



US009065079B2

(12) **United States Patent**
Liu et al.

(10) **Patent No.:** **US 9,065,079 B2**
(45) **Date of Patent:** **Jun. 23, 2015**

(54) **FABRICATION METHOD OF A PIXEL STRUCTURE OF AN ELECTROLUMINESCENT DISPLAY PANEL**

USPC 345/76, 77, 80, 84
See application file for complete search history.

(71) Applicant: **AU Optronics Corp.**, Hsin-Chu (TW)

(56)

References Cited

(72) Inventors: **Meng-Yu Liu**, Hsin-Chu (TW);
Chih-Che Liu, Hsin-Chu (TW);
Shih-Feng Hsu, Hsin-Chu (TW)

U.S. PATENT DOCUMENTS

5,917,280 A 6/1999 Burrows
7,466,294 B2 12/2008 Yamazaki

(73) Assignee: **AU Optronics Corp.**, Science-Based Industrial Park, Hsin-Chu (TW)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

CN 101425529 A 5/2009
EP 2 267 778 A2 12/2010
TW 201129244 8/2011

(21) Appl. No.: **14/452,547**

(22) Filed: **Aug. 6, 2014**

OTHER PUBLICATIONS

(65) **Prior Publication Data**

Huang, "The study of full color display based on white polymer light-emitting devices combined with color filters", Jan. 2008.

US 2014/0342483 A1 Nov. 20, 2014

(Continued)

Related U.S. Application Data

(62) Division of application No. 13/674,088, filed on Nov. 11, 2012, now Pat. No. 8,847,857.

Primary Examiner — Adam R Giesy

(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(30) **Foreign Application Priority Data**

Dec. 8, 2011 (TW) 100145252 A

(57)

ABSTRACT

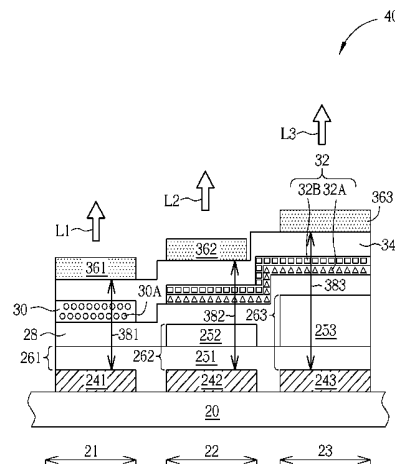
(51) **Int. Cl.**
G09G 3/30 (2006.01)
H01L 51/56 (2006.01)
(Continued)

A fabrication method of a pixel structure of an electroluminescent display panel includes the following steps. A substrate is provided. A first anode, a second anode and a third anode are formed in a first sub-pixel region, a second sub-pixel region and a third sub-pixel region respectively. A first organic light-emitting layer is formed in the first sub-pixel region by using a first fine metal mask. A second organic light-emitting layer is formed in the second sub-pixel region and the third sub-pixel region by using a second fine metal mask. A first cathode, a second cathode and a third cathode are formed in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region, respectively. The first micro cavity in the first sub-pixel region, the second micro cavity in the second sub-pixel region and the third micro cavity have different cavity lengths.

(52) **U.S. Cl.**
CPC **H01L 51/56** (2013.01); **G09G 3/30** (2013.01);
Y10T 29/49002 (2015.01); **H01L 51/5088**
(2013.01); **H01L 51/5265** (2013.01); **H01L**
27/3206 (2013.01); **H01L 2251/56** (2013.01)

(58) **Field of Classification Search**
CPC G09G 2300/0842; G09G 3/3233;
G09G 2320/043; G09G 3/30; H01L 51/56;
H01L 51/5265; H01L 27/3206; H01L
2251/5088; Y01T 29/49002

6 Claims, 10 Drawing Sheets



(51)	Int. Cl. H01L 51/52 H01L 27/32 H01L 51/50	(2006.01) (2006.01) (2006.01)	2011/0180825 A1 7/2011 Lee et al. 2012/0326180 A1 * 12/2012 Ohe et al. 257/88
------	--	-------------------------------------	---

OTHER PUBLICATIONS

(56) **References Cited**

Ma, "Study Forward the Fabrication of High-Efficiency White Organic Light-Emitting Diodes", Jul. 2006.

U.S. PATENT DOCUMENTS

7,872,412 B2 1/2011 Chan

* cited by examiner

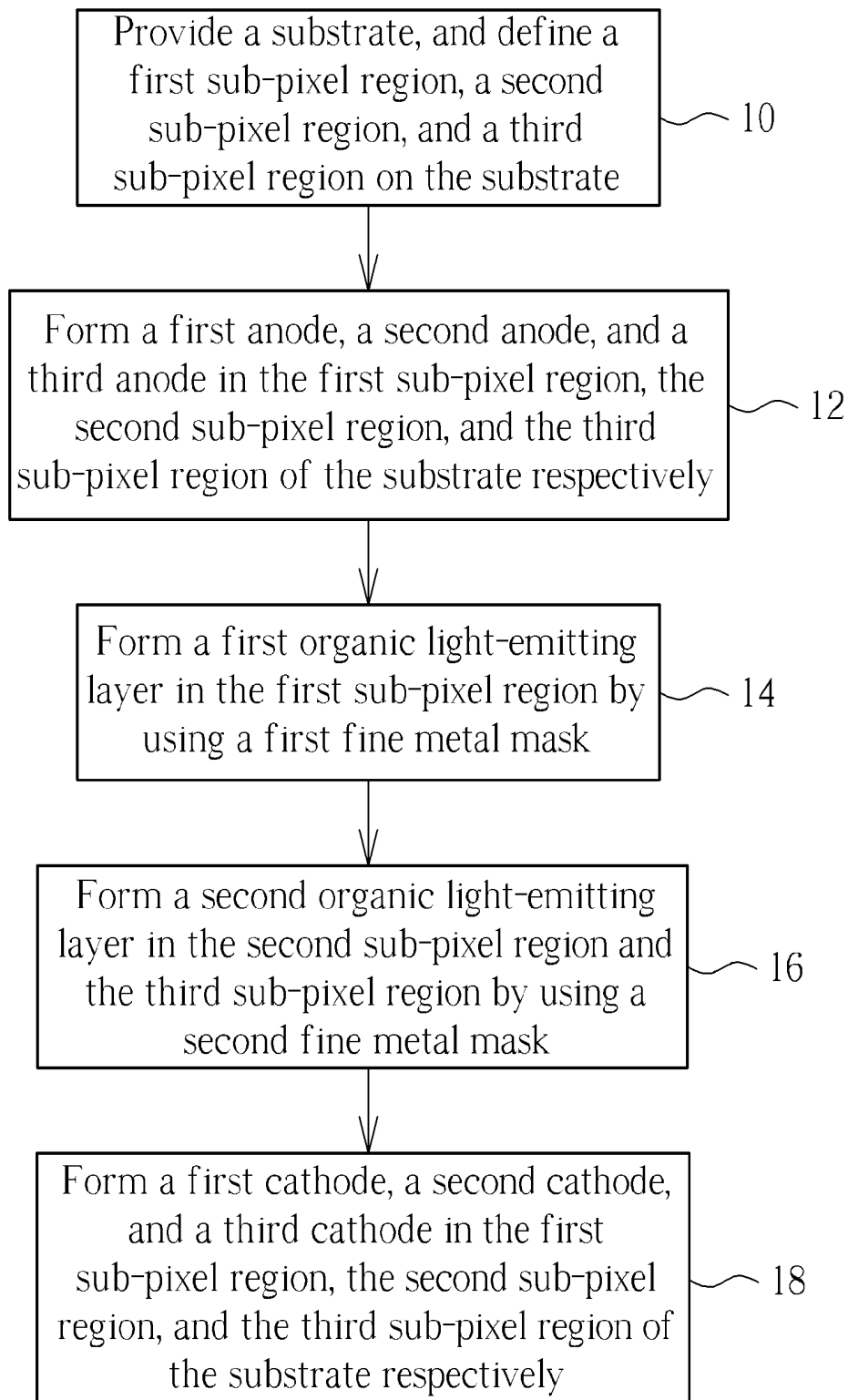


FIG. 1

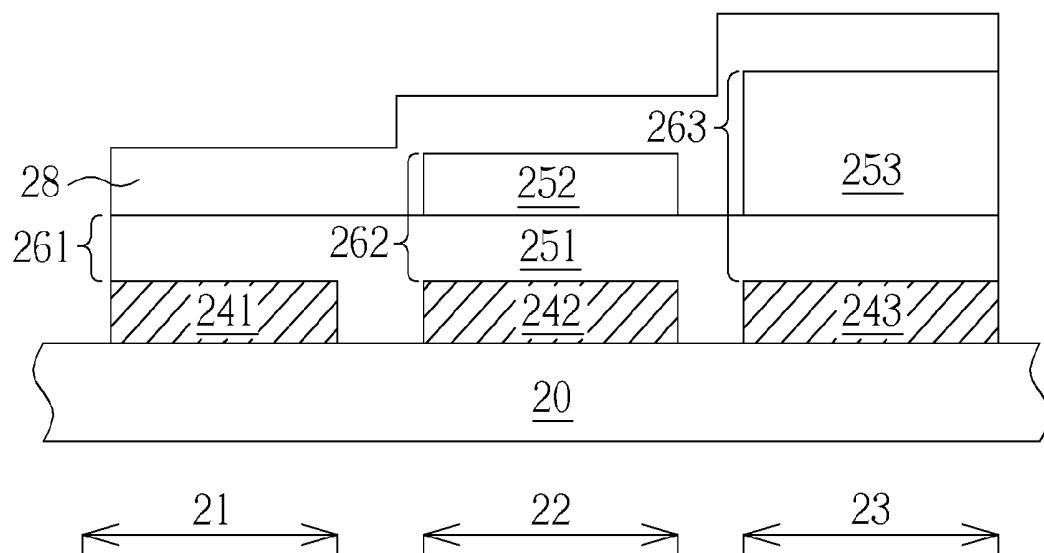


FIG. 2

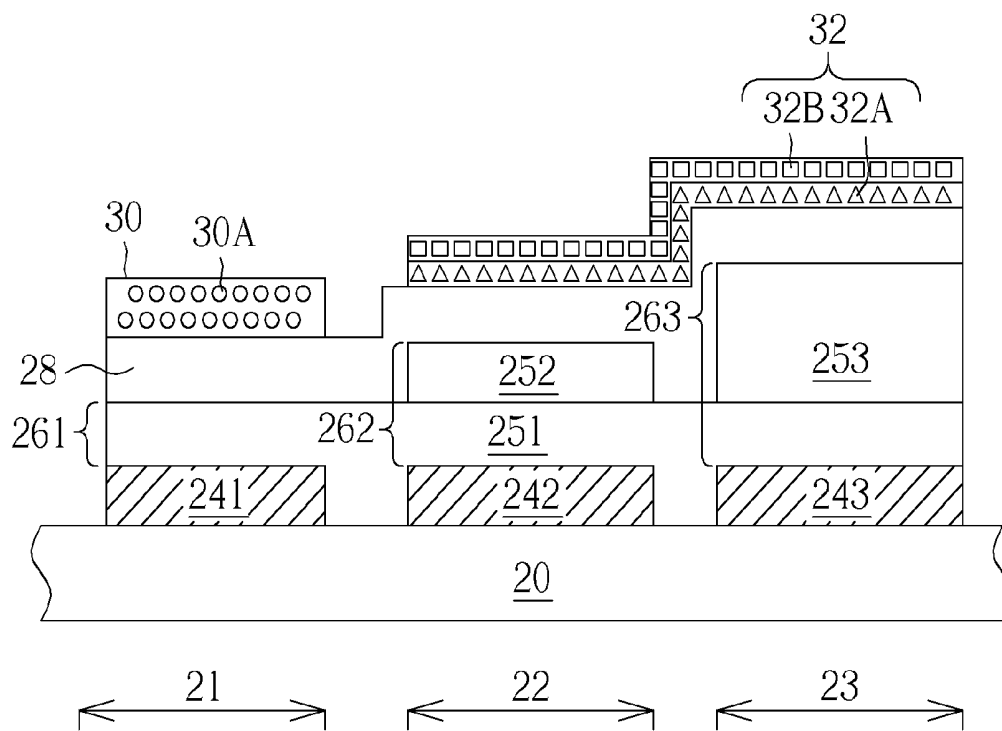


FIG. 3

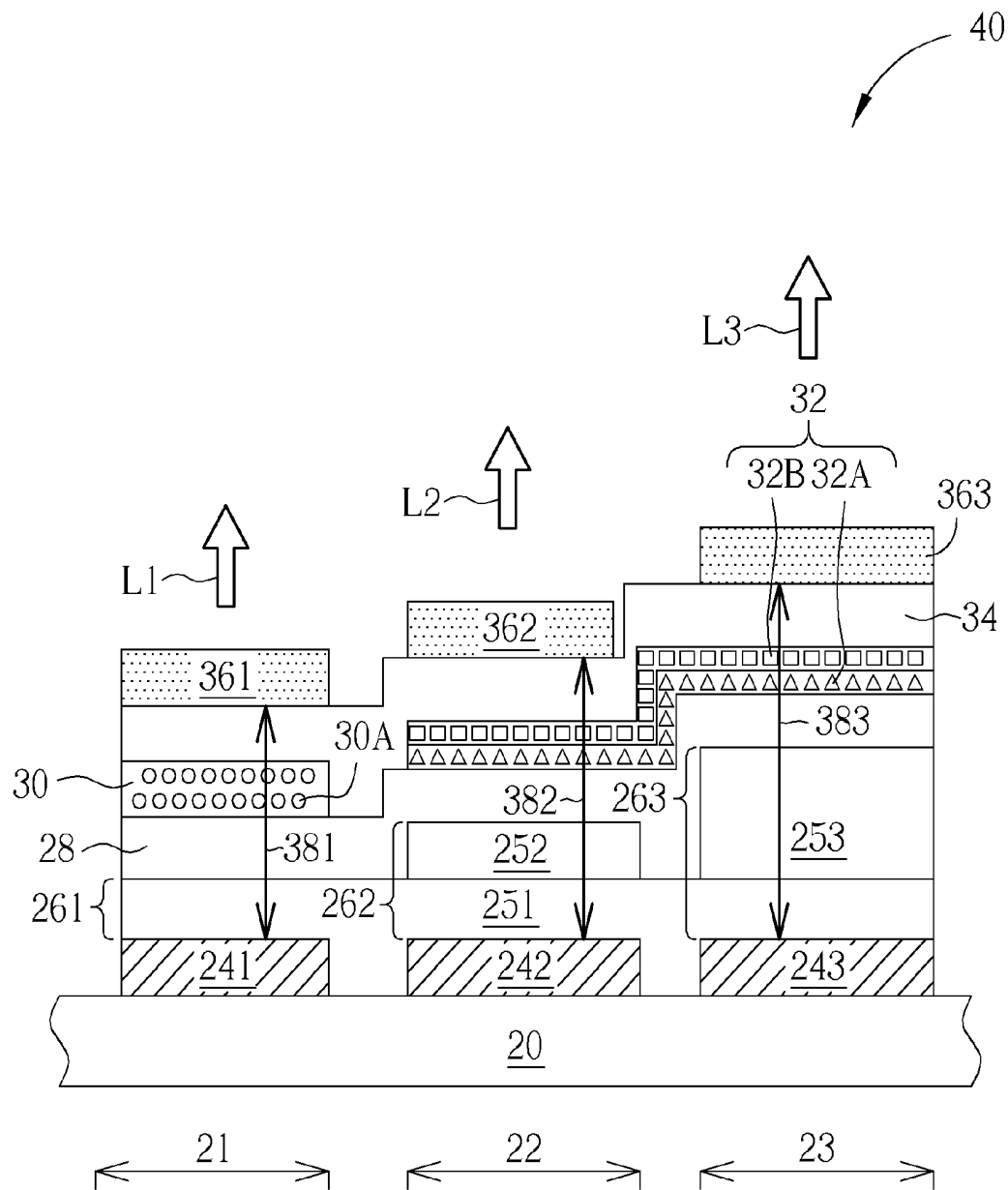


FIG. 4

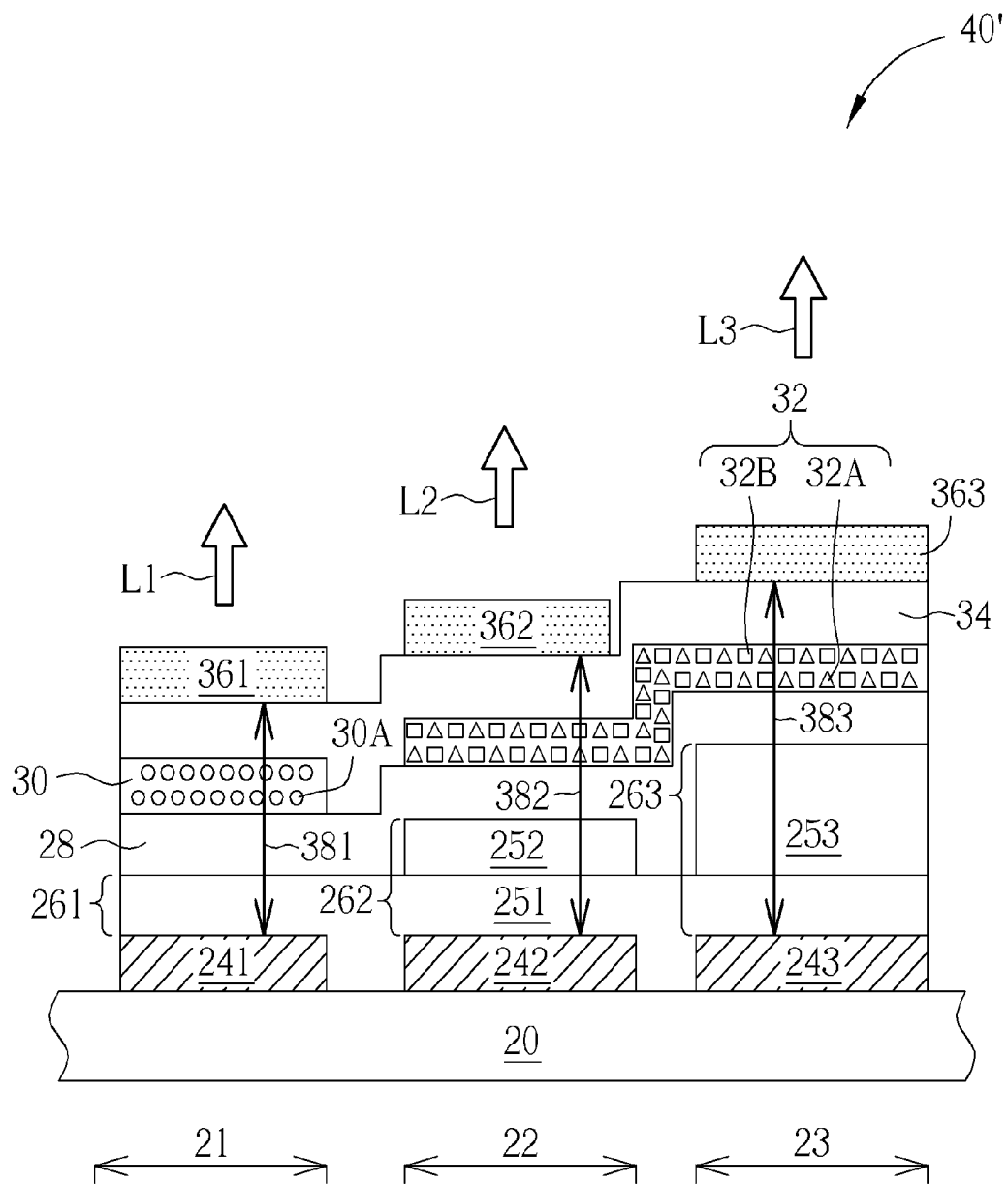


FIG. 5

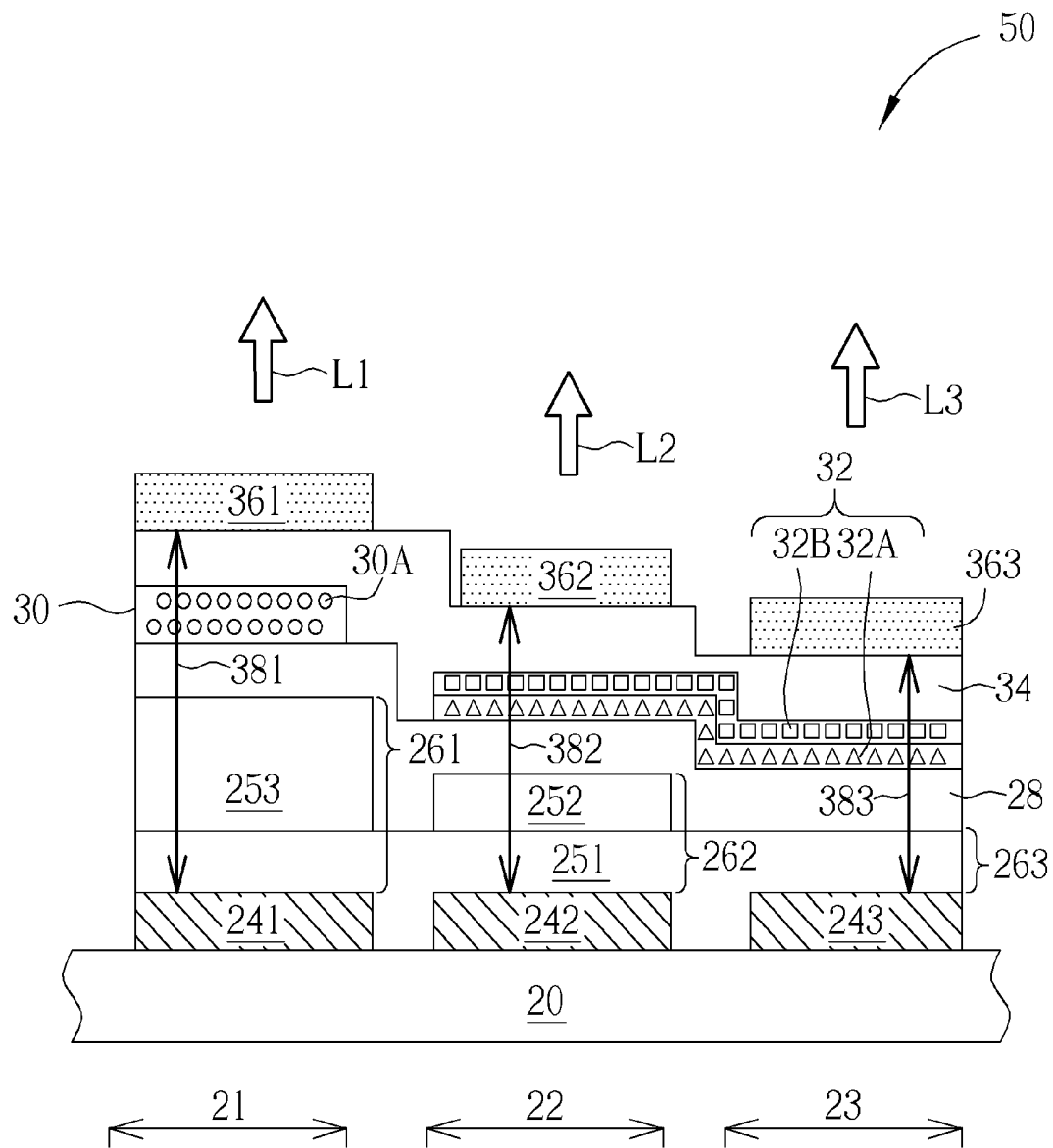


FIG. 6

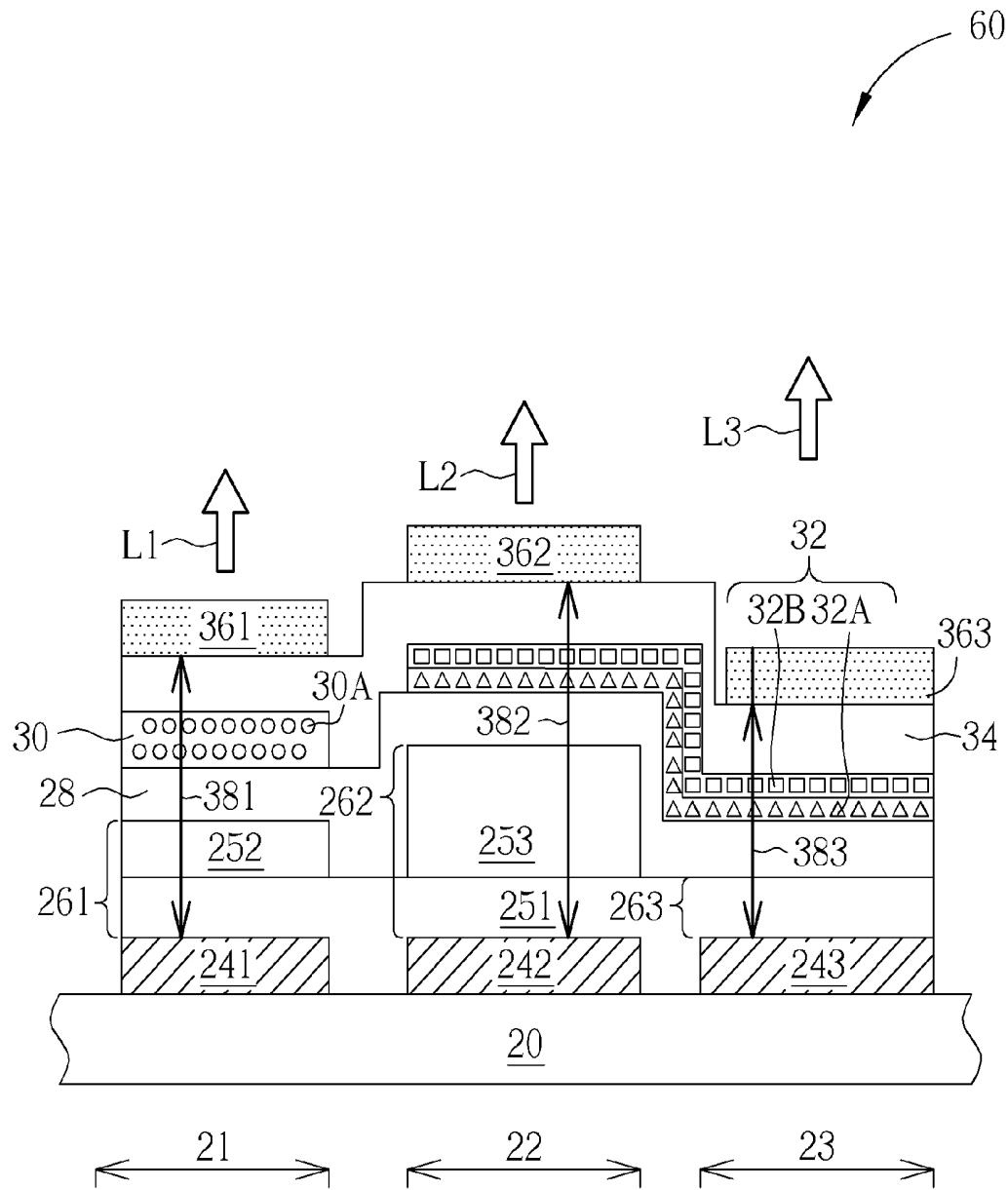


FIG. 7

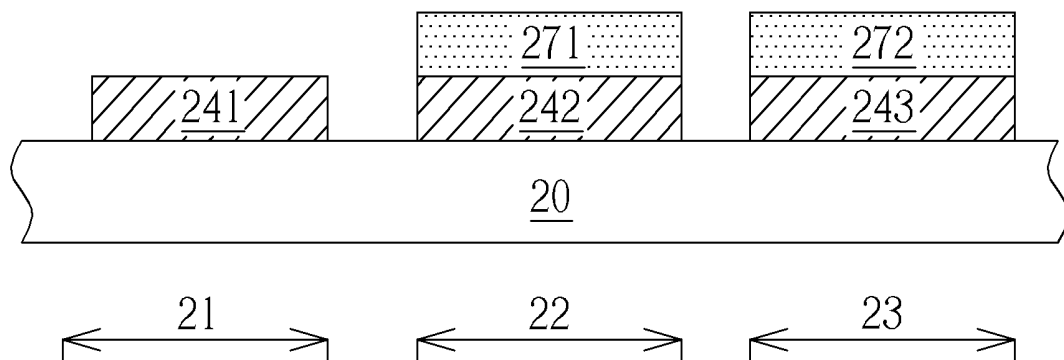


FIG. 8

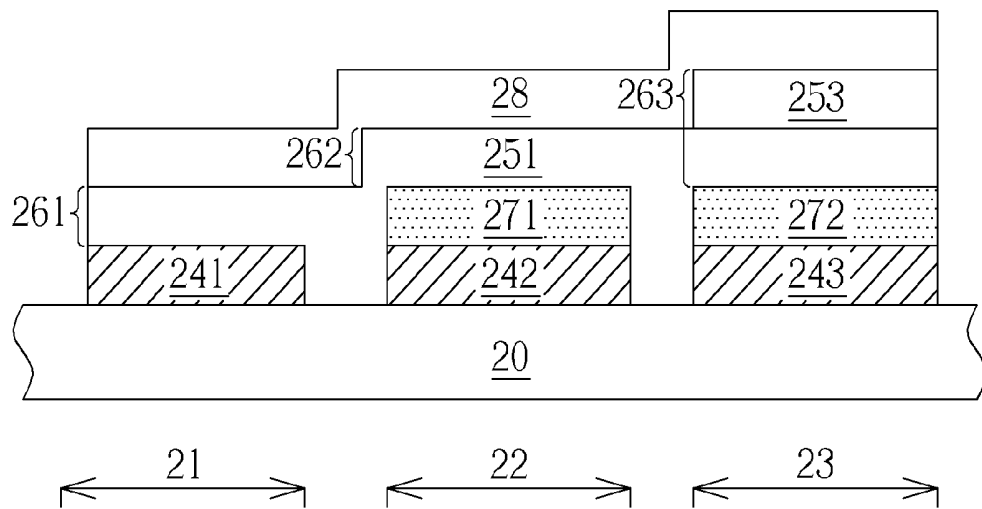


FIG. 9

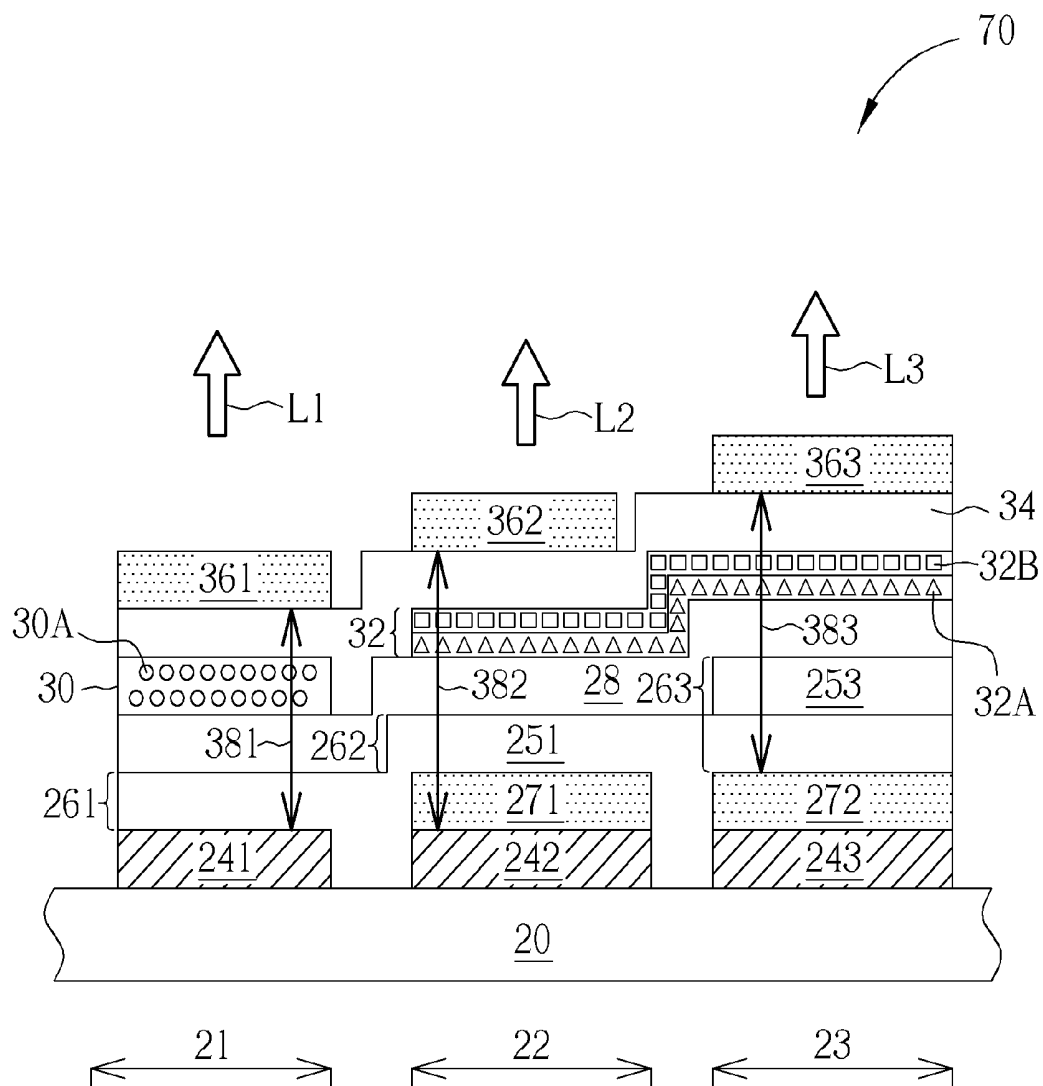


FIG. 10

1

FABRICATION METHOD OF A PIXEL STRUCTURE OF AN ELECTROLUMINESCENT DISPLAY PANEL

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a divisional of application Ser. No. 13/674,088 filed Nov. 11, 2012, now allowed, which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a pixel structure of an electroluminescent display panel, and a fabrication method thereof, and more particularly, to a pixel structure of an electroluminescent display panel having a common organic light-emitting layer formed in two adjacent sub-pixel regions for displaying different primary color lights, and a fabrication method thereof.

2. Description of the Prior Art

Due to its self-luminous, high contrast ratio, compact size, and wide viewing angle properties, electroluminescent display panel e.g. organic light-emitting diode (OLED) display panel has been expected to prevail in the display market of next generation. The organic light-emitting layer used in a conventional electroluminescent display panel is formed through an evaporation process by using a fine metal mask (FMM). However, there exists a distance limitation between the adjacent openings of the fine metal mask, and there has to be disposed certain spacing between adjacent sub-pixel regions of different colors in order to avoid light mixing between adjacent sub-pixel regions that generate different colors of light. Therefore, it is hard to further improve the aperture ratio and resolution of a conventional electroluminescent display panel.

SUMMARY OF THE INVENTION

It is therefore one of the objectives of the present invention to provide a pixel structure of an electroluminescent display panel for avoiding light-mixing problem occurred between adjacent sub-pixel regions with different colors and for raising the aperture ratio and resolution.

According to a preferred embodiment of the present invention, a pixel structure of an electroluminescent display panel having a first sub-pixel region, a second sub-pixel region, and a third sub-pixel region is provided. The pixel structure of the electroluminescent display panel includes a first anode, a second anode, a third anode, a first organic light-emitting layer, a second organic light-emitting layer, a first cathode, a second cathode, and a third cathode. The first anode is disposed in the first sub-pixel region, the second anode is disposed in the second sub-pixel region, and the third anode is disposed in the third sub-pixel region. The first organic light-emitting layer is disposed on the first anode and corresponds to the first sub-pixel region, wherein the first organic light-emitting layer comprises a first organic light-emitting material for generating a first primary color light in the first sub-pixel region. The second organic light-emitting layer is disposed on the second anode and the third anode, and corresponds to the second sub-pixel region and third sub-pixel region, wherein the second organic light-emitting layer is used for generating a second primary color light in the second sub-pixel region and generating a third primary color light in the third sub-pixel region, and the first primary color light, the

2

second primary color light, and the third primary color light have different spectra of wavelength. The first cathode is disposed on the first organic light-emitting layer and corresponds to the first sub-pixel region. The second cathode is disposed on the second organic light-emitting layer and corresponds to the second sub-pixel region. The third cathode is disposed on the second organic light-emitting layer and corresponds to the third sub-pixel region. A first micro cavity is formed between the first anode and the first cathode in the first sub-pixel region. A second micro cavity is formed between the second anode and the second cathode in the second sub-pixel region. A third micro cavity is formed between the third anode and the third cathode in the third sub-pixel region. The first micro cavity, the second micro cavity, and the third micro cavity have different cavity lengths.

According to another preferred embodiment of the present invention, a fabrication method of a pixel structure of an electroluminescent display panel is provided. The fabrication method includes: providing a substrate, and defining a first sub-pixel region, a second sub-pixel region, and a third sub-pixel region on the substrate; respectively forming a first anode, a second anode, and a third anode in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region of the substrate; forming a first organic light-emitting layer in the first sub-pixel region by using a first fine metal mask, wherein the first organic light-emitting layer includes a first organic light-emitting material; forming a second organic light-emitting layer in the second sub-pixel region and the third sub-pixel region by using a second fine metal mask; and respectively forming a first cathode, a second cathode, and a third cathode in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region of the substrate. Wherein, a first micro cavity is formed between the first anode and the first cathode in the first sub-pixel region, a second micro cavity is formed between the second anode and the second cathode in the second sub-pixel region, and a third micro cavity is formed between the third anode and the third cathode in the third sub-pixel region. The first micro cavity, the second micro cavity, and the third micro cavity have different cavity lengths.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a process flow diagram of a fabrication method of a pixel structure of an electroluminescent display panel according to the present invention.

FIG. 2 to FIG. 4 are schematic diagrams illustrating a fabrication method of a pixel structure of an electroluminescent display panel according to a first preferred embodiment of the present invention.

FIG. 5 is a schematic diagram illustrating a pixel structure of an electroluminescent display panel according to a variant embodiment of the first preferred embodiment of the present invention.

FIG. 6 is a schematic diagram illustrating a pixel structure of the electroluminescent display panel according to a second preferred embodiment of the present invention.

FIG. 7 is a schematic diagram illustrating a pixel structure of an electroluminescent display panel according to a third preferred embodiment of the present invention.

FIG. 8 to FIG. 10 are schematic diagrams illustrating a fabrication method of a pixel structure of an electroluminescent display panel according to a fourth preferred embodiment of the present invention.

DETAILED DESCRIPTION

To provide a better understanding of the present invention to the skilled users in the technology of the present invention, preferred embodiments of the present invention are illustrated in the accompanying drawings with numbered elements to elaborate the contents and effects to be achieved.

With reference to FIG. 1, FIG. 1 is a process flow diagram of a fabrication method of a pixel structure of an electroluminescent display panel of the present invention. As shown in FIG. 1, the fabrication method of a pixel structure of an electroluminescent display panel of the present invention mainly includes the following steps:

Step 10: Provide a substrate, and define a first sub-pixel region, a second sub-pixel region, and a third sub-pixel region on the substrate;

Step 12: Respectively form a first anode, a second anode, and a third anode in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region of the substrate;

Step 14: Form a first organic light-emitting layer in the first sub-pixel region by using a first fine metal mask;

Step 16: Form a second organic light-emitting layer in the second sub-pixel region and the third sub-pixel region by using a second fine metal mask; and

Step 18: Respectively form a first cathode, a second cathode, and a third cathode in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region of the substrate.

Accordingly to the fabrication method of a pixel structure of an electroluminescent display panel of the present invention, the first organic light-emitting layer is evaporated into the first sub-pixel region by using the first fine metal mask, for generating a first primary color light in the first sub-pixel region, and the second organic light-emitting layer is evaporated into the second sub-pixel region and the third sub-pixel region at the same time by using the second fine metal mask, for generating a second primary color light in the second sub-pixel region and generating a third primary color light in the third sub-pixel region. Therefore, the amount of fine metal masks needed and fabrication cost of the fabrication method of a pixel structure of an electroluminescent display panel of the present invention are reduced. Also, the aperture ratio and resolution can be increased. A detailed description of different embodiments of a pixel structure of an electroluminescent display panel of the present invention and the fabrication method thereof is provided in the following descriptions.

Please refer to FIG. 2 to FIG. 4. FIG. 2 to FIG. 4 are schematic diagrams illustrating the fabrication method of a pixel structure of an electroluminescent display panel according to a first preferred embodiment of the present invention. As shown in FIG. 2, first, a substrate 20 is provided, which has a first sub-pixel region 21, a second sub-pixel region 22, and a third sub-pixel region 23 for individually displaying different primary color lights. Then, a first anode 241, a second anode 242, and a third anode 243 are formed in the first sub-pixel region 21, the second sub-pixel region 22, and third sub-pixel region 23 of the substrate 20 respectively. The first anode 241, the second anode 242, and the third anode 243 can be formed through, but not limited to, an evaporation process in collocation with a fine metal mask (FMM). In another

variant embodiment, the first anode 241, the second anode 242, and the third anode 243 can also be formed through a chemical vapor deposition process and a photolithography-etching-process (PEP) for example. According to this embodiment, the electroluminescent display panel may be a top emission type electroluminescent display panel. Therefore, the first anode 241, the second anode 242, and the third anode 243 may be reflective electrodes, such as thick metal electrodes, but not limited thereto. When the electroluminescent display panel is a bottom emission type electroluminescent display panel, the first anode 241, the second anode 242, and the third anode 243 may be transmissive electrodes, such as thin metal electrodes. Then, at least a first hole injection layer 261 is formed in the first sub-pixel region 21, at least a second hole injection layer 262 is formed in the second sub-pixel region 22, and at least a third hole injection layer 263 is formed in the third sub-pixel region 23; wherein the first hole injection layer 261, the second hole injection layer 262, and the third hole injection layer 263 have different thicknesses. In this embodiment, the formation of the first hole injection layer 261, the second hole injection layer 262, and the third hole injection layer 263 includes the following processes: at first, blanket forming a hole injection layer 251 in the first sub-pixel region 21, the second sub-pixel region 22, and the third sub-pixel region 23; and then respectively forming a first patterned hole injection layer 252 on the hole injection layer 251 of the second sub-pixel region 22 and forming a second patterned hole injection layer 253 on the hole injection layer 251 of the third sub-pixel region 23; wherein the thickness of the second patterned hole injection layer 253 is greater than the thickness of the first patterned hole injection layer 252. The first patterned hole injection layer 252 and the second patterned hole injection layer 253 can be individually formed through, but not limited to, an evaporation in collocation with a fine metal mask for example. By means of the above-mentioned processes, the hole injection layer 251 forms a first hole injection layer 261 in the first sub-pixel region 21, the hole injection layer 251 and the first patterned hole injection layer 252 stacked thereon form a second hole injection layer 262 in the second sub-pixel region 22, and the hole injection layer 251 and the second patterned hole injection layer 253 stacked thereon form a third hole injection layer 263 in the third sub-pixel region 23. Wherein, the thickness of the first hole injection layer 261 is less than the thickness of the second hole injection layer 262, and the thickness of the second hole injection layer 262 is less than the thickness of the third hole injection layer 263. After that, a hole transmission layer 28 is formed on the first hole injection layer 261, the second hole injection layer 262, and the third hole injection layer 263.

As shown in FIG. 3, a first fine metal mask is used to form a first organic light-emitting layer 30 in the first sub-pixel region 21, and a second fine metal mask is used to form a second organic light-emitting layer 32 in the second sub-pixel region 22 and the third sub-pixel region 23. The first organic light-emitting layer 30 includes a first organic light-emitting material 30A, and the second organic light-emitting layer 32 includes a second organic light-emitting material 32A and a third organic light-emitting material 32B. The first organic light-emitting material 30A is a blue light-emitting material. The second organic light-emitting material 32A and the third organic light-emitting material 32B can be respectively selected from one of a red light-emitting material and a green light-emitting material, and there is no limitation of the stacking order of the red light-emitting material and the green light-emitting material. The first organic light-emitting layer 30 and the second organic light-emitting layer 32 may be

formed through an evaporation process respectively, but not limited thereto. In this embodiment, the second organic light-emitting layer **32** is a composite organic light-emitting layer, and the formation of the second organic light-emitting layer **32** may include the following processes: performing an evaporation process by using a second fine metal mask to form the second organic light-emitting material **32A** in the second sub-pixel region **22** and the third sub-pixel region **23**; and performing another evaporation process by using the same second fine metal mask to form the third organic light-emitting material **32B** in the second sub-pixel region **22** and the third sub-pixel region **23**.

As shown in FIG. 4, an electron transmission layer **34** is formed on the first organic light-emitting layer **30** and the second organic light-emitting layer **32**. Then, a first cathode **361**, a second cathode **362**, and a third cathode **363** are respectively formed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23** of the substrate **20** to complete the fabrication of the pixel structure of an electroluminescent display panel **40** of this embodiment. The electroluminescent display panel of this embodiment is a top emission type electroluminescent display panel, so that the first cathode **361**, the second cathode **362**, and the third cathode **363** may be transmissive electrodes, such as thin film metal electrodes, but not limited thereto. When the electroluminescent display panel is a bottom emission type electroluminescent display panel, the first cathode **361**, the second cathode **362**, and the third cathode **363** may be reflective electrodes, such as thick metal electrodes. The first cathode **361**, the second cathode **362**, and the third cathode **363** may be electrically connected to each other and be driven by being applied with a common voltage. Alternatively, the first cathode **361**, the second cathode **362**, and the third cathode **363** may be electrically separated and applied with different voltages. In the first sub-pixel region **21**, a first micro cavity **381** is formed between the first anode **241** and the first cathode **361**; in the second sub-pixel region **22**, a second micro cavity **382** is formed between the second anode **242** and the second cathode **362**; and in the third sub-pixel region **23**, a third micro cavity **383** is formed between the third anode **243** and the third cathode **363**. Since the first hole injection layer **261**, the second hole injection layer **262**, and the third hole injection layer **263** have different thickness, the first micro cavity **381**, the second micro cavity **382**, and the third micro cavity **383** have different cavity lengths, resulting in that a first primary color light **L1**, a second primary color light **L2**, and a third primary color light **L3** can be generated in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23** respectively. In this embodiment, the thickness of the first hole injection layer **261** is less than the thickness of the second hole injection layer **262** and the thickness of the second hole injection layer **262** is less than the thickness of the third hole injection layer **263**, such that the cavity length of the first micro cavity **381** is less than the cavity length of the second micro cavity **382** and the cavity length of the second micro cavity **382** is less than the cavity length of the third micro cavity **383**. The cavity lengths of the first micro cavity **381**, the second micro cavity **382**, and the third micro cavity **383** may be modified to be different based on the spectra of wavelength of the first primary color light **L1**, the second primary color light **L2**, and the third primary color light **L3**. Specifically, the greater the wavelength is, the greater the cavity length is. When displaying, due to micro cavity effect, the first primary color light (blue light) **L1** generated by the first organic light-emitting layer **30** can emit out from the first sub-pixel region **21**, the second primary color light (green light) **L2** generated by the second organic

light-emitting layer **32** can emit out from the second sub-pixel region **22** but cannot emit out from the third sub-pixel region **23**, and the third primary color light (red light) **L3** generated by the second organic light-emitting layer **32** can emitted out from the third sub-pixel region **23** but cannot emit out from the second sub-pixel region **22**. As a result, the total amount of the fine metal masks used in the fabrication method of the pixel structure of an electroluminescent display panel of this embodiment can be reduced and the light-mixing ratio is lowered. Furthermore, a high aperture ratio and high resolution of the pixel structure of the electroluminescent display panel **40** can be preserved. In addition, due to micro cavity, the first primary color light **L1**, the second primary color light **L2**, and the third primary color light **L3** generated in the pixel structure of the electroluminescent display panel **40** have distinct spectra of wavelength so that the color purity and color saturation can be improved, wherein no color filter is needed in the pixel structure. Furthermore, the pixel structure of the electroluminescent display panel **40** of this embodiment may at least comprise a first sub-pixel region **21**, a second sub-pixel region **22**, and a third sub-pixel region **23**, or may consist of a first sub-pixel region **21**, a second sub-pixel region **22**, and a third sub-pixel region **23**.

The pixel structure of the electroluminescent display panel of the present invention and the fabrication method thereof are not limited by the aforementioned embodiment, and may have other different preferred embodiments and variant embodiments. To simplify the description, the identical components in each of the following embodiments are marked with identical symbols. For making it easier to compare the difference between the embodiments, the following description will detail the dissimilarities among different embodiments and the identical features will not be redundantly described.

Please refer to FIG. 5. FIG. 5 is a schematic diagram of a variant embodiment of the first preferred embodiment of the pixel structure of the electroluminescent display panel of the present invention. As shown in FIG. 5, in this variant embodiment, the second organic light-emitting layer **32** of the pixel structure of the electroluminescent display panel **40'** is a single-layered organic light-emitting layer, not the same as the first preferred embodiment. Furthermore, the formation of the second organic light-emitting layer **32** includes performing an evaporation process by using a second fine metal mask to simultaneously evaporate the second organic light-emitting material **32A** and the third organic light-emitting material **32B** onto the second sub-pixel region **22** and the third sub-pixel region **23**. In another variant embodiment, the second organic light-emitting layer **32** may include only one single light-emitting material. In that case, for instance, when the first organic light-emitting material **30A** is a blue light-emitting material, the second organic light-emitting layer **32** is a yellow light-emitting material.

With reference to FIG. 6, FIG. 6 is a schematic diagram of a pixel structure of the electroluminescent display panel according to a second preferred embodiment of the present invention. As shown in FIG. 6, in the pixel structure of the electroluminescent display panel **50** of this embodiment, the first organic light-emitting material **30A** is a red light-emitting material, the second organic light-emitting material **32A** and the third organic light-emitting material **32B** may be individually selected from one of a blue light-emitting material and a green light-emitting material, wherein the stacking order of the blue light-emitting material and the green light-emitting material is not limited. In addition, the hole injection layer **251** is disposed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23**.

The first patterned hole injection layer **252** is disposed in the second sub-pixel region **22**, and the second patterned hole injection layer **253** is disposed in the first sub-pixel region **21**, wherein the thickness of the second patterned hole injection layer **253** is greater than the thickness of the first patterned hole injection layer **252**. As a result, in the first sub-pixel region **21**, the hole injection layer **251** and the second patterned hole injection layer **253** stacked thereon form a first hole injection layer **261**; in the second sub-pixel region **22**, the hole injection layer **251** and the first patterned hole injection layer **252** stacked thereon form a second hole injection layer **262**; and in the third sub-pixel region **23**, the hole injection layer **251** form a third hole injection layer **263**; wherein the thickness of the first hole injection layer **261** is greater than the thickness of the second hole injection layer **262**, and the thickness of the second hole injection layer **262** is greater than the thickness of the third hole injection layer **263**. As a result, the cavity length of the first micro cavity **381** is greater than the cavity length of the second micro cavity **382**, and the cavity length of the second micro cavity **382** is greater than the cavity length of the third micro cavity **383**. Due to micro cavity, the first primary color light (red light) **L1** generated by the first organic light-emitting layer **30** can emit out from the first sub-pixel region **21**, the second primary color light (green light) **L2** of the second organic light-emitting layer **32** can emit out from the second sub-pixel region **22** but cannot emit out from the third sub-pixel region **23**, and the third primary color light (blue light) **L3** generated by the second organic light-emitting layer **32** can emit out from the third sub-pixel region **23** but cannot emit out from the second sub-pixel region **22**. In one variant embodiment of this embodiment, the second organic light-emitting layer **32** may be a single-layered organic light-emitting layer, and the second organic light-emitting layer **32** may be formed through a co-evaporation process. In another variant embodiment, the second organic light-emitting layer **32** may also include only one single light-emitting material. For example, the first organic light-emitting material **30A** may be a red light-emitting material, and the second organic light-emitting layer **32** may be a cyan light-emitting material.

With reference to FIG. 7, FIG. 7 is a schematic diagram illustrating a pixel structure of an electroluminescent display panel according to a third preferred embodiment of the present invention. As shown in FIG. 7, in the pixel structure of the electroluminescent display panel **60** of this embodiment, the first organic light-emitting material **30A** may further be a green light-emitting material, and the second organic light-emitting material **32A** and the third organic light-emitting material **32B** may be selected from one of a red light-emitting material and a blue light-emitting material, wherein the stacking order of the red light-emitting material and the blue light-emitting material is not limited. In addition, the hole injection layer **251** is disposed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23**. The first patterned hole injection layer **252** is disposed in the first sub-pixel region **21** and the second patterned hole injection layer **253** is disposed in the second sub-pixel region **22**, wherein thickness of the second patterned hole injection layer **253** is greater than the thickness of the first patterned hole injection layer **252**. As a result, the hole injection layer **251** and the first patterned hole injection layer **252** stacked thereon form a first hole injection layer **261** in the first sub-pixel region **21**, the hole injection layer **251** and the second patterned hole injection layer **253** stacked thereon form a second hole injection layer **262** in the second sub-pixel region **22**, and the hole injection layer **251** form a third hole injection layer **263** in the third sub-pixel region **23**. Wherein, the thickness of

the second hole injection layer **262** is greater than the thickness of the first hole injection layer **261**, and the thickness of the first hole injection layer **261** is greater than the thickness of the third hole injection layer **263**. As a result, the cavity length of the second micro cavity **382** is greater than the cavity length of the first micro cavity **381**, and the cavity length of the first micro cavity **381** is greater than the cavity length of the third micro cavity **383**. Due to micro cavity effect, the first primary color light (green light) **L1** generated by the first organic light-emitting layer **30** can emit out from the first sub-pixel region **21**, the second primary color light (red light) **L2** generated by the second organic light-emitting layer **32** can emit out from the second sub-pixel region **22** but cannot emit out from the third sub-pixel region **23**, and the third primary color light (blue light) **L3** generated by the second organic light-emitting layer **32** can emit out from the third sub-pixel region **23** but cannot emit out from the second sub-pixel region **22**. In a variant embodiment of this embodiment, the second organic light-emitting layer **32** may be a single-layered organic light-emitting layer, which may be formed through a co-evaporation process.

Please refer to FIG. 8 to FIG. 10. FIG. 8 to FIG. 10 are schematic diagrams illustrating the fabrication method of a pixel structure of an electroluminescent display panel according to a fourth preferred embodiment of the present invention. First, a substrate **20** is provided, and a first sub-pixel region **21**, a second sub-pixel region **22**, and a third sub-pixel region **23** are defined on the substrate **20**. Then, a first anode **241**, a second anode **242**, and a third anode **243** are respectively formed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23** of the substrate **20**. Sequentially, a first transparent electrode layer **271** is formed on the second anode **242** and a second transparent electrode layer **272** is formed on the third anode **243**. The formation of the first transparent electrode layer **271** and the second transparent electrode layer **272** may include forming a transparent conductive layer (not shown), such as an indium tin oxide (ITO) layer, and then performing a PEP, but not limited thereto.

As shown in FIG. 9, then, at least a first hole injection layer **261**, at least a second hole injection layer **262**, and at least a third hole injection layer **263** are formed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23** respectively. In this embodiment, the formation of the first hole injection layer **261**, the second hole injection layer **262**, and the third hole injection layer **263** includes the following processes. First, a hole injection layer **251** is blanket formed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23**. Then, a second patterned hole injection layer **253** is formed on the hole injection layer **251** of the third sub-pixel region **23**. The second patterned hole injection layer **253** may be formed through, but not limited to, an evaporation process in collocation with a fine metal mask. Based on the abovementioned processes, the hole injection layer **251** forms a first hole injection layer **261** in the first sub-pixel region **21**, the hole injection layer **251** forms a second hole injection layer **262** in the second sub-pixel region **22**, and the hole injection layer **251** and the second patterned hole injection layer **253** stacked thereon form a third hole injection layer **263** in the third sub-pixel region **23**. Wherein, the thickness of the first hole injection layer **261** is the same as the thickness of the second hole injection layer **262**, and the thickness of the second hole injection layer **262** is less than the thickness of the third hole injection layer **263**. Sequentially, a hole trans-

mission layer **28** is formed on the first hole injection layer **261**, the second hole injection layer **262**, and the third hole injection layer **263**.

As shown in FIG. **10**, then a first fine metal mask is used to form a first organic light-emitting layer **30** in the first sub-pixel region **21**, and a second fine metal mask is used to form a second organic light-emitting layer **32** in the second sub-pixel region **22** and the third sub-pixel region **23**. The first organic light-emitting layer **30** includes a first organic light-emitting material **30A**, and the second organic light-emitting layer **32** includes a second organic light-emitting material **32A** and a third organic light-emitting material **32B**. The first organic light-emitting layer **30** and the second organic light-emitting layer **32** may be formed through an evaporation process respectively, but not limited thereto. In this embodiment, the second organic light-emitting layer **32** is a composite-layered organic light-emitting layer, and the formation processes of the second organic light-emitting layer **32** may be similar to those processes illustrated in the aforementioned embodiments. Furthermore, the second organic light-emitting layer **32** may be a single-layered organic light-emitting layer, and the formation of the second organic light-emitting layer **32** may include the processes in the aforementioned embodiments. Then, an electron transmission layer **34** is formed on the first organic light-emitting layer **30** and the second organic light-emitting layer **32**. Sequentially, a first cathode **361**, a second cathode **362**, and a third cathode **363** are respectively formed in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23** of the substrate **20** to complete the fabrication of the pixel structure of the electroluminescent display panel **70** of this embodiment. In this embodiment, because of the disposition of the first transparent electrode layer **271**, the second transparent electrode layer **272**, and the second patterned hole injection layer **253**, the first micro cavity **381**, the second micro cavity **382**, and the third micro cavity **383** have different cavity lengths. To be precise, in this embodiment, the first organic light-emitting material is a blue light-emitting material, the second organic light-emitting material is a green light-emitting material, and the third organic light-emitting material is a red light-emitting material. Therefore, the cavity length of the first micro cavity **381** is less than the cavity length of the second micro cavity **382**, and the cavity length of the second micro cavity **382** is less than the cavity length of the third micro cavity **383**, resulting that a first primary color light (blue light) **L1**, a second primary color light (green light) **L2**, and a third primary color light (red light) **L3** are respectively generated in the first sub-pixel region **21**, the second sub-pixel region **22**, and the third sub-pixel region **23**.

From the above description, according to the present invention, three different primary color lights can be displayed by using only two layers of organic light-emitting layers through modifying the cavity lengths of the micro cavities, wherein the theory of modifying the cavity lengths of micro cavities can be practiced by rendering the thickness of any one of the hole injection layer, the hole transmission layer, the electron transmission, and the electron injection layer in each sub-pixel region different thickness, or by disposing other film layers, such as transparent electrode layers, in some sub-pixel regions. Furthermore, the primary color lights generated by the first organic light-emitting layer, the second organic light-emitting layer, and the third organic light-emitting layer may be individually adjusted if needed, and are not limited to the aforementioned embodiments.

In conclusion, in the pixel structure of the electroluminescent display panel of the present invention, two adjacent sub-pixel regions for displaying different primary color lights

share a common organic light-emitting layer, thus the whole fabrication process can be simplified and the aperture ratio and resolution can be increased. Furthermore, due to micro cavity effect, the pixel structure of the electroluminescent display panel of the present invention only requires two organic light-emitting layers to display a full-color image composed of three different primary lights.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A fabrication method of pixel structure of electroluminescent display panel, comprising:

providing a substrate, and defining a first sub-pixel region, a second sub-pixel region, and a third sub-pixel region on the substrate;

respectively forming a first anode, a second anode, and a third anode in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region of the substrate;

forming a first organic light-emitting layer in the first sub-pixel region by using a first fine metal mask, wherein the first organic light-emitting layer comprises a first organic light-emitting material;

forming a second organic light-emitting layer in the second sub-pixel region and the third sub-pixel region by using a second fine metal mask; and

respectively forming a first cathode, a second cathode, and a third cathode in the first sub-pixel region, the second sub-pixel region, and the third sub-pixel region of the substrate;

wherein a first micro cavity is formed between the first anode and the first cathode in the first sub-pixel region, a second micro cavity is formed between the second anode and the second cathode in the second sub-pixel region, and a third micro cavity is formed between the third anode and the third cathode in the third sub-pixel region, and the first micro cavity, the second micro cavity, and the third micro cavity have different cavity lengths.

2. The fabrication method of pixel structure of electroluminescent display panel of claim 1, wherein the second organic light-emitting layer comprises a second organic light-emitting material and a third organic light-emitting material.

3. The fabrication method of pixel structure of electroluminescent display panel of claim 2, wherein the second organic light-emitting layer is a composite-layered organic light-emitting layer, and a formation process of the second organic light-emitting layer comprises:

performing an evaporation process by using the second fine metal mask to form the second organic light-emitting material in the second sub-pixel region and the third sub-pixel region; and

performing another evaporation process by using the same second fine metal mask to form the third organic light-emitting material in the second sub-pixel region and the third sub-pixel region.

4. The fabrication method of pixel structure of electroluminescent display panel of claim 2, wherein the second organic light-emitting layer is a single-layered organic light-emitting layer, and a formation process of the second organic light-emitting layer comprises performing a co-evaporation process by using the second fine metal mask to form the second organic light-emitting material and the third organic

light-emitting material in the second sub-pixel region and the third sub-pixel region simultaneously.

5. The fabrication method of pixel structure of electroluminescent display panel of claim 1, further comprising forming at least one first hole injection layer in the first sub-pixel region, forming at least one second hole injection layer in the second sub-pixel region, and forming at least one third hole injection layer in the third sub-pixel region before forming the first organic light-emitting layer and the second organic light-emitting layer, wherein the at least one first hole injection layer, the at least one second hole injection layer, and the at least one third hole injection layer have different thicknesses to render the first micro cavity, the second micro cavity, and the third micro cavity different cavity lengths.

6. The fabrication method of pixel structure of electroluminescent display panel of claim 1, further comprising forming at least one first hole injection layer in the first sub-pixel region, forming at least one second hole injection layer in the second sub-pixel region, and forming at least one third hole injection layer in the third sub-pixel region before forming the first organic light-emitting layer and the second organic light-emitting layer, wherein one of the at least one first hole injection layer, the at least one second hole injection layer, and the at least one third hole injection layer has a different thickness from the thicknesses of the other two of the at least one first hole injection layer, the at least one second hole injection layer, and the at least one third hole injection layer, and one of the first anode, the second anode, and the third anode has a different thickness from the thicknesses of the other two of the first anode, the second anode, and the third anode to render the first micro cavity, the second micro cavity, and the third micro cavity different cavity lengths.

* * * * *

专利名称(译)	一种电致发光显示面板的像素结构的制作方法		
公开(公告)号	US9065079	公开(公告)日	2015-06-23
申请号	US14/452547	申请日	2014-08-06
[标]申请(专利权)人(译)	友达光电股份有限公司		
申请(专利权)人(译)	友达光电.		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	LIU MENG YU LIU CHIH CHE HSU SHIH FENG		
发明人	LIU, MENG-YU LIU, CHIH-CHE HSU, SHIH-FENG		
IPC分类号	G09G3/30 H01L51/56 H01L51/52 H01L27/32 H01L51/50		
CPC分类号	H01L51/56 G09G3/30 H01L51/5265 H01L27/3206 Y10T29/49002 H01L51/5088 H01L2251/56		
代理人(译)	HSU, WINSTON MARGO, SCOTT		
优先权	100145252 2011-12-08 TW		
其他公开文献	US20140342483A1		
外部链接	Espacenet USPTO		

摘要(译)

一种电致发光显示面板的像素结构的制作方法，包括以下步骤。提供基板。第一阳极，第二阳极和第三阳极分别形成在第一子像素区域，第二子像素区域和第三子像素区域中。通过使用第一精细金属掩模在第一子像素区域中形成第一有机发光层。通过使用第二精细金属掩模在第二子像素区域和第三子像素区域中形成第二有机发光层。第一阴极，第二阴极和第三阴极分别形成在第一子像素区域，第二子像素区域和第三子像素区域中。第一子像素区域中的第一微腔，第二子像素区域中的第二微腔和第三微腔具有不同的腔长度。

