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Park

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(54) **ORGANIC ELECTRO-LUMINESCENCE DISPLAY DEVICE AND METHOD FOR FABRICATING THE SAME**

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(51) **Int. Cl.**
H01L 51/50 (2006.01)
H01L 51/52 (2006.01)

(52) **U.S. Cl.** **313/506**; 313/503; 313/504; 313/509

(58) **Field of Classification Search** 313/500–512
See application file for complete search history.

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(57) **ABSTRACT**

An organic electro-luminance display device includes a first substrate including a plurality of sub-pixels, a first electrode on the first substrate, a buffer layer on the first electrode of a region that partitions each of the sub-pixels, a spacer on the buffer layer, the buffer layer and the spacer being integrally formed, an organic light-emitting layer on the first electrode that corresponds to each of the sub-pixels and the spacer, and a second electrode on the organic light-emitting layer.

15 Claims, 8 Drawing Sheets

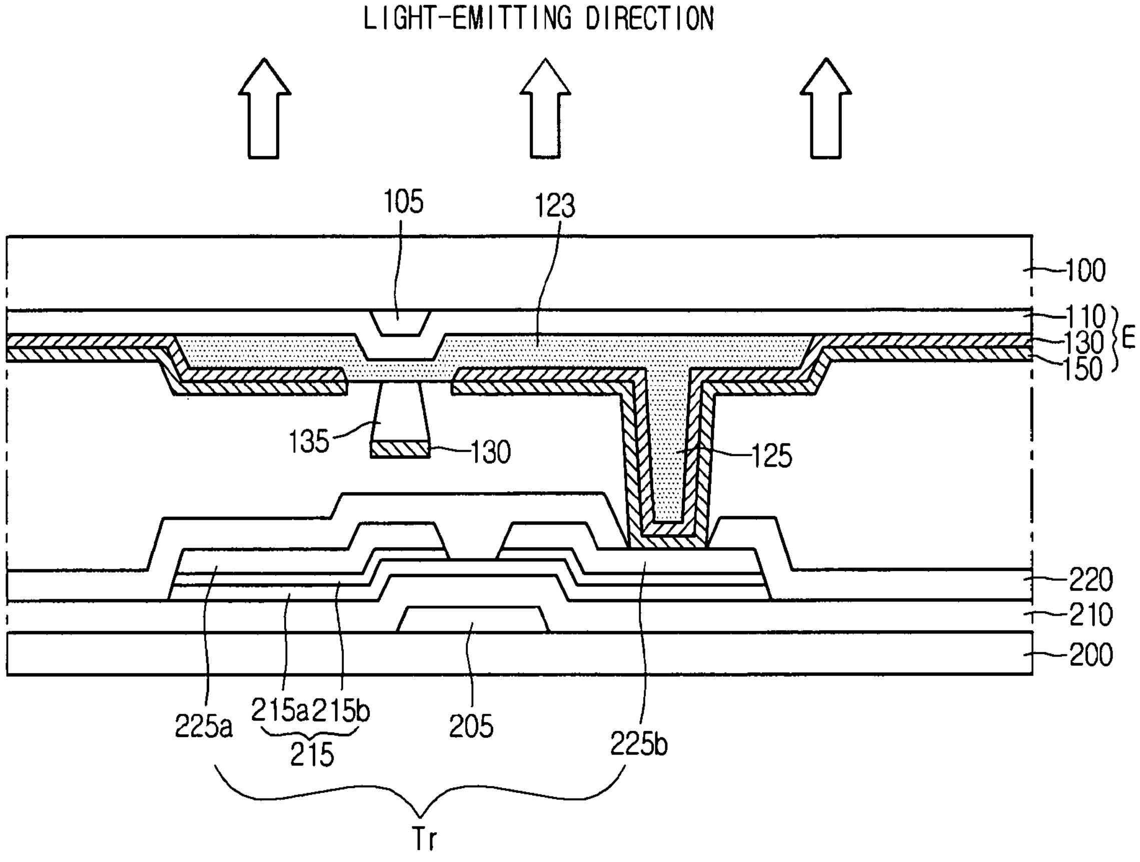


FIG. 1 (RELATED ART)

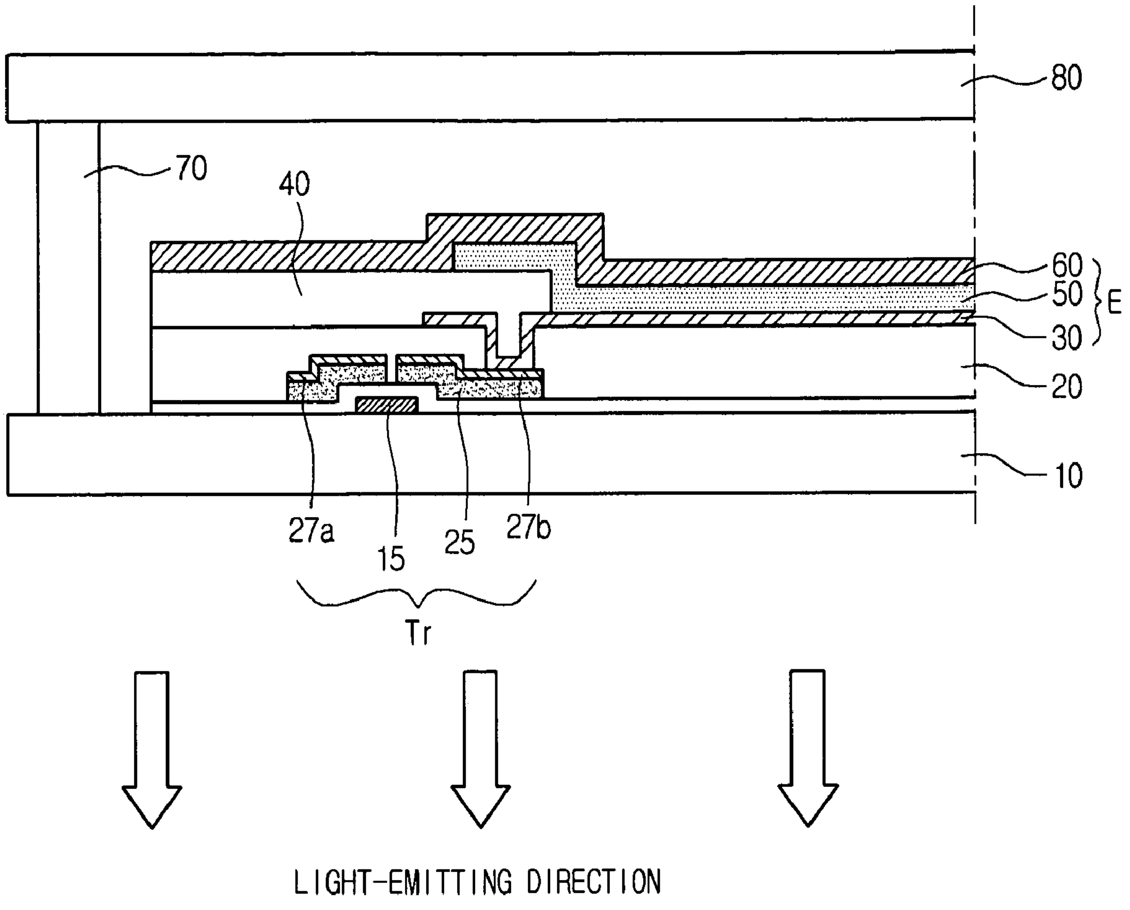


FIG. 2A

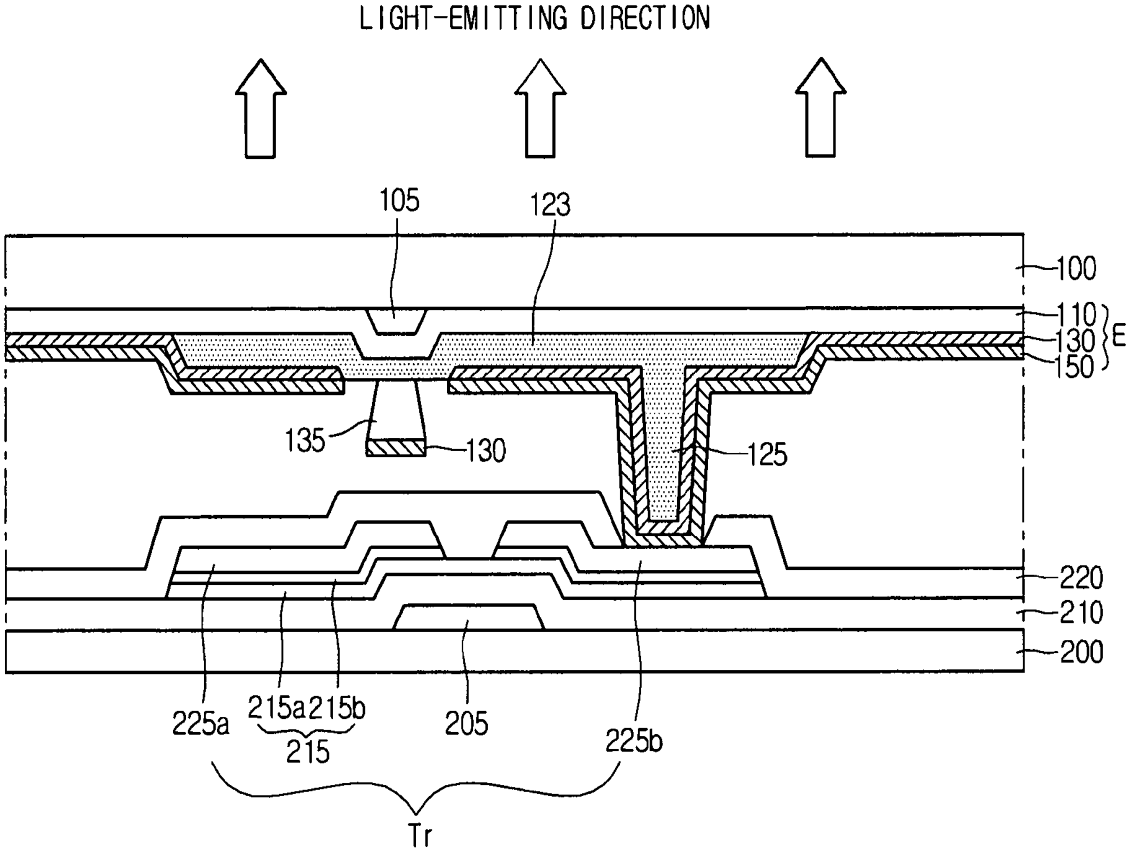

LIGHT-EMITTING DIRECTION
105
123
100
110
130
150
E
135
130
125
220
210
200
225a
215a
215b
215
205
225b
Tr

FIG. 2B

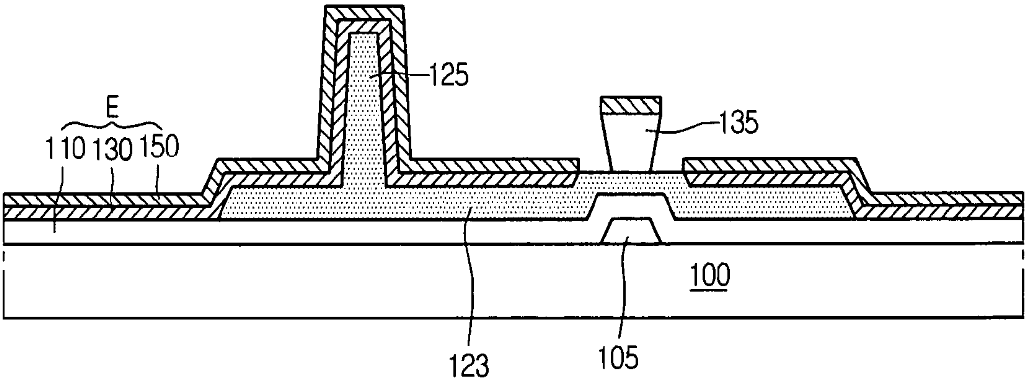

125
E
110
130
150
135
100
123
105

FIG. 2C

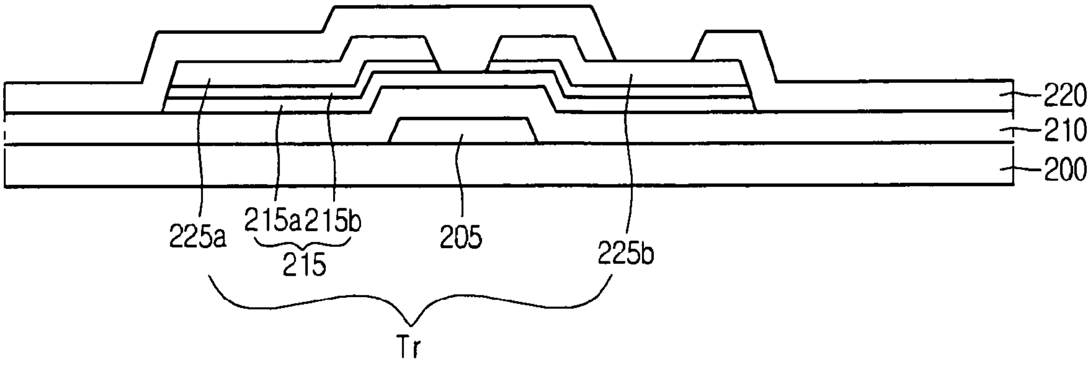


FIG. 3A

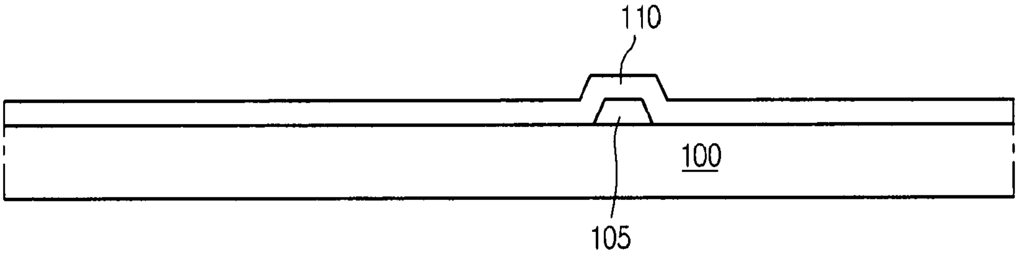


FIG. 3B

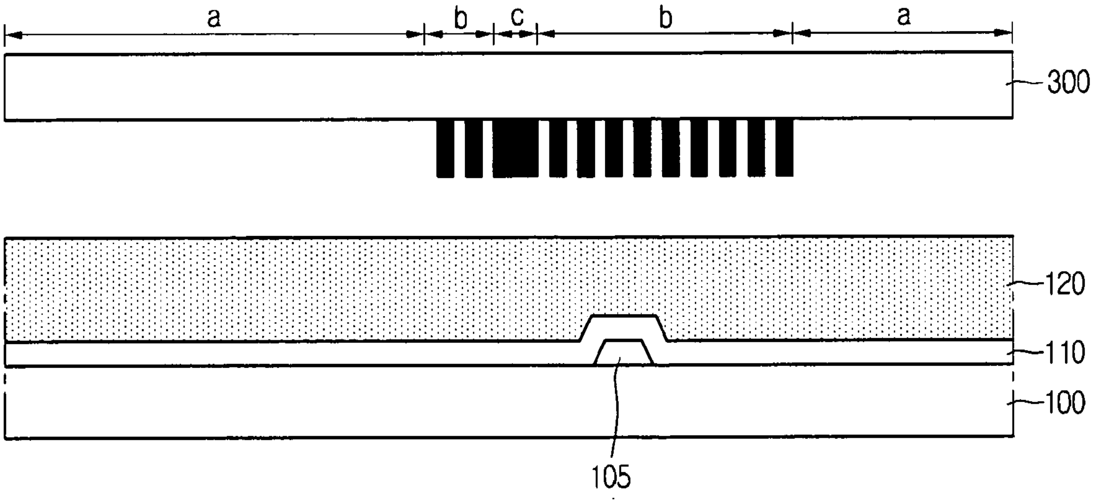


FIG. 3C

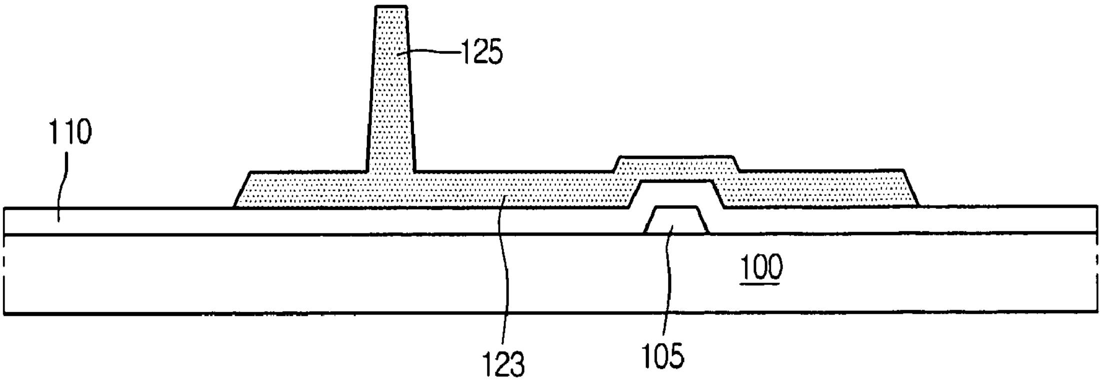


FIG. 3D

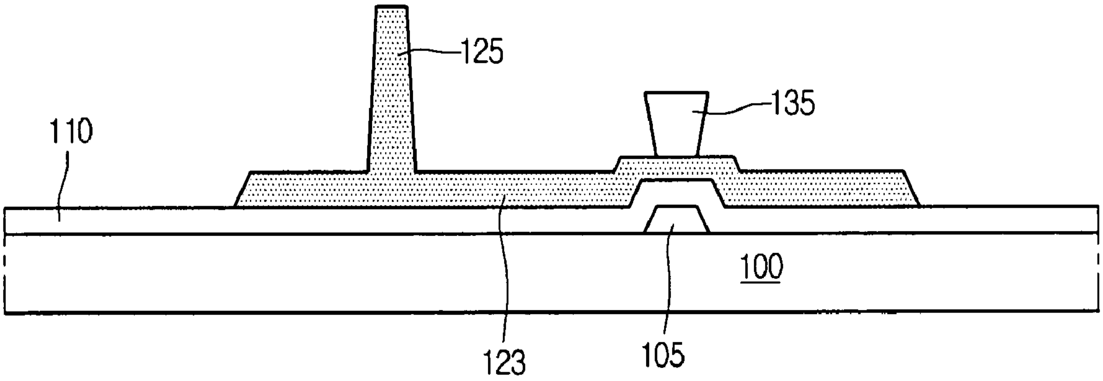


FIG. 3E

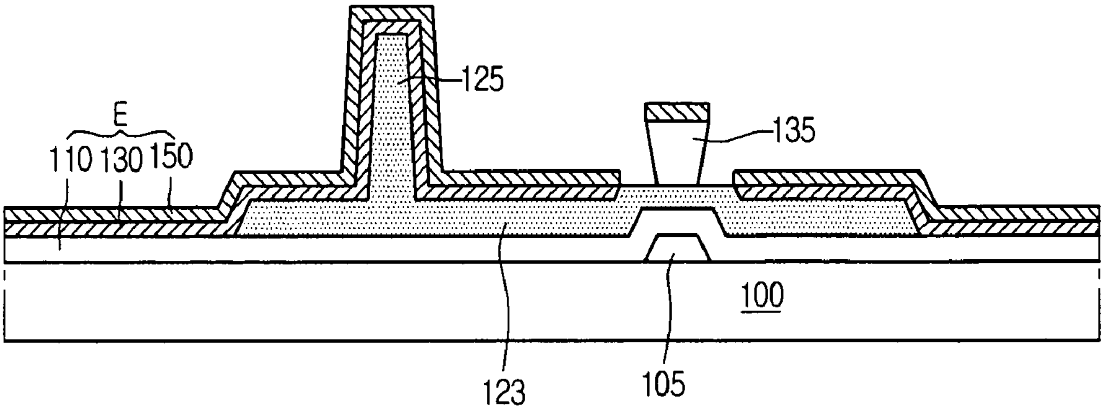


FIG. 3F

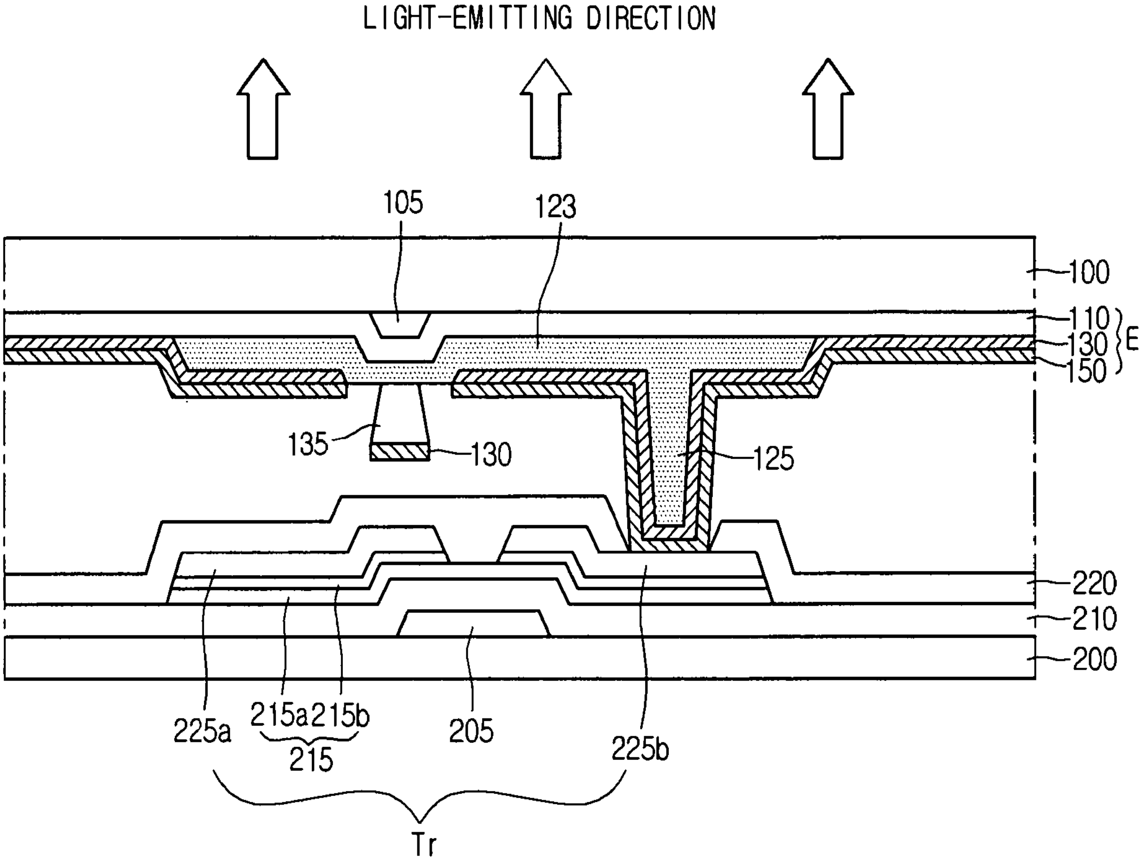

LIGHT-EMITTING DIRECTION
105
123
100
110
130
150
E
135
130
125
220
210
200
225a
215a
215b
215
205
225b
Tr

FIG. 4A

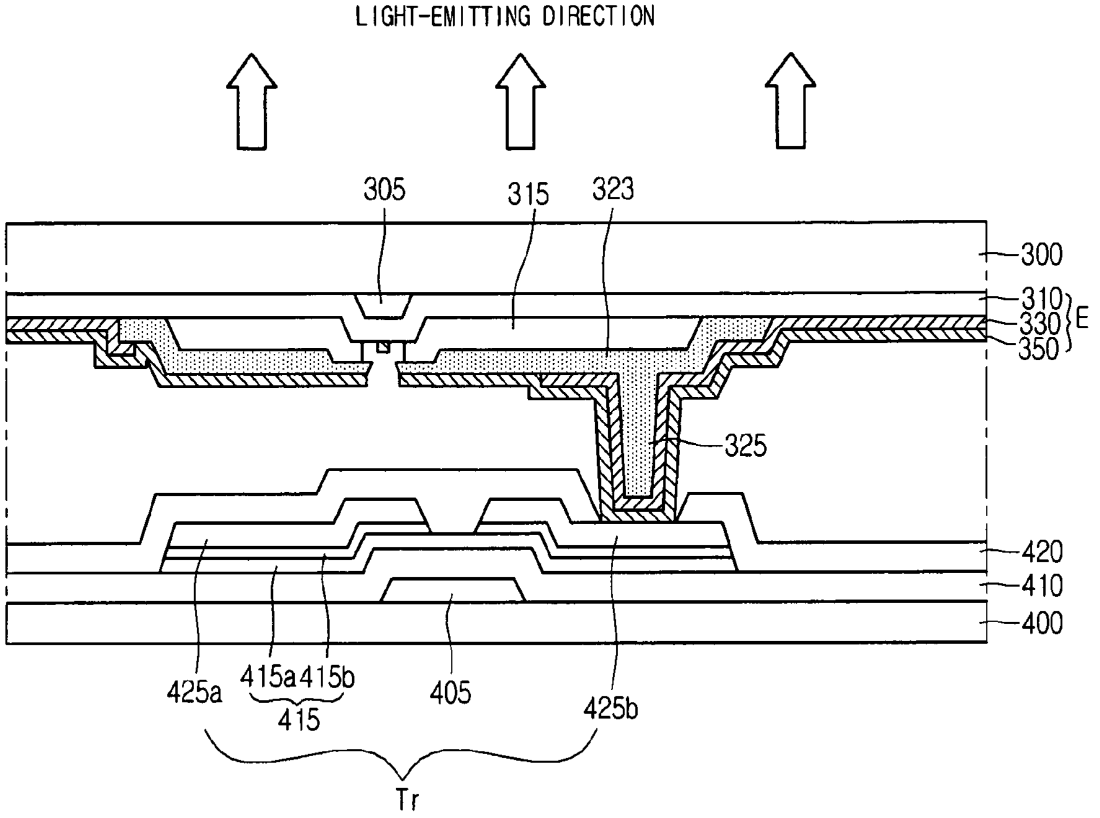

LIGHT-EMITTING DIRECTION
305
315
323
300
310
330
350
E
325
420
410
400
425a
415a
415b
415
405
425b
Tr

FIG. 4B

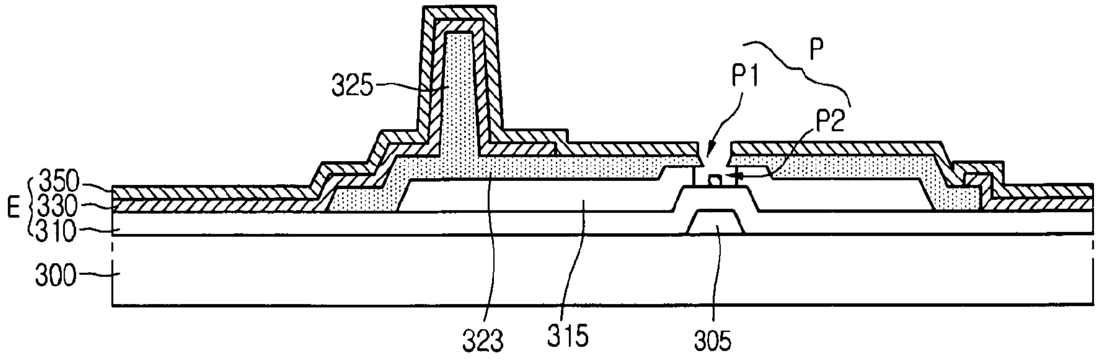

325
P
P1
P2
350
330
310
E
300
323
315
305

FIG. 4C

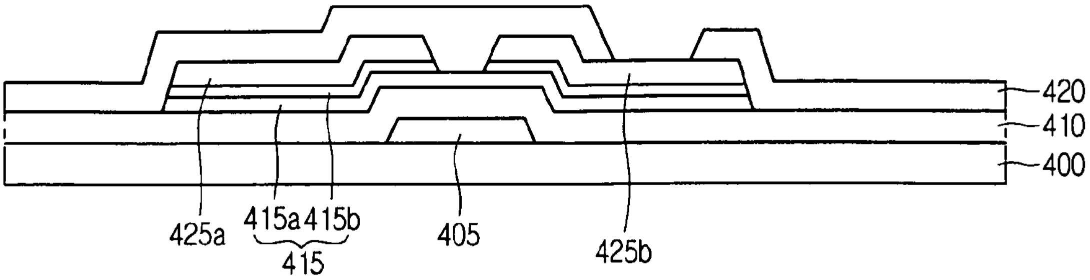


FIG. 5A

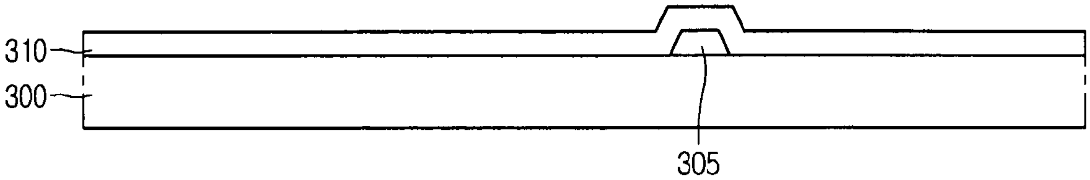


FIG. 5B

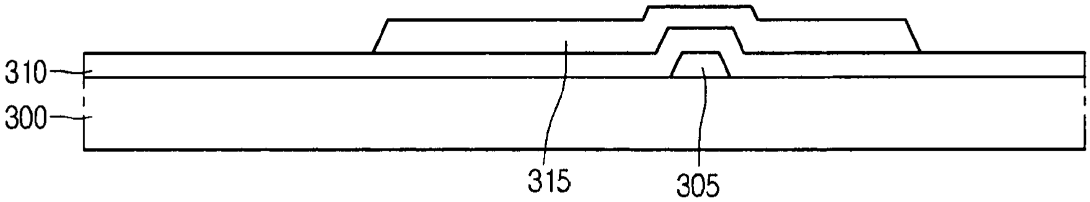


FIG. 5C

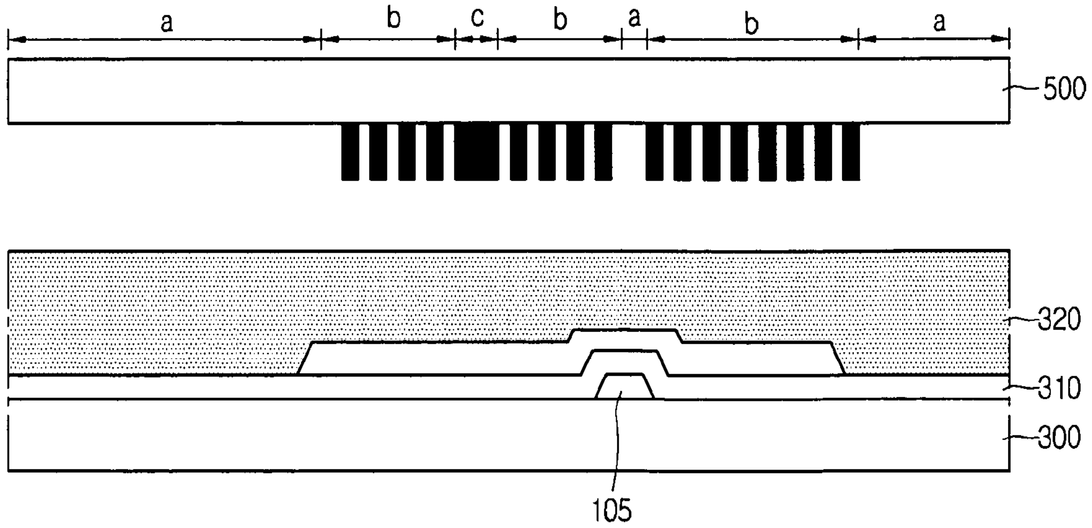


FIG. 5D

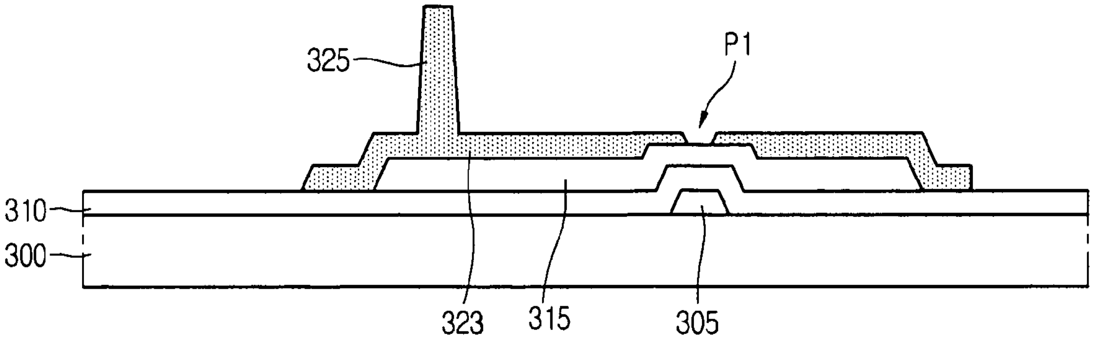


FIG. 5E

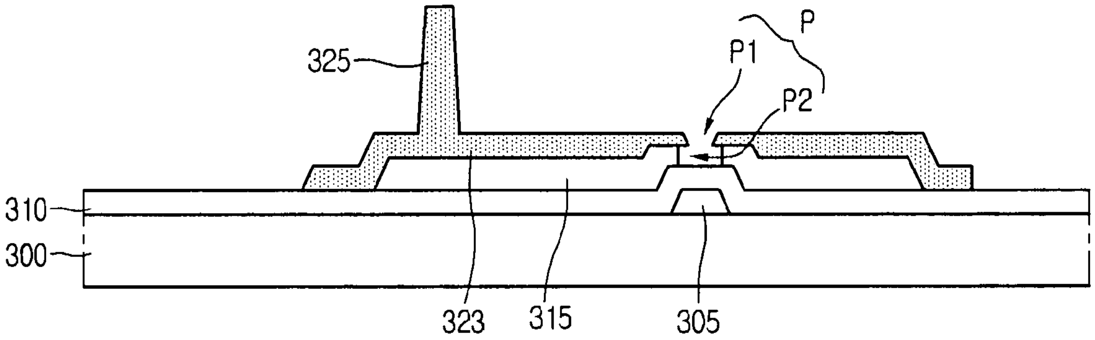
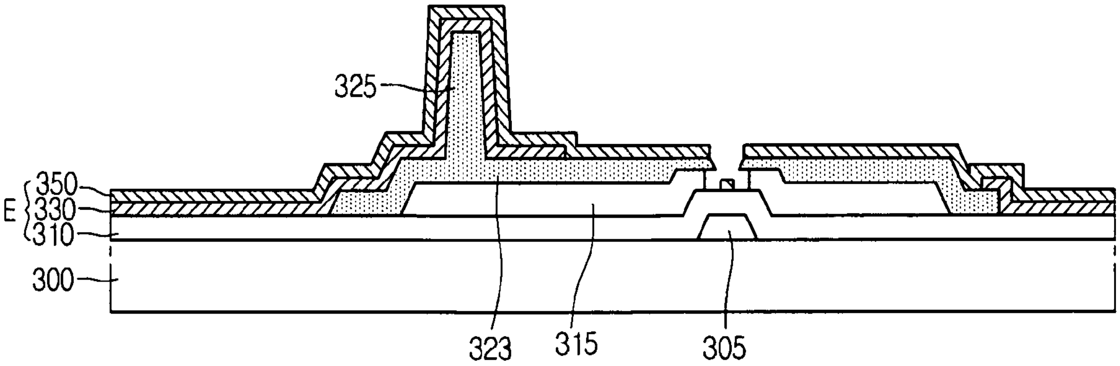


FIG. 5F



ORGANIC ELECTRO-LUMINESCENCE DISPLAY DEVICE AND METHOD FOR FABRICATING THE SAME

The invention claims the benefit of Korean Patent Application No. 123079/2005 filed in Korea on Dec. 14, 2005, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The invention relates to a flat panel display device, and more particularly, to an organic electro-luminescence display device and a method for fabricating the same. Although embodiments of the invention is suitable for a wide scope of applications, it is particularly suitable for increasing production yield in fabricating an organic electro-luminescence device and for improving light efficiency in an organic electro-luminescence display device.

2. Discussion Of The Related Art

An electro-luminescence display device generates light based on the principle of electroluminescence. An exciton which consists of an excited electron-hole pair, is generated inside an emissive layer, and when the exciton's electron and hole combine, a photon can be emitted. Thus, an organic electro-luminescence display device is a self-emission type display device unlike a liquid crystal display (LCD) device, since it does not require an external backlight unit for illuminating light. Therefore, an organic electro-luminescence display device has advantages of light weight, a slim profile, low voltage driving, a high light-emission efficiency, a wide viewing angle, and a fast response time. An organic electro-luminescence display device also is advantageous in realizing a high quality moving image.

In addition, an organic electro-luminescence display device is mostly fabricated using deposition and encapsulation processes, and has a simpler fabrication process in comparison to LCDs and plasma display panels (PDPs). Also, when the organic electro-luminescence display device is an active matrix type using a thin film transistor (TFT) as a switching device in each pixel, high brightness is obtained using a low current. Thus, an organic electro-luminescence display device has further advantages of low power consumption, high definition, and a large size.

FIG. **1** is a cross-sectional schematic diagram illustrating an organic electro-luminescence display device according to the related art. In FIG. **1**, an active-matrix type organic electro-luminescence display device includes a substrate **10** having thin film transistors (TFTs) Tr provided thereon. Each of the TFTs Tr includes a gate electrode **15**, an active layer **25**, and source/drain electrodes **27***a* and **27***b*. An array device is defined by the TFTs Tr. A passivation layer **20** is formed on the TFTs Tr, and a first electrode **30** is formed on a portion of the passivation layer **20** and electrically connected to the drain electrode **27***b*.

An organic light-emitting layer **50** and a second electrode **60** are formed on the first electrode **30**. The second electrode **60** can be used as a common electrode, and can be formed over the entire surface of the substrate **10**. An insulating layer **40** is formed between the second electrode **60** and the passivation layer **20**. Light can be emitted from the organic light-emitting layer **50** by a voltage between the first electrode **30** and the second electrode **60**. An organic light-emitting diode (OLED) E is defined by the first electrode **30**, the organic light-emitting layer **50**, and the second electrode **60**.

In addition, a sealant **70** is formed on an outer region of the substrate **10** to protect the OLED E from external moisture and oxygen, and then an encapsulation process of attaching the substrate **10** to an encapsulation substrate **80** is performed, so that the organic electro-luminescence display device is fabricated. Since the organic electro-luminescence display device is formed by attaching the substrate **10** including the array device and the OLED, to the encapsulating substrate **80**, he yield of the array device and the yield of the OLED determine a yield of the organic electro-luminance display device. Thus, the yield of an entire process is considerably limited by a manufacturing process of the OLED. For example, even when the array device is properly formed, the organic electro-luminance display device is considered as a defective device when a defect is generated by foreign substances or other factors while an organic light-emitting layer using a thin film of about 1000 Å is formed.

Accordingly, a loss in the related costs and material costs consumed for manufacturing a good array device is generated, to thereby reduce product yield. In addition, although the related art organic electro-luminance display device has stability by an encapsulation process and a high degree of freedom in a process, there exists a limitation in an aperture. Therefore, it is difficult to fabricate the related art organic electro-luminance display device as a high resolution display device.

SUMMARY OF THE INVENTION

Accordingly, embodiments of the invention is directed to an organic electro-luminescence display device and a method for fabricating the same that substantially obviate one or more of the problems due to limitations and disadvantages of the related art.

An object of embodiments of the invention is to provide an organic electro-luminescence display device and a method for fabricating the same that increase production yield, reduce defect rate, and improve product management efficiency.

Another object of the invention is to provide an organic electro-luminescence display device and a method for fabricating the same that have improved light efficiency.

Another object of the invention is to provide an organic electro-luminescence display device and a method for fabricating the same that have a simplified fabrication process with reduced number of masks.

Additional features and advantages of embodiments of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of embodiments of the invention. The objectives and other advantages of the embodiments of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages and in accordance with the purpose of embodiments of the invention, as embodied and broadly described, an organic electro-luminance display device includes a first substrate including a plurality of sub-pixels, a first electrode on the first substrate, a buffer layer on the first electrode of a region that partitions each of the sub-pixels, a spacer on the buffer layer, the buffer layer and the spacer being integrally formed, an organic light-emitting layer on the first electrode that corresponds to each of the sub-pixels and the spacer, and a second electrode on the organic light-emitting layer.

In another aspect, an organic electro-luminance display device includes a first substrate including a plurality of sub-pixels, a first electrode on the first substrate, a buffer layer on the first electrode of a region that partitions each of the sub-pixels, a spacer on the buffer layer, the buffer layer and the spacer being integrally formed, a partition wall spaced from the spacer, the partition wall being on the buffer layer, an organic light-emitting layer on the first electrode corresponding to each of the sub-pixels and the spacer, and a second electrode on the organic light-emitting layer.

In another aspect, an organic electro-luminance display device includes a first substrate including a plurality of sub-pixels, a first electrode on the first substrate, a buffer layer on the first electrode of a region that partitions each of the sub-pixels and having a trench therein, a spacer on the buffer layer, the buffer layer and the spacer being integrally formed, an organic light-emitting layer on a portion of the first electrode that corresponds to each of the sub-pixels and the spacer, and a second electrode on the organic light-emitting layer.

In another aspect, a method for fabricating an organic electro-luminance display device includes providing a first substrate including a plurality of sub-pixels, forming a first electrode on the first substrate, simultaneously forming a buffer layer and a spacer on the first electrode of a region that partitions each of the sub-pixels, forming a partition wall spaced from the spacer on the buffer layer, forming an organic light-emitting layer on a portion of the first electrode that corresponds to each of the sub-pixels and the spacer, and forming a second electrode on the organic light-emitting layer.

In another aspect, a method for fabricating an organic electro-luminance display device includes providing a first substrate including a plurality of sub-pixels, forming a first electrode on the first substrate, forming a first buffer layer on the first electrode of a region that partitions each of the sub-pixels, simultaneously forming a second buffer layer and a spacer on the first buffer layer, forming a partition wall spaced from the spacer on the buffer layer, forming an organic light-emitting layer on a portion of the first electrode that corresponds to each of the sub-pixels and the spacer, and forming a second electrode on the organic light-emitting layer.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of embodiments of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of embodiments of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of embodiments of the invention.

FIG. **1** is a cross-sectional schematic diagram illustrating an organic electro-luminescence display device according to the related art;

FIGS. **2**A to **2**C are cross-sectional schematic diagrams an organic electro-luminescence display device according to an embodiment of the invention;

FIGS. **3**A to **3**F are cross-sectional schematic diagrams of a process of fabricating an organic electro-luminescence display device according to an embodiment of the invention;

FIGS. **4**A to **4**C are cross-sectional schematic diagrams of an organic electro-luminescence display device according to another embodiment of the invention; and

FIGS. **5**A to **5**F are cross-sectional schematic diagrams of a process of fabricating an organic electro-luminescence display device according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings.

FIGS. **2**A to **2**C are cross-sectional schematic diagrams an organic electro-luminescence display device according to an embodiment of the invention. In FIG. **2**A, an organic electro-luminescence display device includes a first substrate **100** and a second substrate **200**. The first and second substrates **100** and **200** face each other with a predetermined interval interposed therebetween. An OLED E is formed in a sub-pixel on the first substrate **100**, and an array device including a thin film transistor (TFT) Tr is formed corresponding to the OLED E on the second substrate **200**. A spacer **125** for maintaining a gap is interposed between the first substrate **100** and the second substrate **200**. The OLED is electrically connected to the TFT Tr by the spacer **125**. The OLED E emits light using a voltage applied in response to a switching control of the TFT Tr, and light emitted from the OLED E is incident through the first substrate **100** to provide a display image.

Referring to FIG. **2**B, a plurality of sub-pixels are defined on the first substrate **100**. The first substrate **100** can be a glass substrate or a plastic substrate formed of a transparent material, but the first substrate **100** is not limited thereto. A first electrode **110** is formed on the first substrate **100**. For example, the first electrode **110** can be formed of indium tin oxide (ITO) or indium zinc oxide (IZO). Therefore, since the first electrode **110** having excellent transmittance is formed, the efficiency of light emitted via the first substrate **100** is improved.

An auxiliary electrode **105** electrically connected to the first electrode **110** can be located on the first substrate **100**. The auxiliary electrode **105** reduces resistance of the first electrode **110**. Since the first electrode **110** is formed of a transparent conductive material and thus has high resistance, brightness becomes non-uniform. The auxiliary electrode **105** reduces the resistance of the first electrode **110**, to thereby prevent the brightness non-uniformity. The auxiliary electrode **105** is formed of metal having low resistance. For example, the auxiliary electrode **105** can be formed of at least one of Al, AlNd, Mo, and Co.

In addition, a buffer layer **123** is formed on an outer region of the first electrode **110** that partitions the each sub-pixel. A spacer **125** protrudes from a predetermined region of the buffer layer **123**. In particular, the buffer layer **123** and the spacer **125** may be integrally formed in the same process steps. The number of processes can be reduced by integrally forming the buffer layer **123** and the spacer **125**. The buffer layer **123** and the spacer **125** can be formed of an organic insulating material. For example, each of the buffer layer **123** and the spacer **125** can be formed of a photosensitive resin, to thereby simply fabrication process. Each of the buffer layer **123** and the spacer **125** can be formed of at least one of an acryl-based resin, benzocyclobutene (BCB), polyimide (PI), and novolak-based resin.

A partition wall **135** for partitioning a region by each sub-pixel unit is formed on the buffer layer **123**. The partition wall **135** can have a reversely tapered shape to more efficiently separate respective sub-pixels. In addition, the partition wall **135** can have a height lower than the spacer **125** to allow the OELD E electrically contacting the TFT Tr by means of the spacer **125**, but not the partition wall **135**.

An organic light-emitting layer **130** is formed on the first electrode **110** including the spacer **125**, and the organic light-emitting layer **130** is formed on the spacer **125**. The organic light-emitting layer **130** can further include, on an upper surface thereof or a lower surface thereof, at least one organic layer of a hole injection layer, hole transport layer, a hole suppress layer, an electron transport layer, and an electron injection layer. With this structure, it is possible to efficiently inject electrons and holes into the organic light-emitting layer **130** by properly controlling an energy level at boundaries of the first electrode **110**, the organic light-emitting layer **130**, and a second electrode **150**. By doing so, a light emission efficiency of the completed electro-luminance display device can be improved.

The second electrode **150** is located on the organic light-emitting layer **130**, and can be formed by a sub-pixel unit. It should be noted that the second electrode **150** is formed on the organic light-emitting layer **130** corresponding to the spacer **125**. The second electrode **150** is separated in each sub-pixel unit by the partition wall **135**. The second electrode **150** is formed of a conductive material having a reflective characteristic, and can be formed of one of Mg, Ca, Al, Ag, Ba, and an alloy thereof.

Although not shown, a moisture absorption layer can be further formed on the second electrode **150**. When the organic light-emitting layer **130** reacts with moisture or oxygen, a chemical structure of a material constituting the organic light-emitting layer **130** changes, so that a light-emitting characteristic may be destroyed. Accordingly, there can occur a black spot where a portion of a pixel does not emit light. Furthermore, the black spot increases as a time elapses, and finally light is not emitted from one sub-pixel, which may generate a defect to the completed organic electro-luminance display device and reduce life of the organic electro-luminance display device. Therefore, the moisture absorption layer is further formed to solve this problem. At this point, the moisture absorption layer can be formed of at least one of BaO, CaO, Al_2O_3, $LiSO_4$, $CaSO_4$, $MgSO_4$, $CoSO_4$, $GaSO_4$, $TiSO_4$, $CaCl_2$, and $Ca(NO_3)_2$. The moisture absorption layer may not be formed on a portion of the second electrode **150** that corresponds to the spacer **125**, that is, a region contacting the TFT Tr in order to prevent loose contact with the TFT Tr.

Referring to FIG. **2**B, the second substrate **200** includes a plurality of gate lines and data lines (not shown) disposed to cross each other. The gate lines and the data lines define a plurality of sub-pixels. Each sub-pixel can correspond to a sub-pixel defined on the first substrate **100**. The TFT Tr is provided at each sub-pixel or at an intersection of the gate and data lines. Although one TFT is illustrated as to be formed at each sub-pixel, at least one TFT and one capacitor may be further formed at the each sub-pixel without limitation. An array device including the TFT Tr can be formed by a sub-pixel unit on the first substrate **100**.

The TFT Tr includes a gate electrode **205** located on the second substrate **200**. In addition, a gate insulating layer **210** is located on the second substrate **200** including the gate electrode **205**. The gate insulating layer **210** can be a silicon oxide layer, a silicon nitride layer, or a stacked layer of these layers. Further, an active layer **215** is located on a portion of the gate insulating layer **210** that corresponds to the gate electrode **205**. The active layer **215** can include a channel layer **215*a*** formed of amorphous silicon, and an ohmic contact layer **215*b*** formed of amorphous silicon doped with impurities. Moreover, source/drain electrodes **225*a*** and **225*b*** separated a predetermined distance from each other are formed on the active layer **215**. The source/drain electrodes **225*a*** and **225*b*** can be formed of one of Al, AlNd, Mo, and Cr.

Through the above process, the TFT Tr is formed on the second substrate **200** by the gate electrode **205**, the active layer **215**, and the source/drain electrodes **225*a*** and **225*b***. Although the TFT Tr is illustrated as a bottom gate-type TFT where the TFT Tr is formed of amorphous silicon, the TFT Tr is not limited thereto but a variety of TFTs known in the art can be used.

A passivation layer **220** having a contact hole exposing the drain electrode **225*b*** is formed on the second substrate **200** including the TFT Tr. The passivation layer **220** can be formed of one of an acryl-based resin, benzocyclobutene (BCB), silicon oxide, and silicon nitride. A connection electrode (not shown) electrically connected to the drain electrode **225*b*** exposed by the contact hole can be further formed on the second substrate **200**.

Referring to FIG. **2**A, the drain electrode **225*b*** of the TFT of the second substrate **200** is electrically connected to the second electrode **150** formed on the spacer **125** of the first substrate **100** by means of the spacer **125**. Therefore, a voltage supplied via the TFT Tr of the second substrate **200** is applied to the second electrode **150** on the spacer **125** of the first substrate **100**, and a common voltage is applied to the first electrode **110** of the first substrate **100**. Accordingly, the organic light-emitting layer **130** can emit light using a voltage applied to the first and second electrodes **110** and **150**.

FIGS. **3**A to **3**F are cross-sectional schematic diagrams of a process of fabricating an organic electro-luminescence display device according to an embodiment of the invention. In FIG. **3**A, a first substrate **100** where a plurality of sub-pixels are defined is provided. The first substrate **100** can be a glass substrate or a plastic substrate, and formed of a transparent material. An auxiliary electrode **105** is formed by depositing a conductive material of a low resistor on the first substrate **100**, and patterning the deposited material. The auxiliary electrode **105** reduces resistance of a first electrode **110** that is formed during a subsequent process. For this purpose, the auxiliary electrode **105** can be formed of low resistance metal. The conductive material of a low resistor can be at least one of Al, AlNd, Mo, and Cr. In addition, the first electrode **110** is formed by depositing a transparent conductive material on the first substrate **100** including the auxiliary electrode **105**, and patterning the deposited material. For example, the transparent conductive material can be ITO or IZO.

Referring to FIG. **3**B, an insulating layer **120** formed of an organic insulating material is formed on the first electrode **110**. The insulating layer **120** can be formed of a photosensitive resin. For example, the insulating layer **120** can be formed of at least one of an acryl-based resin, benzocyclobutene (BCB), polyimide (PI), and a novolak-based resin.

A mask **300** is provided on the insulating layer **120**. The mask **300** can be one of a halftone mask, a slit mask, and a halftone/slit combination mask, capable of controlling intensity of light for each region. As illustrated, the mask **300** can be divided into a transmission region ‘a’, a half-transmission region ‘b’, and a non-transmission region ‘c’.

An exposure process is performed using the mask **300**, and a development process is performed to simultaneously form the buffer layer **123** and the spacer **125** as illustrated in FIG. **3**C. The buffer layer **123** is formed by removing a portion of the insulating layer that corresponds to the half-transmission region ‘b’ of the mask **300** using a developer. Also, the spacer **125** is formed by leaving a portion of the insulating layer that corresponds to the non-transmission region ‘c’ without reaction to the developer. Meanwhile, a portion of the insulating layer that corresponds to the transmission region ‘a’ is entirely removed by the developer. Therefore, the spacer **125** and the buffer layer **123** may be integrally formed in the same process steps. In addition, the spacer **125** can have at least a higher height than that of the buffer layer **123**. The insulating layer **120** is illustrated as to be formed of a positive photosensitive resin. The insulating layer **120** also can be formed of a negative photosensitive resin by reversely aligning the mask **300**. For example, the spacer **125** can be formed to correspond to the transmission region 'a' of the mask **300**, and the buffer layer **123** can be formed to correspond to the half-transmission region 'b' of the mask **300**. After that, a curing process is performed by performing a heat treatment process on the buffer layer **123** and the spacer **125**. Since the buffer layer **123** and the spacer **125** can be simultaneously formed using one mask as described above, productivity can improve and manufacturing costs can reduce.

Referring to FIG. **3**D, after a photosensitive resin layer is formed on the buffer layer **123**, an exposure process and a development process are performed to form a partition wall **135**. The partition wall **135** may be formed in a reversely tapered shape to allow a second electrode to be automatically separated using the partition wall **135** by a sub-pixel unit when the second electrode is formed.

Referring to FIG. **3**E, an organic light-emitting layer **130** is formed on the first electrode **110** and the spacer **130**. The organic light-emitting layer **130** may be formed of a material of small molecules or a polymer material. When the organic light-emitting layer **130** is formed of the material of small molecules, the organic light-emitting layer **130** can be formed using vacuum deposition. When the organic light-emitting layer **130** is formed of the polymer material, the organic light-emitting layer **130** can be formed using inkjet printing. At least one organic layer of a hole injection layer, hole transport layer, a hole suppress layer, an electron transport layer, and an electron injection layer can be further formed before or after the organic light-emitting layer **130** is formed.

In addition, the second electrode **150** is formed on the organic light-emitting layer **130**. Thus, the second electrode **150** is separated in a sub-pixel unit by the partition wall **125** while a conductive material is deposited. That is, since the partition wall **125** is formed in a reversely tapered shape, sidewalls of the partition wall **125** are inclined inward. Therefore, when a conductive material is deposited, the conductive material is not deposited on the sidewalls of the partition wall **125**. Accordingly, the second electrode **150** can be separated in the sub-pixel unit by the partition wall **125**. Through the above process, the second electrode **150** can be formed without performing a separate patterning process. At this point, since the second electrode **150** is also formed on the spacer **125**, a portion of the second electrode **150** protrudes upward through the spacer **125** to be electrically connected to a device of the second substrate **200** (of FIG. **3**F) which will be described below. Although not shown, a moisture absorption layer can be further formed on the second electrode **150** to protect the organic light-emitting layer **130** from moisture.

Referring to FIG. **3**F, the second substrate **200** where TFTs are formed is provided. After that, a seal pattern is formed along an outer region of the first substrate **100** or the second substrate **200**, and the first and second substrates **100** and **200** are attached to each other such that an OLED E of the first substrate **100** faces the TFTs of the second substrate **200**, so that an organic electro-luminance display device can be manufactured. At this point, the TFT Tr of the second substrate **200** can be electrically connected to the second electrode **150** formed on the spacer **125** of the first substrate **100** by the spacer **125**.

Since the buffer layer **123** and the spacer **125** are simultaneously formed using one mask as descried above, the number of manufacturing processes of the organic electro-luminance display device can be reduced.

FIGS. **4**A to **4**C are cross-sectional schematic diagrams of an organic electro-luminescence display device according to another embodiment of the invention. A buffer layer having a trench therein may be formed instead of a partition wall for separating the second electrode. Referring to FIG. **4**A, the organic electro-luminance display device includes a first substrate **300** and a second substrate **400** separated a predetermined distance from each other by a spacer **325**. The first substrate **300** includes an OLED E, and the second substrate **400** includes an array device including a TFT Tr. The OLED is electrically connected to the TFT Tr by the spacer **325**.

Referring to FIG. **4**B, a plurality of sub-pixels are defined on the first substrate **300**. A first electrode **310** is located on the first substrate **300**, and can be formed of a transparent conductive material. For example, the first electrode **310** can be formed of ITO or IZO. An auxiliary electrode **305** electrically connected to the first electrode **310** can be formed on the first substrate **300**. The auxiliary electrode **305** reduces resistance of the first electrode **310** to prevent non-uniformity of brightness.

A first buffer layer **315** and a second buffer layer **323** are sequentially formed on an outer region of the first substrate that partitions sub-pixels. The second buffer layer **323** includes a spacer **325** that protrudes from a predetermined region of the second buffer layer **323**. Thus, the second buffer layer **323** and the spacer **325** can be integrally formed. Each of the first and second buffer layers **315** and **323** includes a trench P on a portion of the first electrode **310** that corresponds to the auxiliary electrode **305**. A second electrode **350** is separated in a sub-pixel unit by the trench P. The trench P may have an under-cut shape to efficiently separate the second electrode **350** by a sub-pixel unit. That is, a second trench P**2** formed in the first buffer layer **315** is excessively etched inward in comparison with a first trench P**1** formed in the second buffer layer **323**. A width of the second trench P**2** can be at least greater that of the first trench P**1**.

The first buffer layer **315** can be formed of inorganic insulating material. For example, the first buffer layer **315** can be one of a silicon oxide layer, a silicon nitride layer, and a stacked layer of these layers. The second buffer layer **323** and the spacer **325** can be formed of an organic insulating layer. The second buffer layer **323** and the spacer **325** can be formed of a photosensitive resin for convenience in process. For example, the second buffer layer **323** and the spacer **325** can be formed of at least one of an acryl-based resin, benzocyclobutene (BCB), polyimide (PI), and novolak-based resin.

An organic light-emitting layer **330** is formed on the first electrode **310** and the spacer **325**. The organic light-emitting layer **330** can further include, on an upper surface thereof or a lower surface thereof, at least one organic layer of a hole injection layer, hole transport layer, a hole suppress layer, an electron transport layer, and an electron injection layer.

The second electrode **350** is formed on the organic light-emitting layer **330**. It should be noted that the second electrode **350** is formed on the spacer **325**. As described above, the second electrode **350** is separated in a sub-pixel unit by the trenches P of the first and second buffer layers **315** and **323**. The second electrode **350** is a conductive material having a reflective characteristic, and can be formed of one material of Mg, Ca, Al, Ag, Ba, and an alloy thereof. Although not shown, a moisture absorption layer can be further formed on the second electrode **350**.

Meanwhile, a second substrate **400** including TFTs Tr will be described with reference to FIG. **4**C. Although not shown, the second substrate **400** includes a plurality of gate lines and data lines disposed to cross each other. The plurality of gate and data lines define a plurality of sub-pixels. The TFT Tr is provided at each sub-pixel or at an intersection of the gate and data lines. Though one TFT is formed at each sub-pixel, at least one TFT and one capacitor may be further formed at the each sub-pixel without limitation. However, more than one TFTs and capacitors will be omitted for convenience in description.

The TFT Tr includes a gate electrode **405** formed on the second substrate **400**. A gate insulating layer **410** is located on the second substrate **400** including the gate electrode **405**. An active layer **415** is located on a portion of the gate insulating layer **410** that corresponds to the gate electrode **405**. The active layer **415** can include a channel layer **415***a* formed of amorphous silicon, and an ohmic contact layer **415***b* formed of amorphous silicon doped with impurities. In addition, source/drain electrodes **425***a* and **425***b* separated a predetermined distance from each other are formed on both sides of the active layer **415**. The source/drain electrodes **425***a* and **425***b* can be formed of one of Al, AlNd, Mo, and Cr. Through the above process, the TFT Tr including the gate electrode **405**, the active layer **415**, and the source/drain electrodes **425***a* and **425***b*, is formed on the second substrate **400**. Although the TFT Tr is illustrated as of a bottom gate-type TFT where the TFT Tr is formed of amorphous silicon in the above embodiment of the invention, the TFT Tr is not limited thereto but a variety of TFTs known in the art can be used.

A passivation layer **420** having a contact hole exposing the drain electrode **425***b* is formed on the second substrate **400** including the TFT Tr. A connection electrode (not shown) electrically connected to the drain electrode **425***b* exposed via the contact hole can be further formed on the second substrate **400**.

FIGS. **5**A to **5**F are cross-sectional schematic diagrams of a process of fabricating an organic electro-luminescence display device according to another embodiment of the invention. Referring to FIG. **5**A, a first substrate **300** where a plurality of sub-pixels are defined is provided. The first substrate **300** can be a glass substrate or a plastic substrate, and may be formed of a transparent material. An auxiliary electrode **305** is formed by depositing a conductive material of low resistance on the first substrate **300**, and patterning the deposited material. The auxiliary electrode **305** reduces resistance of a first electrode **310** that is formed during a subsequent process. The conductive material of low resistance can be at least one of Al, AlNd, Mo, and Cr. In addition, the first electrode **310** is formed by depositing a transparent conductive material on the first substrate **300** including the auxiliary electrode **305**, and patterning the deposited material. For example, the transparent conductive material can be ITO or IZO.

Referring to FIG. **5**B, a first buffer layer **315** is formed by forming an inorganic insulating layer on the first electrode **310** and patterning the inorganic insulating layer. The first buffer layer **315** is located on an outer region partitioning each sub-pixel. The first buffer layer **315** can be one of a silicon oxide layer, a silicon nitride layer, and a stacked layer of these layers.

Referring to FIG. **5**C, an organic insulating layer **320** is formed on the first buffer layer **320**. The organic insulating layer **320** can be formed of a photosensitive resin. For example, the organic insulating layer **320** can be formed of at least one of an acryl-based resin, benzocyclobutene (BCB), polyimide (PI), and a novolak-based resin.

A mask **500** is provided on the organic insulating layer **320**. Here, the mask **500** can be one of a halftone mask, a slit mask, and a halftone/slit combination mask, capable of controlling intensity of light for each region. As illustrated, the mask **500** can be divided into a transmission region 'a', a half-transmission region 'b', and a non-transmission region 'c'.

An exposure process is performed using the mask **500**, and a development process is performed to simultaneously form a second buffer layer **323** and a spacer **325** as illustrated in FIG. **5**D. A first trench **P1** exposing the first buffer layer **315** can be formed using the transmission region 'a' of the mask **500** in a predetermined region of the second buffer layer **323**. The second buffer layer **323** is formed by removing a portion of the insulating layer that corresponds to the half-transmission region 'b' of the mask **500** using a developer. Also, the spacer **325** is formed by leaving a portion of the insulating layer that corresponds to the non-transmission region 'c' without reaction to the developer. Thus, the second buffer layer **323** and the spacer **325** can be integrally formed in the same process steps. Moreover, a portion of the insulating layer that corresponds to the transmission region 'a' is entirely removed by the developer, so that the first trench P1 is formed. The insulating layer **120** is illustrated to be formed of a positive photosensitive resin. When the insulating layer **120** is formed of a negative photosensitive resin, the exposure process may be performed by reversely aligning the mask **300** to form the second buffer layer **323**, the spacer **325**, and the first trench **P1**.

After that, a curing process is performed by performing a heat treatment process on the second buffer layer **323** and the spacer **325**. Since the second buffer layer **323**, the spacer **325**, and the first trench PI can be simultaneously formed using one mask as described above, productivity can improve and manufacturing costs can reduce.

Referring to FIG. **5**E, a second trench P**2** is formed in the first buffer layer **315** to correspond to the first trench P1 formed in the second buffer layer **323**. The second trench P2 can be formed to expose the first electrode **310**, or formed in a form of a groove by etching a portion of the first buffer layer **315**. A trench P for automatically separating the second electrodes by a sub-pixel unit can be formed when the second electrode is formed on the first and second buffer layers **315** and **323**. Here, the trench P may be formed in an under-cut shape so that the second electrode is automatically separated with ease in a sub-pixel unit by the trench P when the second electrode is formed. That is, the second trench P**2** of the first buffer layer **315** can be etched further inward than the first trench P1 of the second buffer layer **323**. For this purpose, the second trench P2 can be formed using wet etching.

Referring to FIG. **5**F, an organic light-emitting layer **330** is formed on the first electrode **310**. The organic light-emitting layer **330** may be formed of a material of small molecules or a polymer material. In the case where the organic light-emitting layer **330** is formed of the material of small molecules, the organic light-emitting layer **330** can be formed using vacuum deposition. On the other hand, in the case where the organic light-emitting layer **330** is formed of the polymer material, the organic light-emitting layer **330** can be formed using inkjet printing. At this point, at least one organic layer of a hole injection layer, hole transport layer, a hole suppress layer, an electron transport layer, and an electron injection layer can be further formed before or after the organic light-emitting layer **330** is formed.

After that, the second electrode **350** is formed on the organic light-emitting layer **330**. At this point, the second electrode **350** is automatically separated in a sub-pixel unit by the first buffer layer **315** and the second buffer layer **323** while a conductive material is deposited. Through the above process, the second electrode **350** can be formed without performing a separate patterning process. Since the second electrode **350** is also formed on the spacer **325**, a portion of the second electrode **350** protrudes upward through the spacer **325**.

A moisture absorption layer can be further formed on the second electrode **350** to protect the organic light-emitting layer **330** from moisture. After that, an organic electro-luminance display device can be fabricated by attaching the first substrate **300** including the OLED E to the second substrate **400** including the TFT Tr. Since the second buffer layer **323** and the spacer **325** are integrally formed on the first substrate **300** in the same process steps, the number of processes can be reduced.

According to an embodiment of the invention, after the TFT and the OLED are formed on different substrates, respectively, an organic electro-luminance display device is fabricated by attaching two substrates to each other, so that a defect rate reduces and production yield improves.

According to an organic electro-luminance display device of an embodiment of the invention, since a buffer layer partitioning a sub-pixel and a spacer are integrally formed in the same process steps, the number of processes reduces and productivity improvement is expected.

In addition, since the buffer layer partitioning the sub-pixel and the spacer are integrally formed according to an embodiment of the invention, the buffer layer and the spacer can be formed of the same material.

Further, since the buffer layer partitioning the sub-pixel and the spacer are formed using one mask according an embodiment of the invention, a development process and a strip process can be reduced, and thus manufacturing costs can be reduced.

Moreover, according to an organic electro-luminance display device of an embodiment of the invention, since an electrode is formed of a transparent conductive material, a light efficiency can improve.

It will be apparent to those skilled in the art that various modifications and variations can be made in the organic electro-luminescence display device and the method for fabricating the same of embodiments of the invention without departing from the spirit or scope of the invention. Thus, it is intended that embodiments of the invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An organic electro-luminance display device comprising:

a first substrate including a plurality of sub-pixels;

a first electrode on the first substrate;

a buffer layer on the first electrode of a region that partitions each of the sub-pixels;

a spacer on the buffer layer, the buffer layer and the spacer being integrally formed;

an organic light-emitting layer on the first electrode that corresponds to each of the sub-pixels and the spacer; and

a second electrode on the organic light-emitting layer,

wherein the spacer and the buffer layer are formed by the same material.

2. The organic electro-luminance display device according to claim **1**, further comprising:

a partition wall separated from the spacer, the partition wall being on the buffer layer.

3. The organic electro-luminance display device according to claim **2**, wherein the partition wall has a reversely tapered shape.

4. The organic electro-luminance display device according to claim **1**, wherein the buffer layer includes: a first buffer layer on a portion of the first electrode of the region that partitions each of the sub-pixels; and a second buffer layer on the first buffer layer and including the spacer.

5. The organic electro-luminance display device according to claim **4**, further comprising: trenches separated from the spacer in the first and second buffer layers, respectively.

6. The organic electro-luminance display device according to claim **5**, wherein the trench has an under-cut shape.

7. The organic electro-luminance display device according to claim **1**, wherein the buffer layer and the spacer include an organic insulating material.

8. The organic electro-luminance display device according to claim **1**, wherein the buffer layer and the spacer include a photosensitive resin.

9. The organic electro-luminance display device according to claim **1**, further comprising:

an auxiliary electrode between the first substrate of the region that partitions each sub-pixel and the first electrode.

10. The organic electro-luminance display device according to claim **1**, further comprising:

a second substrate facing the first substrate, the second substrate including a thin film transistor corresponding to each of the sub-pixels.

11. The organic electro-luminance display device according to claim **10**, wherein the second electrode of the first substrate is electrically connected to the thin film transistor of the second substrate via the spacer, wherein the second electrode is directly contacted with the drain electrode of the thin film transistor.

12. An organic electro-luminance display device comprising:

a first substrate including a plurality of sub-pixels;

a first electrode on the first substrate;

a buffer layer on the first electrode of a region that partitions each of the sub-pixels;

a spacer on the buffer layer, the buffer layer and the spacer being integrally formed;

a partition wall spaced from the spacer, the partition wall being on the buffer layer;

an organic light-emitting layer on the first electrode corresponding to each of the sub-pixels and the spacer; and

a second electrode on the organic light-emitting layer.

13. The organic electro-luminance display device according to claim **12**, wherein the partition wall has a reversely tapered shape.

14. The organic electro-luminance display device according to claim **12**, further comprising:

a second substrate facing the first substrate, the second substrate including a thin film transistor corresponding to each of the sub-pixels.

15. The organic electro-luminance display device according to claim **14**, wherein the second electrode of the first substrate is electrically connected to the thin film transistor of the second substrate via the spacer.

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摘要(译)

一种有机电致亮度显示装置，包括：第一基板，包括多个子像素;第一基板上的第一电极;分隔每个子像素的区域的第一电极上的缓冲层;缓冲层，缓冲层和间隔物整体形成，第一电极上的对应于每个子像素和间隔物的有机发光层，以及有机发光层上的第二电极。