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(19) **United States**(12) **Patent Application Publication**
Guo et al.(10) **Pub. No.: US 2015/0340645 A1**(43) **Pub. Date: Nov. 26, 2015**(54) **OLED DISPLAY PANEL AND PRODUCTION
PROCESS THEREOF**(52) **U.S. CL.**CPC *H01L 51/5237* (2013.01); *H01L 51/0097*
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ABSTRACT(72) Inventors: **Yuanhui Guo**, Beijing (CN); **Hui Wang**,
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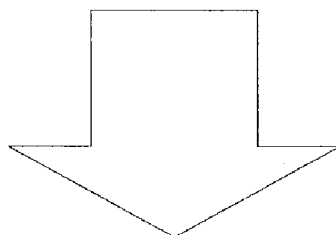
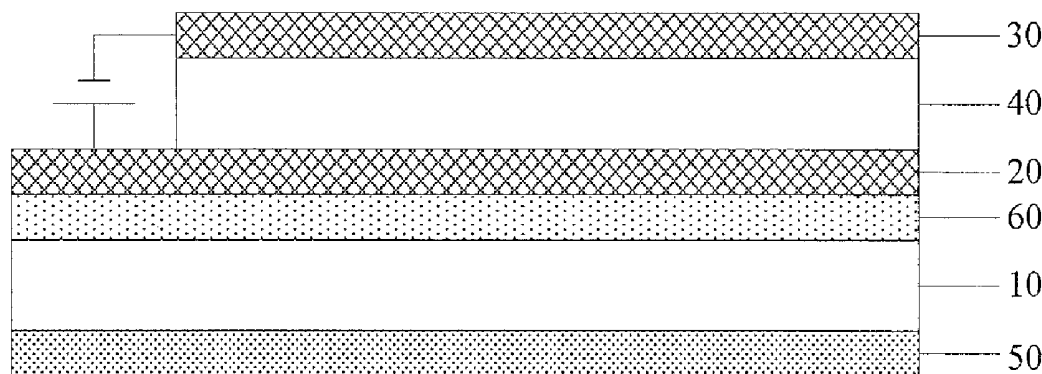
The invention provides an OLED display panel and the production process thereof, which relates to the technical field of display, may improve the surface flatness and the water-oxygen permeation resistance of the flexible base substrate, improve the light output ratio of the display panel, and may control the center wavelength of the electroluminescence spectrum. The display panel comprises an anode and a cathode provided on a flexible base substrate, and an organic material functional layer situated between the anode and the cathode, and it further comprises a reticular light output coupling layer provided on the flexible base substrate and contacting the flexible base substrate; the anode, the cathode, the organic material functional layer are all provided on the reticular light output coupling layer; the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio. The material of the reticular light output coupling layer is a reticular high molecular material having a high refractive index and a low absorptivity in the visible light range; and it is used for the production of the flexible OLED display panel.

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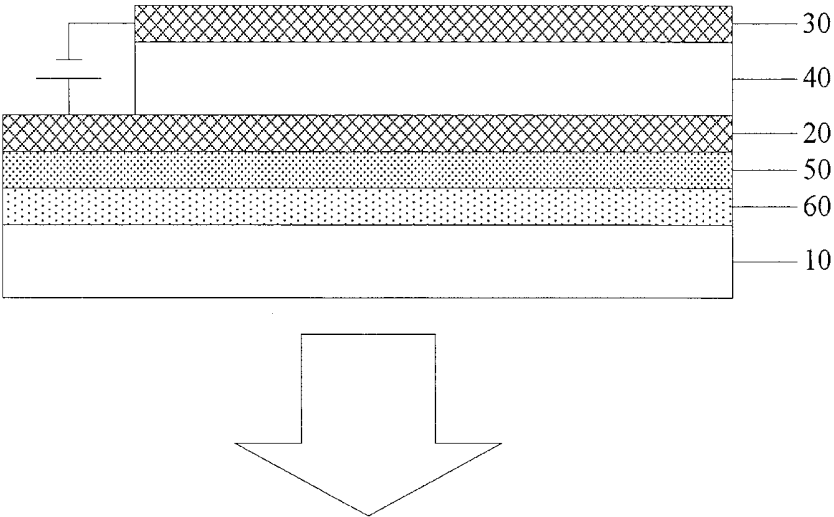


Fig. 1 (a)

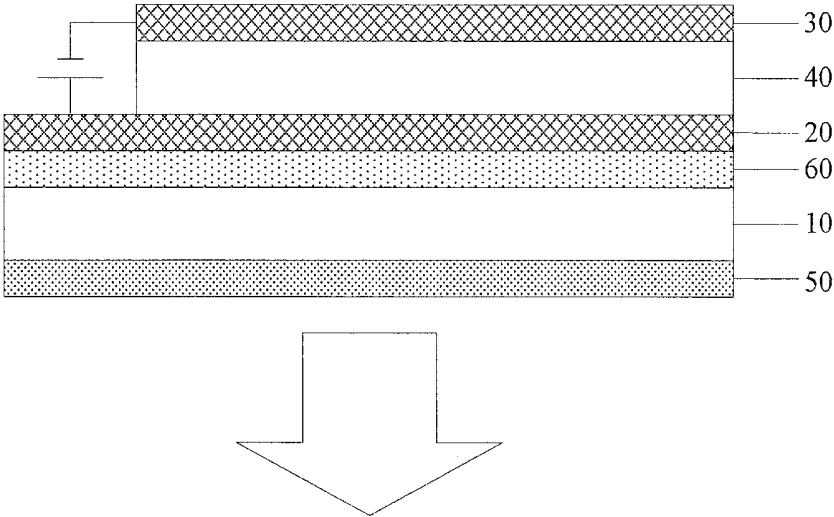


Fig. 1 (b)

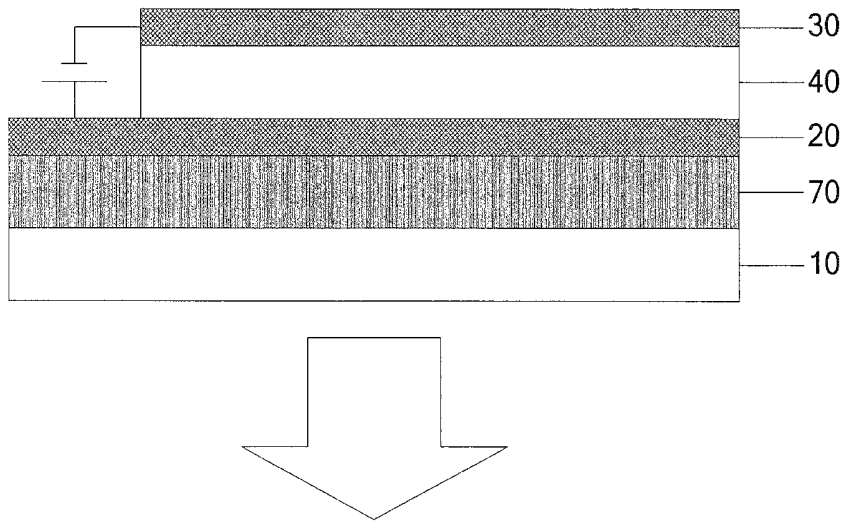


Fig. 2

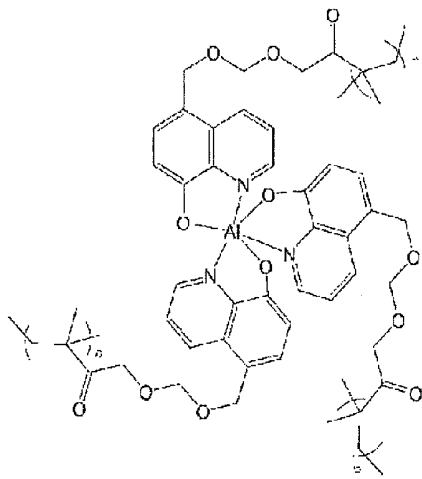


Fig. 3

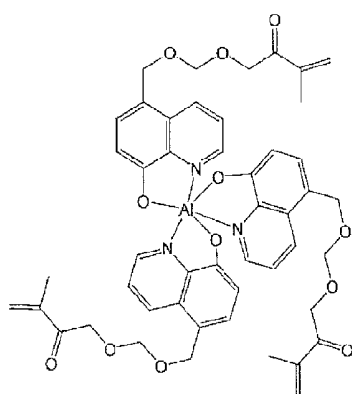


Fig. 4

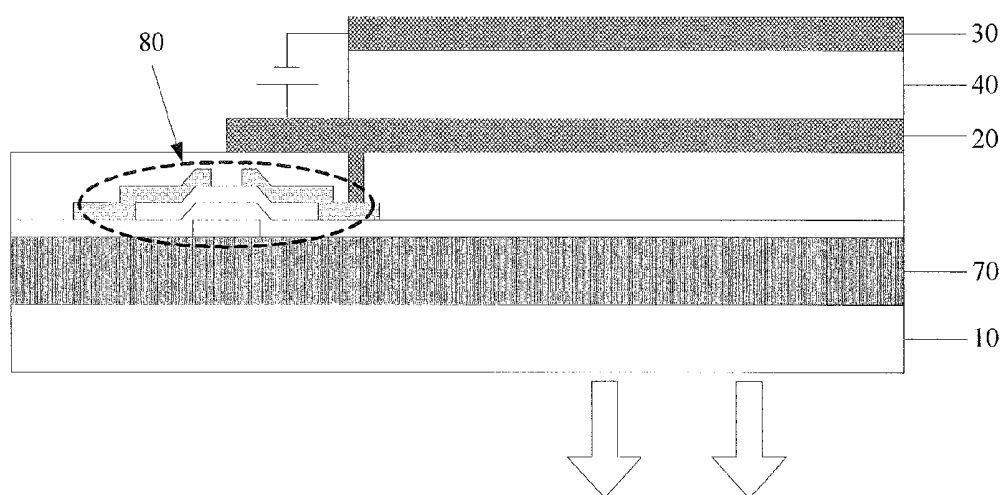


Fig. 5

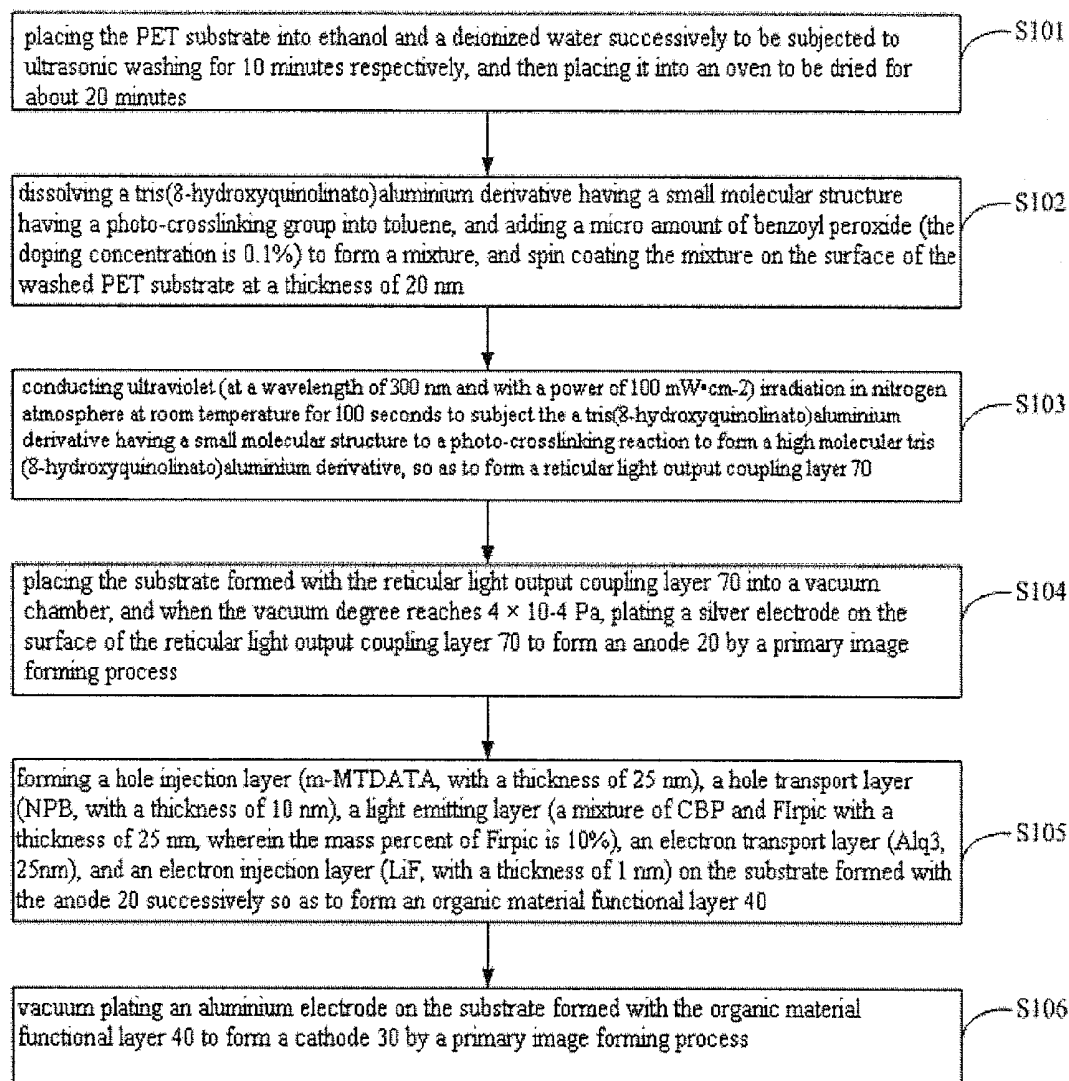


Fig. 6

OLED DISPLAY PANEL AND PRODUCTION PROCESS THEREOF

FIELD OF THE INVENTION

[0001] The invention relates to the technical field of display, especially relates to an OLED display panel and the production process thereof.

BACKGROUND OF THE INVENTION

[0002] Comparing with a liquid crystal display (Liquid Crystal Display, referred to as LCD), an organic electroluminescence diode device (Organic Light-Emitting Diode, referred to as OLED) has the advantages such as thin, light, broad angle of view, initiative luminescence, continuously adjustable emitting color, low cost, fast response speed, low energy cost, low driving voltage, high emitting efficiency, broad working temperature range, simple production process, and flexible display or the like, which is greatly attended by the industry and the science world.

[0003] The basic structure of OLED comprises an anode 20 and a cathode 30 provided on a base substrate 10, and an organic material functional layer 40 provided between the anode 20 and the cathode 30. In order to improve the light output ratio of OLED and reduce the emission loss on the surface of the anode 20, as shown by FIGS. 1(a) and 1(b), a transmission enhanced film 50 may be provided between the anode 20 and the base substrate 10 or provided outside the base substrate 10, to reduce the reflected light using the interference of the thin film, so as to improve the light output ratio.

[0004] In addition, when the base substrate 10 is a flexible base substrate 10, because the surface roughness of the flexible base substrate 10 is generally larger than the surface roughness of the glass base substrate, in the case of bending, the breaking or the peeling off of the film layer provided on the flexible base substrate 10 is very easily caused due to the uneven and the stress effect of the surface of the flexible base substrate 10. In order to solve the flatness problem between the flexible base substrate 10 and the film layer, a buffer layer 60 is generally provided between the flexible base substrate 10 and the film layer. The buffer layer 60 has a stronger adhesion to the flexible base substrate 10 and the film layer. Such a buffer layer 60 comprises various types, wherein the most important ones are materials having a photo-crosslinkable group, such as a photoresist. The high molecular structure formed by this material through ultraviolet curing is not only helpful for improving the surface flatness and the adhesion of the flexible base substrate 10, but also helpful for improving the water-oxygen permeation resistance.

[0005] In the prior art, an OLED display panel using a flexible base substrate 10 should be provided with a two layered structure of a transmission enhanced film 50 and a buffer layer 60 at the same time to achieve the function of improving the surface flatness of the flexible base substrate 10 and to improve the light output ratio. However, it may result in the complication of the production process for the OLED panel.

SUMMARY OF THE INVENTION

[0006] The invention provides an OLED display panel and the production process thereof, which may improve the surface flatness and the water-oxygen permeation resistance of the flexible base substrate, and improve the light output ratio of the display panel.

[0007] In order to achieve the above object, the invention employs the following technical solutions.

[0008] In one aspect, the invention provides an OLED display panel, comprising an anode and a cathode provided on a flexible base substrate, and an organic material functional layer provided between the anode and the cathode; the display panel further comprises a reticular light output coupling layer provided on the flexible base substrate and contacting the flexible base substrate; wherein the anode, the cathode and the organic material functional layer are all provided on the reticular light output coupling layer; the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio; the material of the reticular light output coupling layer is a reticular high molecular material having a high refractive index and a low absorptivity in the visible light range.

[0009] Preferably, the material of the reticular light output coupling layer comprises a high molecular tris(8-hydroxyquinolinato)aluminium derivative.

[0010] More preferably, the thickness of the reticular light output coupling layer is between 0 and 100 nm.

[0011] Alternatively, the anode is a transparent electrode or a metal electrode; the cathode is a metal electrode; wherein the anode is provided close to the reticular light output coupling layer, and in the case where the anode is a metal electrode, the thickness of the anode is between 20 and 40 nm.

[0012] Alternatively, the display panel further comprises a thin film transistor provided on the flexible base substrate; wherein the drain electrode of the thin film transistor is electrically connected to the anode.

[0013] Alternatively, the display panel further comprises a flexible encapsulating substrate or an encapsulating thin film.

[0014] In another aspect, the invention provides a production process of an OLED display panel, comprising: forming a reticular light output coupling layer on a flexible base substrate; on the substrate on which the reticular light output coupling layer is formed, forming an anode and a cathode, and an organic material functional layer between the anode and the cathode; wherein the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio; the material of the reticular light output coupling layer is a reticular high molecular material having a high refractive index and a low absorptivity in the visible light range.

[0015] In an embodiment of the invention, the refractive index of the material of the reticular light output coupling layer is larger than 1.5.

[0016] In an embodiment of the invention, the absorptivity of the material of the reticular light output coupling layer in the visible light range is less than 0.1.

[0017] In an embodiment of the invention, the material of the reticular light output coupling layer is a reticular high molecular material formed by the photo-crosslinking reaction of a small molecular material having a photo-crosslinkable group through ultraviolet curing.

[0018] In an embodiment of the invention, the material of the reticular light output coupling layer comprises a high molecular tris(8-hydroxyquinolinato)aluminium derivative

formed by the photo-crosslinking reaction of a small molecular tris(8-hydroxyquinolino)aluminium derivative having a photo-crosslinkable group.

[0019] Preferably, the material of the reticular light output coupling layer comprises a high molecular tris(8-hydroxyquinolino)aluminium derivative.

[0020] More preferably, the thickness of the reticular light output coupling layer is between 0 and 100 nm.

[0021] Alternatively, the process further comprises forming a thin film transistor on the flexible base substrate; wherein the drain electrode of the thin film transistor is electrically connected to the anode.

[0022] Alternatively, the process further comprises forming a flexible encapsulating substrate or an encapsulating thin film.

[0023] The invention provides an OLED display panel and the production process thereof, wherein the OLED display panel comprises an anode and a cathode provided on a flexible base substrate, and an organic material functional layer provided between the anode and the cathode; the display panel further comprises a reticular light output coupling layer provided on the flexible base substrate and connecting the flexible base substrate; wherein the anode, the cathode, and the organic material functional layer are all provided on the reticular light output coupling layer; the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio; the material of the reticular light output coupling layer is a reticular high molecular material having a high refractive index and a low absorptivity within the visible light range.

[0024] Because the material forming the reticular light output coupling layer has a reticular molecular structure, the reticular light output coupling layer is not only helpful for improving the surface flatness of the flexible base substrate so as to improve the adhesion between the film layer provided on the flexible base substrate and the flexible base substrate, and may also improve the water-oxygen permeation resistance of the display panel. In addition, the material of the reticular light output coupling layer has the features such as a high refractive index, a small absorptivity in the visible light range, and the like, which may be used as a transmission enhanced film, and helpful for reducing the emission loss on the anode surface of the display panel, so as to improve the light output ratio of OLED. Furthermore, the spectrum narrowing and the wavelength shifting may be controlled by controlling the cavity length of the micro-cavity composed of the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer, so as to control the center wavelength of the electroluminescence spectrum and to improve the light output ratio.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] In order to more clearly describe the technical solutions of the invention or the prior art, figures required to be used in the description of examples or prior art will be briefly introduced below. Obviously, figures in the following description are only some examples of the invention. As for a person skilled in the art, without paying inventive labours, other figures may be also obtained according to these figures.

[0026] FIGS. 1(a) and 1(b) are the structural schematic diagrams of an OLED display panel in the prior art;

[0027] FIG. 2 is a structural schematic diagram of an OLED display panel provided by the invention;

[0028] FIG. 3 is a molecular structural schematic diagram of the material of the reticular light output coupling layer (a high molecular tris(8-hydroxyquinolino) aluminium derivative) provided by the invention;

[0029] FIG. 4 is a molecular structure schematic diagram of the material (a small molecular tris(8-hydroxyquinolino) aluminium derivative) used for the reaction forming the reticular light output coupling layer provided by the invention;

[0030] FIG. 5 is a structural schematic diagram of an active matrix OLED display panel provided by the invention;

[0031] FIG. 6 is a flow diagram for preparing an OLED display panel provided by the invention.

REFERENCE SIGN OF FIGURES

[0032] 10—(flexible) base substrate; 20—anode; 30—cathode; 40—organic material functional layer; 50—transmission enhanced film; 60—buffer layer; 70—light output coupling layer; 80—thin film transistor.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The technical solution in the invention will be clearly and completely described below, in combination with figures in the invention. Obviously, the described examples are only a part of the examples in the invention, instead of all examples. On the basis of the examples in the invention, all other examples obtained by the person skilled in the art without paying inventive labours belong to the protection scope of the invention.

[0034] The invention provides an OLED display panel, as shown by FIG. 2, comprising an anode 20 and a cathode 30 provided on a flexible base substrate 10, and an organic material functional layer 40 provided between the anode 20 and the cathode 30; the display panel further comprises a reticular light output coupling layer 70 provided on the flexible base substrate 10 and contacting the flexible base substrate 10; wherein the anode 20, the cathode 30, and the organic material functional layer 40 are all provided on the reticular light output coupling layer 70; the reticular light output coupling layer 70, the anode 20 and the cathode 30, and the organic material functional layer 40 compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio; the material of the reticular light output coupling layer 70 is a reticular high molecular material having a high refractive index and a low absorptivity in the visible light range.

[0035] Wherein, the organic material functional layer 40 is used for the emitting of the display panel. On the basis of the above, the organic material functional layer 40 may at least comprise an electron transport layer and a hole transport layer, and a light emitting layer between them. In order to improve the efficiency of the electron and hole injecting light emitting layer, the organic material functional layer 40 may further comprise an electron injection layer provided between the cathode 30 and the electron transport layer, and a hole injection layer provided between the anode 20 and the hole transport layer.

[0036] When applying a working voltage to the anode 20 and the cathode 30 of the display panel, the holes in the anode 20 and the electrons in the cathode 30 are both injected into the light emitting layer. The holes and the electrons encounter

in the light emitting layer, and they recombine together to form electron-hole pairs due to the action of Coulomb force, and release energy. The energy is emitted in form of light, which passes through different light emitting molecules in the light emitting layer so as to display light with different color, and uniformly emits from two sides of the organic material functional layer 40.

[0037] On the basis of the above, the light emitting layer may at least comprise light emitting molecules emitting red light, green light, and blue light; of course, it may further comprise light emitting molecules emitting white light.

[0038] Based on the above description it can be known that, the light emitted from the organic material functional layer 40 is bidirectional light, that is, the light is emitted from both the upside and the downside of the organic material functional layer 40. Therefore, during the process of the light transmission, if it is not blocked, the light may be directly emitted from the display panel, if it is blocked by for example an electrode made of an opaque material, the light will be reflected back by the electrode made of the opaque material, so as to emit from the other direction of the display panel.

[0039] Therefore, according to the difference between the material of the anode 20 and the cathode 30, the display panel may be divided into a single face emitting display panel and a double face emitting display panel. That is, when the material of one electrode of the anode 20 and the cathode 30 is an opaque material, the display panel is a single face emitting display panel, and when the materials of the anode 20 and the cathode 30 are all transparent materials, the display panel is a double face emitting display panel.

[0040] It should be noticed that, firstly, the reticular light output coupling layer 70 means that the material forming the light output coupling layer is a material having a reticular molecular structure, and such a material may be formed by the photo-crosslinking reaction of a small molecular material having photo-crosslinkable group through ultraviolet curing. The reticular light output coupling layer 70 formed with such material is not only helpful for improving the surface flatness of the flexible base substrate 10 so as to improve the adhesion between the film layer and the flexible base substrate 10, but also helpful for improving the water-oxygen permeation resistance of the display panel.

[0041] Furthermore, when this type of material has the features such as a high refractive index, less absorption in the visible light range, and the like, the reticular light output coupling layer 70 formed from such material may be used as a transmission enhanced film. On the basis of the above, the reticular light output coupling layer 70 may also have the function of reducing the emission loss on the anode surface of the display panel so as to be able to improve the light output ratio of OLED.

[0042] Secondly, the relative positions and the materials of the anode 20 and the cathode 30 are not limited, but in the examples of the invention, because one of the function of the reticular light output coupling layer 70 provided is to improve the light output ratio, therefore, the invention at least has a light output side on the side of the organic material functional layer 40 close to the reticular light output coupling layer 70. On the basis of the above, the electrode close to the reticular light output coupling layer 70 employs a transparent material.

[0043] Furthermore, the invention may have the light output side only on the side of the organic material functional layer 40 close to the reticular light output coupling layer 70, and in this case, the electrode on the side of the organic

material functional layer 40 away from the reticular light output coupling layer 70 employs an opaque material; or the side of the organic material functional layer 40 away from the reticular light output coupling layer 70 may also be a light output side, and in this case, the electrode on the side of the organic material functional layer 40 away from the reticular light output coupling layer 70 also employs a transparent material.

[0044] Thirdly, the reticular light output coupling layer 70, the anode 20 and the cathode 30, and the organic material functional layer 40 compose a micro-cavity. In which, the micro-cavity is an optical micro-cavity, and the optical micro-cavity means an optical micro resonant cavity wherein the size of the cavity in at least one direction is enough small to be comparative with the resonant light wave.

[0045] Herein, in the direction vertical to the display panel, the thickness of the micro-cavity composed of the reticular light output coupling layer 70, the anode 20 and the cathode 30, and the organic material functional layer 40 is the cavity length of the micro-cavity, and the dimension of the cavity length of the micro-cavity is comparable with the resonant light wave.

[0046] Furthermore, the change of the thickness of the reticular light output coupling layer 70 may cause the change of the cavity length of the micro-cavity, so as to change the total optical thickness and the center wavelength of the emitting spectrum. Herein, the total optical thickness and the wavelength peak value of the micro-cavity emitting spectrum satisfy the following relationship:

$$L = \frac{Q_{ij}\lambda_m}{4\pi} + \sum_i n_i d_i = m \frac{\lambda_m}{2}$$

[0047] wherein, L is the total cavity length or the total light path of the micro-cavity; Q_{ij} is the sum of the phase shifts of a light on the reflecting faces of the reticular light output coupling layer 70 and the cathode 30, respectively; n_i and d_i are the refractive index and the thickness of the organic material functional layer 40, respectively; m is the order of the emitting film; λ_m is the wavelength of the film with an order of m.

[0048] According to the above description it can be known that, the total cavity length L of the micro-cavity may be adjusted by changing the thickness of the reticular light output coupling layer 70, while the total cavity length L of the micro-cavity corresponds to the emitting mode m and the peak value of the micro-cavity device in turn. Therefore, the total light path L of the micro-cavity may be adjusted by changing the thickness of the reticular light output coupling layer 70, so as to change the position of the emitting mode m and the emitting wavelength of the micro-cavity device, such that the center wavelength of the electroluminescence spectrum shifts.

[0049] It should be emphasized that, the above described center wavelength shifting phenomenon of the emitting spectrum caused by the micro-cavity effect is not the simple filtering effect to the light wave by the micro-cavity, it shows the enhancement effect with respect to some wavelengths and the suppression effect with respect to other wavelengths by the micro-cavity.

[0050] The invention provides an OLED display panel, comprising an anode 20 and a cathode 30 provided on the

flexible base substrate **10**, and an organic material functional layer **40** provided between the anode **20** and the cathode **30**; the display panel further comprises a reticular light output coupling layer **70** provided on the flexible base substrate **10** and contacting the flexible base substrate **10**; wherein, the anode **20**, the cathode **30**, and the organic material functional layer **40** are all provided on the reticular light output coupling layer **70**; the reticular light output coupling layer **70**, the anode **20** and the cathode **30**, and the organic material functional layer **40** compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio; the material of the reticular light output coupling layer **70** is a reticular high molecular material having a high refractive index and a low absorptivity in the visible light range.

[0051] Because the material forming the reticular light output coupling layer **70** has a reticular molecular structure, the reticular light output coupling layer **70** is not only helpful for improving the surface flatness of the flexible base substrate **10** so as to improve the adhesion between the film layer provided on the flexible base substrate and the flexible base substrate **10**, but also may improve the water-oxygen permeation resistance of the display panel. In addition, the material of the reticular light output coupling layer **70** has the features such as a high refractive index, less adsorption in the visible light range, and the like, which may be used as a transmission enhanced film, and be helpful for reducing the emitting loss on the anode surface of the display panel, so as to improve the light output ratio of OLED. Furthermore, the spectrum narrowing and the wavelength shifting may be controlled by controlling the cavity length of the micro-cavity composed of the reticular light output coupling layer **70**, the anode **20** and the cathode **30**, and the organic material functional layer **40**, so as to control the center wavelength of the electroluminescence spectrum and to improve light output ratio.

[0052] Preferably, the material of the reticular light output coupling layer **70** comprises a high molecular tris(8-hydroxyquinolinato)aluminium derivative.

[0053] In which, the molecular structure of the high molecular tris(8-hydroxyquinolinato)aluminium derivative is as shown by FIG. 3, such a high molecular tris(8-hydroxyquinolinato)aluminium derivative is a high molecular material having a reticular molecular structure.

[0054] Herein, the high molecular tris(8-hydroxyquinolinato)aluminium derivative may be formed from the photo-crosslinking reaction of the tris(8-hydroxyquinolinato)aluminium derivative having a small molecular structure as shown by FIG. 4 through ultraviolet curing; wherein the molecular structure of tris(8-hydroxyquinolinato)aluminium derivative having a small molecular structure comprises a photo-crosslinkable group which may perform photo-crosslinking reaction.

[0055] Because the tris(8-hydroxyquinolinato)aluminium derivative having a small molecular structure has the features such as a high refractive index, less adsorption in the visible light range, and the like, it may satisfy the performance requirements of the transmission enhanced film, and it can be easily processed, and it is nontoxic. Therefore, this type of material is widely applied to the transmission enhanced film. When the above tris(8-hydroxyquinolinato)aluminium derivative having a small molecular structure is subjected to a photo-crosslinking reaction to form the high molecular tris(8-hydroxyquinolinato)aluminium derivative, because only the material having small molecular structure is transformed

into a material having high molecule structure by the photo-crosslinking reaction, without essentially changing the structure thereof, the formed material having a high molecular structure still maintains the initial features. That is, the tris(8-hydroxyquinolinato)aluminium derivative having a high molecular structure has the same properties as those of the tris(8-hydroxyquinolinato)aluminium derivative having a smaller molecular structure, which may also be used as the transmission enhanced film, so as to improve the light output ratio of the display panel.

[0056] In addition, the high molecular tris(8-hydroxyquinolinato)aluminium derivative formed with the tris(8-hydroxyquinolinato)aluminium derivative having a small molecular structure has a reticular molecular structure, which is not only helpful for improving the surface flatness of the flexible base substrate **10** so as to improve the adhesion between the film layer and the flexible base substrate **10**, but also helpful for improving the water-oxygen permeation resistance of the display panel.

[0057] The tris(8-hydroxyquinolinato)aluminium derivative in the invention may be produced according to the following process, for example, it may be produced by firstly synthesizing monomers of a derivative containing 8-hydroxyquinoline, and then complexing it with aluminum. In which, the monomer of the derivative containing 8-hydroxyquinoline may be synthesized by the reaction of a required modified 8-hydroxyquinoline, a catalyst, and a polymerization inhibitor in a proper solvent.

[0058] Furthermore, as for the OLED display panel, the optimal thickness of the reticular light output coupling layer **70** should be determined considering the properties and the thicknesses of the anode **20**, the cathode **30**, and the organic material functional layer **40**. On the basis of the above, preferably, the thickness of the reticular light output coupling layer **70** is between 0 and 100 nm.

[0059] Wherein, the thickness of the reticular light output coupling layer **70** may be designed according to Fresnel coefficient matrix transformation theory to suppress the micro-cavity effect (multi-beam interference effect) so as to achieve a low reflectivity and a high light transmittance in a maximum degree.

[0060] On the basis of the above description, the OLED display panel provided by the invention is preferably a single face emitting display panel, that is, only the side on the organic material functional layer **40** close to the reticular light output coupling layer **70** is the light output side, and in this case, the anode **20** may be a transparent electrode or a metal electrode; the cathode **30** may be a metal electrode.

[0061] In which, the anode **20** is provided closed to the reticular light output coupling layer **70**, and the cathode **30** is provided away from the reticular light output coupling layer **70**.

[0062] Herein, when the anode **20** is a metal electrode, it is necessary to ensure the thickness of the metal electrode is very small, such that the metal electrode may be transparent. On the basis of the above, in the case that the anode **20** is a metal electrode, the thickness of the anode **20** is between 20 and 40 nm; or the anode **20** may employ a transparent electrode, for example an ITO (Indium Tin Oxides) electrode.

[0063] It should be noticed that, the anode **20** and the cathode **30** may be a monolayer structure or a multilayer structure, which are not limited herein.

[0064] As for the active matrix OLED, as shown by FIG. 5, the display panel may also comprise a thin film transistor **80**

provided on the flexible base substrate **10**; wherein, the drain electrode of the thin film transistor **80** is electrically connected to the anode **20**.

[0065] Because the organic material in the above organic material functional layer **40** and the metal material as the electrode are very sensitive to oxygen and steam, oxygen and steam penetrating inside the display panel may influence the lifetime of the display panel, and therefore, all display panels may comprise an encapsulating substrate provided opposite to the flexible base substrate **10** for blocking oxygen and steam; wherein, the encapsulating substrate may be a flexible encapsulating substrate or an encapsulating thin film.

[0066] The invention further provides a production process of an OLED display panel, comprising: forming a reticular light output coupling layer **70** on the flexible base substrate **10**; on the substrate formed with the reticular light output coupling layer **70**, forming an anode **20** and a cathode **30**, and an organic material functional layer **40** between the anode **20** and the cathode **30**; wherein, the reticular light output coupling layer **70**, the anode **20** and the cathode **30**, and the organic material functional layer **40** compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and light output ratio; the material of the reticular light output coupling layer **70** is a reticular high molecular material having a high refractive index and a low absorptivity in the visible light range.

[0067] Herein, the flexible base substrate **10** may comprise at least one of polyethylene (referred to as PE), polypropylene (referred to as PP), polystyrene (referred to as PS), polyethylene terephthalate (referred to as PET), polyethylene naphthalate (referred to as PEN), and polyimide (referred to as PI).

[0068] Because the reticular light output coupling layer **70** has the function of improving the surface flatness of the flexible base substrate **10**, therefore, the reticular light output coupling layer **70** is required to be directly contacted with the flexible base substrate **10**, and the anode **20**, the cathode **30**, and the organic material functional layer **40** are positioned above the reticular light output coupling layer **70**.

[0069] In addition, the relative positions of the anode **20** and the cathode **30** may be exchanged with each other, and the organic material functional layer **40** is between them.

[0070] Preferably, the material of the reticular light output coupling layer **70** comprises a high molecular tris(8-hydroxyquinolinato)aluminium derivative; the molecular structure of the high molecular tris(8-hydroxyquinolinato)aluminium derivative is as shown by FIG. 3.

[0071] In which, when the high molecular tris(8-hydroxyquinolinato)aluminium derivative is formed, the washed surface of the flexible base substrate **10** may be spin coated with a mixture of a tris(8-hydroxyquinolinato)aluminium derivative with a small molecular structure having a photocrosslinkable group as shown by FIG. 4 and a micro amount of a photoinitiator for example benzoyl peroxide (at a doping concentration of 0.1%), and irradiating the mixture spin-coated on the surface of the flexible base substrate **10** with ultraviolet light, so as to subject the mixture to the photocrosslinking reaction under the irradiation of ultraviolet light, to form the high molecular tris(8-hydroxyquinolinato)aluminium derivative. Herein, the tris(8-hydroxyquinolinato)aluminium derivative manufactured by Jilin OLED Optical & Electronic Materials Co., Ltd. may be employed.

[0072] On the basis of the above, more preferably, the thickness of the reticular light output coupling layer **70** is between 0 and 100 nm.

[0073] In the case that the OLED display panel is a single face emitting type display panel, the side of the organic material functional layer **40** close to the reticular light output coupling layer **70** is the light output side; at this time, the anode **20** may be a transparent electrode or a metal electrode, the cathode **30** may be a metal electrode; wherein the anode **20** is provided close to the reticular light output coupling layer **70**, the cathode **30** is provided away from the reticular light output coupling layer **70**.

[0074] When the anode **20** is a metal electrode, in order to ensure that the anode **20** is transparent, preferably, the thickness of the anode is between 20 and 40 nm; or the anode **20** may employ a transparent electrode for example an ITO electrode.

[0075] It should be noticed that, both of the anode **20** and the cathode **30** may be a monolayer structure or a multilayer structure, which is not limited herein.

[0076] As for the active matrix OLED, as shown by FIG. 5, preferably, the process further comprises forming a thin film transistor **80** on the flexible base substrate **10**; wherein, the drain electrode of the thin film transistor **80** is electrically connected to the anode **20**.

[0077] In addition, because the organic material in the organic material functional layer **40** and the metal material as the electrode are very sensitive to oxygen gas and steam, the process further comprises forming an encapsulating substrate opposite to the flexible base substrate **10**; wherein the encapsulating substrate comprises a flexible encapsulating substrate or an encapsulating thin film.

[0078] A specific example is provided below to explain the specific production process of the display panel.

[0079] The display panel comprises a reticular light output coupling layer **70**, an anode **20** and a cathode **30**, and an organic material functional layer **40** between the anode **20** and the cathode **30** sequentially provided on the flexible base substrate **10**.

[0080] In which, the flexible base substrate **10** employs a PET substrate; the material of the reticular light output coupling layer **70** is a high molecular tris(8-hydroxyquinolinato)aluminium derivative with a thickness of 20 nm; the anode **20** is a silver electrode with a thickness of 20 nm; the cathode **30** is an aluminium electrode with a thickness of 120 nm; the organic material functional layer **40** comprises an electron injection layer, an electron transport layer, a light emitting layer, a hole transport layer, and a hole injection layer.

[0081] The production process of the display panel specifically comprises the following steps of:

[0082] S101, placing the PET substrate into ethanol and a deionized water successively to be subjected to ultrasonic washing for 10 minutes respectively, and then placing it into an oven to be dried for about 20 minutes.

[0083] In which, the washing in ethanol may remove contaminations such as lipid and the like on the surface of the PET substrate.

[0084] S102, dissolving a tris(8-hydroxyquinolinato)aluminium derivative having a small molecular structure having a photocrosslinkable group into toluene, and adding a micro amount of benzoyl peroxide (the doping concentration is 0.1%) to form a mixture, and spin coating the mixture on the surface of the washed PET substrate at a thickness of 20 nm.

[0085] S103, conducting ultraviolet (at a wavelength of 300 nm and with a power of $100 \text{ mW} \cdot \text{cm}^{-2}$) irradiation in nitrogen atmosphere at room temperature for 100 seconds to subject the tris(8-hydroxyquinolinato)aluminium derivative having

a small molecular structure to a photo-crosslinking reaction to form a high molecular tris(8-hydroxyquinolino)aluminum derivative, so as to form a reticular light output coupling layer 70.

[0086] S104, placing the substrate formed with the reticular light output coupling layer 70 into a vacuum chamber, and when the vacuum degree reaches 4×10^{-4} Pa, plating a silver electrode on the surface of the reticular light output coupling layer 70 to form an anode 20 by a primary image forming process.

[0087] Herein, a silver electrode with a thickness of 20 nm may be formed on the surface of the reticular light output coupling layer 70.

[0088] S105, forming a hole injection layer (m-MTDATA, with a thickness of 25 nm), a hole transport layer (NPB, with a thickness of 10 nm), a light emitting layer (a mixture of CBP and FIrpic with a thickness of 25 nm, wherein the mass percent of FIrpic is 10%), an electron transport layer (Alq₃, 25 nm), and an electron injection layer (LiF, with a thickness of 1 nm) on the substrate formed with the anode 20 successively so as to form an organic material functional layer 40.

[0089] S106, vacuum plating an aluminium electrode on the substrate formed with the organic material functional layer 40 to form a cathode 30 by a primary image forming process.

[0090] Herein, an aluminium electrode with a thickness of 120 nm may be formed on the surface of the electron injection layer.

[0091] A micro-cavity may be composed by forming the reticular light output coupling layer 70, the anode 20, the organic material functional layer 40, and the cathode 30 on the PET substrate, sequentially; wherein, in the direction vertical to the display panel, the thickness of the micro-cavity composed of the reticular light output coupling layer 70, the anode 20 and the cathode 30, and the organic material functional layer 40 is the cavity length of the micro-cavity.

[0092] As for the active matrix OLED display panel, the display panel further comprises a thin film transistor 80; in such case, the process further comprises: before the above step S104, a thin film transistor 80 may be further formed on the substrate formed with the reticular light output coupling layer 70 thereon.

[0093] Specifically, a gate electrode may be firstly formed on the reticular light output coupling layer 70 by a primary image forming process, then a gate insulating layer is formed; and then a semiconductor active layer is formed by the primary image forming process; and then a source electrode and a drain electrode are formed by the primary image forming process.

[0094] On the basis of the above, steps S104-S106 are then conducted on the substrate formed with the thin film transistor 80, to sequentially form the anode 20, the organic material functional layer 40, and the cathode 30, so as to form active matrix OLED display panel.

[0095] The invention provides a production process of the OLED display panel, wherein by forming a high molecular tris(8-hydroxyquinolino)aluminum derivative having a reticular molecular structure as the light output coupling layer, the transmission enhanced film 50 and the buffer layer 60 in the prior art are combined, which may not only simplifies the structure of the display panel, but also improve the surface flatness of the flexible base substrate 10 and the water-oxygen permeation resistance of the display panel, and improve the light output ratio of the display panel. Further-

more, the spectrum narrowing and the wavelength shifting may be controlled by controlling the cavity length of the micro-cavity composed of the reticular light output coupling layer 70, the anode 20 and the cathode 30, and the organic material functional layer 40, so as to control the center wavelength of the electroluminescence spectrum and to improve the light output ratio.

[0096] The description above is only about the specific embodiments of the invention, but the protection scope of the invention is not limited herein. Any person skilled in the art may easily recognize changes or replacements within the technical range disclosed by the invention, which should be all involved in the protection scope of the invention. Therefore, the protection scope of the invention should be determined by the claims.

What is claimed is:

1. An OLED display panel, comprising an anode and a cathode provided on a flexible base substrate, and an organic material functional layer provided between the anode and the cathode; the display panel further comprises a reticular light output coupling layer provided on the flexible base substrate and contacting the flexible base substrate;

wherein the anode, the cathode and the organic material functional layer are all provided on the reticular light output coupling layer;

the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio;

the material of the reticular light output coupling layer is a reticular high molecular material.

2. The display panel according to claim 1, wherein the material of the reticular light output coupling layer is a reticular high molecular material formed by the photo-crosslinking reaction of a small molecular material having a photo-crosslinkable group through ultraviolet curing.

3. The display panel according to claim 1, wherein the material of the reticular light output coupling layer comprises a high molecular tris(8-hydroxyquinolino)aluminum derivative formed by the photo-crosslinking reaction of a small molecular tris(8-hydroxyquinolino)aluminum derivative having a photo-crosslinkable group.

4. The display panel according to claim 1, wherein the thickness of the reticular light output coupling layer is between 0 and 100 nm.

5. The display panel according to claim 1, wherein, the anode is a transparent electrode or a metal electrode; the cathode is a metal electrode;

wherein the anode is provided close to the reticular light output coupling layer, and in the case where the anode is a metal electrode, the thickness of the anode is between 20 and 40 nm.

6. The display panel according to claim 1, wherein the display panel further comprises a thin film transistor provided on the flexible base substrate;

wherein the drain electrode of the thin film transistor is electrically connected to the anode.

7. The display panel according to claim 1, wherein the display panel further comprises a flexible encapsulating substrate or an encapsulating thin film.

8. A production process of an OLED display panel, comprising:

forming a reticular light output coupling layer on a flexible base substrate;

on the substrate on which the reticular light output coupling layer is formed, forming an anode and a cathode, and an organic material functional layer between the anode and the cathode;

wherein the reticular light output coupling layer, the anode and the cathode, and the organic material functional layer compose a micro-cavity; the micro-cavity is used for controlling the center wavelength of the electroluminescence spectrum and the light output ratio;

the material of the reticular light output coupling layer is a reticular high molecular material.

9. The process according to claim **8**, wherein the material of the reticular light output coupling layer comprises a high molecular tris(8-hydroxyquinolinato)aluminium derivative.

10. The process according to claim **9**, wherein the thickness of the reticular light output coupling layer is between 0 and 100 nm.

11. The process according to claim **8**, wherein the process further comprises forming a thin film transistor on the flexible base substrate;

wherein the drain electrode of the thin film transistor is electrically connected to the anode.

12. The process according to claim **8**, wherein the process further comprises forming a flexible encapsulating substrate or an encapsulating thin film.

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专利名称(译)	OLED显示面板及其制造工艺		
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摘要(译)

本发明提供一种OLED显示面板及其制作工艺，涉及显示技术领域，可提高柔性基底的表面平整度和水氧渗透性，提高显示面板的光输出率，并且可以控制电致发光光谱的中心波长。显示面板包括设置在柔性基础基板上的阳极和阴极，以及位于阳极和阴极之间的有机材料功能层，并且还包括设置在柔性基础基板上并接触柔性基板的网状光输出耦合层基础衬底；阳极，阴极，有机材料功能层均设置在网状光输出耦合层上；网状光输出耦合层，阳极和阴极，以及有机材料功能层组成微腔；微腔用于控制电致发光光谱的中心波长和光输出比。网状光输出耦合层的材料是在可见光范围内具有高折射率和低吸收率的网状高分子材料；它用于生产柔性OLED显示板。

