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(54) **ORGANIC LIGHT EMITTING DISPLAY
DEVICE AND MANUFACTURING METHOD
THEREOF**

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(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**,
Yongin-si (KR)
(72) Inventor: **Sung-hoon Kim**, Seoul (KR)
(73) Assignee: **Samsung Display Co., Ltd.**, Yongin-si
(KR)

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Primary Examiner — Tuan H Nguyen

(74) *Attorney, Agent, or Firm* — Lewis Roca Rothgerber
Christie LLP

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2227/323 (2013.01)

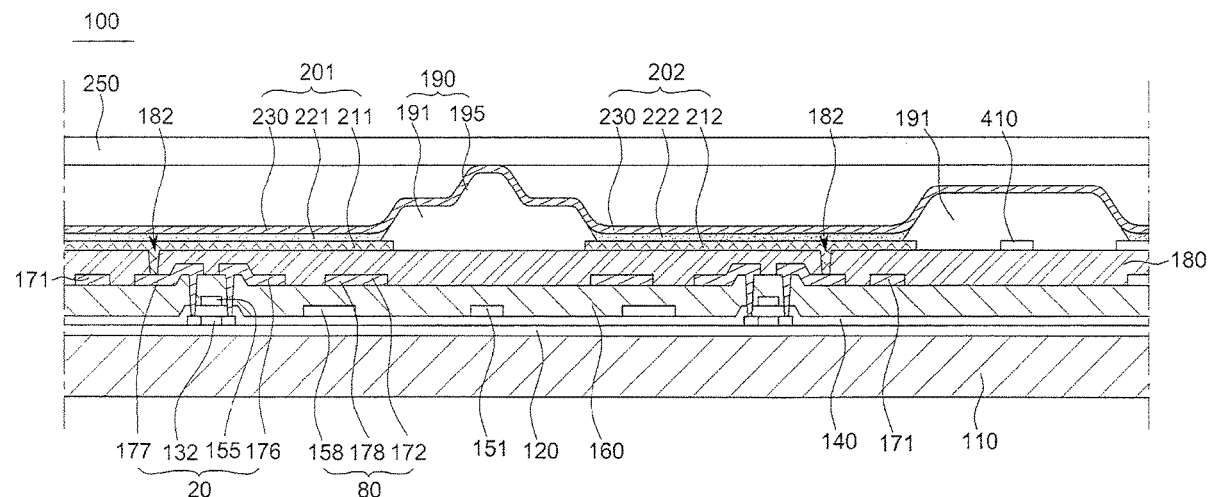
(58) **Field of Classification Search**
CPC H01L 27/3246; H01L 27/3276; H01L
27/3272; H01L 27/3258; H01L 51/525;
H01L 51/0023

See application file for complete search history.

(57) **ABSTRACT**

An organic light emitting diode display may include a substrate, a pixel defining layer on the substrate, being configured to define a pixel area, a pixel electrode on the pixel area, a light emitting layer on the pixel electrode, a common electrode on the light emitting layer, and an auxiliary wire spaced apart from the pixel electrode and disposed on the same layer as the pixel electrode. The pixel defining layer may include a pixel defining part configured to define a pixel area and a spacer protruding from the pixel defining part. The auxiliary wire may not overlap the spacer.

45 Claims, 9 Drawing Sheets



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FIG. 1

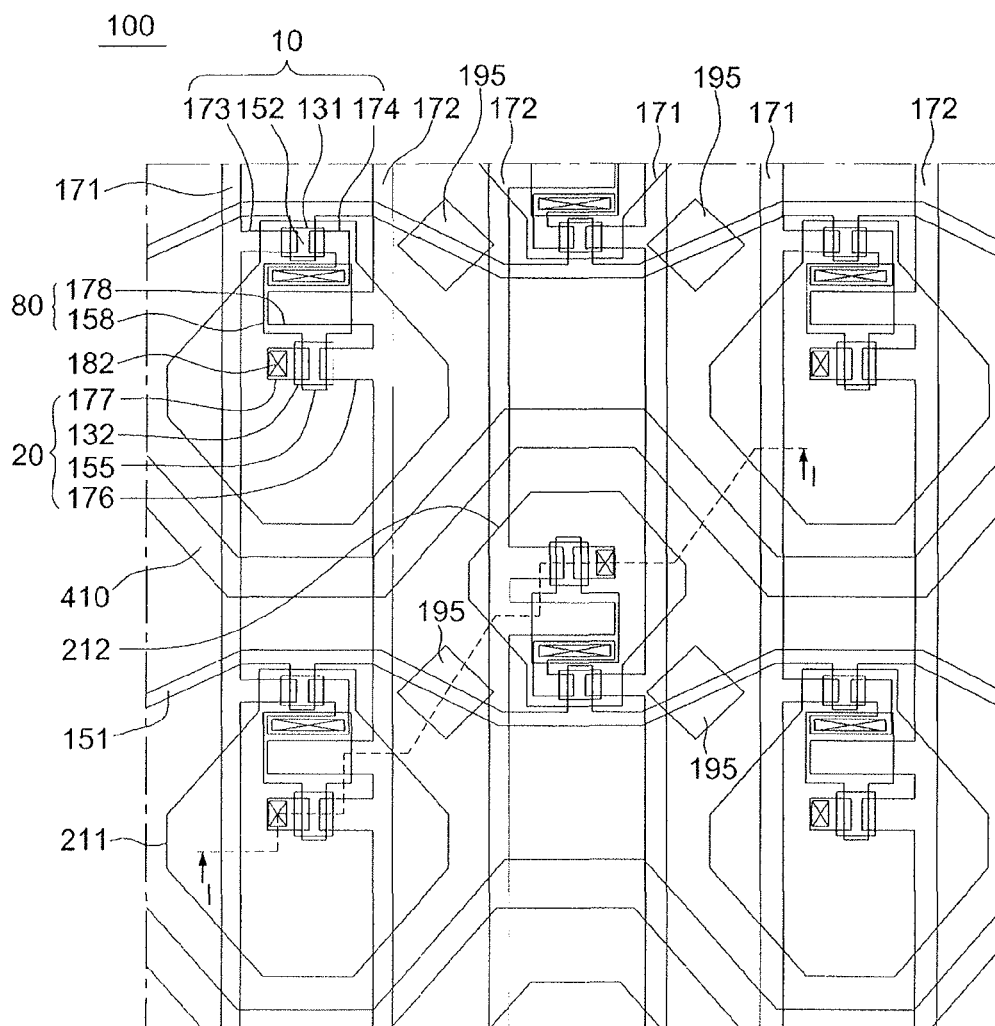


FIG. 2

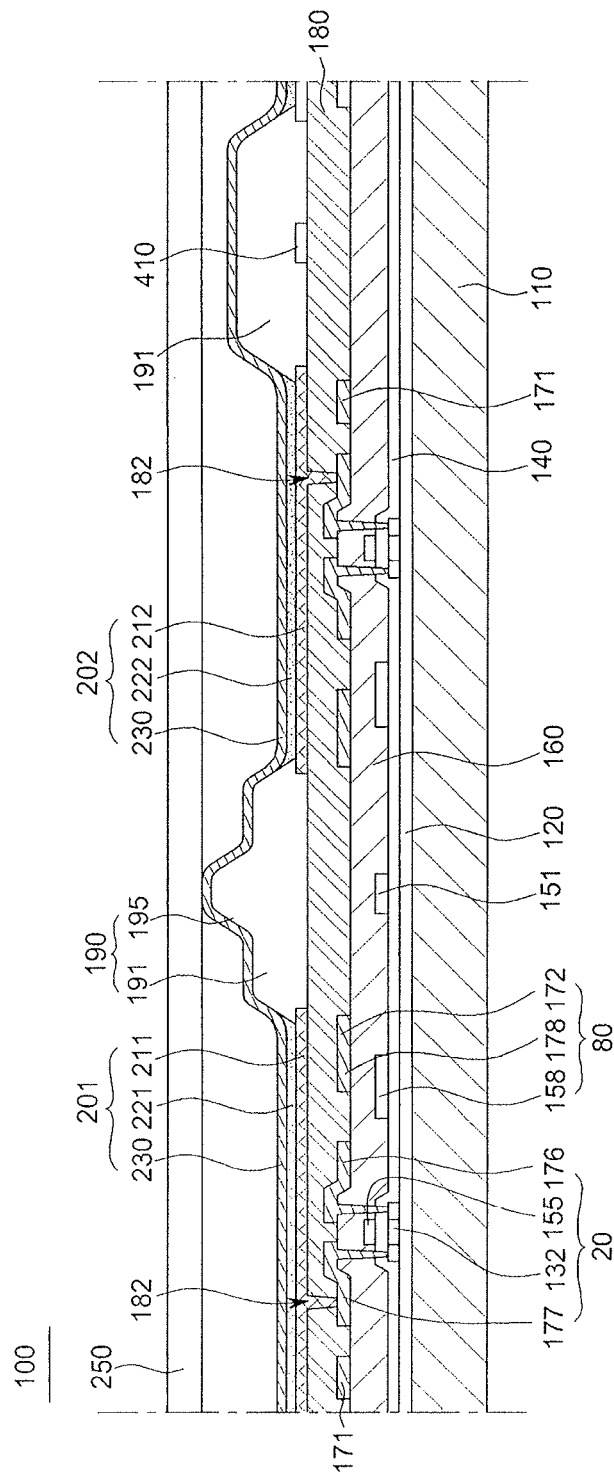


FIG. 3

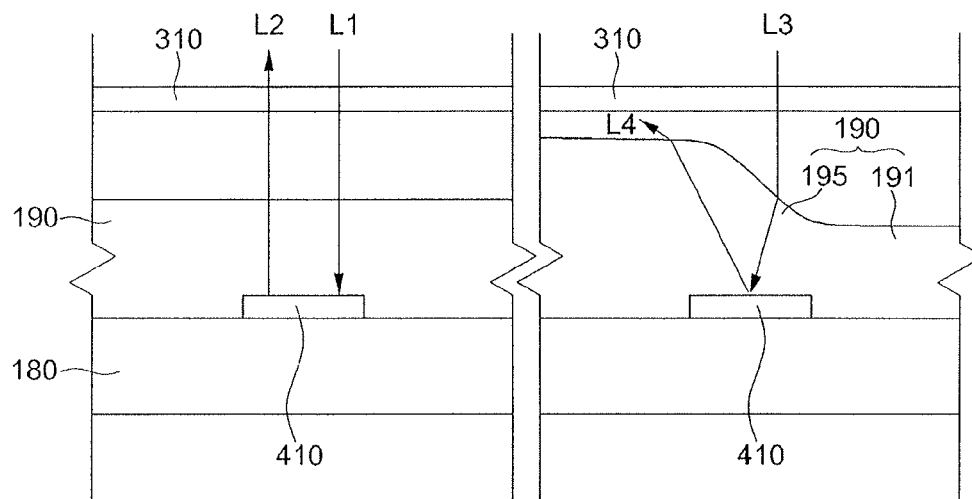


FIG. 4A

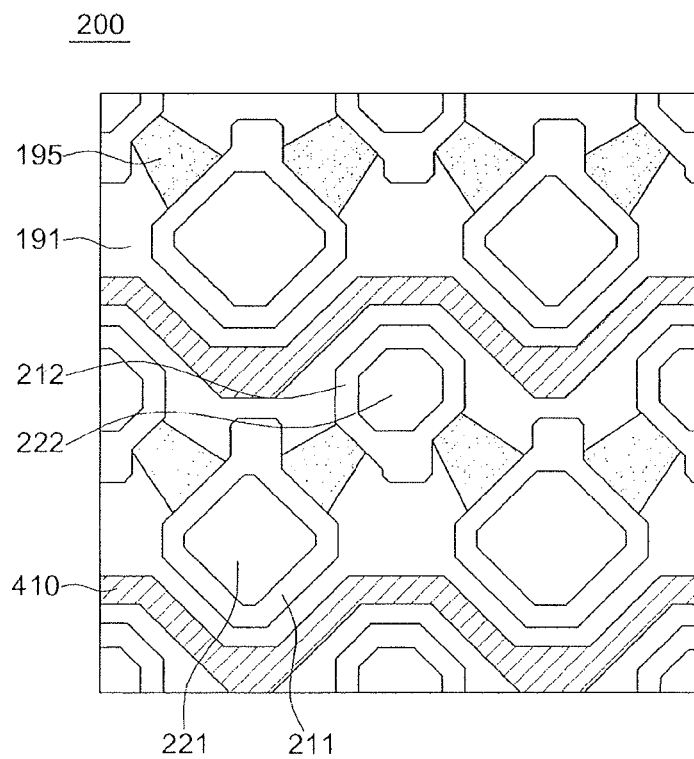


FIG. 4B

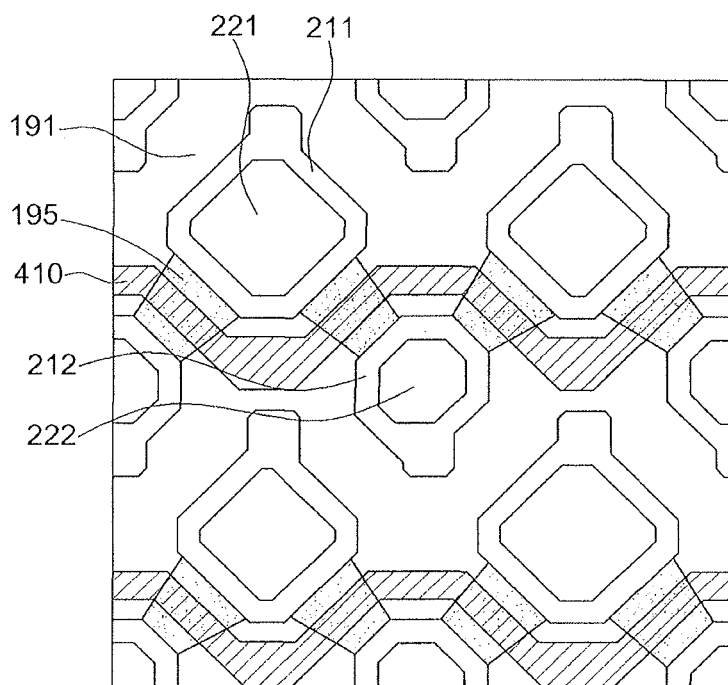


FIG. 5

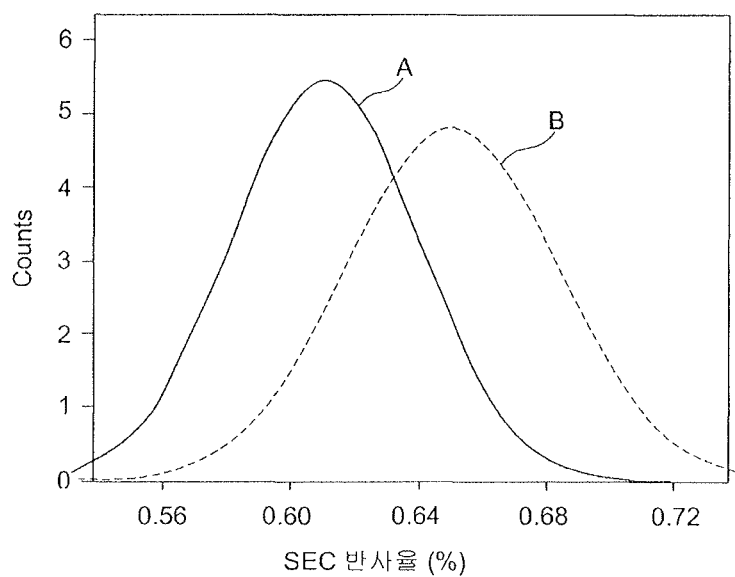


FIG. 6

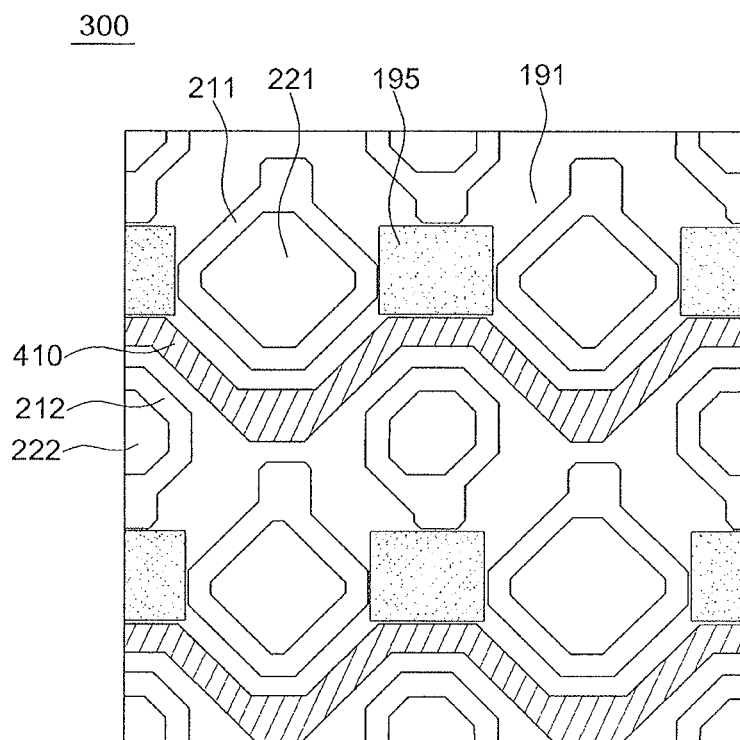


FIG. 7A

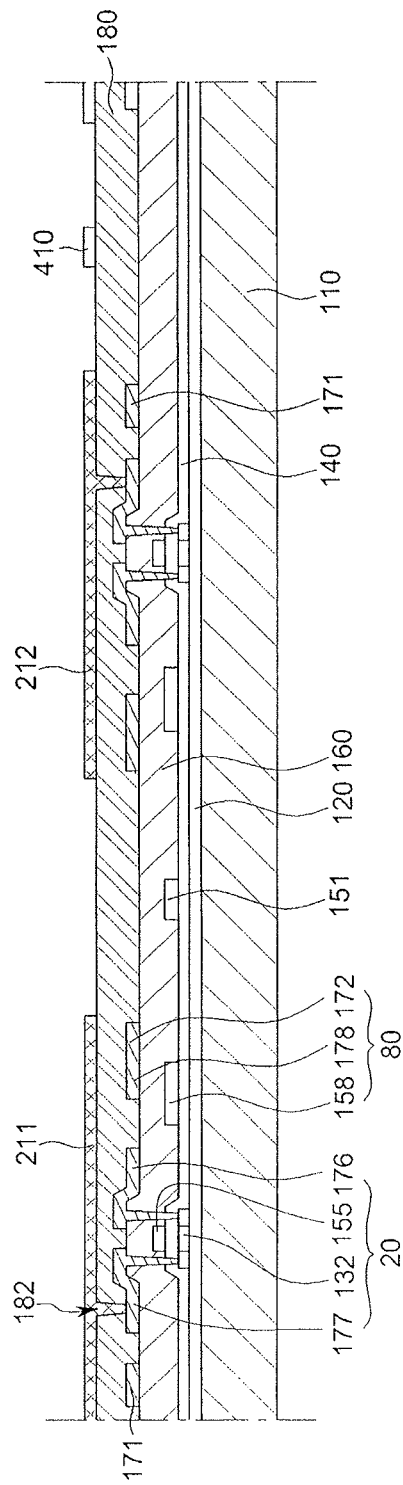


FIG. 7B

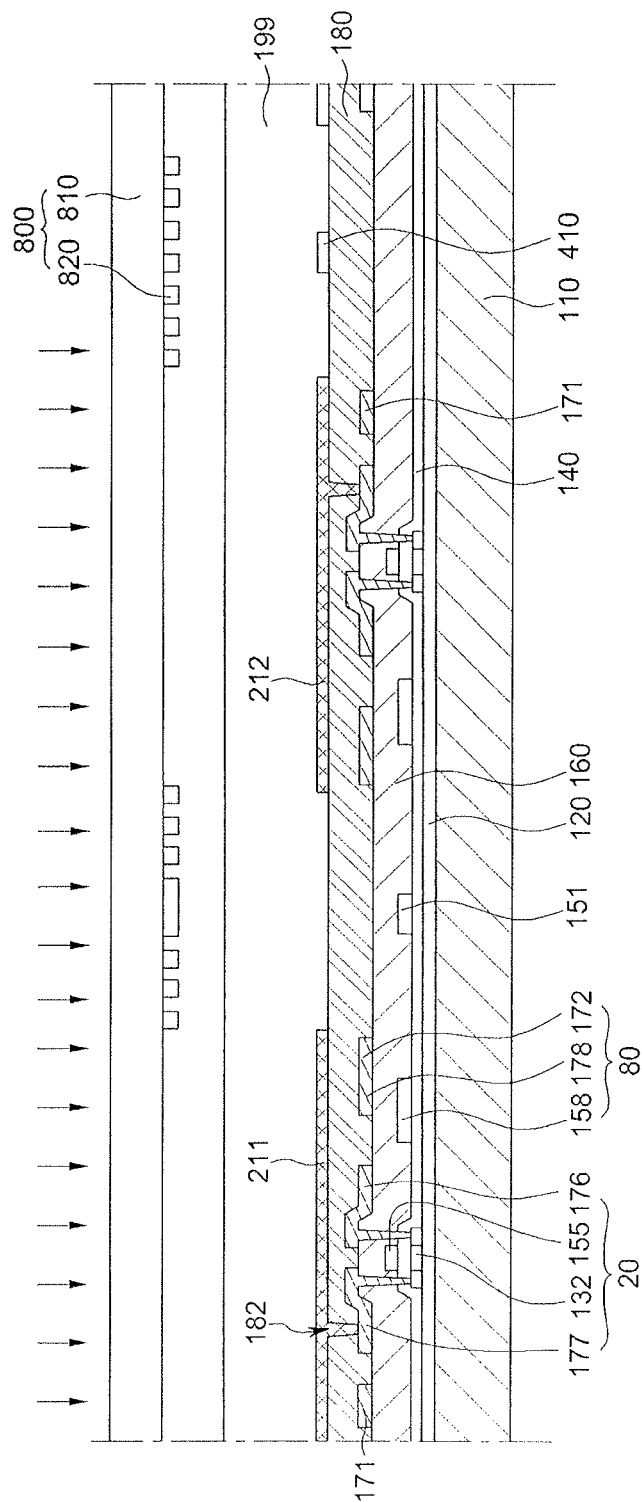


FIG. 7C

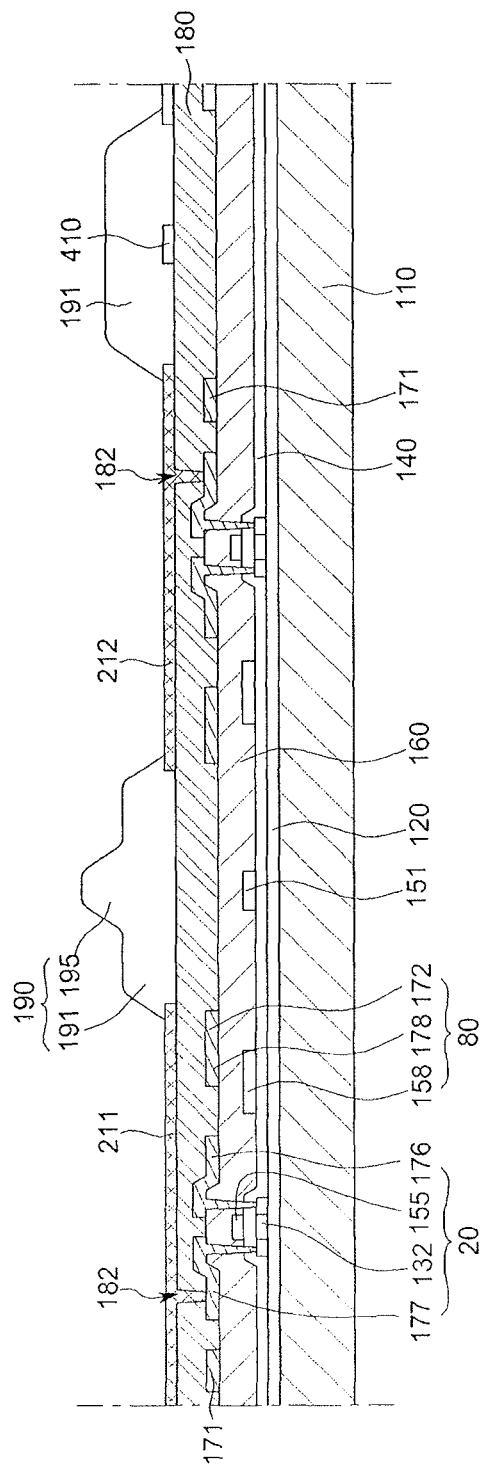
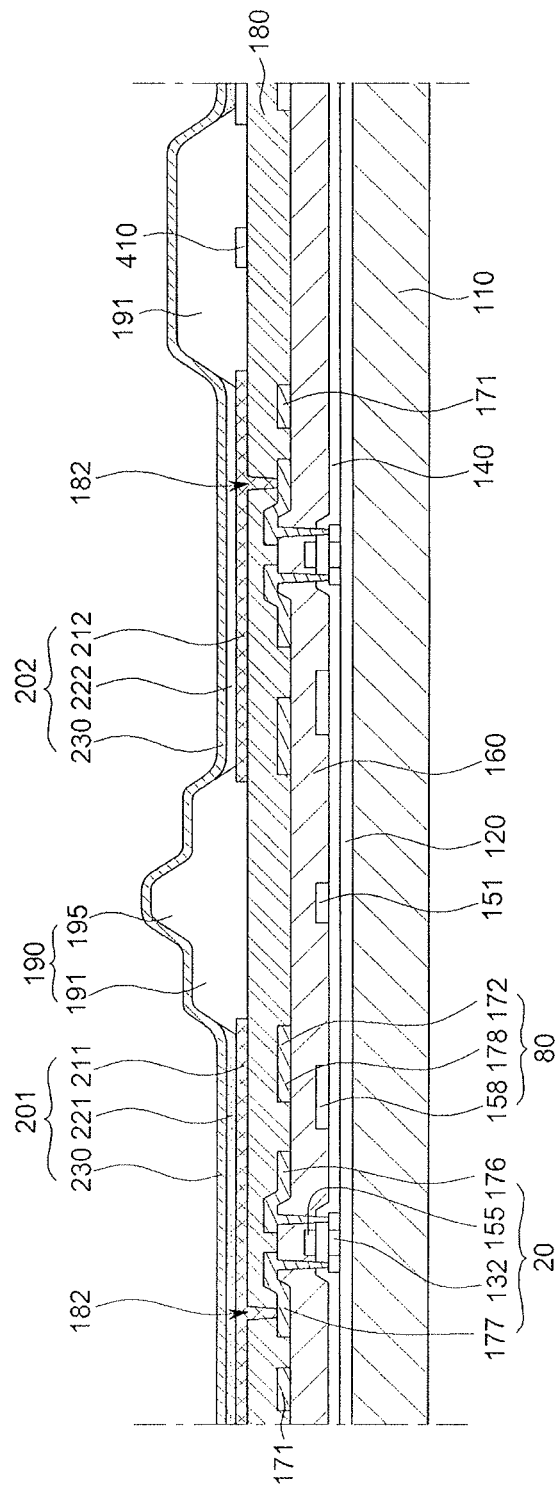


FIG. 7D



1

ORGANIC LIGHT EMITTING DISPLAY DEVICE AND MANUFACTURING METHOD THEREOF

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATION

The present patent application is a Reissue of U.S. Pat. No. 9,466,648 B2 issued Oct. 11, 2016, and which claims priority under 35 U.S.C. § 119 of Korean Patent Application No. 10-2014-0010048, filed on Jan. 28, 2014, in the Korean Intellectual Property Office, and entitled: "Organic Light Emitting Display Device And Manufacturing Method Thereof," may be incorporated by reference herein in its entirety.

BACKGROUND

1. Field

Embodiments relate to an organic light emitting diode display including a pixel defining layer with a spacer, and a manufacturing method thereof.

2. Description of Related Art

An organic light emitting diode (OLED) display may be an image display device using an organic light emitting diode (OLED). The OLED generally may include a hole injection electrode and an electron injection electrode. In the OLED, a hole injected from the hole injection electrode and an electron injected from the electron injection electrode may be combined with each other in a light emitting layer to form an exciton, and the OLED may emit light by energy generated when the exciton falls from an excited state to a ground state.

The OLED display may be a self-emission display device and may be advantageous over a liquid crystal display (LCD) in that the OLED display does not require a separate light source, and thus may have a relatively small thickness and light weight. Further, the OLED display may be receiving attention as the next generation display by virtue of characteristics such as low power consumption, high brightness, and short response time.

SUMMARY

According to exemplary embodiments, an OLED display may include a substrate; a pixel defining layer disposed on the substrate and configured to define a pixel area; a pixel electrode in the pixel area; a light emitting layer on the pixel electrode; a common electrode on the light emitting layer; and an auxiliary wire disposed on the same layer with the pixel electrode and spaced apart from the pixel electrode. The pixel defining layer may include a pixel defining part configured to define the pixel area and a spacer protruding from the pixel defining part, and the auxiliary wire may not overlap the spacer.

The auxiliary wire may be an initialization voltage wire.

The pixel electrode and the auxiliary wire may be made of the same material.

2

The auxiliary wire may include at least one metal layer and at least one transparent conductive oxide layer.

The auxiliary wire may include a metal layer on the substrate and a transparent conductive oxide layer on the metal layer.

The OLED display may further include a sealing member facing the substrate with the pixel defining layer interposed between the sealing member and the substrate, and the spacer of the pixel defining layer may maintain a space between the substrate and the sealing member.

The pixel defining part and the spacer may be made of the same material.

The spacer may have any of the following shapes: a truncated pyramid, a prism, a truncated cone, a cylinder, a hemisphere, and a hemispheroid.

The auxiliary wire may overlap the pixel defining part.

According to exemplary embodiments, a method of manufacturing an OLED display may include steps of: forming a pixel electrode and an auxiliary wire on a substrate; forming a photosensitive material layer on the pixel electrode and the auxiliary wire; forming a pixel defining layer having a pixel area that exposes a part of the pixel electrode by patterning the photosensitive material layer; forming a light emitting layer on the pixel electrode; and forming a common electrode on the light emitting layer. The pixel defining layer may include a pixel defining part configured to define the pixel area and a spacer protruding from the pixel defining part, and the auxiliary wire may not overlap the spacer.

A mask having a light shielding pattern (i.e. a light blocking pattern) may be used in the forming of the pixel defining layer.

A halftone exposure may be performed in the forming of the pixel defining layer.

The method may further include arranging a sealing member to face the substrate with the pixel defining layer interposed between the sealing member and the substrate, and the spacer of the pixel defining layer may maintain a space between the substrate and the sealing member.

The spacer may have any one of the following shapes: a truncated pyramid, a prism, a truncated cone, a cylinder, a hemisphere, and a hemispheroid.

The forming of the pixel defining layer and the auxiliary wire may include forming a conductive material layer including at least one metal layer and at least one transparent conductive oxide layer on the substrate; and patterning the conductive material layer.

The foregoing summary may be illustrative only and may be not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Features will become apparent to those of ordinary skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. 1 illustrates a layout view showing an OLED display according to a first embodiment;

FIG. 2 illustrates a cross-sectional view taken along line I-I' of FIG. 1;

FIG. 3 illustrates a mimetic diagram of a path of ambient light incident on an auxiliary wire;

FIG. 4A illustrates a plan view showing an OLED display according to a second embodiment, and FIG. 4B illustrates a plan view showing an OLED display according to a comparative example;

FIG. 5 illustrates a graph comparing reflectivities of the OLED displays of FIGS. 4A and 4B;

FIG. 6 illustrates a layout view showing an OLED display according to a third embodiment; and

FIGS. 7A to 7D illustrate cross-sectional views sequentially showing a manufacturing process of the OLED display of FIG. 1.

DETAILED DESCRIPTION

Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

The accompanying drawings are selected to illustrate exemplary embodiments. In the drawings, respective elements and shapes may be simplified or exaggerated to better illustrate the exemplary embodiments, and other elements present in an actual product may be omitted from the drawings. Thus, the drawings are intended to facilitate the understanding of the exemplary embodiments. Like reference numerals refer to like elements throughout the specification.

Throughout the specification, when an element may be referred to as being "connected" to another element, the element may be "directly connected" to the other element, or "electrically connected" to the other element with one or more intervening elements interposed therebetween. It will be further understood that the terms "comprises," "comprising," "includes" and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

In addition, when a layer or element may be referred to as being "on" another layer or element, the layer or element may be directly on the other layer or element, or one or more intervening layers or elements may be interposed therebetween.

Hereinafter, a first embodiment will be described with reference to FIGS. 1 and 2.

As illustrated in FIGS. 1 and 2, an OLED display 100 according to a first embodiment may have a plurality of pixels that include a switching thin film transistor (TFT) 10, a driving TFT 20, a capacitor 80 and OLEDs 201 and 202. Herein, the pixel is the smallest unit that displays an image, and the OLED display may display an image through the plurality of pixels.

Referring to FIG. 1, two TFTs and one capacitor may be included in one pixel; however, the first embodiment may be not limited thereto. Thus, the OLED display may include three or more TFTs and two or more capacitors in one pixel, or may be configured to have various structures by further including separate wires.

The OLED display 100 may include a gate line 151 on a substrate 110, and a data line 171 and a common power source line 172 that may be insulated from and intersect the gate line 151. A pixel area may be defined by the gate line

151, the data line 171, and the common power source line 172, but it may be not limited thereto. The pixel area may also be defined by a black matrix or a pixel defining layer.

The substrate 110 may be made of an insulating material including glass, quartz, ceramic, or plastic. However, the first embodiment may be not limited thereto. Therefore, the substrate 110 may also be made of a metal material such as stainless steel.

A buffer layer 120 may be disposed on the substrate 110. The buffer layer 120 may reduce or prevent penetration of undesirable elements and planarize a surface, and may include various materials in accordance therewith. For instance, the buffer layer 120 may include at least one of the following: a silicon nitride (SiNx) layer, a silicon oxide (SiO₂) layer, and a silicon oxynitride (SiO_xN_y) layer. However, the buffer layer 120 may be omitted according to the kind of the substrate 110 and process conditions thereof.

A switching semiconductor layer 131 and a driving semiconductor layer 132 may be disposed on the buffer layer 120. The switching semiconductor layer 131 and the driving semiconductor layer 132 may be made of a polycrystalline silicon layer, an amorphous silicon layer, or an oxide semiconductor.

A gate insulating layer 140 made of silicon nitride (SiNx) or silicon oxide (SiO₂) may be disposed on the switching semiconductor layer 131 and the driving semiconductor layer 132. A gate wire including a driving gate electrode 155 may be disposed on the gate insulating layer 140. The gate wire further may include a gate line 151, a first capacitor plate 158, and other wires. Further, a switching gate electrode 152 may be disposed to overlap at least a part of the switching semiconductor layer 131, and the driving gate electrode 155 may be disposed to overlap at least a part of the driving semiconductor layer 132.

An interlayer insulating layer 160 configured to cover the driving gate electrode 155 may be disposed on the gate insulating layer 140. The gate insulating layer 140 and the interlayer insulating layer 160 may have in common a via hole (through hole) exposing a source region and a drain region of the switching and driving semiconductor layers 131 and 132. The interlayer insulating layer 160 may be made of silicon nitride (SiNx) or silicon oxide (SiO₂) in the same manner as the gate insulating layer 140.

A data wire may be disposed on the interlayer insulating layer 160, wherein the data wire includes a switching source electrode 173, a switching drain electrode 174, a driving source electrode 176, and a driving drain electrode 177. The data wire further may include the data line 171, the common power source line 172, a second capacitor plate 178, and other wires. Further, the switching source electrode 173, the switching drain electrode 174, the driving source electrode 176, and the driving drain electrode 177 may each be connected to the source region and the drain region of the switching semiconductor layer 131 and the driving semiconductor layer 132.

As described above, the switching TFT 10 may include the switching semiconductor layer 131, the switching gate electrode 152, the switching source electrode 173, and the switching drain electrode 174, and the driving TFT 20 may include the driving semiconductor layer 132, the driving gate electrode 155, the driving source electrode 176, and the driving drain electrode 177. The configuration of the TFTs 10 and 20 may be not limited to the above-described embodiment, and may vary based on many different configurations which are known to and can be easily carried out by those skilled in the art.

The capacitor **80** may include the first capacitor plate **158** and the second capacitor plate **178** with the gate insulating layer **140** interposed therebetween.

The switching TFT **10** may be used as a switching element configured to select a pixel for emitting light. The switching gate electrode **152** may be connected to the gate line **151**. The switching source electrode **173** may be connected to the data line **171**. The switching drain electrode **174** may be spaced apart from the switching source electrode **173** and may be connected to the first capacitor plate **158**.

The driving TFT **20** may apply driving power to the pixel electrodes **211** and **212** so that the light emitting layers **221** and **222** of the OLEDs **201** and **202** in the selected pixel emit light. The driving gate electrode **155** may be connected to the first capacitor plate **158**. The driving source electrode **176** and the second capacitor plate **178** may each be connected to the common power source line **172**. The driving drain electrode **177** may be connected to the pixel electrodes **211** and **212** of the OLEDs **201** and **202** through a contact hole **182**.

With the above-described structure, the switching TFT **10** may be driven by a gate voltage applied to the gate line **151** to transmit a data voltage applied to the data line **171** to the driving TFT **20**. A voltage equivalent to a difference between a common voltage applied from the common power source line **172** to the driving TFT **20** and the data voltage transmitted from the switching TFT **10** may be stored in the capacitor **80**, and a current corresponding to the voltage stored in the capacitor **80** may flow to the OLEDs **201** and **202** through the driving TFT **20**, so that the OLEDs **201** and **202** may emit light.

A planarization layer **180** configured to cover the data wires **171**, **172**, **173**, **174**, **176**, **177**, and **178** may be disposed on the interlayer insulating layer **160**. The planarization layer **180** may be configured to planarize a surface of the OLEDs **201** and **202** by eliminating or reducing steps so as to increase luminous efficiency of the OLEDs **201** and **202** that will be disposed on the planarization layer.

Further, the planarization layer **180** may have a contact hole **182** that may expose a part of the driving drain electrode **177**.

The planarization layer **180** may be made of at least one of the following materials: polyacrylate resin, epoxy resin, phenolic resin, polyamide resin, polyimide resin, unsaturated polyesters resin, polyphenylenethers resin, polyphenylenesulfides resin, and benzocyclobutene (BCB).

The pixel electrodes **211** and **212** of the OLEDs **201** and **202** may be disposed on the planarization layer **180**. The pixel electrodes **211** and **212** may be connected to the driving drain electrode **177** through the contact hole **182** of the planarization layer **180**. The pixel electrodes **211** and **212** may be any one of the following types: a transmissive type, a translucent type, and a reflective type.

A transmissive electrode may be made of transparent conductive oxide (TCO) such as indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), or indium oxide (In₂O₃).

A translucent or reflective electrode may be made of a metal such as magnesium (Mg), silver (Ag), gold (Au), calcium (Ca), lithium (Li), chromium (Cr), aluminum (Al), and copper (Cu), or a metal alloy thereof. In this case, whether an electrode may be a reflective type or a translucent type may depend on the thickness of the electrode. Generally, the translucent electrode may have a thickness of about 200 nm or less, and the reflective electrode have a thickness of about 300 nm or more. As the thickness of the

translucent electrode decreases, the transmittance of light and the resistance may increase. Conversely, as the thickness of the translucent electrode increases, the transmittance of light may decrease.

Further, the translucent and reflective electrodes may have a multilayer structure including a metal layer made of a metal or a metal alloy and a transparent conductive oxide layer laminated on the metal layer.

The OLED display **100** may be classified into the following types: a top emission type, a bottom emission type, and a dual emission type, depending on the materials used to form the pixel electrodes **211** and **212** and the common electrode **230**. The OLED display **100** according to the first embodiment may be classified as a top emission type. Thus, the OLEDs **201** and **202** may emit light in the direction of the common electrode **230** to display an image.

In the case of the top emission OLED display, the pixel electrodes **211** and **212** may be a reflective electrode in order to increase emission efficiency of light generated in the OLEDs **201** and **202**. An example of such a reflective electrode includes an electrode in which a transparent conductive oxide made of ITO may be laminated on a metal layer made of silver (Ag). In addition, an electrode having a triple-layered structure in which the silver (Ag) layer, the ITO layer, and the silver (Ag) layer is sequentially laminated, may be used.

According to the first embodiment, the OLED display **100** may include an auxiliary wire **410** spaced apart from the pixel electrodes **211** and **212** and disposed on the planarization layer **180**.

The auxiliary wire **410** may be an initialization voltage wire, Vint, for example. The initialization voltage wire may supply an initialization voltage that initializes the driving TFT **20**. The initialization voltage wire may be used for the OLEDs **201** and **202** to discharge electric charges or for the OLEDs **201** and **202** to have the same potential as each other after being driven. Although not illustrated, the OLEDs **201** and **202** and the auxiliary wire **410** may be connected by a thin film transistor. However, the auxiliary wire **410** according to the first embodiment may be not limited to the initialization voltage wire Vint, and may be other wires. The auxiliary wire **410** may be a signal wire (line) or may be a bypass wire (line) allowing a leakage current to flow.

The auxiliary wire **410** may be disposed on the same layer as the pixel electrodes **211** and **212**. The auxiliary wire **410** may be manufactured by the same manufacturing process, may be made of the same material, and may have the same laminated structure as the pixel electrodes **211** and **212**. In other words, the pixel electrodes **211** and **212** and the auxiliary wire **410** may be formed together at a time. Therefore, the auxiliary wire **410** may also include at least one metal layer and at least one transparent conductive oxide layer. That is, the auxiliary wire **410** may include the metal layer on the planarization layer **180** on the substrate **110** and the transparent conductive oxide layer on the metal layer.

A pixel defining layer **190** may be disposed on the planarization layer **180**. The pixel defining layer **190** may include a pixel defining part **191** configured to define a pixel area by exposing the pixel electrodes **211** and **212**, and a plurality of spacers **195** protruding from an upper portion of the pixel defining part **191**, namely in the opposite direction of the planarization layer **180**. In this case, the pixel electrodes **211** and **212** may be disposed to correspond to an opening that is the pixel area of the pixel defining part **191**.

In detail, the pixel defining layer **190** may be made of polyacrylate resin, polyimide resin, and the like.

The pixel defining part **191** and the spacer **195** of the pixel defining layer **190** may be integrated with each other using a photosensitive material through photolithography. In other words, the pixel defining part **191** and the spacer **195** may be made of the same material. In detail, the pixel defining part **191** and the spacer **195** may be formed together by adjusting exposure dose by a halftone exposure process. However, the first embodiment is not limited thereto. Therefore, the pixel defining part **191** and the spacer **195** may be formed sequentially or separately, and each may be made of different materials.

The spacer **195** may be disposed on a space between the pixel electrodes **211** and **212**, and may have any one of the following shapes: a truncated pyramid, a prism, a truncated cone, a cylinder, a hemisphere, and a hemispheroid.

According to the first embodiment, the pixel electrodes **211** and **212** may be a reflective electrode, and thus the auxiliary wire **410** may also be a reflective electrode. Therefore, the auxiliary wire **410** may reflect ambient light.

The reflection of ambient light from the auxiliary wire **410** will be described below with reference to FIG. 3.

The pixel defining layer **190** may also be disposed on the auxiliary wire **410** as well as on the planarization layer **180**, except for the pixel area where the pixel electrodes **211** and **212** are placed. In the case where the pixel defining layer **190** on the auxiliary wire **410** is flat, ambient light **L1** incident on the auxiliary wire **410** may be reflected as typical reflected light **L2**. Therefore, in the case where a polarizer for blocking ambient light is disposed on the upper portion of the pixel defining layer **190**, the ambient light **L1** may be blocked by the polarizer.

On the other hand, as illustrated in the right side of FIG. 3, if there are an inclined surface formed by the spacer **195** on the upper portion of the auxiliary wire **410**, even when ambient light **L3** may be incident perpendicularly, the incident light **L3** may be refracted when passing through the inclined surface, and thus light **L4** which has been reflected from the auxiliary wire **410** may take a different path than the incident light **L3**. In this case, even though a polarizer **310** is disposed, destructive interference between the incident light **L3** and the reflected light **L4** may not or may not substantially occur.

Further, the polarization state of the ambient light **L3** may be changed after passing through the inclined surface. In detail, in the case where the polarizer **310** having circular polarization properties (circular polarizer) is disposed on the upper portion of the pixel defining layer **190**, the ambient light **L3** which has reached the auxiliary wire **410** by passing through the polarizer **310** and the inclined surface of the pixel defining layer **190** may be reflected in an elliptical polarization state. Destructive interference between the elliptically polarized reflected light **L4** and the circularly polarized incident light **L3** may not occur or may not or may not substantially occur.

Thus, in the case where the spacer **195** is disposed on the reflective auxiliary wire **410**, reflected light which is not subject to destructive interference may increase so that visibility of the OLED display **100** may be lowered.

The patterned spacer **195** is illustrated in FIG. 2, but a pixel defining layer-forming material may be reflowed in a heat curing process after the pixel defining layer **190** is formed so that the shape of the spacer **195** of the pixel defining layer **190** may be distorted. Accordingly, changes in a path of the ambient light and polarization may become larger on the inclined surface of the spacer **195**.

Thus, in order to reduce or prevent ambient light incident on the inclined surface of the spacer **195** from being

reflected from the auxiliary wire **410**, the spacer **195** of the pixel defining layer **190** according to the first embodiment may not overlap the auxiliary wire **410**. In other words, the spacer **195** may not be disposed on the upper portion of the auxiliary wire **410**.

The light emitting layers **221** and **222** may be disposed on the pixel electrodes **211** and **212** in the opening of the pixel defining part **191**. The common electrode **230** may be disposed on the pixel defining layer **190** and the light emitting layers **221** and **222**.

The light emitting layers **221** and **222** may include a low molecular weight organic material or a high molecular weight organic material. At least one of a hole injection layer HIL and a hole transporting layer HTL may be further disposed between the pixel electrodes **211** and **212** and the light emitting layers **221** and **222**. At least one of an electron transporting layer ETL and an electron injection layer EIL may be further disposed between the light emitting layers **221** and **222** and the common electrode **230**.

The common electrode **230** may be made of a translucent layer. The translucent layer used as the common electrode **230** may be made of at least one metal including magnesium (Mg), silver (Ag), calcium (Ca), lithium (Li), chromium (Cr), aluminum (Al) and copper (Cu). The common electrode **230** may have a multilayer structure including a metal layer including at least one of magnesium (Mg), silver (Ag), calcium (Ca), lithium (Li), chromium (Cr), aluminum (Al) and copper (Cu), and a transparent conductive oxide (TCO) layer laminated on the metal layer.

As described above, the OLEDs **201** and **202** may include the pixel electrodes **211** and **212**, the light emitting layers **221** and **222** on the pixel electrodes **211** and **212**, and the common electrode **230** on the light emitting layers **221** and **222**. Herein, the pixel electrodes **211** and **212** may serve as an anode which may be a hole injection electrode, and the common electrode **230** may serve as a cathode which may be an electron injection electrode. However, the first embodiment is not limited thereto, and thus, the pixel electrodes **211** and **212** may be cathodes, and the common electrode **230** may be an anode according to a driving method of the OLED display **100**.

The OLED display **100** as illustrated in FIG. 2 may further include the pixel defining layer **190** and a sealing member **250**.

The sealing member **250** may be bonded to the substrate **110** so as to seal the OLEDs **201** and **202** interposed therebetween. The sealing member **250** may seal and cover the TFTs **10** and **20** and the OLEDs **201** and **202** on the substrate **110** for protection. An insulating substrate made of glass or plastic may be used for the sealing member **250**.

The spacer **195** of the pixel defining layer **190** may serve to maintain a space between the substrate **110** and the sealing member **250**.

A polarizer may be disposed on the sealing member **250**.

The following comparison is provided in order to highlight characteristics of one or more embodiments, but it will be understood that the example and comparative example are not to be construed as limiting the scope of the embodiments, nor is the comparative example to be construed as being outside the scope of the embodiments. Further, it will be understood that the embodiments are not limited to the particular details described in the examples and comparative example.

FIGS. 4A and 4B illustrate layout views showing an OLED display for comparison of reflectivities depending on the position of the spacer **195**. FIGS. 4A and 4B illustrate only the pixel electrodes **211** and **212**, light emitting layers

221 and 222, the spacer 195 and the auxiliary wire 410. In detail, FIG. 4A is a plan view showing an OLED display 200 according to a second embodiment, and FIG. 4B is a plan view showing an OLED display according to a comparative example.

All elements of the OLED display 200 of FIG. 4A and the OLED display of FIG. 4B may be the same except for the position of the spacer 195. That is, the spacer 195 of FIG. 4A does not overlap the auxiliary wire 410, and the spacer 195 of FIG. 4B overlaps the auxiliary wire 410.

FIG. 5 illustrates a graph comparing reflectivities between the OLED displays of FIGS. 4A and 4B. The reflectance of specular component excluded (SCE) may be measured. SCE reflectance may be obtained by only measuring diffuse reflection excluding specular reflection. When humans perceive an object, the diffuse reflection may only be perceived except for the specular reflection, and thus the SCE reflectance may be measured.

Distributions of reflectance values are shown in the graph of FIG. 5 based on measurement of reflectance at a plurality of times using the OLED displays of FIGS. 4A and 4B. Referring to FIG. 5, the OLED display A of FIG. 4A has an average reflectance of 0.61%, and the OLED display B of FIG. 4B has an average reflectance of 0.65%. Thus, compared to the OLED display of the comparative example B, the OLED display 200 according to the second embodiment A has reflectance reduced by 6.15%.

FIG. 6 illustrates a layout view showing an OLED display 300 according to a third embodiment. The spacer 195 of the OLED display 300 of FIG. 6 does not overlap the auxiliary wire 410 unlike the OLED displays 100 and 200 of FIG. 4B.

Hereinafter, a method of manufacturing the OLED display 100 according to the first embodiment will be described with reference to FIGS. 7A to 7D.

As illustrated in FIG. 7A, the TFT 20, the capacitor 80, and the pixel electrodes 211 and 212 connected to the drain electrode 177 of the TFT 20 may be formed on the substrate 110. In this case, the auxiliary wire 410 may be disposed between the pixel electrodes 211 and 212. The auxiliary wire 410 may be disposed on the same layer as the pixel electrodes 211 and 212. That is, the pixel electrodes 211 and 212 and the auxiliary wire 410 may be disposed on the planarization layer 180.

A forming of the pixel electrodes 211 and 212 and the auxiliary wire 410 may include forming a conductive material layer including at least one metal layer and at least one transparent conductive oxide layer on the planarization layer 180 on the substrate 110, and patterning the conductive material layer. The patterning of the conductive material layer may be performed by a photolithography process.

Next, a photosensitive material may be coated on the pixel electrodes 211 and 212 and the auxiliary wire 410 to form a photosensitive material layer 199, and the photolithography process may be performed using a mask 800 (FIG. 7B).

The mask 800 may include a mask substrate 810 and a light shielding pattern 820 on the mask substrate 810. The photolithography process may include a halftone exposure in which a slit patterned mask 800 may be used. An exposed part in the photosensitive material layer 199 may be removed from the photosensitive material layer 199 in a developing process, and a non-exposed part may remain after the developing process. In this case, the exposed part may remain and the non-exposed part may be removed depending on the kind of the photosensitive material layer 199.

In this case, the light shielding pattern 820 may be configured such that the spacer 195 may not be formed on

the auxiliary wire 410 but may be formed on a region where the auxiliary wire 410 is not disposed. The pixel defining part 195 may be disposed only on the auxiliary wire 410.

Next, as illustrated in FIG. 7C, the pixel defining layer 190 including the pixel defining part 191 and the spacer 195 may be formed through the developing process. Further, a curing process may be performed after the developing process so that the pixel defining layer 190 becomes stable. For the curing, heat may be applied to the pixel defining layer 190, or light may be irradiated thereto in some cases. In the heat curing process, a material forming the pixel defining layer 190 may partially flow down so that the spacer 195 may have a gradual slope.

Next, as illustrated in FIG. 7D, the light emitting layers 221 and 222 may be formed on the pixel electrodes 211 and 212 exposed through the opening of the pixel defining part 191, and the common electrode 230 may be formed on the light emitting layers 221 and 222 and the pixel defining layer 190.

Herein, the common electrode 230 may be a translucent layer including at least one metal of magnesium (Mg), silver (Ag), calcium (Ca), lithium (Li), chromium (Cr), and aluminum (Al).

Next, the sealing member 250 may be disposed on the common electrode 230 to form the OLED display 100 as illustrated in FIG. 2. In this case, the spacer 195 of the pixel defining layer 190 may maintain a space between the substrate 110 and the sealing member 250.

According to the above described method, an OLED display 100 in which visibility may be improved by suppressing reflection of ambient light may be manufactured.

By way of summation and review, electrodes and wires disposed on an OLED display may reflect ambient light. Due to the ambient light reflection, the OLED display may have difficulty in accurately displaying black color and may have a low contrast, thereby exhibiting poor display characteristics.

In contrast, in the embodiments disclosed herein, an OLED display is provided with improved visibility by limiting ambient light reflection. In particular, according to exemplary embodiments, an OLED display may include a spacer provided in a pixel defining layer and an auxiliary wire on the same layer as a pixel electrode, and the auxiliary wire may be disposed not to overlap the spacer. Accordingly, ambient light reflection occurring in the auxiliary wire may be reduced so that visibility of the OLED display may be improved.

Further, exemplary embodiments are directed to a method of manufacturing the OLED display.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

What is claimed is:

1. An organic light emitting diode display, comprising:
a substrate;
a plurality of pixel electrodes on the substrate;

11

a pixel defining layer on the substrate[, the pixel defining layer defining pixel areas];

[a pixel electrode on each pixel area;]

a light emitting layer on [the] a pixel electrode from among the plurality of pixel electrodes;

a common electrode on the light emitting layer; and an auxiliary wire spaced apart from the pixel electrode and on a same layer as the pixel electrode,

wherein:

the pixel defining layer includes a pixel defining part [defining the pixel areas] and a plurality of spacers protruding from the pixel defining part,

the auxiliary wire does not overlap the [spacer] plurality of spacers, [and]

the plurality of spacers are discontinuously arranged [in a region between the pixel areas] on the pixel defining part between some of the plurality of pixel electrodes in a plan view, and

the auxiliary wire extends between some adjacent pixel electrodes from among the plurality of pixel electrodes.

2. The organic light emitting diode display as claimed in claim 1, wherein the auxiliary wire is an initialization voltage wire.

3. The organic light emitting diode display as claimed in claim 1, wherein the pixel electrode and the auxiliary wire are made of a same material.

4. The organic light emitting diode display as claimed in claim 3, wherein the auxiliary wire comprises at least one metal layer and at least one transparent conductive oxide layer.

5. The organic light emitting diode display as claimed in claim 3, wherein the auxiliary wire comprises a metal layer on the substrate and a transparent conductive oxide layer on the metal layer.

6. The organic light emitting diode display as claimed in claim 1, further comprising a sealing member facing the substrate,

wherein:

the pixel defining layer is between the sealing member and the substrate, and

the [spacer] plurality of spacers of the pixel defining layer maintains a space between the substrate and the sealing member.

7. The organic light emitting diode display as claimed in claim 1, wherein the pixel defining part and the [spacer] plurality of spacers are made of a same material.

8. The organic light emitting diode display as claimed in claim 1, wherein the [spacer has] plurality of spacers have any one of the following shapes: a truncated pyramid, a prism, a truncated cone, a cylinder, a hemisphere, and a hemispheroid.

9. The organic light emitting diode display as claimed in claim 1, wherein the auxiliary wire overlaps the pixel defining part.

10. A method of manufacturing an organic light emitting diode display, the method comprising:

forming a plurality of pixel [electrode] electrodes and an auxiliary wire on a substrate;

forming a photosensitive material layer on the plurality of pixel [electrode] electrodes and the auxiliary wire;

forming a pixel defining layer including [pixel areas] a pixel area that [expose] exposes a part of [the] a pixel electrode from among the plurality of pixel electrodes by patterning the photosensitive material layer;

forming a light emitting layer on the pixel electrode; and forming a common electrode on the light emitting layer,

12

wherein:

the pixel defining layer includes a pixel defining part defining [the] pixel areas and a plurality of spacers protruding from the pixel defining part,

the auxiliary wire does not overlap the [spacer] plurality of spacers, [and]

the plurality of spacers are discontinuously arranged in a region between the pixel areas, and

at least a portion of the auxiliary wire is disposed between some adjacent pixel electrodes from among the plurality of pixel electrodes.

11. The method as claimed in claim 10, wherein forming the pixel defining layer includes using a mask including a light shielding pattern.

12. The method as claimed in claim 10, wherein forming the pixel defining layer includes performing a halftone exposure.

13. The method as claimed in claim 10, further comprising arranging a sealing member to face the substrate, wherein:

the pixel defining layer is formed between the sealing member and the substrate, and

the [spacer] plurality of spacers of the pixel defining layer maintains a space between the substrate and the sealing member.

14. The method as claimed in claim 10, wherein the [spacer has] plurality of spacers have any one of the following shapes: a truncated pyramid, a prism, a truncated cone, a cylinder, a hemisphere, and a hemispheroid.

15. The method as claimed in claim 10, wherein the forming of the pixel electrode and the auxiliary wire comprises:

forming a conductive material layer comprising at least one metal layer and at least one transparent conductive oxide layer on the substrate; and

patterning the conductive material layer.

16. The method as claimed in claim 10, wherein the auxiliary wire overlaps the pixel defining part.

17. The organic light emitting diode display as claimed in claim 6, wherein the common electrode is between the [spacer] plurality of spacers and the sealing member.

18. The organic light emitting diode display as claimed in claim 1, wherein the common electrode is on the [spacer] plurality of spacers.

19. The method as claimed in claim 10, wherein the common electrode is formed on the [spacer] plurality of spacers.

20. The organic light emitting diode display as claimed in claim 1, wherein the plurality of spacers are made of a same material as the pixel defining layer.

21. The organic light emitting diode display as claimed in claim 1,

wherein the auxiliary wire comprises a first portion, a second portion and a third portion connected to the first portion and the second portion, and

wherein the first portion and the second portion extend in a first direction, and the third portion extends in a second direction different from the first direction.

22. The organic light emitting diode display as claimed in claim 21,

wherein the pixel electrodes comprise a first pixel electrode and a second pixel electrode having a different size from the first pixel electrode, and

wherein the third portion extends between the first pixel electrode and the second pixel electrode.

13

23. The organic light emitting diode display as claimed in claim 22, wherein at least one of the first pixel electrode or the second pixel electrode has substantially a diamond shape in a plan view.

24. The organic light emitting diode display as claimed in claim 1, wherein the spacers are disposed between adjacent pixel electrodes having different sizes from each other.

25. The organic light emitting diode display as claimed in claim 1, further comprising other auxiliary wire disposed adjacent to the auxiliary wire, wherein pixel electrodes having different sizes from each other from among the plurality of pixel electrodes are disposed between the auxiliary wire and the other auxiliary wire.

26. An organic light emitting diode display, comprising:
a substrate;

a plurality of thin film transistors on the substrate;

an insulating layer on the thin film transistors;

a plurality of pixel electrodes on the insulating layer;

an auxiliary wire spaced apart from the pixel electrodes on the insulating layer;

a pixel defining layer on the pixel electrodes, the pixel defining layer defining pixel areas;

a plurality of spacers discontinuously arranged in a region between the pixel areas;

light emitting layers on the pixel electrodes; and

a common electrode on the light emitting layers,

wherein the auxiliary wire is serpentine and extends between the pixel electrodes, and

wherein the plurality of pixel electrodes is comprised of at least two kinds of pixel electrodes in size.

27. The organic light emitting diode display as claimed in claim 26, wherein the auxiliary wire is an initialization voltage wire.

28. The organic light emitting diode display as claimed in claim 26, wherein the auxiliary wire is disposed on a same layer as the pixel electrodes.

29. The organic light emitting diode display as claimed in claim 28, wherein the auxiliary wire comprises at least one metal layer and at least one transparent conductive oxide layer.

30. The organic light emitting diode display as claimed in claim 28, wherein the auxiliary wire comprises a metal layer on the substrate and a transparent conductive oxide layer on the metal layer.

31. The organic light emitting diode display as claimed in claim 28, wherein the auxiliary wire is an initialization voltage wire.

32. The organic light emitting diode display as claimed in claim 31, wherein the auxiliary wire is made of a same material as the pixel electrodes.

14

33. The organic light emitting diode display as claimed in claim 32, wherein the auxiliary wire comprises at least one metal layer and at least one transparent conductive oxide layer.

34. The organic light emitting diode display as claimed in claim 33, wherein the auxiliary wire comprises a metal layer on the substrate and a transparent conductive oxide layer on the metal layer.

35. The organic light emitting diode display as claimed in claim 34, wherein the auxiliary wire does not overlap the spacers.

36. The organic light emitting diode display as claimed in claim 26, further comprising a sealing member facing the substrate,

wherein:

the pixel defining layer is between the sealing member and the substrate, and

the spacers maintain a space between the substrate and the sealing member.

37. The organic light emitting diode display as claimed in claim 26, wherein the spacers are made of a same material as the pixel defining layer.

38. The organic light emitting diode display as claimed in claim 26, wherein the spacers have any one of the following shapes: a truncated pyramid, a prism, a truncated cone, a cylinder, a hemisphere, and a hemispheroid.

39. The organic light emitting diode display as claimed in claim 26, wherein the auxiliary wire has a zigzag pattern.

40. The organic light emitting diode display as claimed in claim 26, wherein the auxiliary wire is between the substrate and the pixel defining layer.

41. The organic light emitting diode display as claimed in claim 26, wherein the auxiliary wire is disposed between the substrate and the pixel defining layer in a vertical direction.

42. The organic light emitting diode display as claimed in claim 26, wherein the common electrode is disposed on the pixel defining layer and the spacers.

43. The organic light emitting diode display as claimed in claim 26, wherein the two kinds of pixel electrodes have different shapes from each other.

44. The organic light emitting diode display as claimed in claim 26, wherein the spacers protrude from the pixel defining layer.

45. The organic light emitting diode display as claimed in claim 26, wherein the auxiliary wire is spaced apart from the common electrode.

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