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Beak et al.

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(54) **ORGANIC LIGHT EMITTING DISPLAY DEVICE WITH IMPROVED APERTURE RATIO AND METHOD FOR MANUFACTURING THE SAME**

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(58) **Field of Classification Search**

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See application file for complete search history.

(71) Applicant: **LG Display Co., Ltd.**, Seoul (KR)

(72) Inventors: **Jung-Sun Beak**, Paju-si (KR);
Jeong-Oh Kim, Goyang-si (KR);
Jong-Won Lee, Seoul (KR)

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(73) Assignee: **LG Display Co., Ltd.**, Seoul (KR)

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Primary Examiner — Nduka E Ojeh

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(74) *Attorney, Agent, or Firm* — Fenwick & West LLP

(Continued)

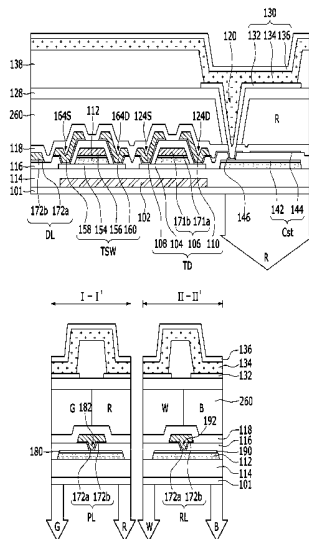
(57) **ABSTRACT**

(52) **U.S. Cl.**

CPC *H01L 27/3262* (2013.01); *H01L 27/3248* (2013.01); *H01L 27/3258* (2013.01); *H01L 27/3276* (2013.01); *H01L 51/0096* (2013.01); *H01L 51/56* (2013.01); *H01L 27/124* (2013.01); *H01L 27/1248* (2013.01); *H01L 27/1255* (2013.01); *H01L 27/1262* (2013.01);

Disclosed are an organic light emitting display device to improve an aperture ratio, and a method of manufacturing the same. The organic light emitting display device includes a plurality of contact holes overlapping an anode of an organic light emitting element in each sub-pixel region, wherein conductive films connected through at least one of the contact holes are transparent, thus allowing regions, where the contact holes are formed, to be used as light emitting regions, thereby improving an aperture ratio.

20 Claims, 12 Drawing Sheets



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H01L 29/45 (2006.01)

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FIG. 1

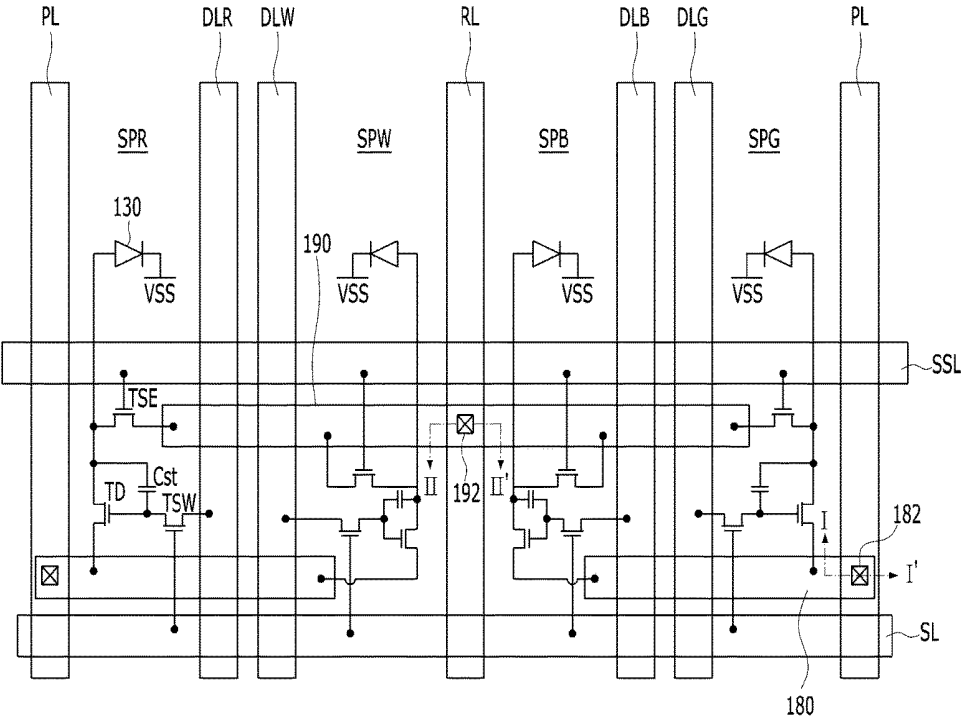


FIG. 2

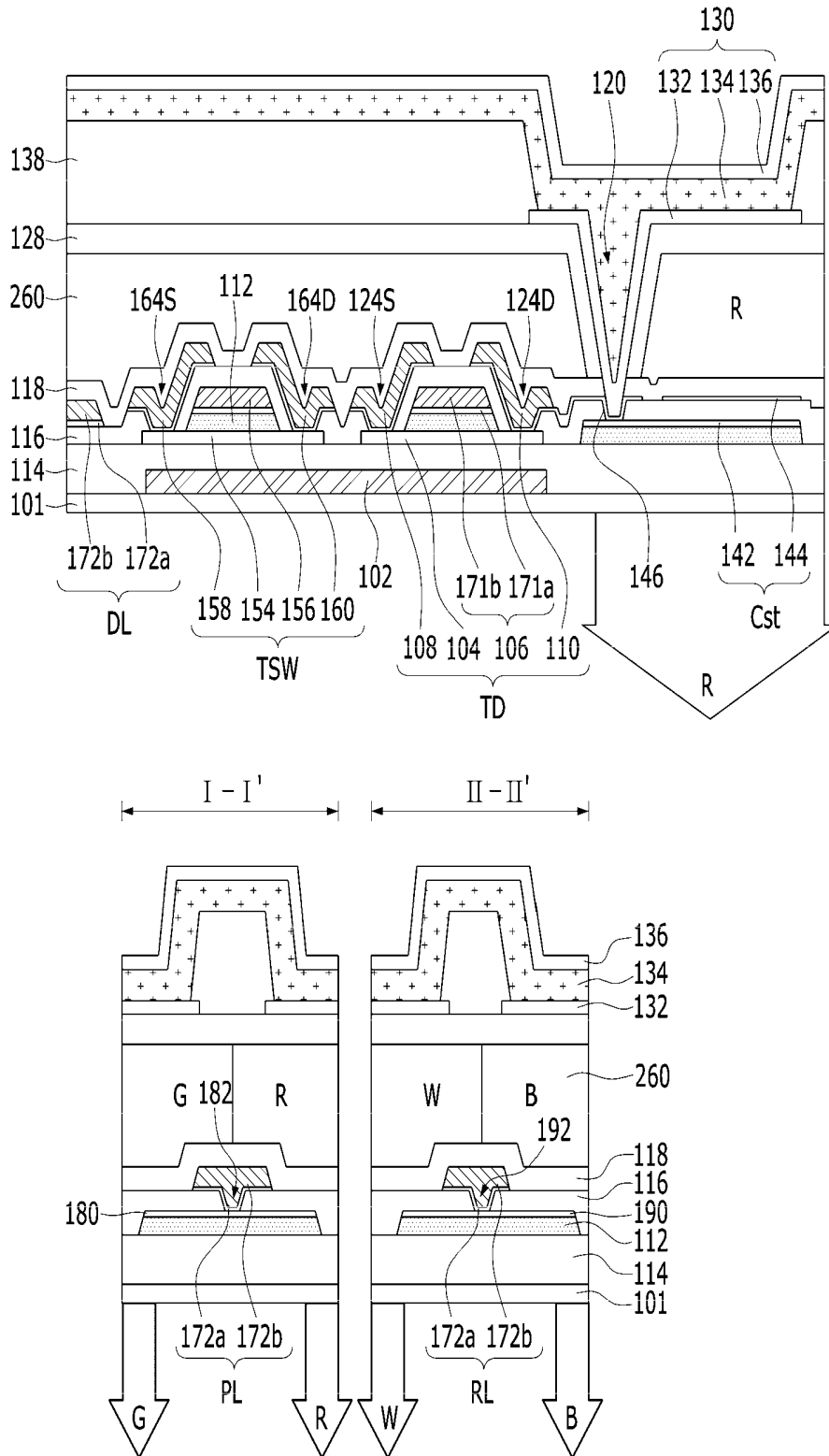


FIG. 3

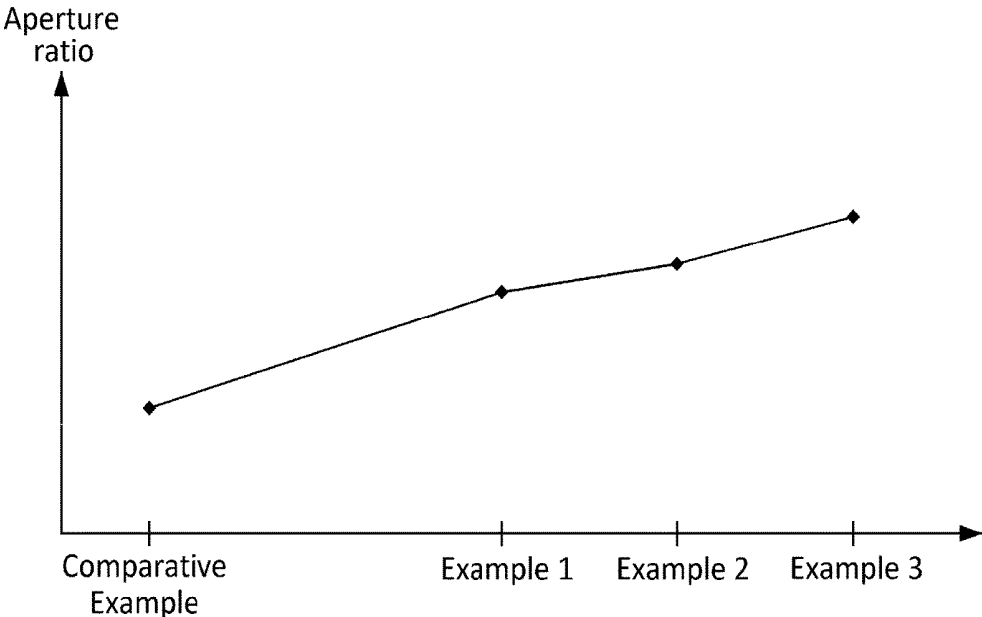


FIG. 4A

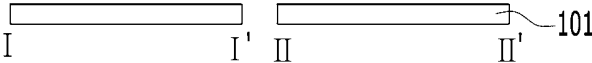
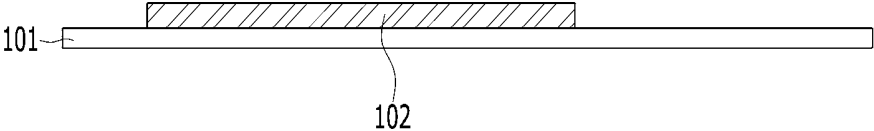


FIG. 4B

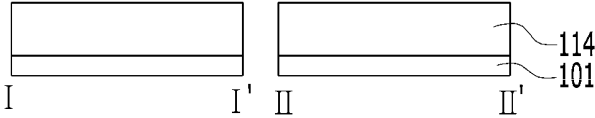
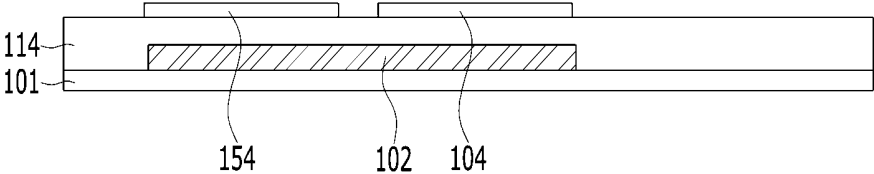


FIG. 4C

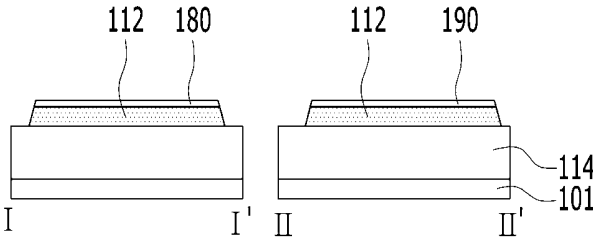
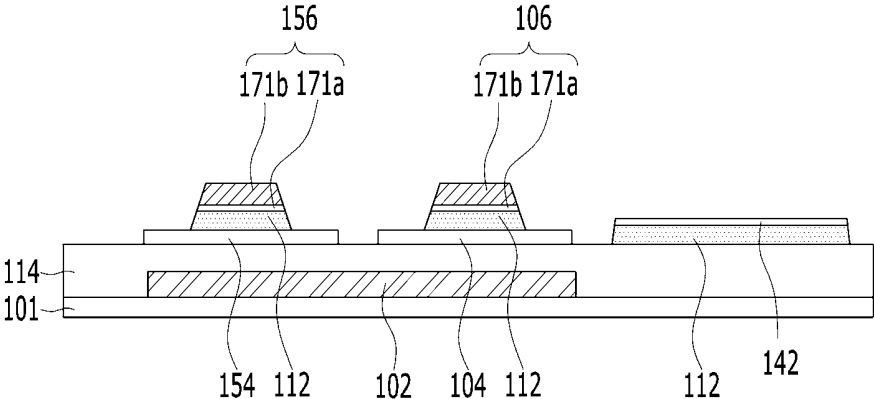


FIG. 4D

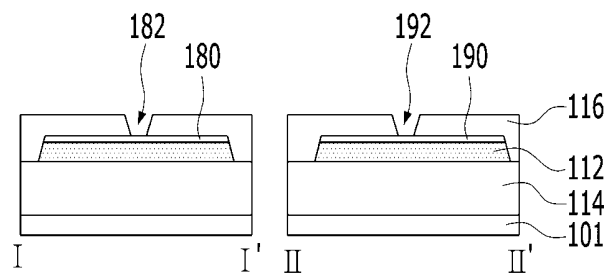
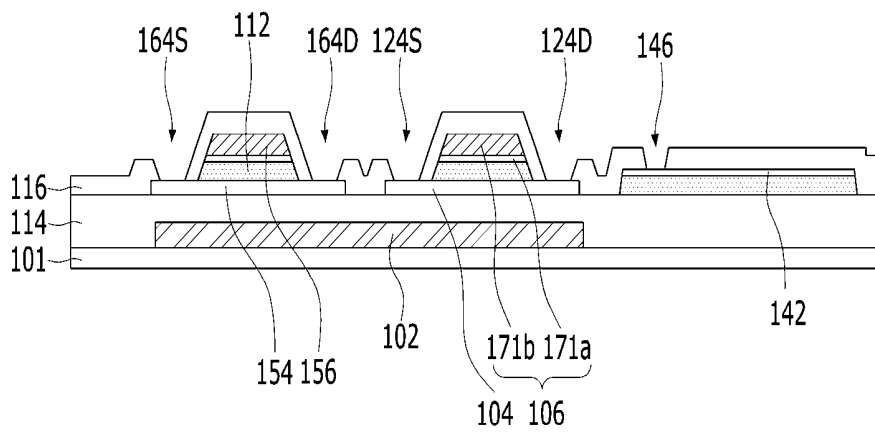


FIG. 4E

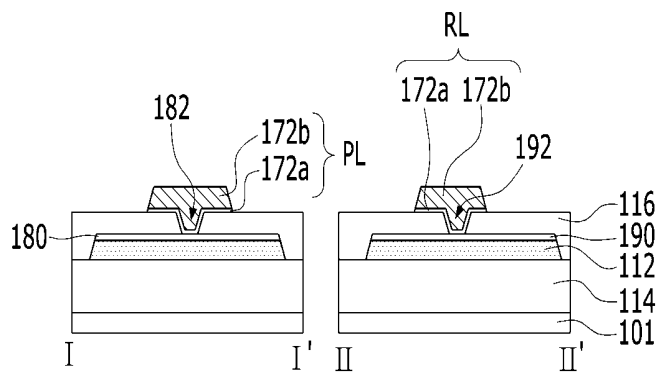
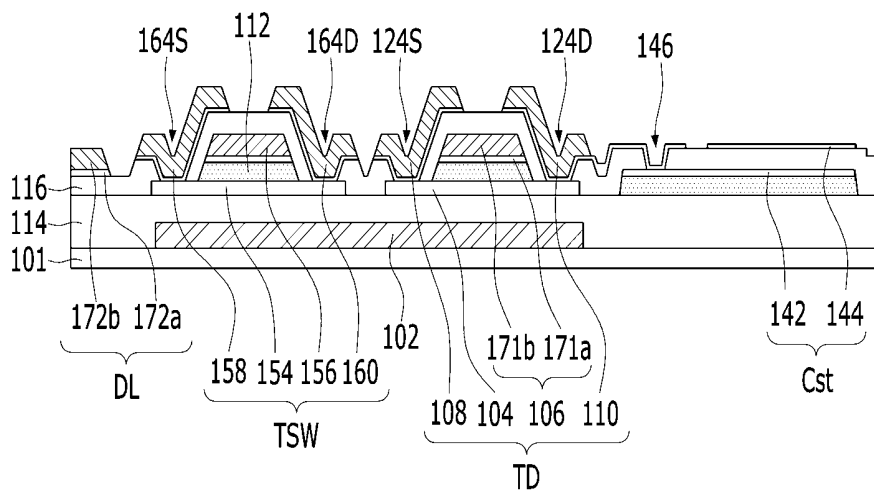


FIG. 4F

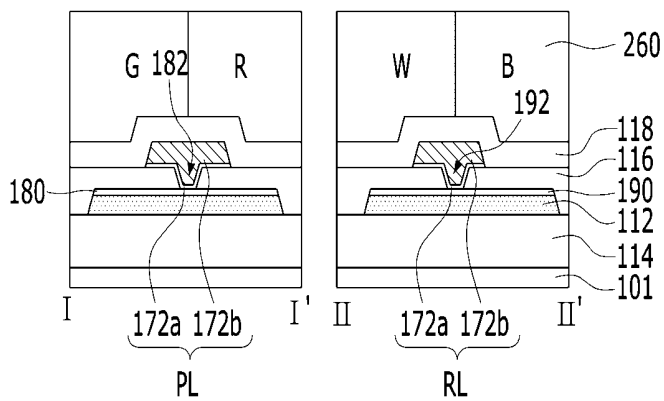
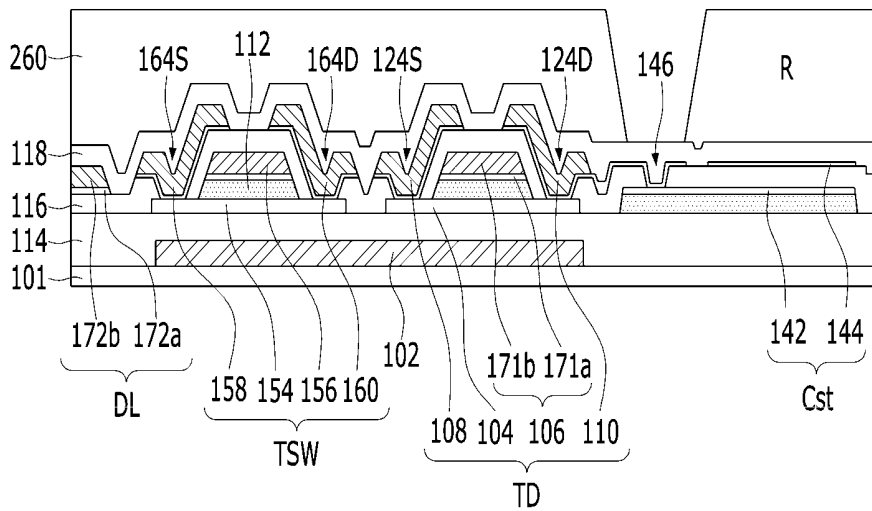


FIG. 4G

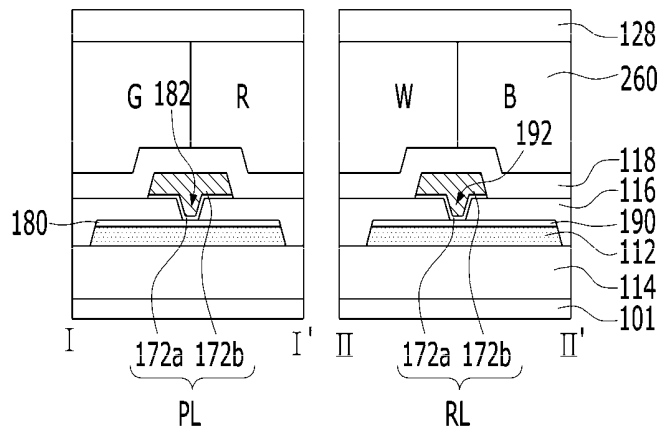
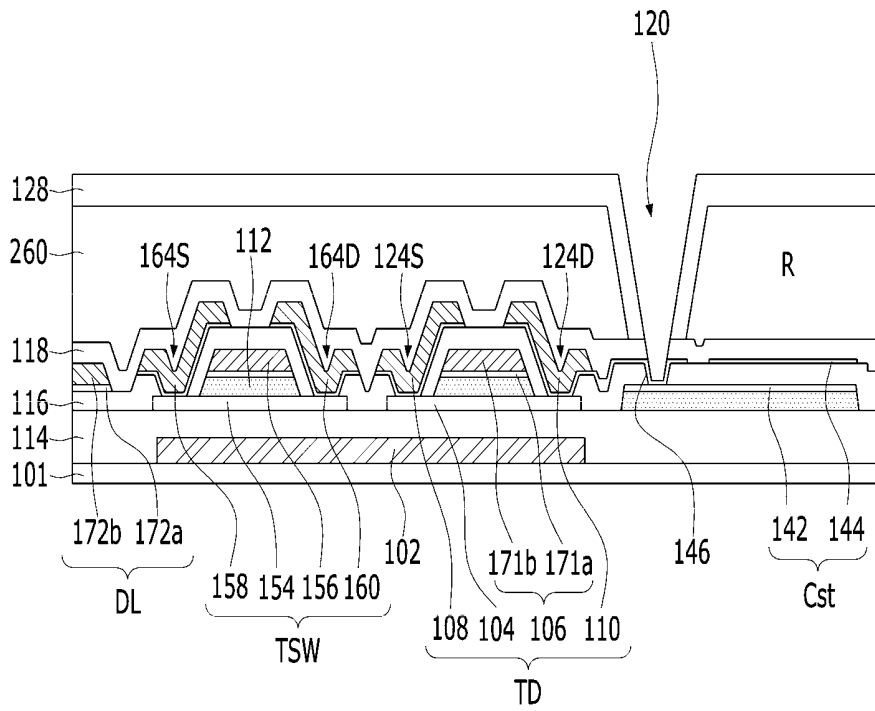


FIG. 4H

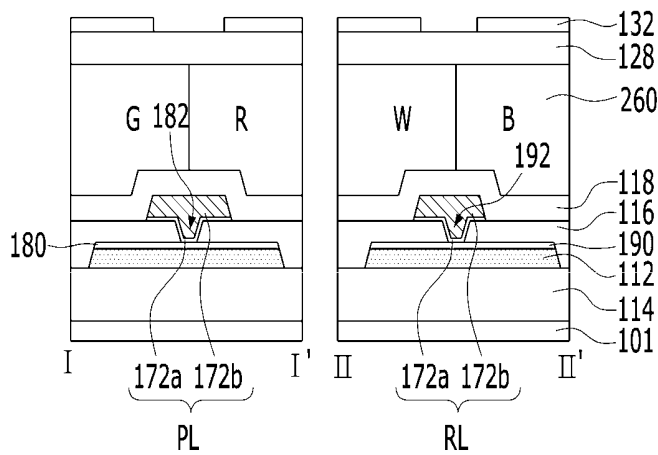
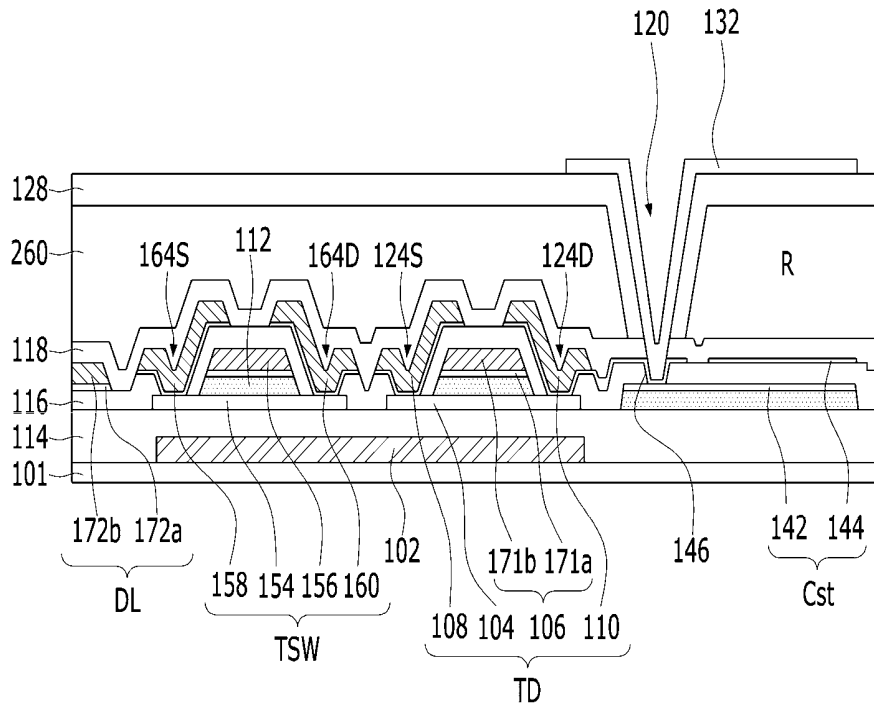
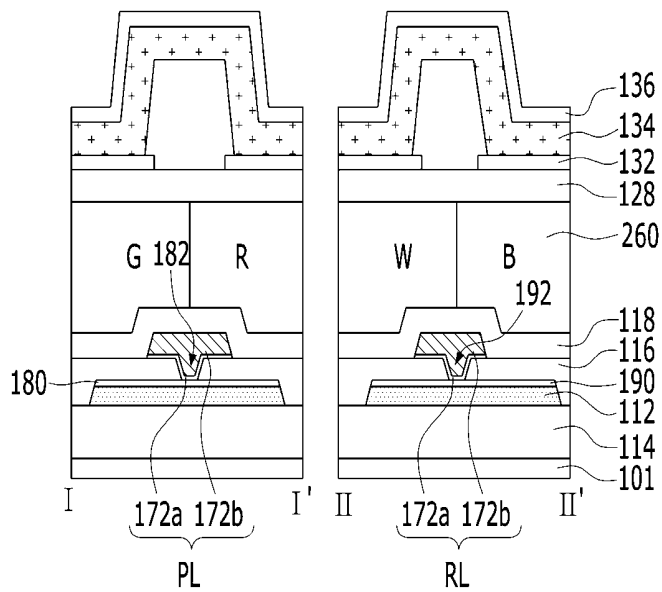
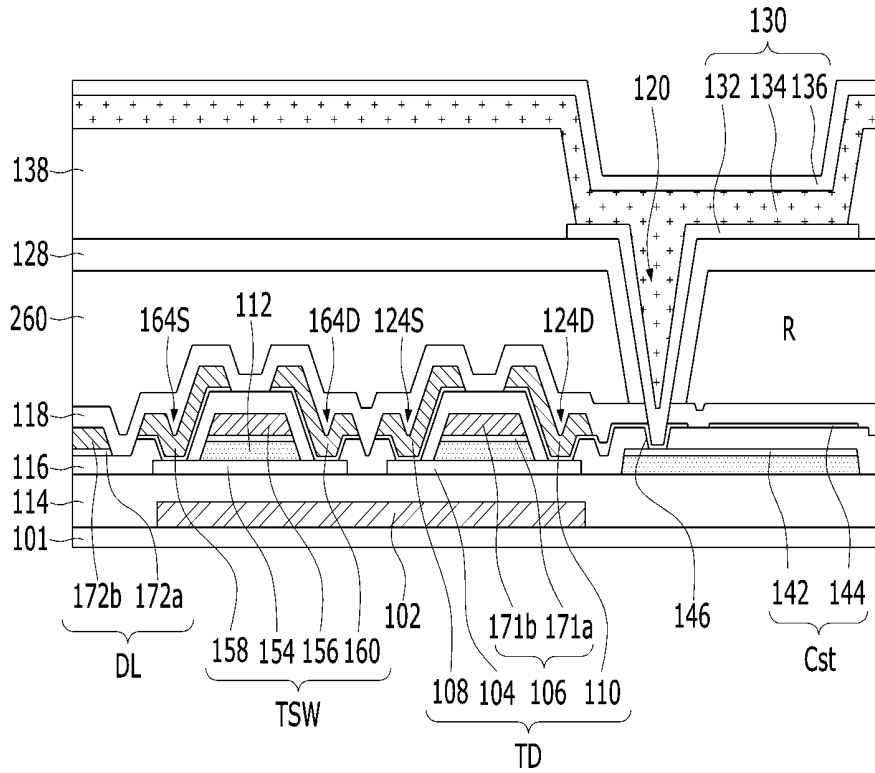


FIG. 4I



**ORGANIC LIGHT EMITTING DISPLAY
DEVICE WITH IMPROVED APERTURE
RATIO AND METHOD FOR
MANUFACTURING THE SAME**

CROSS-REFERENCE TO RELATED
APPLICATIONS

This application claims priority to Republic of Korea Patent Application No. 10-2016-0143984, filed on Oct. 31, 2016, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND

Field

The present disclosure relates to an organic light emitting display device and a method of manufacturing the same. More particularly, the present disclosure relates to an organic light emitting display device to improve an aperture ratio and a method of manufacturing the same.

Discussion of the Related Art

Image display devices for displaying a variety of information on a screen are significant technologies in the information-technology era, which are being developed into slimmer, lighter, more portable, and higher-functional forms. In response to these requirements, organic light emitting displays that display an image by controlling the amount of light emitted by an organic light emitting layer attract a great deal of attention as flat panel display devices capable of reducing the weight and volume, which are drawbacks of cathode ray tubes. Organic light emitting displays (OLEDs), which spontaneously emit light, have low consumption power, rapid response speed, high luminous efficacy, high brightness, and wide viewing angle.

Organic light emitting displays display an image through a plurality of pixels disposed in the form of a matrix. Each pixel includes a light emitting element and a pixel circuit which independently operates the light emitting element and includes a plurality of transistors.

For the organic light emitting display, light generated by the light emitting element can be emitted to the rear surface of a substrate in a region where the pixel circuit is disposed. A plurality of conductive layers included in the pixel circuit are made of an opaque material, thus preventing light generated by the light emitting element from being emitted externally. Accordingly, conventional organic light emitting displays have an aperture ratio which decreases in proportion to the area occupied by the pixel circuit. In addition, recently, a compensation circuit is required for each sub-pixel region, thus disadvantageously making it difficult to secure an appropriate aperture ratio.

SUMMARY

Accordingly, the present disclosure is directed to an organic light emitting display device and a method of manufacturing the same that substantially obviate one or more problems due to limitations and disadvantages of the related art.

An object of the present disclosure is to provide an organic light emitting display device to improve an aperture ratio and a method of manufacturing the same.

Additional advantages, objects, and features of the disclosure will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the disclosure. The objectives and other advantages of the disclosure may 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 objects and other advantages and in accordance with the purpose of the disclosure, as embodied and broadly described herein, provided are an organic light emitting display device which includes a plurality of contact holes overlapping an anode of an organic light emitting element in each sub-pixel region wherein conductive films connected through at least one of the contact holes are transparent, thus allowing regions, where the contact holes are formed, to be used as light emitting regions, thereby improving an aperture ratio, and a method of manufacturing the same.

Embodiments also relate to a display device including a transparent substrate and a plurality of pixels on the substrate. Each pixel includes a light emitting element on the substrate, and a first thin film transistor (TFT) on the substrate. The first TFT includes an active layer and a first electrode electrically connected to the active layer. The first electrode includes a first conductive layer formed of transparent conductive material, and including a first portion and a second portion. The first electrode also includes a second conductive layer contacting the first portion of the first conductive layer. The second portion of the first conductive layer is disposed below the light emitting element, and does not contact the second conductive layer.

Embodiments also relate to a method of manufacturing a display device. An active layer of a first thin film transistor (TFT) is formed on the substrate. A first electrode of the first TFT electrically connected to the active layer is formed. The first electrode includes a first conductive layer formed of transparent conductive material, and includes a second conductive layer that contacts a first portion of the first conductive layer. A light emitting element is formed on the substrate. The second portion of the first conductive layer is disposed below the light emitting element, and does not contact the second conductive layer.

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

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the disclosure and together with the description serve to explain the principle of the disclosure. In the drawings:

FIG. 1 is a plan view illustrating an organic light emitting display device according to an embodiment of the present disclosure.

FIG. 2 is a sectional view illustrating the organic light emitting display device according to an embodiment of the present disclosure.

FIG. 3 shows aperture ratios of organic light emitting display devices according to Comparative Example and Example of the present disclosure.

FIGS. 4A to 4I are sectional views illustrating a method of manufacturing the organic light emitting display device shown in FIG. 2 according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

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

FIG. 1 is a plan view illustrating an organic light emitting display device according to an embodiment of the present disclosure.

The organic light emitting display device according to the present disclosure shown in FIG. 1 includes a plurality of sub-pixel regions SPR, SPG, SPB, and SPW formed by intersections between scan lines SL, sensing control lines SSL, data lines DL, power supply lines PL, and reference lines RL.

The sub-pixel regions include a red sub-pixel region SPR, a green sub-pixel region SPG, a blue sub-pixel region SPB, and a white sub-pixel region SPW. Although FIG. 1 shows that the red sub-pixel region SPR, the white sub-pixel region SPW, the green sub-pixel region SPG, and the blue sub-pixel region SPB are disposed in this order, the disposition order thereof is highly varied in each unit pixel and changes depending on color and configuration. According to the present disclosure, in addition to the red, green, and blue sub-pixel regions SPR, SPG, and SPB, the white sub-pixel region SPW with a high transmission is further provided in order to improve luminous efficacy.

Each of the red, green, blue, and white sub-pixel regions SPR, SPG, SPB, and SPW includes a light emitting element 130 and a pixel driving circuit to independently operate the light emitting element 130. The pixel driving circuit includes a switching thin film transistor TSW, a driving thin film transistor TD, a sensing thin film transistor TSE, and a storage capacitor Cst.

When a sensing pulse is supplied to the sensing control line SSL, the sensing thin film transistor TSE is turned on and detects a threshold voltage of the driving thin film transistor TD and a threshold voltage of the light emitting element 130. That is, when the sensing thin film transistor TSE is turned on, a current pass to the sensing thin film transistor TSE and the reference line RL is created. A data driver (not shown) or a timing controller (not shown) detects a current flowing through the current pass, thereby detecting the threshold voltage of the driving thin film transistor TD and the threshold voltage of the light emitting element 130. Based on the detected threshold voltage, a data voltage is compensated and the compensated data voltage is supplied to data lines DLR, DLG, DLB, and DLW. For this purpose, the sensing thin film transistor TSE includes a gate electrode connected to the sensing control line SSL, a source electrode connected to the reference line RL, and a drain electrode connected to the driving thin film transistor TD. The reference line RL is connected through a second jumping line 190 protruding from the reference line RL to the source electrodes of the sensing thin film transistors TSE in the red, green, blue, and white sub-pixel regions SPR, SPG, SPB, and SPW. The reference line RL is interposed between the white and blue sub-pixel regions SPW and SPB rendering different colors, to prevent color mixing between the white and blue sub-pixels SPW and SPB.

When a scan pulse is supplied to the scan line SL, the switching thin film transistor TSW is turned on and detects the data signal from the data lines DLR, DLG, DLB, and

DLW to the storage capacitor Cst and the gate electrode 106 of the driving thin film transistor TD. As shown in FIG. 2, the switching thin film transistor 150 includes a first gate electrode 156 connected to the scan line SL, a first source electrode 158 connected to the data line DL, a first drain electrode 160 connected to the second gate electrode 106, and a first active layer 154.

The driving thin film transistor TD controls the current supplied from the power supply line PL according to the driving voltage charged in the storage capacitor Cst, and supplies the current in proportion to the driving voltage to the light emitting element 130, so the light emitting element 130 can emit light. The driving thin film transistor TD includes a second gate electrode 106 connected to the first drain electrode 160, a second source electrode 108 connected to the power supply line PL, a second drain electrode 110 connected to the light emitting element 130, and a second active layer 104. Here, the power supply line PL is connected through a first jumping line 180 protruding from the power supply line PL to the second source electrodes 108 of the driving thin film transistors TD of the red, green, blue, and white sub-pixel regions SPR, SPG, SPB, and SPW. The power supply line PL is interposed between the green and red sub-pixel regions SPG and SPR rendering different colors, to prevent color mixing between the green and red sub-pixels SPG and SPR.

Meanwhile, the first and second gate electrodes 156 and 106 of the switching thin film transistor TSW and the driving thin film transistor TD overlap with the first and second active layers 154 and 104, respectively, with the gate insulation pattern 112 interposed therebetween.

The first active layer 154 overlaps with the first gate electrode 156 disposed on the gate insulation pattern 112 to form a channel between the first source electrode 158 and the first drain electrode 160. The second active layer 104 overlaps with the second gate electrode 106 disposed on the gate insulation pattern 112 to form a channel between the second source electrode 108 and the second drain electrode 110. Each of the first and second active layers 154 and 104 is formed of an oxide semiconductor which includes at least one metal selected from Zn, Cd, Ga, In, Sn, Hf, and Zr, or polycrystalline silicon or amorphous silicon.

The first and second source electrodes 158 and 108 are respectively connected to first and second active layers 154 and 104 through first and second source contact holes 164S and 124S penetrating through the interlayer insulation film 116. The first and second drain electrodes 160 and 110 are respectively connected to first and second active layers 154 and 104 through first and second drain contact holes 164D and 124D penetrating through the interlayer insulation film 116.

The first drain electrode 160 is electrically connected through a connection electrode (not shown) to the second gate electrode 106 of the driving thin film transistor TD. The second drain electrode 110 is connected to a portion of the lower storage electrode 142 exposed through the storage contact hole 146 penetrating through the interlayer insulation film 116. The second drain electrode 110 is exposed through a pixel contact hole 120 penetrating through a protective film 118 and a planarization layer 128 and is connected to an anode 132. The second drain electrode 110 includes a second transparent conductive layer 172a in a region where the second drain electrode 110 overlaps the anode 132, and the second drain electrode 110 includes the second transparent conductive layer 172a and a second opaque conductive layer 172b stacked on the second trans-

parent conductive layer **172a** in a region where the second drain electrode **110** overlaps the second active layer **104**.

The storage capacitor **140** includes a lower storage electrode **142** and an upper storage electrode **144** which overlap each other with the interlayer insulation film **116** between. In this case, the lower storage electrode **142** is formed in the form of a transparent conductive layer on the gate insulation pattern **112**, and the upper storage electrode **144** is formed in the form of a transparent conductive layer on the interlayer insulation film **116**. As such, the lower storage electrode **142** and the upper storage electrode **144** constituting the storage capacitor **140** are disposed as transparent conductive layers in a light emitting region, thereby improving aperture ratio.

The light emitting element **130** includes an anode **132**, an organic light emitting layer **134** formed on the anode **132**, and a cathode **136** formed on the organic light emitting layer **134**.

The anode **132** is electrically connected to a second drain electrode **110** exposed through the pixel contact hole **120** penetrating through the protective film **118** and the planarization layer **128**. Meanwhile, in the case of a bottom emission-type organic light emitting display device, the anode **132** is formed of transparent conductive oxide (TCO).

The organic light emitting layer **134** is formed by stacking a hole-related layer, a light emitting layer, and an electron-related layer in this order or a reverse order on the anode **132**.

A bank **138** is formed so as to expose the anode **132** disposed in the light emitting region, as shown in FIG. 2.

The cathode **136** is formed on upper and side surfaces of the organic light emitting layer **134** and the bank **138** such that it faces the anode **132** via the organic light emitting layer **134**. In the case of a bottom emission type organic light emitting display device, the cathode **136** has a structure in which a transparent conductive layer such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), and a metal layer including aluminum (Al), silver (Ag), APC (Ag;Pb;Cu) or the like are stacked together.

Meanwhile, at least one of the first and second gate electrodes **156** and **106**, the scan line SL, and the sensing control line SSL includes the first transparent conductive layer **171a** and the first opaque conductive layer **171b** formed on the first transparent conductive layer **171a**. At least one of the lower storage electrode **142**, and the first and second jumping lines **180** and **190** includes a first transparent conductive layer **171a**.

In addition, at least one of the first and second source electrodes **158** and **108**, the first drain electrode **160**, a region of the second drain electrode **110** overlapping the second active layer **104**, the data lines DLR, DLG, DLB, and DLW, the power supply line PL, and the reference line RL includes the second transparent conductive layer **172a** and the second opaque conductive layer **172b** formed on the second transparent conductive layer **172a**.

The region of the second drain electrode **110** overlapping the anode **132**, and the upper storage electrode **144** include the second transparent conductive layer **172a**.

Here, the first and second transparent conductive layers **171a** and **172a** include a transparent conductive material such as ITO, and the first and second opaque conductive layers **171b** and **172b** may be a single layer or multiple layers which include any one of molybdenum (Mo), aluminum (Al), chromium (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) and copper (Cu), or an alloy thereof, but the present disclosure is not limited thereto.

In one embodiment, a first transistor may include a first electrode (e.g., source or drain electrode) electrically connected to the active layer, in which the first electrode includes a first conductive layer (e.g., second transparent conductive layer **172a**) and a second conductive layer (e.g., second opaque conductive layer **172b**). The first conductive layer may be formed of transparent conductive material, and may include a first portion and a second portion. The second conductive layer may contact the first portion of the first conductive layer, and the second portion of the first conductive layer may be disposed below the light emitting element **130**, and may not contact the second conductive layer. Thus, the protective film **118** disposed on the first electrode may contact a top surface of the second conductive layer, and contact a top surface of the second portion of the first conductive layer. The second portion of the first conductive layer may be disposed in an opening of the interlayer insulation film **116**. In one embodiment, the second portion of the first conductive layer may contact a third conductive layer disposed below the interlayer insulation film **116** exposed through the opening. The third conductive layer may also be formed of transparent conductive material.

In one embodiment, the transistor corresponds to the driving transistor TD, and the first electrode corresponds to the drain electrode **110**. In particular, the lower storage electrode **142** and the second drain electrode **110**, which overlap the anode **132**, are each formed as transparent conductive layers **171a** and **172a** in a region where the storage contact hole **146** is formed. In this case, the region where the storage contact hole **146** is formed becomes transparent, thus emitting light generated by the organic light emitting layer **134** through the region where the storage contact hole **146** is formed to the bottom of the substrate **101**. The anode electrode **132** of the light emitting element **130** may contact the second portion of the second transparent conductive layer **172a** of the drain electrode **110** disposed below the light emitting element **130** that does not contact the second opaque conductive layer **172b** of the drain electrode **110**. In addition, the second portion of the second transparent conductive layer **172a** of the drain electrode **110** may contact the lower storage electrode **142** of the storage capacitor Cst. As a result, the present disclosure utilizes, as light emitting regions, the light emitting region where the anode **132** is disposed as well as the region where the storage contact hole **146** is formed, thereby improving aperture ratio. The electrodes disposed in the region where the storage contact hole **146** is formed, as well as the region corresponding to the contact hole disposed in the pixel driving circuit, are formed as the transparent conductive layer **172a**.

In another embodiment, the transistor corresponds to the switching transistor TSW, and the first electrode corresponds to the first drain electrode **160**. For example, electrodes disposed in the region where the contact hole to connect the first drain electrode **160** to the second gate electrode **106** is formed, are formed as the transparent conductive layer **172a**, thereby improving aperture ratio. In such an embodiment, the second portion of the second transparent conductive layer **172a** of the first drain electrode **160** may contact a conductive layer extending from a part of the gate electrode **106** of the driving transistor TD.

In addition, the first jumping line **180** to connect the second source electrode **108** of the driving thin film transistor TD to the power supply line PL is formed with the same pattern as the gate insulation pattern **112** on the gate insulation pattern **112**. The first jumping line **180** is exposed through the first power contact hole **182** and is electrically

connected to the power supply line PL. The first jumping line **180** protrudes from the power supply line PL toward the sub-pixel region parallel to the scan line SL in order to connect the power supply line PL to the second source electrode **108** of the driving thin film transistor TD. In this case, the first jumping line **180** is formed as the first transparent conductive layer **171a** in the sub-pixel region. In this case, the first jumping line **180** becomes transparent, thus emitting light generated by the organic light emitting layer **134** through the first jumping line **180** to the bottom of the substrate **101**. Accordingly, the present disclosure can utilize the region where the first jumping line **180** is formed in the sub-pixel region as a light emitting region, thereby improving an aperture ratio.

In addition, the second jumping line **190** to connect the source electrode of the sensing thin film transistor TSE to the reference line RL is formed in the same pattern as the gate insulation pattern **112** on the gate insulation pattern **112**. The second jumping line **190** is exposed through the second power contact hole **192** and is electrically connected to the reference line RL. The second jumping line **190** protrudes from the reference line RL toward each sub-pixel region parallel to the scan line SL in order to connect the source electrode of the sensing thin film transistor TSE to the reference line RL. In this case, the second jumping line **190** is formed as the first transparent conductive layer **171a** in each sub-pixel region. In this case, the second jumping line **190** becomes transparent, thus emitting light generated by the organic light emitting layer **134** through the second jumping line **190** to the bottom of a substrate **101**. Accordingly, the present disclosure can utilize the region where the second jumping line **190** is formed in the sub-pixel region as a light emitting region, thereby improving an aperture ratio.

In other words, a conductive line (e.g., PL or RL) may extend on the substrate in a first direction. A jumping line (e.g., **180** or **190**) formed of transparent conductive material electrically connected to the conductive line may extend in a second direction different from the first direction on the substrate. The jumping line may be formed in a same layer as a gate electrode of a driving transistor TD or a switching transistor TSW. For example, the jumping line may be formed in the same layer as the transparent conductive layer **171a**.

FIG. 3 shows aperture ratios of organic light emitting display devices according to Comparative Example and Example according to the present disclosure.

In FIG. 3, Example 1 relates to an organic light emitting display in which the region of the storage contact hole **146** is also transparent, because the lower storage electrode **142** formed as the first transparent conductive layer **171a** is connected to the second drain electrode **110** formed as the second transparent conductive layer **172a** through the storage contact hole **146**. Example 2 relates to an organic light emitting display in which the region of the storage contact hole **146** as well as the first jumping line **180** are transparent. Example 3 relates to an organic light emitting display device in which the region of the storage contact hole **146**, and the first and second jumping lines **180** and **190** are transparent. Comparative Example relates to a conventional organic light emitting display device in which the storage contact hole region and the first and second jumping lines are opaque.

As can be seen from FIG. 3, Examples 1 to 3 exhibit better aperture ratio than Comparative Example. In particular, Example 3, where regions of the storage contact hole **146**, and the first and second jumping lines **180** and **190** are transparent, exhibits a 7% increase in aperture ratio as compared to the convention organic light emitting display

device of the Comparative Example, where the storage contact hole region, and first and second jumping lines are opaque.

FIGS. 4A to 4I are sectional views illustrating a method of manufacturing the organic light emitting display device shown in FIG. 2 according to an embodiment of the present disclosure.

Referring to FIG. 4A, a light-shielding layer **102** is formed on a substrate **101**.

More specifically, the light-shielding layer **102** is formed by depositing a light-shielding material over the entire surface of the substrate **101** and patterning the light-shielding material by photolithography and etching processes.

Referring to FIG. 4B, a buffer film **114** is formed on the substrate **101** provided with the light-shielding layer **102**, and first and second active layers **154** and **104** are formed on the buffer film **114**.

More specifically, the buffer film **114** having a single layer or multilayer structure is formed by depositing an inorganic insulation material such as SiO_x or SiN_x over the entire surface of the substrate **101** provided with the light-shielding layer **102**. In one embodiment, an amorphous silicon thin film is formed on the substrate **101** provided with the buffer film **114** by a method such as low pressure chemical vapor deposition (LPCVD) or plasma enhanced chemical vapor deposition (PECVD). Then, the amorphous silicon thin film is crystallized into a poly-silicon thin film. In addition, the poly-silicon thin film is patterned by photolithography and etching processes to form first and second active layers **154** and **104**. In other embodiments, when the first and second active layers **154** and **104** are formed of oxide semiconductor material, an oxide semiconductor film may be formed on the substrate **101**, and etched to form the first and second active layers **154** and **104**.

Referring to FIG. 4C, first and second gate electrodes **156** and **106**, a lower storage electrode **142**, first and second jumping lines **180** and **190**, and a gate insulation pattern **112** are formed on the substrate **101** provided with the first and second active layers **154** and **104**. In one embodiment, these layers may be formed in the same line width on the substrate **101**.

More specifically, a gate insulation film is formed on the substrate **101** provided with the first and second active layers **154** and **104**, and a first transparent conductive layer **171a** and a first opaque conductive layer **171b** are sequentially formed thereon by a deposition method such as sputtering. The gate insulation film is formed using an inorganic insulation material such as SiO_x or SiN_x . The first transparent conductive layer **171a** is formed using a transparent conductive material such as ITO. The first opaque conductive layer **171b** is formed as a single layer using a metal material such as Mo, Ti, Cu, AlNd, Al or Cr, or an alloy thereof, or as multiple layers using the same. Then, a multi-step photoresist pattern is formed by a photolithographic process using a half-tone mask. Through an etching process using this multi-step photoresist pattern as a mask, the first transparent conductive layer **171a**, the first opaque conductive layer **171b** and the gate insulation film are simultaneously patterned to form the first and second gate electrodes **156** and **106**, the lower storage electrode **142**, the first and second jumping lines **180** and **190**, and the gate insulation pattern **112** in the same pattern. In this case, each of the first and second gate electrodes **156** and **106**, the lower storage electrode **142**, and the first and second jumping lines **180** and **190** is formed by sequentially stacking the first transparent conductive layer **171a** and the first opaque conductive layer **171b** on the first transparent conductive layer **171a**.

Then, the photoresist pattern with a multi-step structure is ashed to expose the first opaque conductive layer **171b** of each of the lower storage electrode **142**, and the first and second jumping lines **180** and **190**. The exposed first opaque conductive layer **171b** of the lower storage electrode **142**, and the exposed first and second jumping lines **180** and **190** are removed by an etching process using the ashed photoresist pattern as a mask, thereby forming the lower storage electrode **142**, and the first and second jumping lines **180** and **190** with the first transparent conductive layer **171a**.

Referring to FIG. 4D, an interlayer insulation film **116** including first and second source contact holes **164S** and **124S**, first and second drain contact holes **164D** and **124D**, first and second power contact holes **182** and **192**, and a storage contact hole **146** is formed on the substrate **101** provided with the first and second gate electrodes **156** and **106**, the lower storage electrode **142**, and the first and second jumping lines **180** and **190**.

More specifically, the interlayer insulation film **116** is formed by a deposition method such as PECVD on the substrate **101** provided with the first and second gate electrodes **156** and **106**, the lower storage electrode **142**, and the first and second jumping lines **180** and **190**. Then, the interlayer insulation film **116** is patterned by a photolithographic process and an etching process, to form the first and second source contact holes **164S** and **124S**, the first and second drain contact holes **164D** and **124D**, the first and second power contact holes **182** and **192**, and the storage contact hole **146**.

Referring to FIG. 4E, first and second source electrodes **158** and **108**, first and second drain electrodes **160** and **110**, an upper storage electrode **144**, a power supply line PL, and a reference line RL are formed on the interlayer insulation film **116** provided with the first and second source contact holes **164S** and **124S**, the first and second drain contact holes **164D** and **124D**, the first and second power contact holes **182** and **192**, and the storage contact hole **146**. In other words, a first electrode of a first transistor may be formed, where the first electrode includes a first conductive layer (e.g., **172a**) formed of transparent conductive material, and a second conductive layer (e.g., **172b**) that contacts a first portion of the first conductive layer.

More specifically, a second transparent conductive layer **172a** and a second opaque conductive layer **172b** are sequentially deposited by a deposition method such as sputtering on the interlayer insulation film **116** provided with the first and second source contact holes **164S** and **124S**, the first and second drain contact holes **164D** and **124D**, the first and second power contact holes **180** and **190**, and the storage contact hole **146**. The second transparent conductive layer **172a** is formed using a transparent conductive material such as ITO. The second opaque conductive layer **172b** is formed as a single layer using a metal such as Mo, Ti, Cu, AlNd, Al, Cr or an alloy thereof, or as multiple layers using the same. Then, a multi-step photoresist pattern is formed by a photolithographic process using a half-tone mask. Through an etching process using this multiple-step photoresist pattern as a mask, the second transparent conductive layer **172a** and the second opaque conductive layer **172b** are simultaneously patterned to form first and second source electrodes **158** and **108**, first and second drain electrodes **160** and **110**, an upper storage electrode **144**, a power supply line PL, and a reference line RL. In this case, the first and second source electrodes **158** and **108**, the first and second drain electrodes **160** and **110**, the upper storage electrode **144**, the power supply line PL, and the reference line RL are formed by sequentially stacking the second transparent conductive

layer **172a** and the second opaque conductive layer **172b**. Then, the photoresist pattern with a multi-step structure is ashed to expose the second opaque conductive layer **172b** of the storage upper electrode **144** and a region of the second drain electrode **110** overlapping the lower storage electrode **142**. The exposed upper storage electrode **144** and the first opaque conductive layer **171b** of the region of the second drain electrode **110** overlapping the lower storage electrode **142** are removed by an etching process using the ashed photoresist pattern as a mask. Thus, a part of the second opaque conductive layer **172b** is etched to expose the second portion of the second transparent conductive layer **172a**. As a result, each of the region of the second drain electrode **110** overlapping the lower storage electrode **142** and the upper storage electrode **144** is formed as the second transparent conductive layer **172a**. In one embodiment, the second portion of the second transparent conductive layer **172a** may contact the lower storage electrode **142** of the storage capacitor Cst disposed below the interlayer insulation film **116**. In another embodiment, the second portion of the second transparent conductive layer **172a** may contact a conductive layer extending from a part of the gate electrode **106** of the driving transistor TD.

Referring to FIG. 4F, a protective film **118** is formed on the interlayer insulation film **116** provided with the first and second source electrodes **158** and **108**, the first and second drain electrodes **160** and **110**, the upper storage electrode **144**, the power supply line PL, and the reference line RL, and a color filter **260** is formed on the protective film **118**. In one embodiment, the protective film **118** contacts the second opaque conductive layer **172b** and the second portion of the second transparent conductive layer **172a** that does not contact the second opaque conductive layer **172b**. The color filter is formed to overlap the emission area and to cover at least one of the switching thin film transistor TSW and the driving thin film transistor TD.

More specifically, the protective film **118** is formed on the interlayer insulation film **116** provided with the first and second source electrodes **158** and **108**, the first and second drain electrodes **160** and **110**, the upper storage electrode **144**, the power supply line PL, and the reference line RL. The protective film **118** is formed using an inorganic insulation material such as SiO_x or SiN_x. Then, a color resin is applied and then patterned by a photolithographic process to form a color filter **260**.

Referring to FIG. 4G, a planarization layer **128** having a pixel contact hole **120** is formed on the substrate **101** provided with the color filter **260**.

More specifically, the planarization layer **128** is formed by applying an organic film such as a photoacrylic resin over the entire surface of the substrate **101** provided with the color filter **260**. Then, the planarization layer **128** is patterned by a photolithographic process to form a pixel contact hole **120**.

Referring to FIG. 4H, an anode **132** is formed on the planarization layer **128** having the pixel contact hole **120**.

More specifically, a transparent conductive layer is stacked on the planarization layer **128** having the pixel contact hole **120**. Then, the transparent conductive layer is patterned by a photolithographic process and an etching process to form an anode **132**.

Referring to FIG. 4I, a bank **138**, an organic light emitting layer **134**, and a cathode **136** are sequentially formed on the substrate **101** provided with the anode **132**.

More specifically, an organic film such as a photoacrylic resin is applied over the entire surface of the substrate **101** provided with the anode **132**. Then, the organic film is

patterned by a photolithographic process to form the bank 138. Then, an organic light emitting layer 134 rendering white is applied over the entire surface of the substrate 101 provided with the bank 138, and a cathode 136 is formed on the substrate 101 provided with the organic light emitting layer 134. A second portion of the first conductive layer 172a of the first drain electrode 160 or the second drain electrode 110 that does not contact the second conductive layer 172b may be disposed below the light emitting element 130.

As such, according to the present disclosure, at least one of a region where the storage contact hole 146 is formed, and regions where the first and second jumping lines 180 and 190 are formed becomes transparent. As a result, the present disclosure facilitates high-resolution based on improved aperture ratio, because a light emitting region where the anode 132 is disposed as well as transparent regions can be used as light emitting regions.

Meanwhile, although the present disclosure suggests, as an example, the case where the first and second jumping lines 180 and 190 are simultaneously formed with the same mask process as the first and second gate electrodes 156 and 106, the first and second jumping lines 180 and 190 may be formed by the same mask process as in the light-shielding layer 102, or the first jumping line 180 may be formed by extending the second transparent conductive layer 172a of the power supply line PL into a light emitting region without the first power contact hole 182, or the second jumping line 190 may be formed by extending the second transparent conductive layer 172a of the reference line RL into a light emitting region without the second power contact hole 192.

As apparent from the foregoing, in accordance with the present disclosure, at least one of a region where the storage contact hole 146 is formed, and regions where the first and second jumping lines 180 and 190 are formed becomes transparent. As a result, the present disclosure can facilitate high-resolution based on improved aperture ratio because a light emitting region where the anode 132 is disposed as well as transparent regions can be used as light emitting regions.

In addition, it will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure without departing from the spirit or scope of the disclosure. Thus, it is intended that the present disclosure covers the modifications and variations of this disclosure provided they come within the scope of the appended claims and their equivalents. For example, respective components specifically shown in the embodiments can be implemented in modified forms.

What is claimed is:

1. A display device, comprising:

a transparent substrate;

a conductive line on the substrate, the conductive line including at least one of a reference line or a power line;

a jumping line on the substrate electrically connected to the conductive line wherein the jumping line is formed of transparent conductive material, and

a plurality of sub pixels on the substrate, each sub pixel comprising:

a light emitting element on the substrate; and

a first thin film transistor (TFT) on the substrate, the first TFT including an active layer and a first electrode electrically connected to the active layer, wherein the first electrode includes:

a first conductive layer formed of transparent conductive material, the first conductive layer including a first portion and a second portion, and

a second conductive layer contacting the first portion of the first conductive layer,

a sensing transistor electrically connected to the light emitting element on the substrate;

wherein the second portion of the first conductive layer is disposed below the light emitting element, and does not contact the second conductive layer,

wherein the jumping line protrudes from the reference line towards each sub-pixel region of the plurality of sub pixels parallel to a scan line to connect the reference line to the sensing transistor, or the jumping line protrudes from the power line toward each sub-pixel region parallel to a scan line to connect the power line to the first TFT.

2. The display device of claim 1, wherein the pixel further comprises an insulating layer on the first electrode, wherein the insulating layer contacts a top surface of the second conductive layer, and contacts a top surface of the second portion of the first conductive layer.

3. The display device of claim 1, wherein the pixel further comprises an insulating layer on the substrate formed with an opening, and wherein the second portion of the first conductive layer is disposed in the opening.

4. The display device of claim 3, wherein the light emitting element includes an anode electrode, and the anode electrode contacts the second portion of the first conductive layer.

5. The display device of claim 3, wherein the pixel further comprises a third conductive layer below the insulating layer, wherein the third conductive layer is formed of transparent conductive material, and wherein the second portion of the first conductive layer contacts a portion of the third conductive layer exposed through the opening.

6. The display device of claim 5, wherein the pixel further comprises a storage capacitor below the light emitting element, and wherein the third conductive layer is a lower storage electrode of the storage capacitor.

7. The display device of claim 5, wherein the pixel further comprises a driving TFT for driving the light emitting element, and wherein the third conductive layer extends from at least a part of a gate electrode of the driving transistor.

8. The display device of claim 1, wherein the second conductive layer is formed of opaque metal.

9. The display device of claim 1, wherein the conductive line extends in a first direction, and wherein the jumping line extends in a second direction different from the first direction.

10. The display device of claim 9, wherein a portion of the jumping line is disposed below the light emitting element.

11. The display device of claim 9, wherein the conductive line is a power line and the first TFT is a driving transistor for driving the light emitting element, and wherein the jumping line is electrically connected to the first TFT.

12. The display device of claim 9, wherein the first TFT includes a gate electrode, and the jumping line is formed in a same layer as a part of the gate electrode.

13. A method of manufacturing a display device, comprising:

forming an active layer of a first thin film transistor (TFT) on a substrate;

forming a conductive line on the substrate, the conductive line including at least one of a reference line or a power line;

forming a jumping line on the substrate electrically connected to the conductive line, wherein the jumping line is formed of transparent conductive material,

13

forming a first conductive layer of a first electrode of the first TFT electrically connected to the active layer, wherein the first electrode includes a first conductive layer formed of transparent conductive material, and includes a second conductive layer that contacts a first portion of the first conductive layer; and forming a light emitting element electrically connected to a sensing transistor on the substrate, wherein a second portion of the first conductive layer is disposed below the light emitting element, and does not contact the second conductive layer, wherein the jumping line protrudes from the reference line toward each sub-pixel region of the plurality of sub pixels parallel to a scan line to connect the reference line to the sensing transistor, or the jumping line protrudes from the power line toward each sub-pixel region parallel to a scan line to connect the power line to the first TFT.

14. The method of claim 13, wherein forming the first electrode further comprises:

- depositing a first conductive pattern formed of the transparent conductive material on the substrate;
- depositing a second conductive pattern on the first conductive pattern;
- patterning the first conductive pattern and the second conductive pattern to form the first conductive layer and a third conductive pattern on the first conductive layer; and
- etching a part of the third conductive pattern to form the second conductive layer and expose the second portion of the first conductive layer.

15. The method of claim 13, further comprising forming an insulating layer on the first electrode, wherein the insulating layer contacts a top surface of the second conductive layer, and contacts a top surface of the second portion of the first conductive layer.

16. The method of claim 13, further comprising: forming an insulating layer on the substrate; and forming an opening in the insulating layer,

14

wherein the second portion of the first conductive layer is disposed in the opening.

17. The method of claim 16, wherein the light emitting element includes an anode electrode, and the anode electrode contacts the second portion of the first conductive layer.

18. The method of claim 13, wherein the conductive line extends in a first direction, and wherein the jumping line extends in a second direction different from the first direction.

19. The method of claim 18, wherein a portion of the jumping line is disposed below the light emitting element.

20. A display device, comprising:
 a transparent substrate;
 a conductive line on the substrate;
 a jumping line on the substrate electrically connected to the conductive line wherein the jumping line is formed of transparent conductive material, and
 a plurality of sub pixels on the substrate, each sub pixel comprising:

- a light emitting element on the substrate; and
- a first thin film transistor (TFT) on the substrate, the first TFT including an active layer and a first electrode electrically connected to the active layer, wherein the first electrode includes:
 - a first conductive layer formed of transparent conductive material, the first conductive layer including a first portion and a second portion, and
 - a second conductive layer contacting the first portion of the first conductive layer,
- a sensing transistor electrically connected to the light emitting element on the substrate;
- wherein the second portion of the first conductive layer is disposed below the light emitting element, and does not contact the second conductive layer,
- wherein the conductive line is a reference line electrically connected to the sensing transistor, and wherein the jumping line is electrically connected to the sensing transistor.

* * * * *

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摘要(译)

公开了一种用于提高开口率的有机发光显示装置及其制造方法。有机发光显示装置在每个子像素区域中包括与有机发光元件的阳极交叠的多个接触孔，其中通过至少一个接触孔连接的导电膜是透明的，因此允许在其中接触的区域。形成孔以用作发光区域，从而提高开口率。

