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Kim

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(54) **ORGANIC LIGHT-EMITTING DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME**

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H01L 27/32 (2006.01)

(52) **U.S. Cl.**
USPC **257/59**; 257/71; 257/72; 257/E33.001; 257/E27.001; 438/34

(58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

An organic light-emitting display device includes an active layer of a thin film transistor (TFT) formed on a substrate; a gate electrode of the TFT, wherein a first gate electrode including a transparent conductive material, a first insulating layer, and a second gate electrode are sequentially stacked; a pixel electrode disposed on the first insulating layer and including the transparent conductive material; a source electrode and a drain electrode of the TFT, a second insulating layer disposed between the source electrode and the drain electrode; a light reflector including the same material as the source electrode and the drain electrode, and disposed on the pixel electrode; an emission layer disposed on top of the pixel electrode and surrounded by an inner side of the light reflector; and a counter electrode facing towards the pixel electrode, wherein the emission layer is disposed between the pixel electrode and the counter electrode.

23 Claims, 7 Drawing Sheets

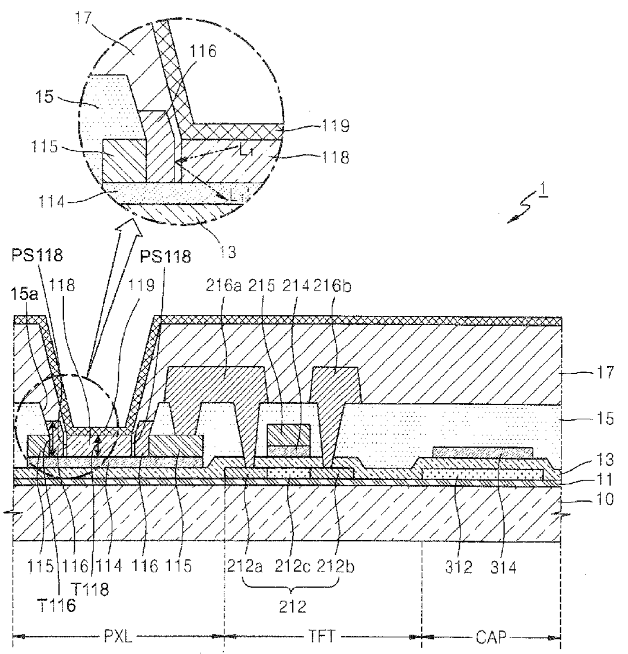


FIG. 1

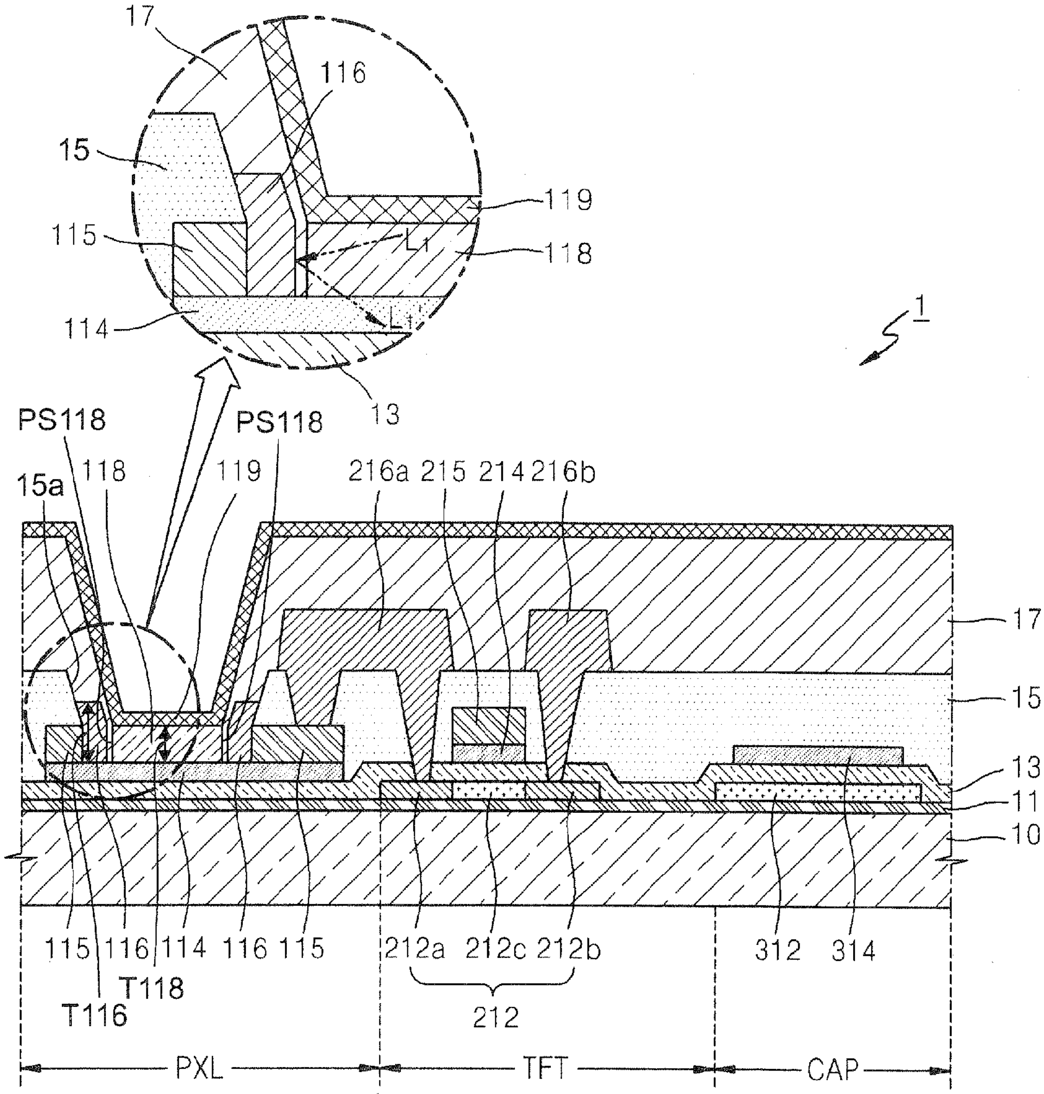

17
116
15
119
115
L1
118
114
L1'
13
1
PS118
PS118
15a
118
119
216a
215
214
216b
17
15
13
11
10
115
116
114
116
115
212a
212c
212b
312
314
T118
T116
212
PXL
TFT
CAP

FIG. 2

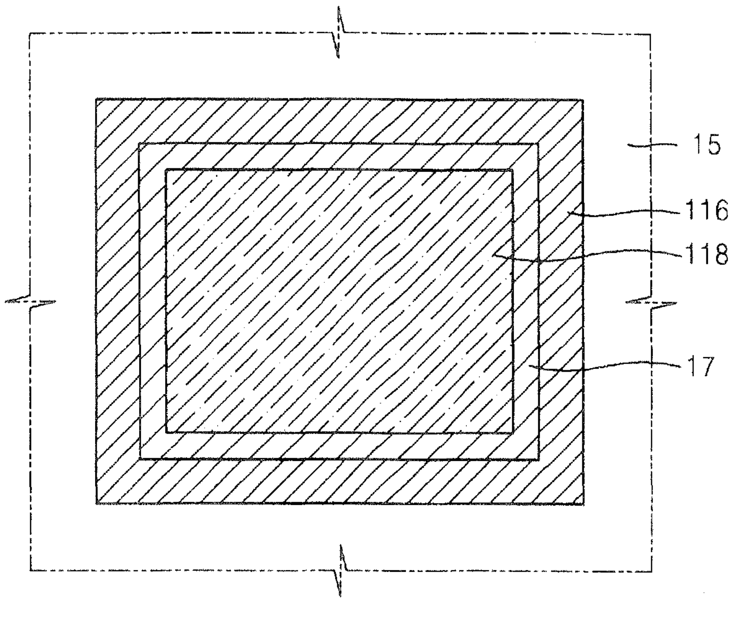


FIG. 3A

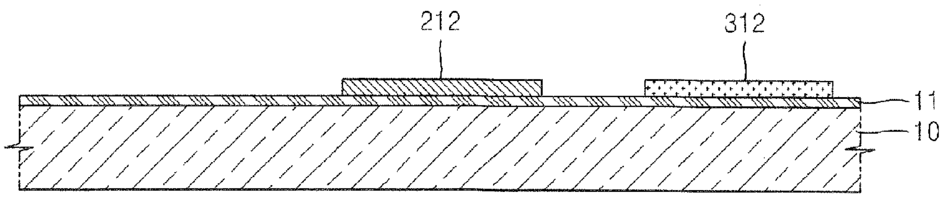

212
312
11
10

FIG. 3B

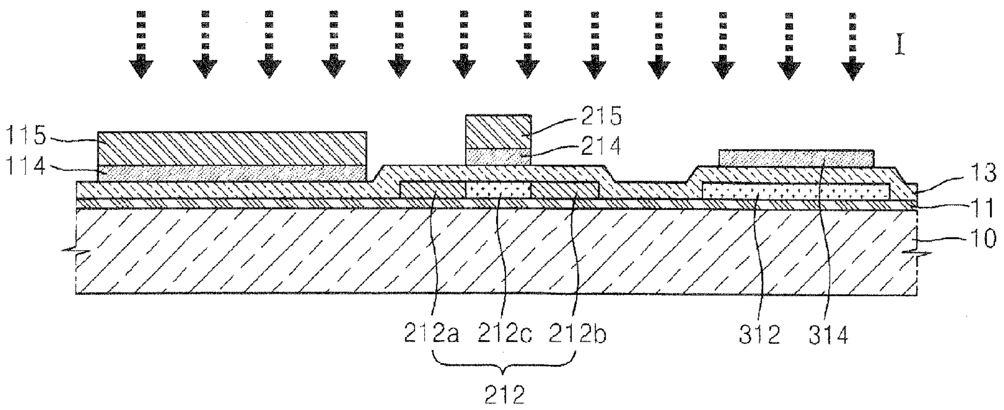

I
115
114
215
214
13
11
10
212a
212c
212b
212
312
314

FIG. 3C

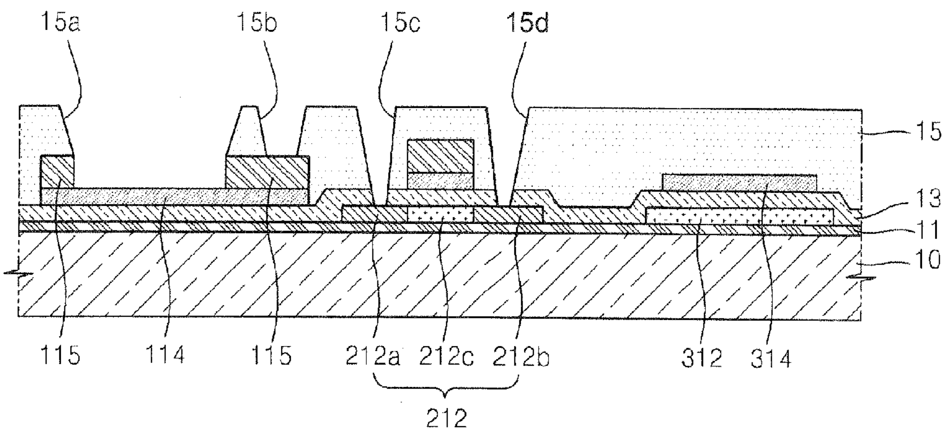

15a
15b
15c
15d
15
13
11
10
115
114
115
212a
212c
212b
212
312
314

FIG. 3D

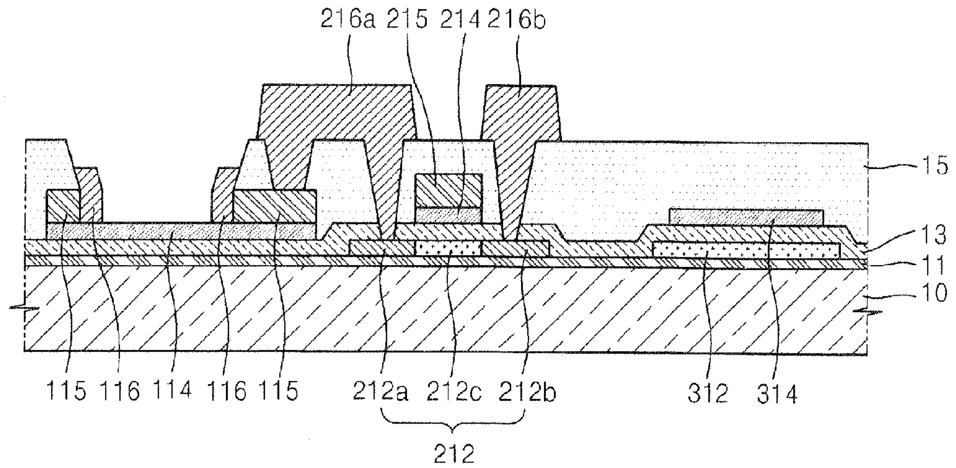

216a
215
214
216b
15
13
11
10
115
116
114
116
115
212a
212c
212b
212
312
314

FIG. 3E

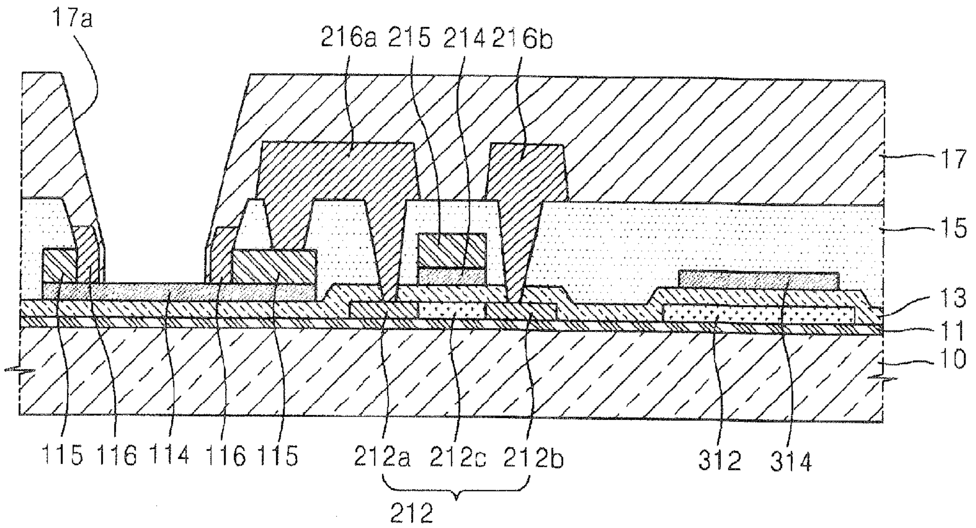

17a
216a 215 214 216b
17
15
13
11
10
115 116 114 116 115
212a 212c 212b
212
312 314

FIG. 4

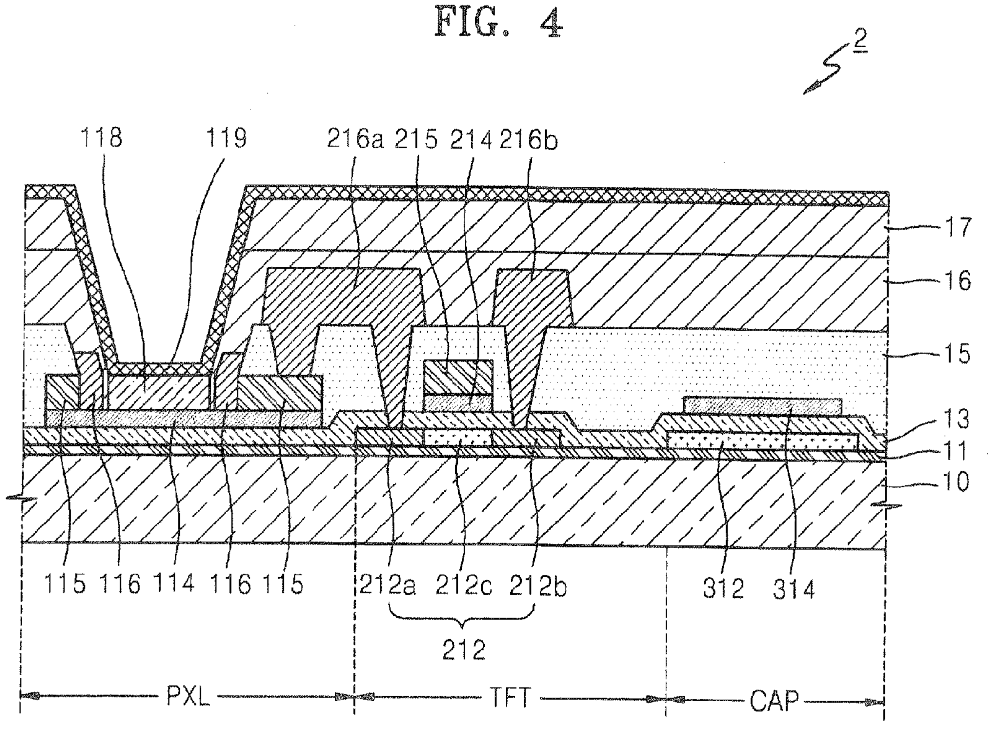

2
118 119 216a 215 214 216b
17
16
15
13
11
10
115 116 114 116 115
212a 212c 212b
212
312 314
PXL
TFT
CAP

FIG. 5

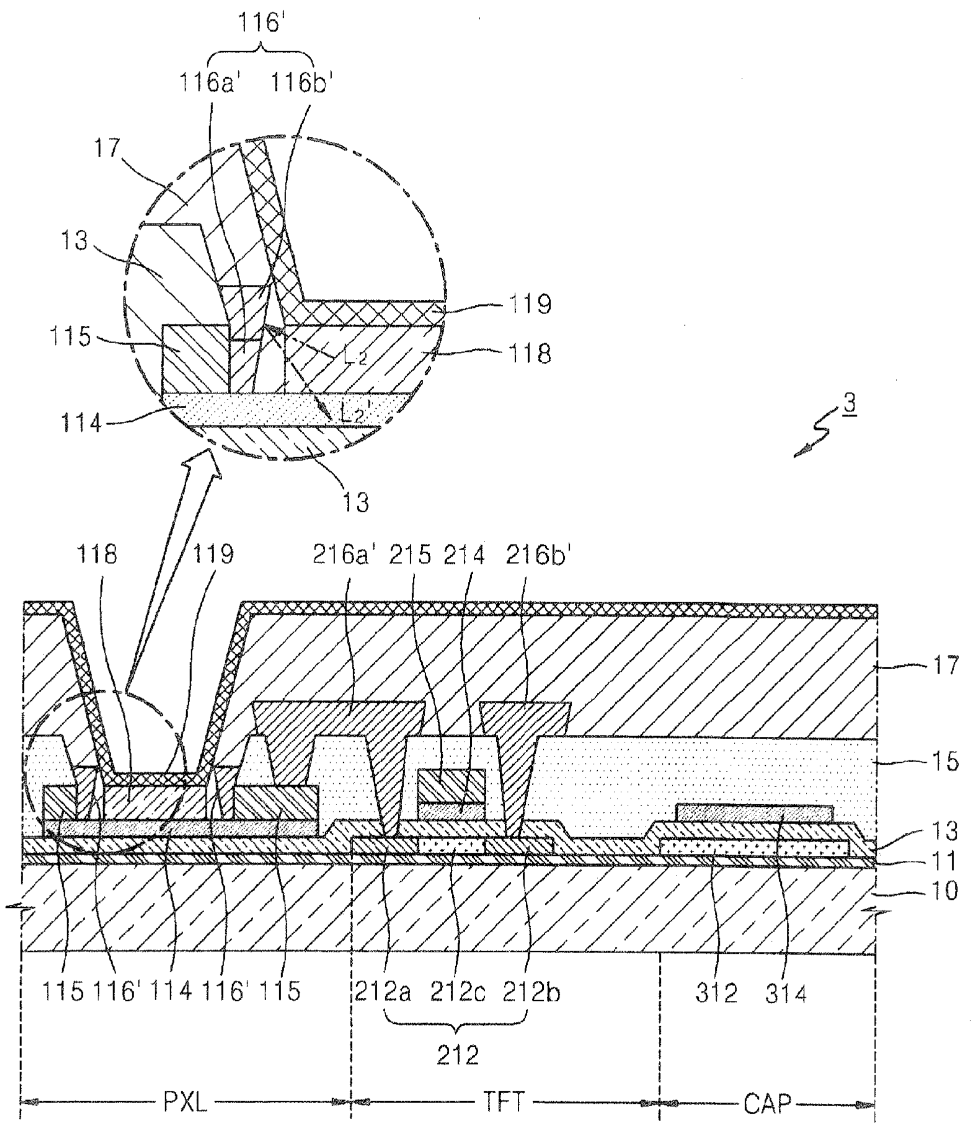
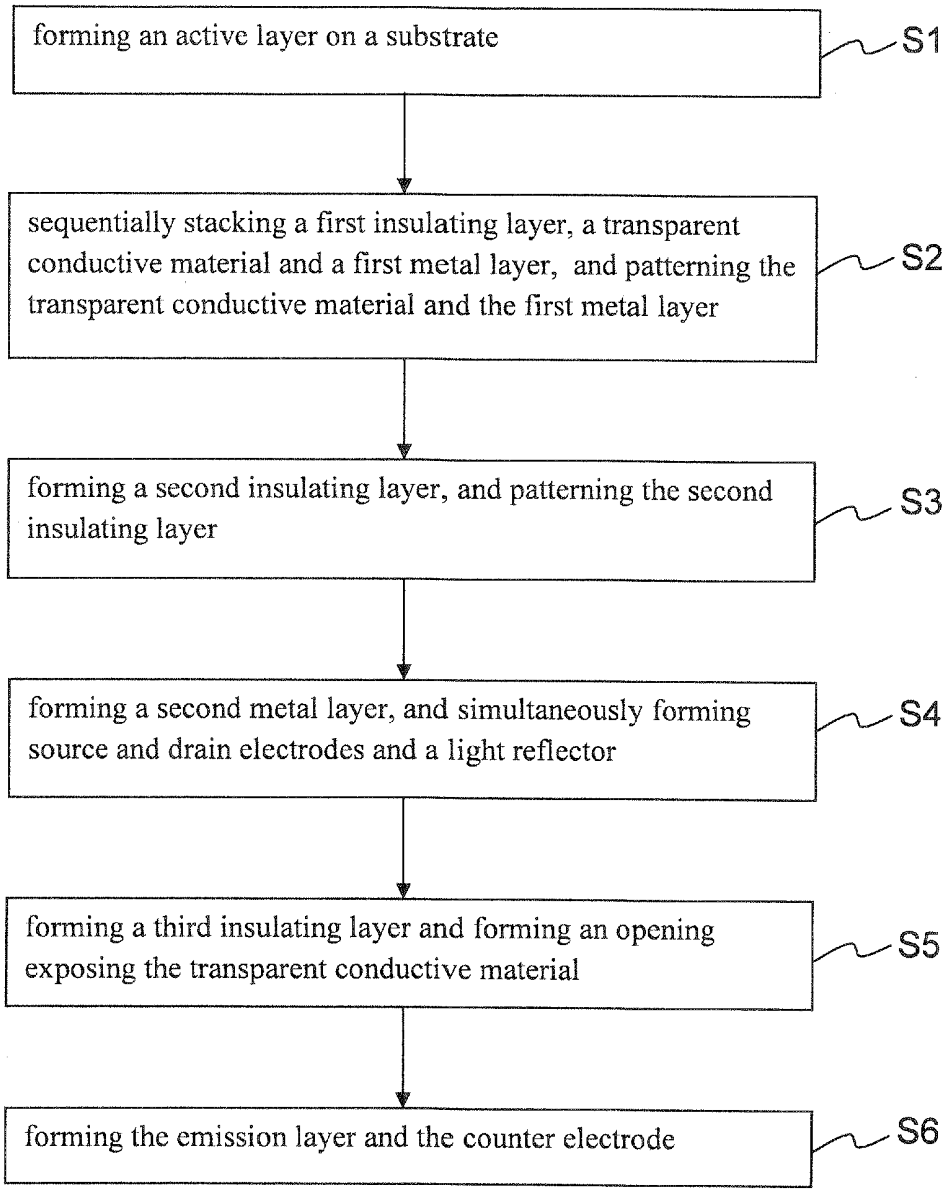

116'
116a'
116b'
17
13
119
115
118
L2
114
L2'
13
3
118
119
216a'
215
214
216b'
17
15
13
11
10
115
116'
114
116'
115
212a
212c
212b
212
312
314
PXL
TFT
CAP

FIG. 6


forming an active layer on a substrate
S1
sequentially stacking a first insulating layer, a transparent conductive material and a first metal layer, and patterning the transparent conductive material and the first metal layer
S2
forming a second insulating layer, and patterning the second insulating layer
S3
forming a second metal layer, and simultaneously forming source and drain electrodes and a light reflector
S4
forming a third insulating layer and forming an opening exposing the transparent conductive material
S5
forming the emission layer and the counter electrode
S6

ORGANIC LIGHT-EMITTING DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

CLAIM OF PRIORITY

This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application earlier filed in the Korean Intellectual Property Office on 29 Sep. 2010 there duly assigned Serial No. 10-2010-0094465.

BACKGROUND OF THE INVENTION

1. Field of the Invention

An embodiment of the present invention relates to an organic light-emitting display device and a method of manufacturing the organic light-emitting display device.

2. Description of the Related Art

Organic light-emitting display devices are attracting attention as next generation display devices because not only the organic light-emitting display devices are lighter and thinner, but also the organic light-emitting display devices have a wider viewing angle, quicker response speeds, and lower power consumption.

Light emitted from an emission layer of the organic light-emitting display device is generally emitted without certain directivity, and is emitted in random directions in statistically uniform distribution. A considerable number of photons emitted in random directions do not reach an actual observer due to total internal reflection of the organic light-emitting display device, and thus light extraction efficiency of the organic light-emitting display device may be unsatisfactorily reduced.

SUMMARY OF THE INVENTION

One embodiment of the present invention provides an organic light-emitting display device having a simple manufacturing process and an excellent display quality, and a method of manufacturing the same.

In accordance with an aspect of the present invention, an organic light-emitting display device may include an active layer of a thin film transistor formed on a substrate; a gate electrode of the thin film transistor, wherein a first gate electrode including a transparent conductive material, a first insulating layer, and a second gate electrode including a metal are sequentially stacked; a pixel electrode disposed on the first insulating layer and the pixel electrode including a transparent conductive material; a source electrode and a drain electrode of the thin film transistor, which are electrically connected to the active layer, wherein a second insulating layer is disposed between the source electrode and the drain electrode; a light reflector including the same material as the source electrode and the drain electrode, and the light reflector being disposed at an upper edge of the pixel electrode; an emission layer disposed on top of the pixel electrode and an inner side of the light reflector; and a counter electrode facing towards the pixel electrode, wherein the emission layer is disposed between the pixel electrode and the counter electrode.

The light reflector may have a closed loop shape. The light reflector may surround the emission layer.

A thickness of the light reflector may be equal to or greater than a thickness of the emission layer.

A thickness of the light reflector may be equal to each thickness of the source electrode and the drain electrode.

The light reflector may be formed inside an opening formed by etching the second insulating layer and the light reflector may be disposed on top of the pixel electrode.

The light reflector may have an inverse tapered shape in such a way that a thickness of the light reflector far away from the pixel electrode is thicker than a thickness of the light reflector closer to the pixel electrode.

The light reflector may include a metal of at least two layers having different etching rates when the light reflector is subjected to an etching process.

The metal may have a higher etching rate near the pixel electrode than far from the pixel electrode.

The organic light-emitting display device may further include a third insulating layer between the source and drain electrodes and the counter electrode, and between the light reflector and the emission layer.

The organic light-emitting display device may further include a third insulating layer between the source and drain electrodes and the counter electrode, and a fourth insulating layer between the light reflector and the emission layer, wherein the fourth insulating layer has a higher light transmittance than the third insulating layer.

The third insulating layer may include an organic insulating material and the fourth insulating layer may include an inorganic insulating material.

The transparent conductive material of the pixel electrode may be the same material as that of the first gate electrode.

The organic light-emitting display device may further include a second pixel electrode disposed on an upper edge of the transparent conductive material of the pixel electrode and including the same metal as the second gate electrode, wherein the light reflector is disposed on an inner side of the second pixel electrode, with the inner side of the second pixel electrode facing towards the emission layer.

The transparent conductive material may include at least one selected from the group consisting of indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium oxide (In2O3), indium gallium oxide (IGO), and aluminum zinc oxide (AZO).

End shapes of etched surfaces of the first and second gate electrodes may be the same.

The active layer may include an ion impurity-doped semiconductor.

The ion impurity-doped semiconductor may include amorphous silicon or polysilicon.

The organic light-emitting display device may further include a lower capacitor electrode including the same material as the active layer and formed on the same layer as the active layer; and an upper capacitor electrode including the same material as the first gate electrode and formed on the first insulating layer.

The lower capacitor electrode may include an ion impurity-doped semiconductor.

The counter electrode may be a reflective electrode that reflects light emitted from the emission layer.

In accordance with another aspect of the present invention, a method of manufacturing an organic light-emitting display device may include steps of forming an active layer on a substrate; sequentially stacking a first insulating layer, a transparent conductive material, and a metal on the active layer, and simultaneously forming a pixel electrode and a gate electrode of a thin film transistor by patterning the transparent conductive material and the metal; forming a second insulating layer on a resultant structure obtained through the sequential stacking and simultaneous forming, and forming a first opening exposing the transparent conductive material of the pixel electrode and source and drain regions of the active layer by patterning the second insulating layer; forming a metal layer on a resultant structure obtained through the forming of the second insulating layer and forming of the first opening, and simultaneously forming source and drain electrodes, which contact the source and drain regions by patterning the metal layer, and a light reflector on the transparent conductive material of the pixel electrode; and forming a third insulating layer on a resultant structure obtained through the forming of the metal layer and simultaneous forming, wherein the third insulating layer exposes the transparent conductive material of the pixel electrode.

The method may further include forming an emission layer in a second opening formed by the third insulating layer, and forming a counter electrode covering the emission layer.

In the step of forming of the metal layer and simultaneous forming, the metal layer may include a metal of at least two layers having different etching rates, and the etching rate may increase towards the pixel electrode.

The forming of the third insulating layer may further include forming a fourth insulating layer having a higher light transmittance than the third insulating layer between the second insulating layer and the third insulating layer, wherein the third and fourth insulating layers expose the transparent conductive material of the pixel electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention, and many of the attendant advantages thereof, will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference symbols indicate the same or similar components, wherein:

FIG. **1** is a cross-sectional view schematically illustrating an organic light-emitting display device constructed with an embodiment of the present invention;

FIG. **2** is a plan view schematically illustrating a light reflector of FIG. **1**;

FIG. **3**A is a cross-sectional view schematically illustrating a result of performing a first mask process of an organic light-emitting display device, according to an embodiment of the present invention;

FIG. **3**B is a cross-sectional view schematically illustrating a result of performing a second mask process of an organic light-emitting display device, according to an embodiment of the present invention;

FIG. **3**C is a cross-sectional view schematically illustrating a result of performing a third mask process of an organic light-emitting display device, according to an embodiment of the present invention;

FIG. **3**D is a cross-sectional view schematically illustrating a result of performing a fourth mask process of an organic light-emitting display device, according to an embodiment of the present invention;

FIG. **3**E is a cross-sectional view schematically illustrating a result of performing a fifth mask process of an organic light-emitting display device, according to an embodiment of the present invention;

FIG. **4** is a cross-sectional view schematically illustrating an organic light-emitting display device constructed with another embodiment of the present invention; and

FIG. **5** is a cross-sectional view schematically illustrating an organic light-emitting display device constructed with another embodiment of the present invention.

FIG. **6** is a flow chart showing the procedural steps for the manufacture of the organic light-emitting display devices.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, the present invention will be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown.

An organic light-emitting display device **1** constructed as an embodiment of the present invention will now be described with reference to FIGS. **1** and **2**.

FIG. **1** is a cross-sectional view schematically illustrating the organic light-emitting display device **1** constructed with an embodiment of the present invention, and FIG. **2** is a plan view schematically illustrating a light reflector **116** of FIG. **1**.

Referring to FIG. **1**, a pixel region PXL, including an emission layer **118**, a transistor region TFT, including a thin film transistor, and a capacitor region CAP, including a capacitor are formed on a substrate **10**.

An active layer **212** of the thin film transistor is disposed on the substrate **10** and a buffer layer **11**, in the transistor region TFT. The active layer **212** is formed of a semiconductor including amorphous silicon or polysilicon, and may include source and drain regions **212***a* and **212***b* and a channel region **212***c*, which are doped with ion impurities.

On the active layer **212**, a first gate electrode **214** and a second gate electrode **215**, which include a transparent conductive material, are sequentially formed in a location corresponding to the channel region **212***c* of the active layer **212**, wherein a first insulating layer **13** is disposed between the channel region **212***c* and the first and second gate electrodes **214** and **215**.

Source and drain electrodes **216***a* and **216***b* respectively contacting the source and drain regions **212***a* and **212***b* of the active layer **212** are disposed on the first and second gate electrodes **214** and **215**, wherein a second insulating layer **15** is disposed between the first and second gate electrodes **214** and **215**, and the source and drain electrodes **216***a* and **216***b*. A third insulating layer **17**, covering the second and drain electrodes **216***a* and **216***b*, is disposed on the second insulating layer **15**.

In the capacitor region CAP, a lower capacitor electrode **312** which is formed of the same material as the active layer **212** of the thin film transistor, the first insulating layer **13**, and an upper capacitor electrode **314** which is formed of the same material as a first pixel electrode **114**, are sequentially disposed on the substrate **10** and the buffer layer **11**. Accordingly, the lower capacitor electrode **312** is formed of the same material as the active layer **212** of the thin film transistor, and may include an ion impurity-doped semiconductor.

In the pixel region PXL, the first pixel electrode **114** formed of the same transparent electrically conductive material as the first gate electrode **214**, and a second pixel electrode **115** formed of the same material as the second gate electrode **215** and disposed on an upper edge of the first pixel electrode **114**, are sequentially disposed on the substrate **10**, the buffer layer **11**, and the first insulating layer **13**.

In the present embodiment, the second pixel electrode **115** is disposed on the upper edge of the first pixel electrode **114**, but a location of the second pixel electrode **115** is not limited thereto, and the second pixel electrode **115** may not be disposed on the first pixel electrode **114**.

The organic light-emitting display device **1** further includes a counter electrode **119** facing the first pixel electrode **114**, wherein the emission layer **118** is disposed between the first pixel electrode **114** and the counter electrode **119**.

The emission layer **118** may be formed of a lower molecular weight organic material or a higher molecular weight organic material.

When the emission layer **118** is formed of a lower molecular weight organic material, the emission layer **118** may include a hole transport layer (HTL), a hole injection layer (HIL), an electron transport layer (ETL), and an electron injection layer (EIL). The emission layer **118** may include other layers if required. Here, examples of the lower molecular weight organic material include copper phthalocyanine (CuPc), N,N'-Di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), and tris-8-hydroxyquinoline aluminum (Alq3).

Also, when the emission layer **118** is formed of a higher molecular weight organic material, the emission layer **118** may include an HTL. The HTL may be formed of poly-(2,4)-ethylene-dihydroxy thiophene (PEDOT) or polyaniline (PANI). Here, the higher molecular weight organic material may be a polyphenylene vinylene (PPV)-based or polyfluorene-based high molecular weight organic material.

The counter electrode **119** is deposited as a common electrode, on the emission layer **118**. In the organic light-emitting display device **1** constructed as the present embodiment, the first and second pixel electrodes **114** and **115** may be used as an anode, and the counter electrode **119** is used as a cathode. However, polarities of the first and second pixel electrodes **114** and **115** and the counter electrode **119** may be the opposite.

The counter electrode **119** may be a reflective electrode including a reflective material. Here, the counter electrode **119** may include at least one material selected from the group consisting of aluminum (Al), magnesium (Mg), lithium (Li), calcium (Ca), lithium fluoride (LiF)/Ca, LiF/Al and the combinations thereof.

When the counter electrode **119** is a reflective electrode, light emitted from the emission layer **118** may be reflected by the counter electrode **119**, penetrates through the first pixel electrode **114** formed of the transparent conductive material, and is emitted to the substrate **10**.

On an outer region of the emission layer **118**, the light reflector **116**, formed of the same material as the source and drain electrodes **216***a* and **216***b*, is disposed on an upper edge of the first pixel electrode **114**, wherein the third insulating layer **17** is disposed between the light reflector **116** and the first pixel electrode **114**.

The light reflector **116** reflects light L1 reaching the light reflector **116**, from among photons generated from the emission layer **118** and emitted in random directions, specifically from a boundary around the emission layer **118**, thereby helping reflected light L**1'** to be emitted to the outside of the organic light-emitting display device **1**.

Referring to FIGS. **1** and **2**, the light reflector **116** is disposed in an opening **15***a* formed by etching the second insulating layer **15** on the first pixel electrode **114** and the light reflector **116** forms a closed loop surrounding the emission layer **118**, wherein the third insulating layer **17** is disposed between the light reflector **116** and the emission layer **118**. Accordingly, a maximum number of photons emitted from the emission layer **118** may be reflected by the reflector **116**, and thus light extraction efficiency of the organic light-emitting display device **1** may be improved.

Also, as will be described later, a thickness of the light reflector **116** may be equal to each of the thicknesses of the source and drain electrodes **216***a* and **216***b*, since the light reflector **116** is simultaneously formed together with the source and drain electrodes **216***a* and **216***b* and with the same material as the source and drain electrodes **216***a* and **216***b*, during the same mask process. Here, the thicknesses of the source and drain electrodes **216***a* and **216***b* and the thickness T**116** of the light reflector **116** may be thicker than the thickness T**118** of the emission layer **118** so that the light reflector **116** may reflect as many photons emitted from the emission layer **118** as possible.

A method of manufacturing the organic light-emitting display device **1**, according to an embodiment of the present invention, will now be described with reference to FIGS. **3**A through **3**E.

FIG. **3**A is a cross-sectional view schematically illustrating a result of performing a first mask process of the organic light-emitting display device **1**, according to an embodiment of the present invention.

Referring to FIG. **3**A, on the buffer layer **11** disposed on the substrate **10**, the active layer **212** of the thin film transistor is formed in the transistor region TFT and the lower capacitor electrode **312** is formed in the capacitor region CAP.

The substrate **10** may be formed of transparent glass including silicon dioxide (SiO2) as a main component, and the buffer layer **11**, including SiO2 and/or silicon nitride (SiNx), may be further disposed on the substrate **10** so as to smoothen the substrate **10** and prevent impure elements from penetrating into the substrate **10**.

Although not illustrated in FIG. **3**A, the active layer **212** of the thin film transistor and the lower capacitor electrode **312** are simultaneously formed by depositing a semiconductor layer (not shown) on the buffer layer **11**, coating a photoresist (not shown) on the semiconductor layer, and then patterning the semiconductor layer by using a first photo mask (not shown) in a photolithography process.

The first mask process according to the photolithography process is performed via a series of processes, such as developing, etching, and stripping or ashing, after exposing the first photo mask to light by using a light exposure device.

The semiconductor layer may include amorphous silicon or polysilicon. Here, the polysilicon may be formed by crystallizing the amorphous silicon. The amorphous silicon may be crystallized by using any method, such as a rapid thermal annealing (RTA) method, a solid phase crystallization (SPC) method, an excimer laser annealing (ELA) method, a metal-induced crystallization (MIC) method, a metal-induced lateral crystallization (MILC) method, and a sequential lateral solidification (SLS) method.

FIG. **3**B is a cross-sectional view schematically illustrating a result of performing a second mask process of the organic light-emitting display device **1**, according to an embodiment of the present invention.

Referring to FIG. **3**B, the first insulating layer **13** is stacked on a resultant structure obtained via the first mask process of FIG. **3**A, and layers (not shown) including a transparent conductive material and a metal are sequentially stacked on the first insulating layer **13**, and are patterned.

Accordingly, the first pixel electrode **114**, including the transparent conductive material, and the second pixel electrode **115**, including the metal, are sequentially formed on the first insulating layer **13** in the pixel region PXL, the first gate electrode **214**, including the transparent conductive material, and the second gate electrode **215**, including the metal, are sequentially formed on the first insulating layer **13** in the transistor region TFT, and the upper capacitor electrode **314**, including the transparent conductive material, is formed on the first insulating layer **13** in the capacitor region CAP simultaneously with the first pixel electrode **114** and the first gate electrode **214**. Accordingly, the first and second gate electrodes **214** and **215** have same pattern and boundary. Also, the first and second pixel electrodes **114** and **115** have same pattern and boundary.

The first insulating layer **13** may include a single layer or multiple layers formed of SiO2, SiNx, or the like, and the first insulating layer **13** may operate as a gate insulating layer of a thin film transistor and a dielectric layer of a capacitor.

The transparent conductive material forming the first pixel electrode **114**, the first gate electrode **214**, and the upper capacitor electrode **314** may include at least one material selected from the group consisting of indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium oxide (In2O3), indium gallium oxide (IGO), aluminum zinc oxide (AZO) and the combinations thereof.

The metal forming the second pixel electrode **115** and the second gate electrode **215** may be a single layer or a plurality of layers of at least one metal selected from the group consisting of aluminum (Al), platinum (Pt), palladium (Pd), silver (Ag), magnesium (Mg), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), lithium (Li), calcium (Ca), molybdenum (Mo), titanium (Ti), tungsten (W), copper (Cu).

In the current embodiment, a half-tone mask may be used as a second photo mask (not shown) during the second mask process so that metal layers, such as the second pixel electrode **115** and second gate electrode **215**, are not formed on top of the upper capacitor electrode **314**.

The resultant structure obtained as described above is doped with ion impurities I. B- or P-ions may be doped as the ion impurities I in a concentration of 1×10^{15} atoms/cm^2 or above, while targeting the lower capacitor electrode **312**, including the semiconductor, and the active layer **212** of the thin film transistor.

Accordingly, electrical conductivity of the lower capacitor electrode **312** is increased, thereby increasing capacity of the capacitor as the lower capacitor electrode **312**, the first insulating layer **13**, and the upper capacitor electrode **314** form a metal-insulator-metal (MIM) capacitor.

Also, the active layer **212** is doped with the ion impurities by using the first and second gate electrodes **214** and **215** as a self-aligned mask, and thus the active layer **212** includes the source and drain regions **212***a* and **212***b*, and the channel region **212***c* therebetween. In other words, the source and drain regions **212***a* and **212***b* are formed without having to add a separate photo mask, by using the first and second gate electrodes **214** and **215** as the self-aligned mask.

FIG. **3**C is a cross-sectional view schematically illustrating a result of performing a third mask process of the organic light-emitting display device **1**, according to an embodiment of the present invention.

Referring to FIG. **3**C, the second insulating layer **15** is stacked on a resultant structure obtained via the second mask process of FIG. **3**B, and a first opening **15***a* exposing the first pixel electrode **114**, a second opening **15***b* exposing the second pixel electrode **115**, a third opening **15***c* exposing the source region **212***a* of the active layer **212**, and a fourth opening **15***d* exposing the drain region **212***b* of the active layer **212** are formed by patterning the second insulating layer **15**.

After patterning the second insulating layer **15** to form the first through fourth openings **15***a* through **15***d*, the second pixel electrode **115** exposed by the first opening **15***a* is removed. The second pixel electrode **115** may be etched by using an etchant for etching the second pixel electrode **115** including the metal, without having to perform a separate mask process. Alternatively, the second pixel electrode **115** may be removed during the second mask process.

FIG. **3**D is a cross-sectional view schematically illustrating a result of performing a fourth mask process of the organic light-emitting display device **1**, according to an embodiment of the present invention.

Referring to FIG. **3**D, the source and drain electrodes **216***a* and **216***b* are formed on the second insulating layer **15** by filling the second through fourth openings **15***b* through **15***d* formed in the second insulating layer **15** of the transistor region TFT, and the light reflector **116**, formed of the same material as the source and drain electrodes **216***a* and **216***b*, is formed in the first opening **15***a* formed in the second insulating layer **15** of the pixel region PXL.

The source and drain electrodes **216***a* and **216***b*, and the light reflector **116** may be formed of a single layer or a plurality of layers of at least one metal selected from the group consisting of Al, Pt, Pd, Ag, Mg, Au, Ni, Nd, Ir, Cr, Li, Ca, Mo, Ti, W, and Cu.

The light reflector **116** may be formed without having to perform a separate mask process, since the light reflector **116** is formed during the same mask process as the source and drain electrodes **216***a* and **216***b* and with the same material as the source and drain electrodes **216***a* and **216***b*. Since the source and drain electrodes **216***a* and **216***b* are formed of the metal and the metal has excellent reflexibility, reflexibility of the light reflector **116**, formed of the same material as the source and drain electrodes **216***a* and **216***b*, is also excellent. Thus, light extraction efficiency of the organic light-emitting display device **1** is increased.

FIG. **3**E is a cross-sectional view schematically illustrating a result of performing a fifth mask process of the organic light-emitting display device **1**, according to an embodiment of the present invention.

Referring to FIG. **3**E, the third insulating layer **17** is stacked on a resultant structure obtained via the fourth mask process of FIG. **3**D, and an opening **17***a* exposing the top of the first pixel electrode **114** is formed by patterning the third insulating layer **17**.

Besides defining a light-emitting area, the opening **17***a* also prevents a short circuit of the first and second pixel electrodes **114** and **115** and the counter electrode **119** of FIG. **1** by increasing a distance between edges of the first and second pixel electrodes **114** and **115** and the counter electrode **119** to prevent an electric field from concentrating on the edges of the first and second pixel electrodes **114** and **115**. Also, a short circuit that may be generated when the emission layer **118** of FIG. **1** and the light reflector **116** directly contact each other is prevented by disposing the third insulating layer **17** between the emission layer **118** and the light reflector **116**. The third insulating layer **17** may be an organic insulating layer or an inorganic insulating layer. In one embodiment, the third insulating layer **17** may completely cover the exposed surface of the light reflector **116** of the resultant structure obtained via the fourth mask process of FIG. **3**D.

In the organic light-emitting display device **1** of FIG. **1** according to the current embodiment, wherein the emission layer **118** of FIG. **1** and the counter electrode **119** of FIG. **1** are formed on a resultant structure obtained via the fifth mask process, light extraction efficiency of extracted light emitted from the emission layer **118** is high since the light reflector **116**, formed of the metal having high reflexibility, surrounds the emission layer **118**. In one embodiment, the light reflector **116** may surround the entirety of the peripheral surface PS **118** of the emission layer **118**. Also, the light reflector **116** is simply formed without having to perform a separate and additional process, since the light reflector **116** is formed of the same material as the source and drain electrodes **216***a* and **216***b* during the same mask process. Also, the light extraction efficiency of extracted light emitted from the emission layer **118** may be increased by forming the thickness of the light reflector **116** thicker than the thickness of the emission layer **118**.

FIG. **6** is a flow chart showing steps of manufacturing the organic light-emitting display device **1**. The manufacturing procedural steps include steps for forming an active layer on a substrate (S**1**); sequentially stacking a first insulating layer, a transparent conductive material, and a first metal layer on the active layer, and simultaneously forming a pixel electrode and a gate electrode of a thin film transistor by patterning the transparent conductive material and the first metal layer (S**2**); forming a second insulating layer on a first resultant structure obtained by step S**2** and simultaneous forming the pixel electrode and the gate electrode, and forming an opening exposing the transparent conductive material of the pixel electrode and source and drain regions of the active layer by patterning the second insulating layer (S**3**); forming a metal layer on a second resultant structure obtained by step S**3**, and simultaneously forming source and drain electrodes which respectively contact the source and drain regions by patterning the metal layer, and a light reflector disposed on the transparent conductive material of the pixel electrode (S**4**); and forming a third insulating layer on a third resultant structure obtained by step S**4** and simultaneous forming the source and drain electrodes and the light reflector, wherein the third insulating layer exposes the transparent conductive material of the pixel electrode (S**5**).

Furthermore, the emission layer **118** is formed within the opening **17***a* of the third insulating layer **17** and the emission layer **118** is surrounded by the light reflector **116**. The counter electrode **119** is formed to cover the third insulating layer **17** and the emission layer **118** (S**6**).

An organic light-emitting display device **2** constructed as another embodiment of the present invention will now be described with reference to FIG. **4**.

FIG. **4** is a cross-sectional view schematically illustrating the organic light-emitting display device **2** according to another embodiment of the present invention. Differences between the organic light-emitting display device **1** and the organic light-emitting display device **2** will be mainly described. Like reference numerals denote like elements.

Referring to FIG. **4**, the pixel region PXL including the emission layer **118**, the transistor region TFT including the thin film transistor, and the capacitor region CAP including the capacitor, are formed on the substrate **10**.

The active layer **212** of the thin film transistor and the lower capacitor electrode **312**, formed of the same material as the active layer **212**, are formed on the same layer, i.e., on the substrate **10** and the buffer layer **11**. The first insulating layer **13** is formed to cover the active layer **212** and the lower capacitor electrode **212**.

The first gate electrode **214** of the thin film transistor, including the transparent conductive material, and the second gate electrode **215**, including the metal, are sequentially formed on the first insulating layer **13**. The first pixel electrode **114**, including the same transparent conductive material as the first gate electrode **214**, and the second pixel electrode **115**, including the same metal as the second gate electrode **215**, are formed in the pixel region PXL, and the upper capacitor electrode **314**, including the same transparent conductive material as the first gate electrode **214**, is formed in the capacitor region CAP. The second insulating layer **15** is formed to cover the first and second pixel electrodes **114** and **115**, the first and second gate electrodes **214** and **215**, and the upper capacitor electrode **314**.

The source and drain electrodes **216***a* and **216***b* respectively contacting the source and drain regions **212***a* and **212***b* of the active layer **212** are formed on the second insulating layer **15**, and the light reflector **116**, formed of the same material as the source and drain electrodes **216***a* and **216***b*, is formed in an opening formed in the second insulating layer **15** to expose the top of the first pixel electrode **114**. A fourth insulating layer **16** and the third insulating layer **17** are sequentially formed to cover the light reflector **116** and the source and drain electrodes **216***a* and **216***b*.

The fourth insulating layer **16** directly contacting the light reflector **116** is formed of a material having a higher light transmittance in comparison with that of the third insulating layer **17**. For example, if the third insulating layer **17** is an organic insulating layer, the fourth insulating layer **16** may be an inorganic insulating layer having a higher light transmittance than the organic insulating layer.

Accordingly, the organic light-emitting display device **2** according to the current embodiment has a higher light extraction efficiency than the organic light-emitting display device **1** according to the previous embodiment, since more photons emitted from the emission layer **118** may reach the light reflector **116** by passing through the fourth insulating layer **16** having higher light transmittance or lower light absorptance.

An organic light-emitting display device **3** according to another embodiment of the present invention will now be described with reference to FIG. **5**.

FIG. **5** is a cross-sectional view schematically illustrating the organic light-emitting display device **3** according to another embodiment of the present invention. Differences between the organic light-emitting display device **1** and the organic light-emitting display device **3** will be mainly described. Like reference numerals denote like elements.

The organic light-emitting display device **3** according to the current embodiment is different from the organic light-emitting display device **1** according to the previous embodiment in shapes and structures of source and drain electrodes **216***a*' and **216***b*' and a light reflector **116'**.

The source and drain electrodes **216***a*' and **216***b*' and the light reflector **116'** of the organic light-emitting display device **3** according to the current embodiment are formed of a metal of at least two layers having different etching rates while being etched by an etching method. The source and drain electrodes **216***a*' and **216***b*' and the light reflector **116'** may be respectively formed of two layers, but the present invention is not limited thereto and may be formed of more than two layers.

The etching rate of the metal of a plurality of layers forming the source and drain electrodes **216***a*' and **216***b*' and the light reflector **116'** may increase toward a lower layer portion, for example, toward the first and second pixel electrodes **114** and **115**. For example, a lower layer portion **116***a*' of the light reflector **116'** may be formed of molybdenum, and upper layer portion **116***b*' of the light reflector **116'** may include an aluminum alloy.

As such, when the lower layer portion **116***a*' of the light reflector **116'** is formed of a material having a higher etching rate than the upper layer portion **116***b*' of the light reflector **116'**, an etching degree of the light reflector **116'** increases from the upper layer portion **116***b*' toward the lower layer portion **116***a*', and thus the light reflector **116'** has an inverse tapered shape, wherein the light reflector **116'** narrows from the upper layer portion **116***b*' towards the lower layer portion **116***a*'. In one embodiment, the source and drain electrodes **216***a*' and **216***b*' may respectively have an inverse tapered shape.

When the light reflector **116'** has the inverse tapered shape, light extraction efficiency of the organic light-emitting display device **3** is higher than that of the organic light-emitting display device **1** since more photons from among photons emitted in random directions from the emission layer **118** reach the light reflector **116'**, and light L**2** that reaches the light reflector **116'** is reflected so that more reflected light L**2'** is emitted to the outside the organic light-emitting display device **3**.

The light reflector surrounding the periphery of the emission layer may efficiently increase the light extinction efficiency of the organic light-emitting display device.

According to an organic light-emitting display device and a method of manufacturing the same of the present invention, light extraction efficiency of the organic light-emitting display device can be increased by forming a light reflector around an emission layer, by using a metal having high reflexibility like that of source and drain electrodes. Also, manufacturing processes can be simplified since the light reflector is formed without having to perform a separate mask process. Moreover, the organic light-emitting display device, including the light reflector, can be manufactured by performing **5** mask processes.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. An organic light-emitting display device, comprising:

an active layer of a thin film transistor formed on a substrate;

a gate electrode of the thin film transistor, wherein a first gate electrode comprising a transparent conductive material, a first insulating layer, and a second gate electrode comprising a metal are sequentially stacked;

a pixel electrode disposed on the first insulating layer and the pixel electrode comprising the transparent conductive material;

a source electrode and a drain electrode of the thin film transistor, which are electrically connected to the active layer, and a second insulating layer disposed between the source electrode and the drain electrode;

a light reflector comprising a same material as the source electrode and the drain electrode, the light reflector being disposed at an upper edge of the pixel electrode;

an emission layer emitting light, the emission layer being disposed on top of the pixel electrode and the emission layer being surrounded by the light reflector; and

a counter electrode facing towards the pixel electrode, wherein the emission layer is disposed between the pixel electrode and the counter electrode.

2. The organic light-emitting display device of claim **1**, wherein the light reflector has a closed loop shape surrounding the emission layer.

3. The organic light-emitting display device of claim **1**, wherein a thickness of the light reflector is equal to or greater than a thickness of the emission layer.

4. The organic light-emitting display device of claim **1**, wherein a thickness of the light reflector is equal to each thickness of the source electrode and the drain electrode.

5. The organic light-emitting display device of claim **1**, wherein the light reflector is formed inside an opening formed by etching the second insulating layer disposed on top of the pixel electrode.

6. The organic light-emitting display device of claim **1**, wherein the light reflector has an inverse tapered shape in which the cross-sectional area of the light reflector gradually decreases towards the pixel electrode.

7. The organic light-emitting display device of claim **6**, wherein the light reflector comprises at least two layers of a metal with each layer having different etching rates when the two layers are simultaneously etched by an etching method.

8. The organic light-emitting display device of claim **7**, wherein, when the metal is etched by the etching method, the metal has a higher etching rate at a first portion of the metal which is disposed closer to the pixel electrode and has a lower etching rate at a second portion of the metal which is disposed farther away from the pixel electrode.

9. The organic light-emitting display device of claim **1**, further comprising a third insulating layer disposed between the source and drain electrodes and the counter electrode, and between the light reflector and the emission layer.

10. The organic light-emitting display device of claim **1**, further comprising a third insulating layer disposed between the source and drain electrodes and the counter electrode, and a fourth insulating layer disposed between the light reflector and the emission layer, wherein the fourth insulating layer has a higher light transmittance than the third insulating layer.

11. The organic light-emitting display device of claim **10**, wherein the third insulating layer comprises an organic insulating material and the fourth insulating layer comprises an inorganic insulating material.

12. The organic light-emitting display device of claim **1**, wherein the pixel electrode is formed by a same transparent conductive material forming the first gate electrode.

13. The organic light-emitting display device of claim **12**, further comprising a second pixel electrode disposed on an upper edge of the transparent conductive material of the pixel electrode and the second pixel electrode comprising the same metal forming the second gate electrode,

wherein the light reflector is disposed on an inner side of the second pixel electrode, and the inner side of the second pixel electrode faces toward the emission layer.

14. The organic light-emitting display device of claim **12**, wherein the transparent conductive material comprises at least one material selected from the group consisting of indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium oxide (In2O3), indium gallium oxide (IGO), aluminum zinc oxide (AZO) and the combinations thereof.

15. The organic light-emitting display device of claim **1**, wherein end shapes of etched surfaces of the first and second gate electrodes are the same.

16. The organic light-emitting display device of claim **1**, wherein the active layer comprises an ion impurity-doped semiconductor.

17. The organic light-emitting display device of claim **16**, wherein the ion impurity-doped semiconductor comprises amorphous silicon or polysilicon.

18. The organic light-emitting display device of claim **1**, further comprising:

a lower capacitor electrode comprising the same material as the active layer and formed on the same layer as the active layer; and

an upper capacitor electrode comprising the same material as the first gate electrode and being formed on the first insulating layer.

19. The organic light-emitting display device of claim **18**, wherein the lower capacitor electrode comprises an ion impurity-doped semiconductor.

20. The organic light-emitting display device of claim **1**, wherein the counter electrode is a reflective electrode that reflects light emitted from the emission layer.

21. A method of manufacturing an organic light-emitting display device, the method comprising: forming an active layer on a substrate; sequentially stacking a first insulating layer, a transparent conductive material, and a first metal layer on the active layer, and simultaneously forming a pixel electrode and a gate electrode of a thin film transistor by patterning the transparent conductive material and the first metal layer, the gate electrode comprising the transparent conductive material and the first metal layer; forming a second insulating layer on a first resultant structure obtained through the steps of sequential stacking the first insulating layer and the transparent conductive material and the first metal layer and simultaneous forming the pixel electrode and the gate electrode, and forming a first opening exposing the transparent conductive material of the pixel electrode and source and drain regions of the active layer by patterning the second insulating layer; forming a second metal layer on a second resultant structure obtained through steps of forming of the second insulating layer and forming of the first opening, and simultaneously forming source and drain electrodes which respectively contact the source and drain regions by patterning the second metal layer, and a light reflector disposed on the transparent conductive material of the pixel electrode, the light reflector comprising a same material as the source electrode and the drain electrode, the light reflector disposed at an upper edge of the pixel electrode; forming a third insulating layer on a third resultant structure obtained through steps of the forming of the second metal layer and simultaneous forming the source and drain electrodes and the light reflector, the third insulating layer exposing the transparent conductive material of the pixel electrode, forming an emission layer in a second opening formed within the third insulating layer, with the emission layer being surrounded by the light reflector; and forming a counter electrode covering the emission layer.

22. The method of claim **21**, wherein in the steps of forming of the second metal layer and simultaneous forming the source and drain electrodes, the second metal layer comprises at least two metal layers having different etching rates, and the etching rate increases toward the pixel electrode.

23. The method of claim **21**, wherein the step of forming of the third insulating layer further comprises forming a fourth insulating layer having a higher light transmittance than the third insulating layer and the fourth insulating layer being disposed between the second insulating layer and the third insulating layer, wherein the third and fourth insulating layers expose the transparent conductive material of the pixel electrode.

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专利名称(译)	有机发光显示装置及其制造方法		
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[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星移动显示器有限公司. LTD.		
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摘要(译)

一种有机发光显示装置，包括形成在基板上的薄膜晶体管（TFT）的有源层; TFT的栅电极，其中依次堆叠包括透明导电材料的第一栅电极，第一绝缘层和第二栅电极;像素电极，设置在第一绝缘层上并包括透明导电材料; TFT的源电极和漏电极，设置在源电极和漏电极之间的第二绝缘层;光反射器，包括与源电极和漏电极相同的材料，并设置在像素电极上;发光层，设置在像素电极的顶部，并被光反射器的内侧包围;面对像素电极的对电极，其中发光层设置在像素电极和对电极之间。