrate is greater than or equal to 300 nm and less than or equal to 400 nm; or a thickness of the second sub-electrode layer in the direction perpendicular to the substrate is greater than or equal to 120 nm and less than or equal to 130 nm.

4. The display panel according to claim 2, further comprising: an insulation layer located between the reflective layer and the light-emitting functional layer and covering at least the reflective layer; wherein the reflective layer comprises a conductive material; and the conductive material comprises at least one of silver, gold and platinum.

5. The display panel according to claim 4, wherein the reflective layer comprises a stacked structure of indium tin oxide/silver/indium tin oxide.

6. The display panel according to claim 4, wherein the insulation layer is made of a material comprising an inorganic insulation material; and a thickness of the insulation layer in the direction perpendicular to the substrate is greater than or equal to 150 nm and less than or equal to 200 nm.

7. The display panel according to claim 4, further comprising a second film layer, a third film layer and a fourth film layer which are sequentially stacked on a side of the second electrode layer away from the substrate, wherein a refractive index of the fourth film layer is less than a refractive index of the third film layer, and the refractive index of the third film layer is greater than or equal to a refractive index of the second film layer; and the third film layer fills at least entire part of the pixel opening.

8. The display panel according to claim 7, wherein the first film layer comprises a first region located between the side wall and the substrate and a second region surrounding the pixel opening, an orthographic projection of the first region on the substrate overlapping with an orthographic projection of the side wall on the substrate; and the light-emitting functional layer covers the second sub-electrode layer and the first region and the second region of the first film layer; or the second electrode layer covers the second sub-electrode layer and the first region and the second region of the first film layer.

9. The display panel according to claim 8, wherein the second film layer comprises a first section and a second section connected to the first section, the first section covering the side wall and the bottom portion, the second section being located on a surface of a side of the second region away from the substrate, and at least part of the second section contacted with the fourth film layer; and a maximum thickness of the third film layer in the direction perpendicular to the substrate is greater than or equal to a maximum distance between the first section and the second section.

10. The display panel according to claim 7, wherein the maximum thickness of the third film layer in the direction perpendicular to the substrate is greater than or equal to 2 μm and less than or equal to 3 μm.

11. The display panel according to claim 7, wherein a side of the third film layer away from the substrate covers at least the pixel opening; and a surface of the third film layer away from the substrate comprises a first portion and a second portion, an orthographic projection of the first portion on the substrate covering at least the pixel opening, and the second portion surrounding the first portion and being connected to the first portion.

12. The display panel according to claim 11, wherein a shape of a cross section of the second portion in the direction perpendicular to the substrate is any one of: an arc, a straight segment perpendicular to the substrate, and a straight segment at a preset angle to the substrate; or a shape of the cross section of the first portion in the direction perpendicular to the substrate is an arc or is a straight segment parallel to the substrate.

13. The display panel according to claim 8, wherein the reflective layer covers the side wall and at least part of a surface, away from the substrate, of the second region of the first film layer; or the insulation layer covers the side wall and at least part of the surface, away from the substrate, of the second region of the first film layer.

14. The display panel according to claim 7, further comprising a fifth film layer arranged on a side of the fourth film layer away from the substrate, wherein the first film layer is made of an organic material; the third film layer or the fourth film layer is made of an organic material; and the second film layer or the fifth film layer is made of an inorganic material.

15. The display panel according to claim 1, further comprising: a sixth film layer arranged on a side of the first film layer close to the substrate, wherein the first film layer or the sixth film layer is made of an organic material; a maximum thickness of the first film layer in the direction perpendicular to the substrate is greater than or equal to 1 μm and less than or equal to 2 μm; and the sum of the maximum thickness of the first film layer and a maximum thickness of the sixth film layer in the direction perpendicular to the substrate is greater than or equal to 4 μm and less than or equal to 5 μm.

16. The display panel according to claim 1, wherein the side wall is obliquely arranged on the peripheral side of the bottom portion; and the side wall is a straight line or an arc with respect to a cross section along the direction perpendicular to the substrate.

17. The display panel according to claim 16, wherein an angle between the side wall and the bottom portion is an obtuse angle; and the side wall is a straight line with respect to the cross section along the direction perpendicular to the substrate, and the obtuse angle is greater than or equal to 135° and less than or equal to 145°.

18. The display panel according to claim 8, wherein the first film layer defines at least two pixel openings in a side away from the substrate in an enclosing manner, the adjacent pixel openings are spaced apart from each other, and the second region is located between the plurality of the pixel openings.

19. The display panel according to claim 18, wherein the reflective layer extends along a surface of the second region and is connected to the reflective layer in the adjacent pixel opening; the insulation layer extends along the surface of the second region and is connected to the insulation layer in the adjacent pixel opening; and the light-emitting functional layer in the pixel opening extends along the surface of the second region and is connected to the light-emitting functional layer in the adjacent pixel opening, or the second electrode layer in the pixel opening extends along the surface of the second region and is connected to the second electrode layer in the adjacent pixel opening.

20. A display device, comprising: a display panel further comprising, a substrate; a first film layer arranged on one side of the substrate and defining at least one pixel opening in an enclosing manner, the pixel opening comprising a bottom portion and a side wall arranged on a peripheral side of the bottom portion; a first electrode layer located at the bottom portion of the pixel opening; a reflective layer located on a side of the first film layer away from the substrate and covering at least the side wall; a light-emitting functional layer located on a side of the first electrode layer away from the substrate; and a second electrode layer located on a side of the light-emitting functional layer away from the substrate.