

(10) **Patent No.:** US 9,859,344 B2
(45) **Date of Patent:** Jan. 2, 2018

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

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**,
Yongin-si, Gyeonggi-Do (KR)

(72) Inventors: **Jiyoung Choung**, Yongin-si (KR); **Jungsun Park**, Yongin-si (KR); **Minsoo Shin**, Yongin-si (KR); **Insung Hwang**, Yongin-si (KR)

(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**,
Yongin-si, Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 95 days.

(21) Appl. No.: 14/838,390

(22) Filed: **Aug. 28, 2015**

(65) **Prior Publication Data**

US 2016/0247863 A1 Aug. 25, 2016

(30) **Foreign Application Priority Data**

Feb. 24, 2015 (KR) 10-2015-0025911

(51) **Int. Cl.**
H01L 27/32 (2006.01)
H01L 51/52 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 27/3246*** (2013.01); ***H01L 27/32H***
(2013.01); ***H01L 51/5225*** (2013.01); ***H01L***
27/3216 (2013.01); ***H01L 27/3218*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 51/5225
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,656,084 B2* 2/2010 Ishida H01L 51/5278
313/504

8,809,111 B2 8/2014 Ober et al.

8,846,301 B2 9/2014 Ober et al.

9,153,791 B2* 10/2015 Akamatsu H05B 33/22

9,331,127 B2* 5/2016 Kim H01L 27/3246

2003/0038589 A1 2/2003 Kim et al.

(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2002-0059535 A 7/2002

KR	10-2003-0017695	A	3/2003
----	-----------------	---	--------

KR	10-2007-0037091	A	4/2007
----	-----------------	---	--------

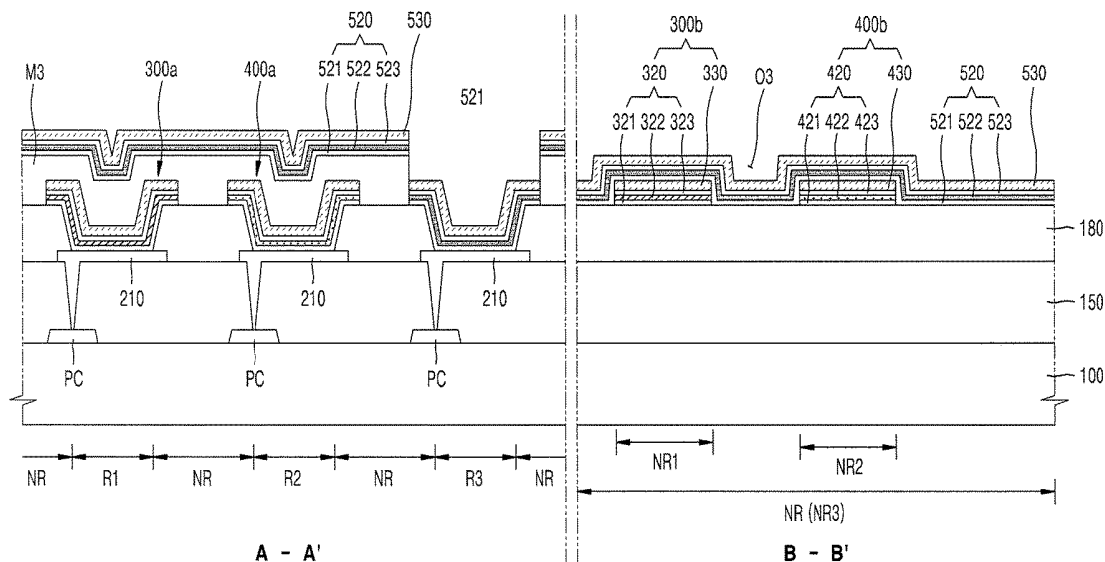
Primary Examiner — Lex Malsawma

(74) *Attorney, Agent, or Firm* — Lee & Morse, P.C.

(57) **ABSTRACT**

An organic light-emitting display device, including a substrate that includes a plurality of first emission portions that realize a first color and a plurality of second emission portions that realize a second color; a pixel-defining film that defines the plurality of first emission portions and the plurality of second emission portions; a plurality of pixel electrodes that are separate from each other and respectively correspond to the plurality of first emission portions; and a first stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer including an organic emission layer emitting light of the first color, the first stacked structure further including first emission pattern portions respectively corresponding to the plurality of first emission portions, and first connection pattern portions on the pixel-defining film, the first connection pattern portions connecting the first emission pattern portions.

28 Claims, 17 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

2013/0236999	A1	9/2013	Lee et al.	
2014/0127625	A1	5/2014	Defranco et al.	
2014/0175390	A1	6/2014	Kim et al.	
2015/0069362	A1*	3/2015	Ito	H01L 27/323 257/40

* cited by examiner

FIG. 1

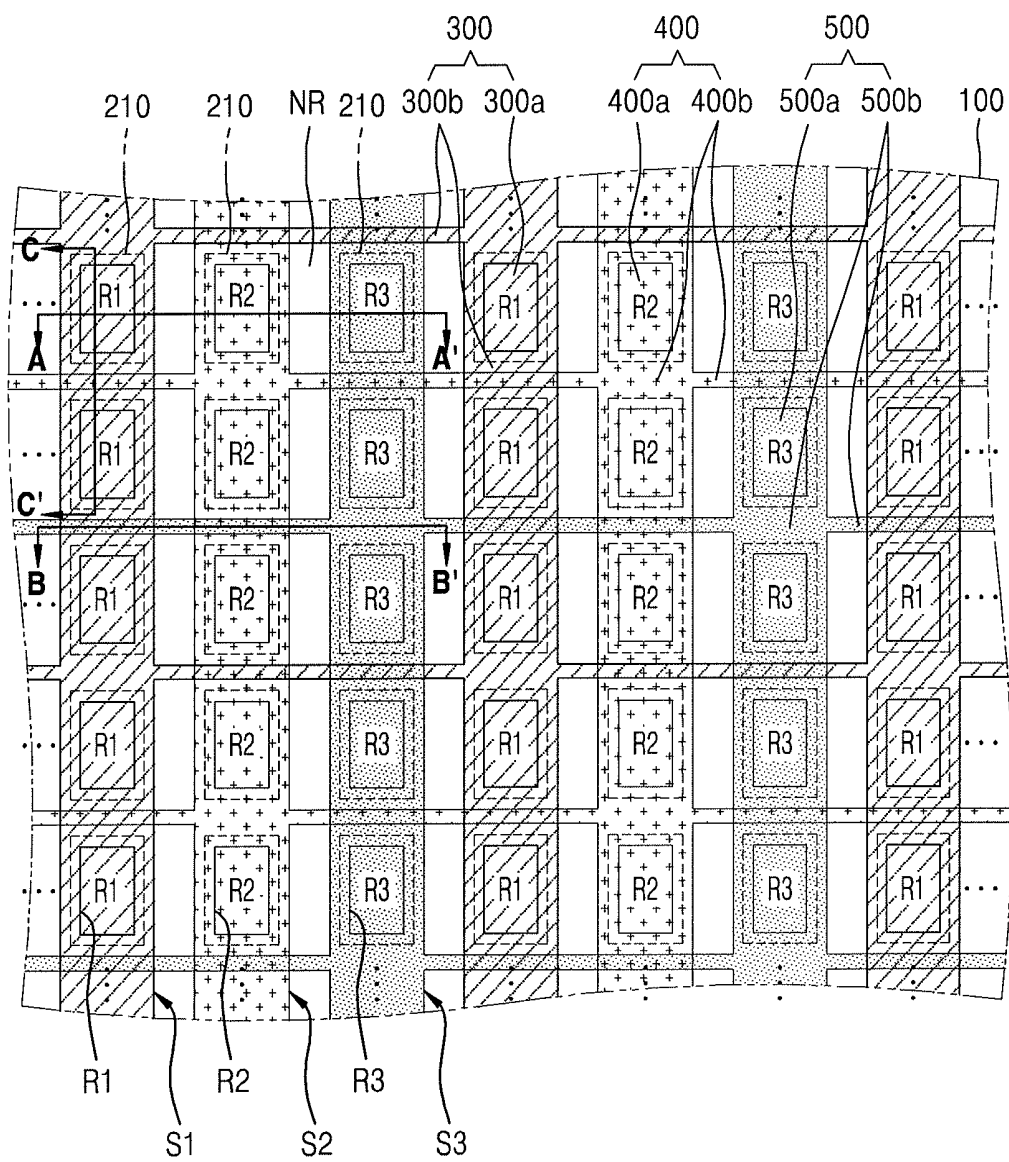


FIG. 2

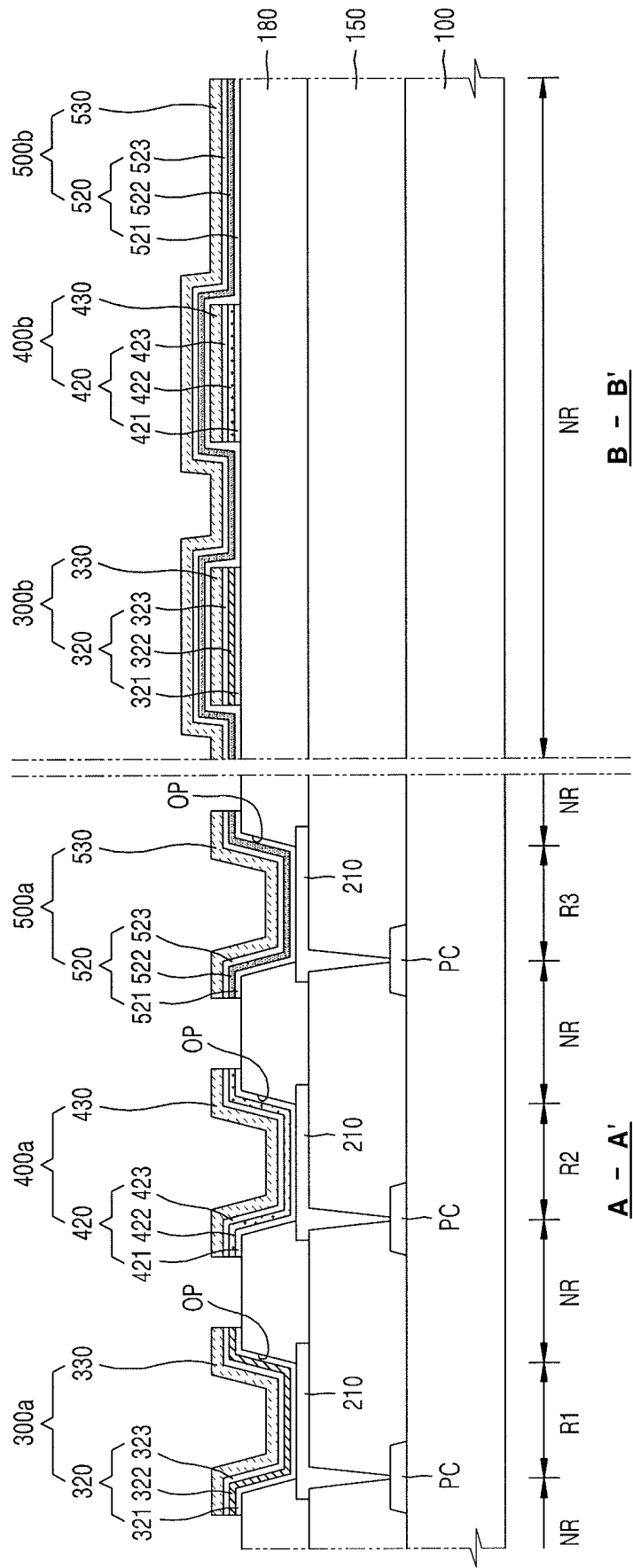


FIG. 4

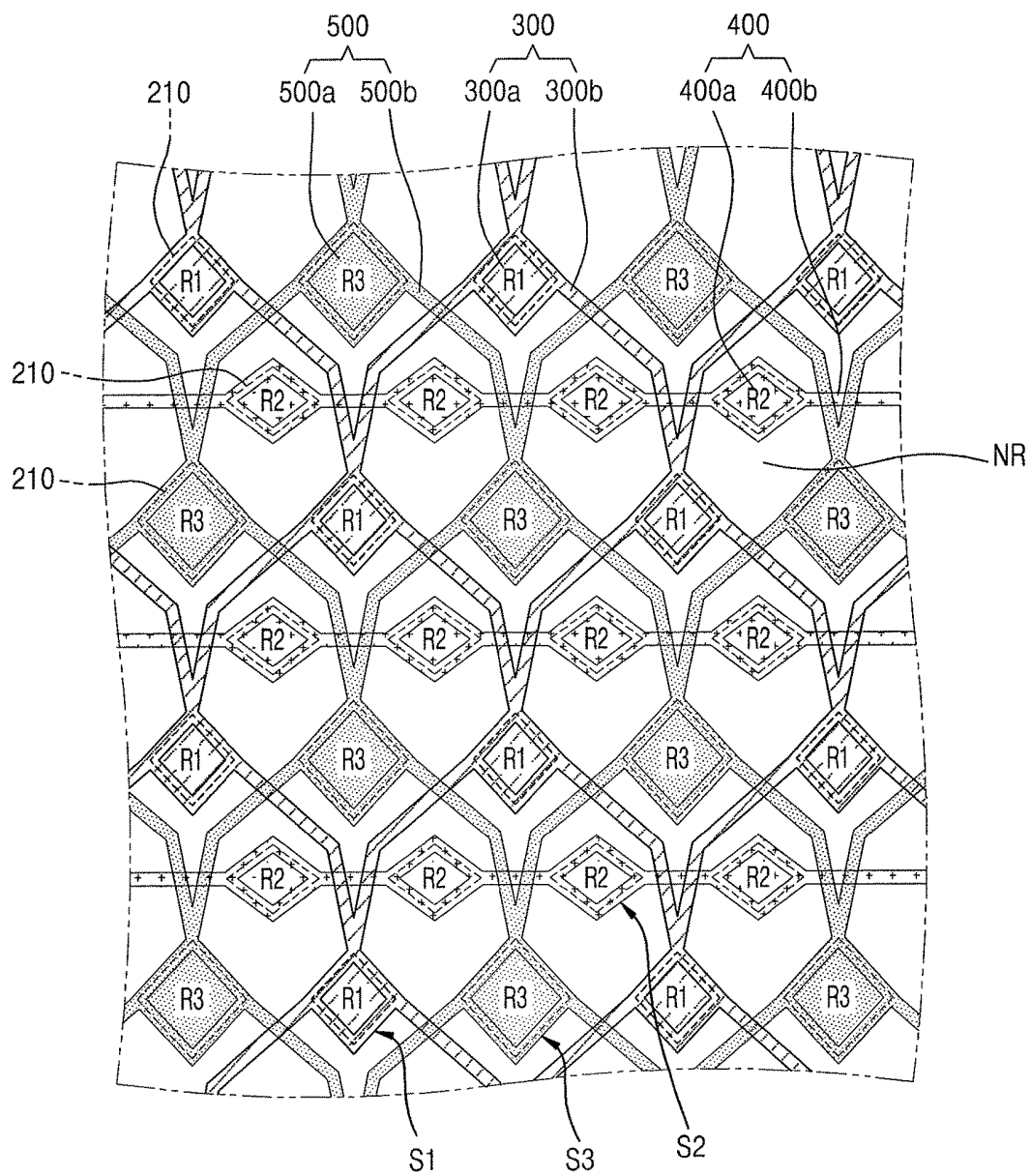


FIG. 5

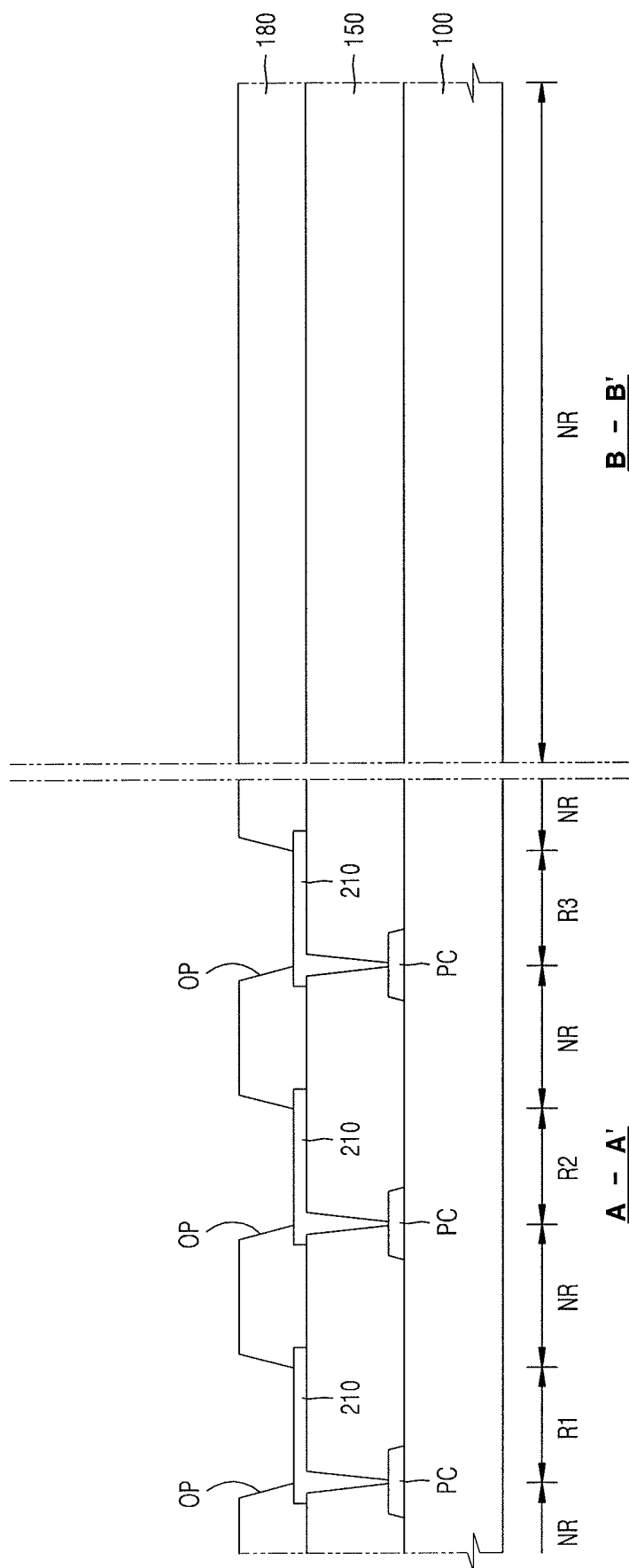


FIG. 6

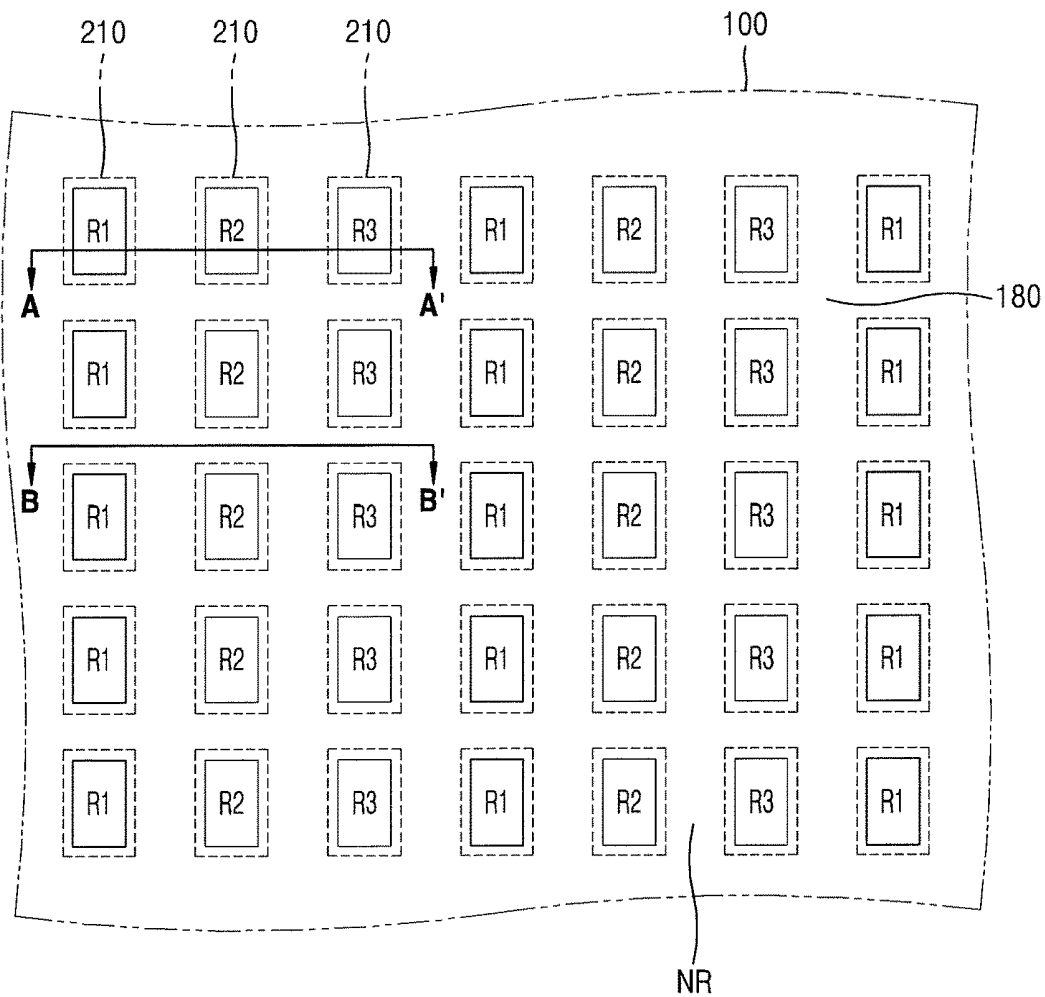


FIG. 7

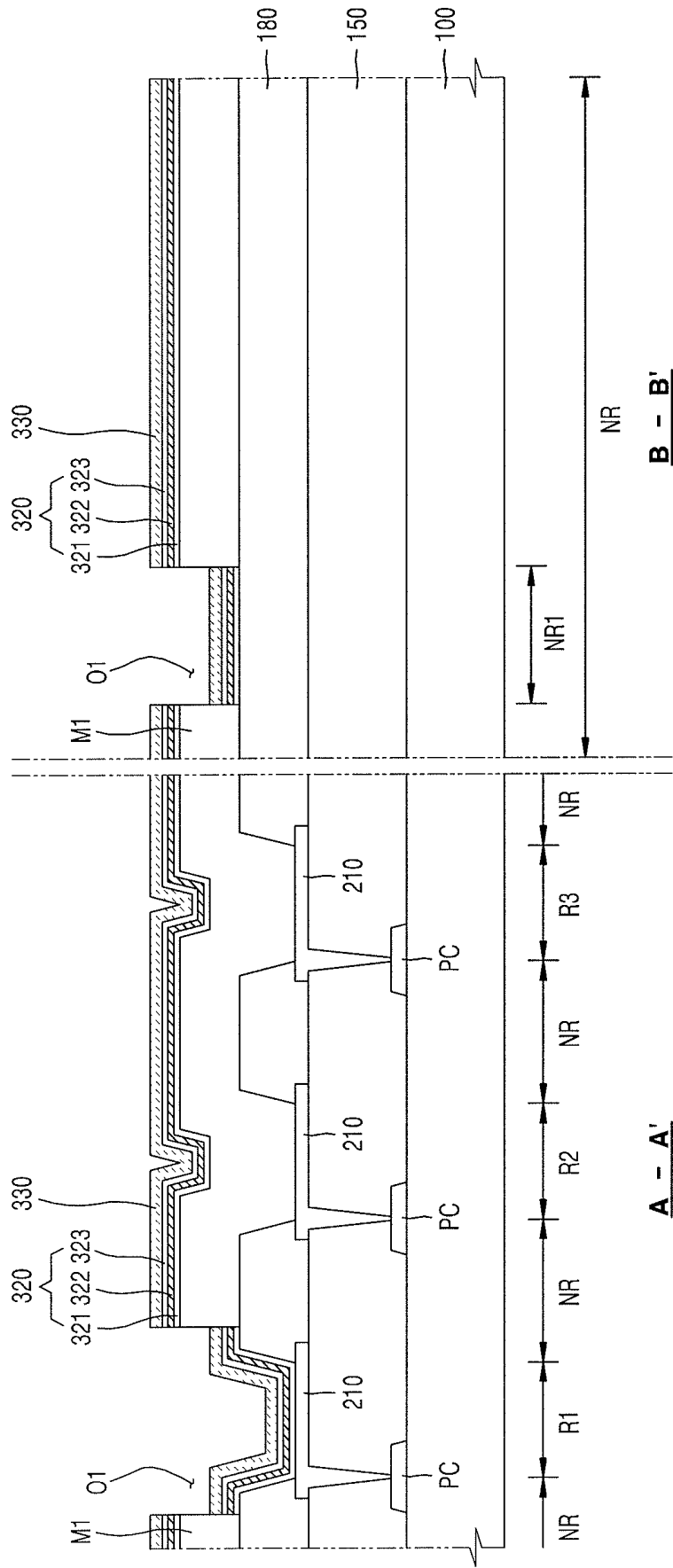


FIG. 8

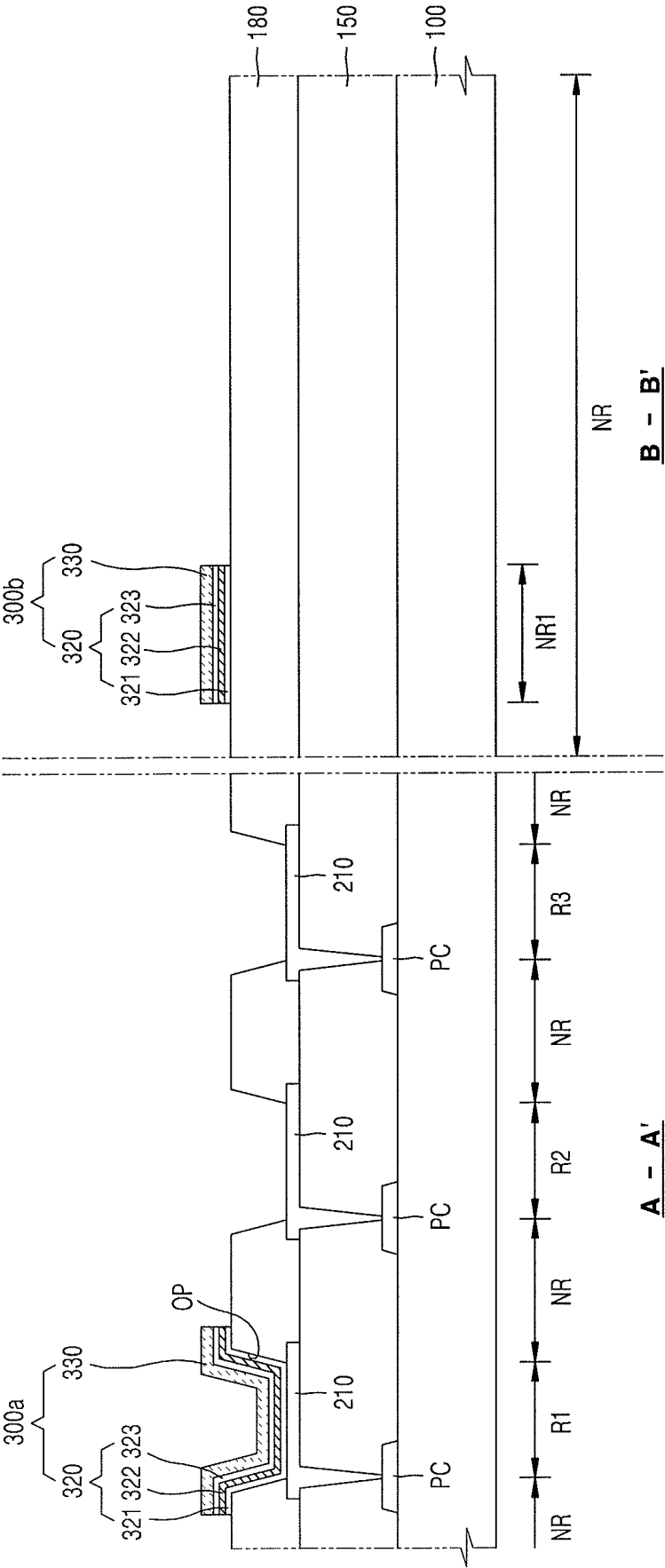


FIG. 9

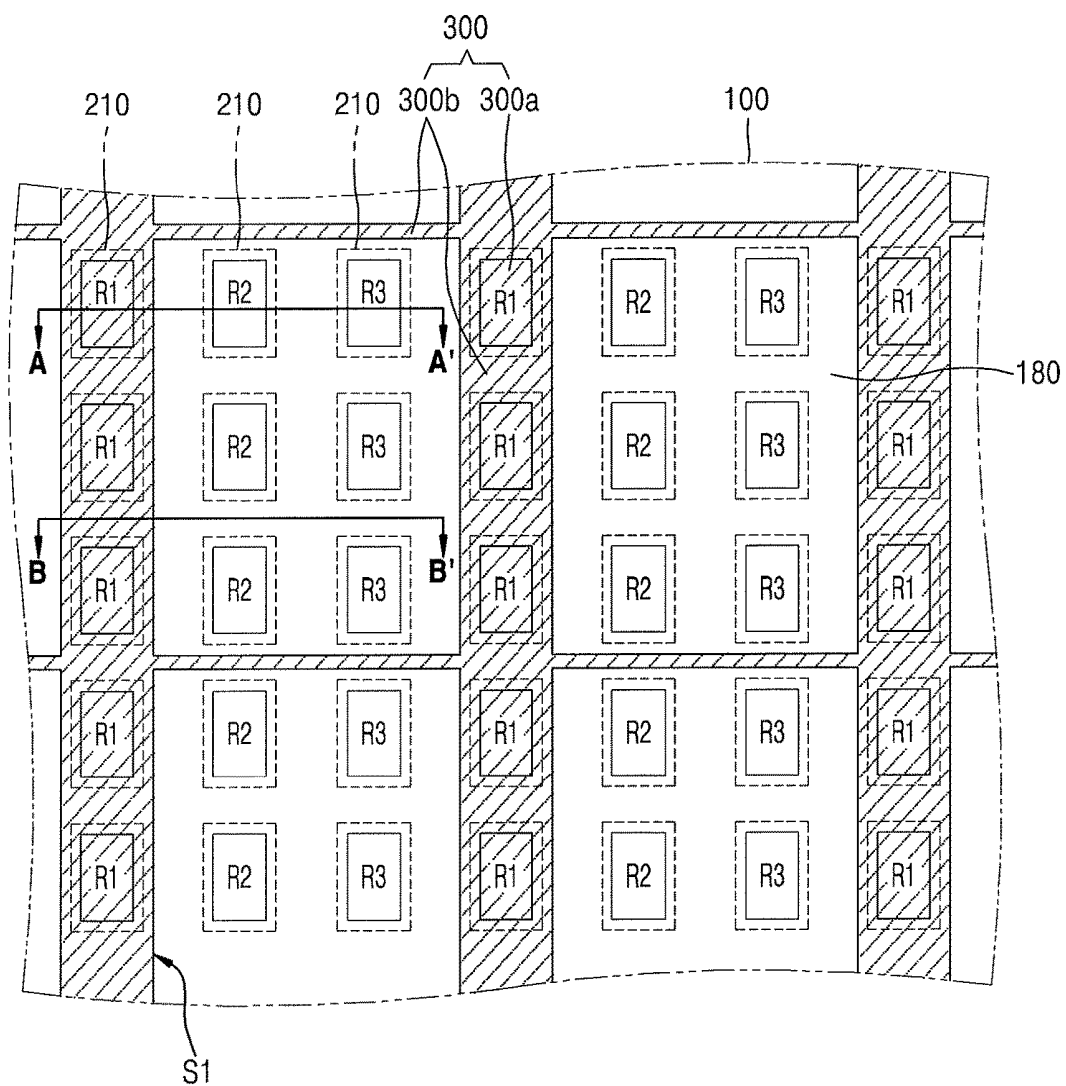


FIG. 12

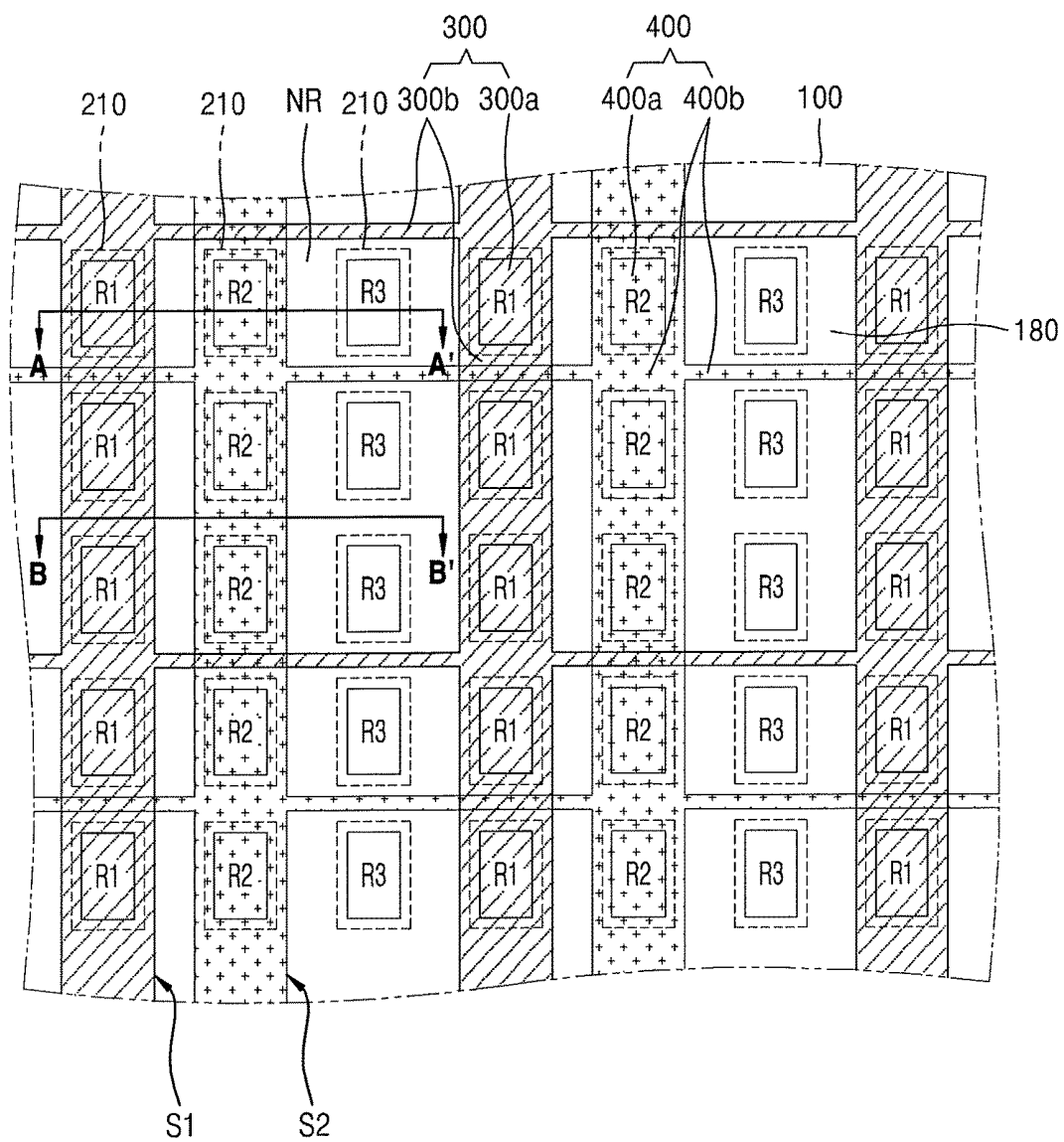


FIG. 15

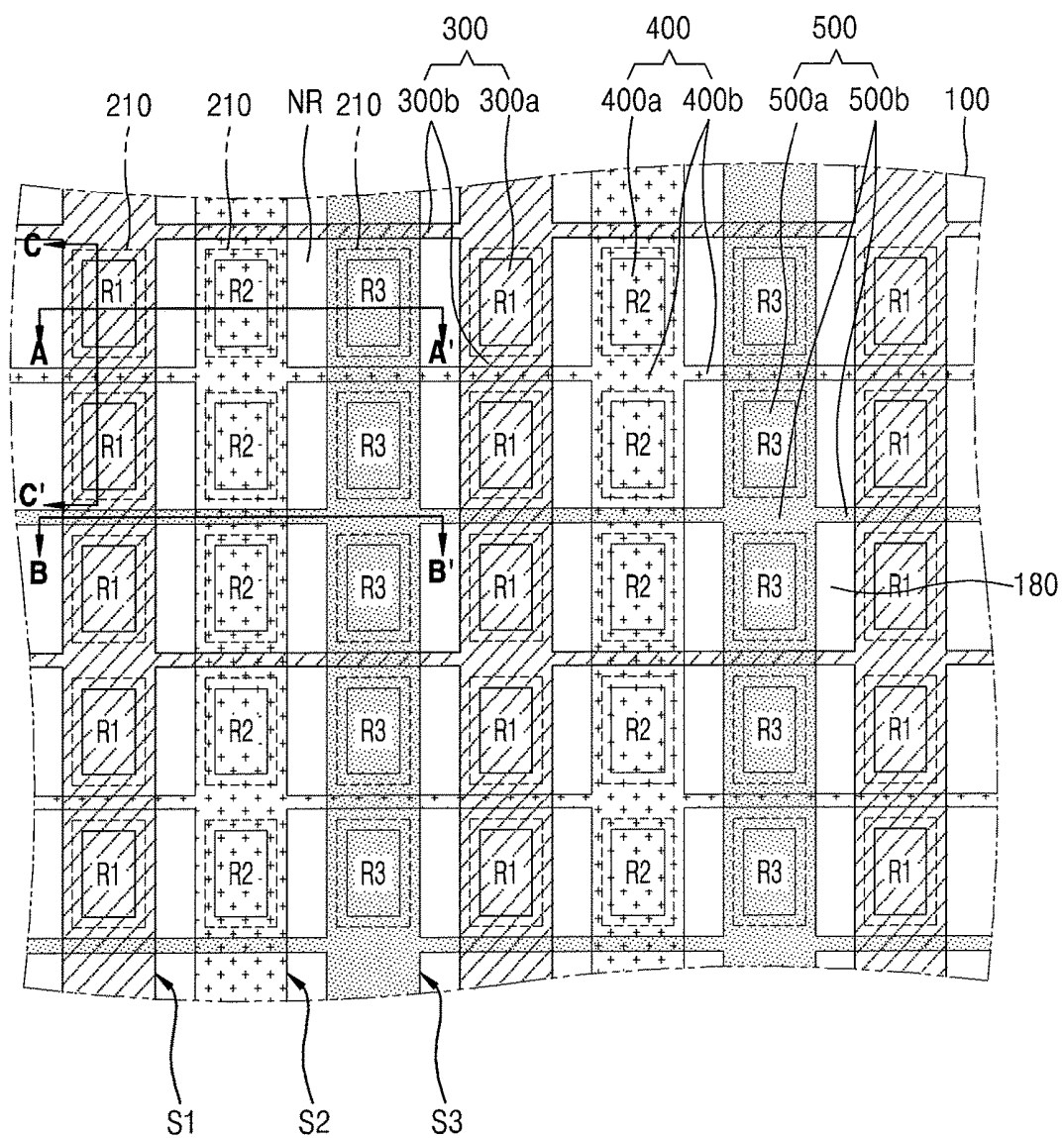
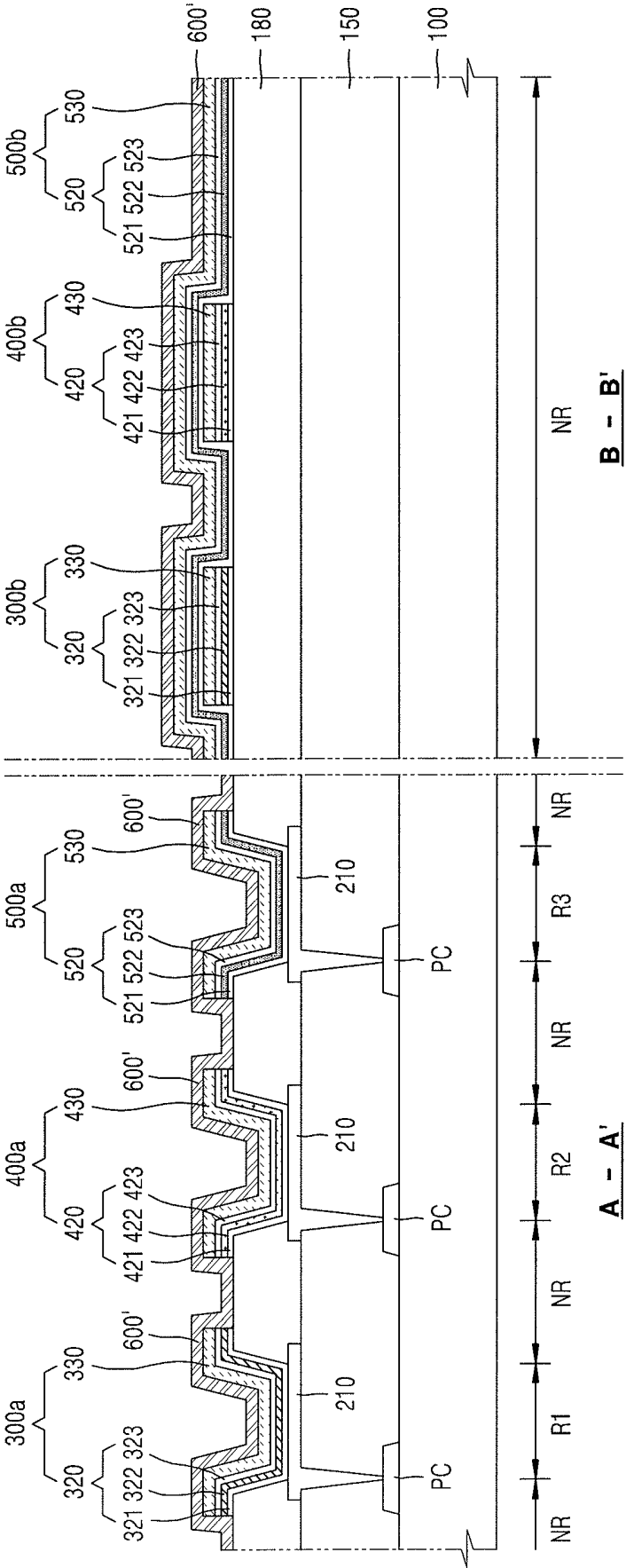


FIG. 17



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

CROSS-REFERENCE TO RELATED APPLICATION

Korean Patent Application No. 10-2015-0025911, filed on Feb. 24, 2015, in the Korean Intellectual Property Office, and entitled: "Organic Light-Emitting Display Device and Method of Manufacturing the Same," is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

One or more exemplary embodiments relate to an organic light-emitting display device and a method of manufacturing the same.

2. Description of the Related Art

An organic light-emitting display device is a display device in which pixels may each include an organic light-emitting diode (OLED). The OLED may include a pixel electrode, a counter electrode facing the pixel electrode, and an emission layer disposed between the pixel electrode and the counter electrode. In the organic light-emitting display device, the pixel electrodes may have island shapes patterned according to the pixels, and the counter electrode may be shaped such that the counter electrode integrally covers the pixels.

SUMMARY

One or more exemplary embodiments may include an organic light-emitting display device and a method of manufacturing the same.

Embodiments may be realized by providing an organic light-emitting display device, including a substrate that includes a plurality of first emission portions that realize a first color and a plurality of second emission portions that realize a second color; a pixel-defining film that defines the plurality of first emission portions and the plurality of second emission portions; a plurality of pixel electrodes that are separate from each other and respectively correspond to the plurality of first emission portions; and a first stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer including an organic emission layer emitting light of the first color, the first stacked structure further including first emission pattern portions respectively corresponding to the plurality of first emission portions, and first connection pattern portions connecting the first emission pattern portions.

The first connection pattern portions may be on a portion of a top surface of the pixel-defining film.

The counter electrode of the first stacked structure may include first regions that face the pixel electrodes respectively corresponding to the plurality of first emission portions; and a second region that connects the first regions.

The intermediate layer of the first stacked structure may include third regions that are on the pixel electrodes respectively corresponding to the plurality of first emission portions; and a fourth region that connects the third regions.

The pixel-defining film may include openings corresponding to the plurality of first emission portions, and the third regions may be at locations respectively corresponding

to the openings, and the fourth region may be on a portion of a top surface of the pixel-defining film.

The intermediate layer of the first stacked structure and the counter electrode of the first stacked structure may have a substantially same pattern.

The intermediate layer of the first stacked structure may further include a first intermediate layer that is below the organic emission layer in a direction away from the counter electrode, and the organic emission layer may be between the counter electrode and the first intermediate layer.

The first intermediate layer may include a hole transport layer.

The organic light-emitting display device may further include a second stacked structure including an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer of the second stacked structure including an organic emission layer emitting light of the second color. The second stacked structure may further include second emission pattern portions respectively corresponding to the plurality of second emission portions, and second connection pattern portions on the pixel-defining film, the second connection pattern portions connecting the second emission pattern portions.

The second connection pattern portions may be on a portion of a top surface of the pixel-defining film.

At least one of the first connection pattern portions and at least one of the second connection pattern portions may overlap each other on the portion of the top surface of the pixel-defining film.

The counter electrode of the second stacked structure may include fifth regions that face the pixel electrodes respectively corresponding to the plurality of second emission portions; and a sixth region that connects the fifth regions.

The intermediate layer of the second stacked structure may include seventh regions that are on the pixel electrodes respectively corresponding to the plurality of second emission portions; and an eighth region that connects the seventh regions.

The intermediate layer of the second stacked structure and the counter electrode of the second stacked structure may have a substantially same pattern.

The organic light-emitting display device may further include a protection film on the counter electrode of the first stacked structure.

The protection film may have a substantially same pattern as the intermediate layer and the counter electrode of the first stacked structure.

The counter electrode of the first stacked structure may include a semi-transmissive metal layer, and the protection film may be transparent.

Embodiments may be realized by providing a method of manufacturing an organic light-emitting display device, the method including preparing a substrate that includes a plurality of first emission portions that realize a first color and a plurality of second emission portions that realize a second color; forming a plurality of pixel electrodes having an island shape so as to separate from each other and respectively correspond to the plurality of first emission portions of the substrate; forming, on the substrate, a pixel-defining film that includes openings corresponding to the plurality of first emission portions and the plurality of second emission portions; and forming a first stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer including an organic emission layer emitting light of the first color, the first stacked structure further including first emission pattern portions respectively corresponding to the plu-

3

ality of first emission portions, and first connection pattern portions on the pixel-defining film, the first connection pattern portions connecting the first emission pattern portions.

The first connection pattern portions of the first stacked structure may be on a portion of a top surface of the pixel-defining film.

The intermediate layer of the first stacked structure and the counter electrode of the first stacked structure may have a substantially same pattern.

Forming the first stacked structure may include forming, on the substrate, a masking pattern that includes an opening exposing the plurality of first emission portions, and a first non-emission portion connecting the plurality of first emission portions, the first non-emission portion corresponding to a portion of a top surface of the pixel-defining film; forming the intermediate layer including the organic emission layer emitting the light of the first color, on an entire surface of the substrate on which the masking pattern is formed; forming the counter electrode on the intermediate layer; and removing the masking pattern such that the first emission pattern portions respectively corresponding to the plurality of first emission portions remain, and the first connection pattern portions that correspond to the first non-emission portion and connect the first emission pattern portions remain.

The intermediate layer of the first stacked structure may further include a first intermediate layer that is below the organic emission layer in a direction away from the counter electrode, and the organic emission layer may be between the counter electrode and the first intermediate layer.

The first intermediate layer may include a hole transport layer.

The method may further include forming a second stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer including an organic emission layer emitting light of the second color. The second stacked structure may further include second emission pattern portions respectively corresponding to the plurality of second emission portions, and second connection pattern portions on the pixel-defining film, the second connection pattern portions connecting the second emission pattern portions.

At least one of the second connection pattern portions and at least one of the first connection pattern portions may overlap each other on a portion of a top surface of the pixel-defining film.

The intermediate layer of the second stacked structure and the counter electrode of the second stacked structure may have a substantially same pattern.

The method may further include forming a protection film on the counter electrode of the first stacked structure.

The protection film may have a substantially same pattern as the intermediate layer and the counter electrode of the first stacked structure.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 illustrates a schematic top view of an organic light-emitting display device according to an exemplary embodiment;

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

4

FIG. 3 illustrates a cross-sectional view taken along a line C-C' of FIG. 1;

FIG. 4 illustrates a schematic top view of an organic light-emitting display device according to an exemplary embodiment;

FIG. 5 illustrates a schematic side view of a substrate on which a plurality of emission portions are disposed;

FIG. 6 illustrates a top view of FIG. 5;

FIGS. 7 and 8 illustrate cross-sectional views for describing a process of forming a first stacked structure having a first pattern;

FIG. 9 illustrates a top view of FIG. 8;

FIGS. 10 and 11 illustrate cross-sectional views for describing a process of forming a second stacked structure having a second pattern;

FIG. 12 illustrates a top view of FIG. 11;

FIGS. 13 and 14 illustrate cross-sectional views for describing a process of forming a third stacked structure having a third pattern;

FIG. 15 illustrates a top view of FIG. 14;

FIG. 16 illustrates a schematic cross-sectional view of an organic light-emitting display device according to an exemplary embodiment; and

FIG. 17 illustrates a schematic cross-sectional view of an organic light-emitting display device according to an exemplary embodiment.

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.

In drawings, like reference numerals refer to like elements throughout and overlapping descriptions shall not be repeated.

As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

It will be understood that although the terms "first", "second", etc., may be used herein to describe various components, these components should not be limited by these terms. These components are only used to distinguish one component from another.

As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

It will be further understood that the terms "comprises" and/or "comprising" used herein specify the presence of stated features or components, but do not preclude the presence or addition of one or more other features or components.

It will be understood that when a layer, region, or component is referred to as being "formed on," another layer, region, or component, it can be directly or indirectly formed on the other layer, region, or component. That is, for example, intervening layers, regions, or components may be present.

Sizes of elements in the drawings may be exaggerated for convenience of explanation. In other words, since sizes and thicknesses of components in the drawings are arbitrarily illustrated for convenience of explanation, the following embodiments are not limited thereto.

When a certain embodiment may be implemented differently, a specific process order may be performed differently from the described order. For example, two consecutively described processes may be performed substantially at the same time or performed in an order opposite to the described order.

It will be understood that when a component or layer is referred to as being "on" another component or layer, the component or layer can be directly on another component or layer or intervening component or layers. Further, it will be understood that when a layer is referred to as being "under" another layer, it can be directly under, and one or more intervening layers may also be present. In addition, it will also be understood that when a layer is referred to as being "between" two layers, it can be the only layer between the two layers, or one or more intervening layers may also be present.

FIG. 1 illustrates a schematic top view of an organic light-emitting display device according to an exemplary embodiment.

Referring to FIG. 1, the organic light-emitting display device may include a plurality of emission portions (active areas), i.e., first through third emission portions R1 through R3. The first through third emission portions R1 through R3 may be disposed to form a matrix. The first through third emission portions R1 through R3 may each emit different lights and may each correspond to a pixel. For example, each of the first through third emission portions R1 through R3 may be a pixel realizing, e.g., displaying, red, green, or blue. Hereinafter, for convenience of description, the first emission portion R1 realizes red, the second emission portion R2 realizes green, and the third emission portion R3 realizes blue, but an exemplary embodiment is not limited thereto. Colors realized by the first through third emission portions R1 through R3 are not limited to red, green, and blue as long as full color is realized. According to an exemplary embodiment, any combination of colors may be used, such as a combination of four colors, i.e., red, green, blue, and white, as long as full color is realized.

Pixel electrodes 210 and first through third stacked structures 300 through 500 may be disposed on a substrate 100. The pixel electrodes 210 may be patterned in island types to be separated from each other correspondingly to the first through third emission portions R1 through R3. The first through third stacked structures 300 through 500 may be patterned to have patterns connected to each other, like a net. The first stacked structure 300 may include first emission pattern portions 300a corresponding to the first emission portions R1, and first connection pattern portions 300b connecting the first emission pattern portions 300a, wherein the first emission pattern portions 300a and the first connection pattern portions 300b may form a first pattern S1 like a net. The second stacked structure 400 may include second emission pattern portions 400a corresponding to the second emission portions R2, and second connection pattern portions 400b connecting the second emission pattern portions 400a, wherein the second emission pattern portions 400a and the second connection pattern portions 400b may form a second pattern S2 like a net. The third stacked structure 500 may include third emission pattern portions 500a corresponding to the third emission portions R3, and third connection pattern portions 500b connecting the third emission pattern portions 500a, wherein the third emission pattern portions 500a and the third connection pattern portions 500b may form a third pattern S3 like a net.

The first through third stacked structures 300 through 500 may include intermediate layers 320 through 520 (refer to

FIG. 2) and counter electrodes 330 through 530 (refer to FIG. 2), respectively. The intermediate layers 320 through 520 and the counter electrodes 330 through 530 may be patterned to have substantially the same patterns.

According to a comparative example, when a counter electrode is formed on an entire surface of the substrate 100 to integrally cover a plurality of pixels, i.e., the first through third emission portions R1 through R3, a voltage drop (IR drop) may occur, for example, due to resistance of the counter electrode, and luminance deviation may occur. However, according to one or more exemplary embodiments, the counter electrodes 330 through 530 may be patterned together with the intermediate layers 320 through 520, an increase in the resistance of the counter electrodes 330 through 530 may be prevented, and IR drop and consequent luminance deviation may be reduced or prevented.

FIG. 2 illustrates a cross-sectional view taken along a line A-A' and a line B-B' of FIG. 1, and FIG. 3 illustrates a cross-sectional view taken along a line C-C' of FIG. 1.

The substrate 100 may be formed of one of various materials, such as a glass material, a metal material, and a plastic material such as polyethylene terephthalate (PET), polyethylene naphthalate (PEN), or polyimide. According to some embodiments, the substrate 100 may have higher flexibility when the substrate 100 is formed of a plastic material or a metal material than when the substrate 100 is formed of a glass material. A buffer layer formed of SiO₂ and/or SiNx may be disposed on the substrate 100 to prevent impurities from penetrating into the substrate 100.

The substrate 100 may include a plurality of emission portions (active areas) R1 through R3, and a non-emission portion (non-active area) NR surrounding the emission portions R1 through R3.

A pixel circuit PC may include a thin-film transistor (TFT) and a capacitor, and may be electrically connected to the pixel electrode 210. A top surface of the pixel circuit PC may be covered by an insulating film 150 that is approximately flat.

The pixel electrode 210 may be formed in each of the first through third emission portions R1 through R3. The pixel electrode 210 may be disposed on the insulating film 150 and may be patterned in an island type correspondingly to each of the first through third emission portions R1 through R3. The pixel electrode 210 may be electrically connected to the TFT of the pixel circuit PC.

The pixel electrode 210 may be a (semi-)transparent electrode having translucency, or a reflective electrode. When the pixel electrode 210 is a (semi-)transparent electrode, the pixel electrode 210 may be formed of, for example, indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium oxide (In₂O₃), indium gallium oxide (IGO), or aluminum zinc oxide (AZO). When the pixel electrode 210 is a reflective electrode, a reflective film may be formed of silver (Ag), magnesium (Mg), aluminum (Al), platinum (Pt), palladium (Pd), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), or a compound thereof. According to an exemplary embodiment, the pixel electrode 210 may include a reflective film including Ag, Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, or a compound thereof, and a film formed of ITO, IZO, ZnO, or In₂O₃ on the reflective film.

A pixel-defining film 180 may include openings OP respectively corresponding to the first through third emission portions R1 through R3. The openings OP of the pixel-defining film 180 respectively may correspond to the first through third emission portions R1 through R3 from

which lights may be emitted, and a region where the pixel-defining film **180** is disposed may correspond to a non-emission portion (non-active area) NR. At least a portion of a top surface of the pixel electrode **210** may not be covered by the pixel-defining film **180**. For example, the opening OP may be formed in the pixel-defining film **180**, and a portion of the top surface of the pixel electrode **210** may not be covered by the pixel-defining film **180**. An edge of the pixel electrode **210** may be covered by the pixel-defining film **180**. The pixel-defining film **180** may include an organic insulating film formed of, for example, acrylic resin. The pixel-defining film **180** may increase a distance between an end of the pixel electrode **210** and the counter electrodes **330** through **530**, and an electric arc may be prevented from being generated at the end of the pixel electrode **210**.

The first through third stacked structures **300** through **500** may be independently, for example, separately, patterned. The first through third stacked structures **300** through **500** may have structures in which the intermediate layers **320** through **520** and the counter electrodes **330** through **530** are sequentially stacked, and have the first through third patterns S1 through S3, respectively.

The first stacked structure **300** may have the first pattern S1 including the first emission pattern portions **300a** and the first connection pattern portions **300b**. Each of the first emission pattern portions **300a** may be disposed on the first emission portion R1, and the first connection pattern portions **300b** may be disposed on the non-emission portion NR to connect the first emission pattern portions **300a**.

The first stacked structure **300** may include the intermediate layer **320** and the counter electrode **330** stacked on the intermediate layer **320**, and the intermediate layer **320** may include a first intermediate layer **321**, an organic emission layer **322** emitting a red light, and a second intermediate layer **323**, which are sequentially stacked on each other.

The first intermediate layer **321** may have a single layer or multi-layer structure. For example, when the first intermediate layer **321** is formed of a high molecular weight material, the first intermediate layer **321** may be a hole transport layer (HTL) having a single layer structure and may be formed of poly-(3,4)-ethylene-dihydroxy thiophene (PEDOT) or polyaniline (PANI). When the first intermediate layer **321** is formed of low molecular weight material, the first intermediate layer **321** may include a hole injection layer (HIL) and a HTL.

The organic emission layer **322** may be disposed on the first intermediate layer **321**. According to an exemplary embodiment, the organic emission layer **322** may include, as a host material, an anthracene derivative or a carbazole-based compound, and may include, as a dopant material, a phosphor including at least one of PIr(acac)(bis(1-phenylisoquinoline)acetylacetonate iridium), PQIr(acac)(bis(1-phenylquinoline)acetylacetonate iridium), PQIr(tris(1-phenylquinoline) iridium), and PtPEP(octaethylporphyrin platinum). According to an exemplary embodiment, the organic emission layer **322** may include a fluorescent material, such as, for example, PED:Eu(DBM)3(Phen) or perylene.

The second intermediate layer **323** may be disposed on the organic emission layer **322**. The second intermediate layer **323** may be omitted in some embodiments. For example, when the first intermediate layer **321** and the organic emission layer **322** are formed of a high molecular weight material, the second intermediate layer **323** may be omitted. When the first intermediate layer **321** and the organic emission layer **322** are formed of a low molecular

weight material, the second intermediate layer **323** may be formed such that light-emitting characteristic is increased. The second intermediate layer **323** may have a single layer or a multi-layer structure, and may include an electron transport layer (ETL) and/or an electron injection layer (EIL).

The counter electrode **330** may be a (semi-)transparent electrode having translucency or a reflective electrode. According to an exemplary embodiment, when the counter electrode **330** is a (semi-)transparent electrode, the counter electrode **330** may include a semi-transmissive metal layer including Ag and Mg. For example, the counter electrode **330** may be formed of an Ag—Mg alloy in which an amount of Ag is higher than an amount of Mg. According to an exemplary embodiment, the counter electrode **330** may include a layer formed of lithium (Li), calcium (Ca), lithium fluoride (LiF)/Ca, LiF/Al, Al, Mg, or a compound thereof, and another layer disposed on the layer and formed of a (semi-)transparent material, such as ITO, IZO, ZnO, or In_2O_3 .

When the counter electrode **330** is a reflective electrode, the reflective electrode may be formed by forming a layer including, for example, at least one of Li, Ca, LiF/Ca, LiF/Al, Al, Ag, and Mg. In an embodiment, a structure and material of the counter electrode **330** may vary; for example, the counter electrode **330** may be formed of another material and may have a multi-layer structure.

The counter electrode **330** may be patterned to be disposed on the first emission portions R1 and a part of the non-emission portion NR (for example, a portion of the top surface of the pixel-defining film **180**), resistance may be reduced, and IR drop caused by the resistance of the counter electrode **330** and consequent luminance deviation may be reduced or prevented.

The first stacked structure **300** may include the intermediate layer **320** and the counter electrode **330** disposed on the intermediate layer **320**, and the intermediate layer **320** and the counter electrode **330** may have substantially the same pattern. For example, the intermediate layer **320** and the counter electrode **330** may have the first pattern S1. For example, the counter electrode **330** may include regions (hereinafter, referred to as first regions) corresponding to the first emission pattern portions **300a** and disposed in the first emission portion R1, and a region (hereinafter, referred to as a second region) corresponding to the first connection pattern portion **300b** and disposed on a portion of the top surface of the pixel-defining film **180** to connect the first regions. The intermediate layer **320** may include regions (hereinafter, referred to as third regions) corresponding to the first emission pattern portions **300a** and disposed in the first emission portion R1, and a region (hereinafter, referred to as a fourth region) corresponding to the first connection pattern portion **300b** and disposed on a portion of the top surface of the pixel-defining film **180** to connect the third regions. The first region of the counter electrode **330** and the third region of the intermediate layer **320** may overlap each other, and the second region of the counter electrode **330** and the fourth region of the intermediate layer **320** may overlap each other.

Since the intermediate layer **320** of the first emission pattern portion **300a**, i.e., the third region of the intermediate layer **320**, is disposed between the pixel electrode **210** and the counter electrode **330**, when an electric signal is applied to each of the pixel electrode **210** and the counter electrode **330**, excitons generated as holes and electrons discharged from the pixel electrode **210** and the counter electrode **330** that may combine at the organic emission layer **322** may

change from an excited state to a ground state to generate a red light. Since the intermediate layer **320** of the first connection pattern portion **300b**, i.e., the fourth region of the intermediate layer **320**, is disposed on the pixel-defining film **180** where the pixel electrode **210** is not disposed, light may not be emitted even when an electric signal is applied to the counter electrode **330** of the first stacked structure **300**.

The second stacked structure **400** may have the second pattern **S2** including the second emission pattern portions **400a** and the second connection pattern portions **400b**. Each of the second emission pattern portions **400a** may be disposed on the second emission portion **R2**, and the second connection pattern portions **400b** may be disposed on the non-emission portion **NR** to connect the second emission pattern portions **400a**.

The second stacked structure **400** may include the intermediate layer **420** and the counter electrode **430** stacked on the intermediate layer **420**, and the intermediate layer **420** may include a first intermediate layer **421**, an organic emission layer **422** emitting a green light, and a second intermediate layer **423**, which are sequentially stacked on each other.

The first intermediate layer **421** may have a single layer or a multi-layer structure. For example, when the first intermediate layer **421** is formed of a high molecular weight material, the first intermediate layer **421** may be an HTL having a single layer structure and formed of PEDOT or PANI. When the first intermediate layer **421** is formed of a low molecular weight material, the first intermediate layer **421** may include an HIL and an HTL.

The organic emission layer **422** may be disposed on the first intermediate layer **421**. According to an exemplary embodiment, the organic emission layer **422** may include, as a host material, an anthracene derivative or a carbazole-based compound, and may include, as a dopant material, a phosphor including fac tris(2-phenylpyridine) iridium (Ir(ppy)₃). According to an exemplary embodiment, the organic emission layer **422** may include a fluorescent material such as, for example, tris(8-hydroxyquinoline) aluminum (Alq₃).

The second intermediate layer **423** may be disposed on the organic emission layer **422**. The second intermediate layer **423** may be omitted in some embodiments. For example, when the first intermediate layer **421** and the organic emission layer **422** are formed of a high molecular weight material, the second intermediate layer **423** may be omitted. When the first intermediate layer **421** and the organic emission layer **422** are formed of a low molecular material, the second intermediate layer **423** may be formed such that light-emitting characteristic is increased. The second intermediate layer **423** may have a single layer or a multi-layer structure, and may include an ETL and/or an EIL.

The counter electrode **430** may be a (semi-)transparent electrode having translucency or a reflective electrode. According to an exemplary embodiment, when the counter electrode **430** is a (semi-)transparent electrode, the counter electrode **430** may include a semi-transmissive metal layer including Ag and Mg. For example, the counter electrode **430** may be formed of an Ag—Mg alloy in which an amount of Ag is higher than an amount of Mg. According to an exemplary embodiment, the counter electrode **430** may include a layer formed of Li, Ca, LiF/Ca, LiF/Al, Al, Mg, or a compound thereof, and another layer disposed on the layer and formed of a (semi-) transparent material, such as ITO, IZO, ZnO, or In₂O₃.

When the counter electrode **430** is a reflective electrode, the reflective electrode may be formed by forming a layer including, for example, at least one of Li, Ca, LiF/Ca, LiF/Al, Al, Ag, and Mg. In an embodiment, a structure and material of the counter electrode **430** may vary; for example, the counter electrode **430** may be formed of another material and may have a multi-layer structure.

The counter electrode **430** may be patterned to be disposed on the second emission portions **R2** and a part of the non-emission portion **NR** (for example, a portion of the top surface of the pixel-defining film **180**), resistance may be reduced, and IR drop caused by the resistance of the counter electrode **430** and consequent luminance deviation may be reduced or prevented.

The second stacked structure **400** may include the intermediate layer **420** and the counter electrode **430** disposed on the intermediate layer **420**, and the intermediate layer **420** and the counter electrode **430** may have substantially the same pattern. For example, the intermediate layer **420** and the counter electrode **430** may have the second pattern **S2**. For example, the counter electrode **430** may include regions (hereinafter, referred to as fifth regions) corresponding to the second emission pattern portions **400a** and disposed in the second emission portion **R2**, and a region (hereinafter, referred to as a sixth region) corresponding to the second connection pattern portion **400b** and disposed on a portion of the top surface of the pixel-defining film **180** to connect the fifth regions. The intermediate layer **420** may include regions (hereinafter, referred to as seventh regions) corresponding to the second emission pattern portions **400a** and disposed in the second emission portion **R2**, and a region (hereinafter, referred to as an eighth region) corresponding to the second connection pattern portion **400b** and disposed on a portion of the top surface of the pixel-defining film **180** to connect the seventh regions. The fifth region of the counter electrode **430** and the seventh region of the intermediate layer **420** may overlap each other, and the sixth region of the counter electrode **430** and the eighth region of the intermediate layer **420** may overlap each other.

Since the intermediate layer **420** of the second emission pattern portion **400a**, i.e., the seventh region of the intermediate layer **420**, is disposed between the pixel electrode **210** and the counter electrode **430**, when an electric signal is applied to each of the pixel electrode **210** and the counter electrode **430**, excitons generated as holes and electrons discharged from the pixel electrode **210** and the counter electrode **430** that may combine at the organic emission layer **422** may change from an excited state to a ground state to generate a green light. Since the intermediate layer **420** of the second connection pattern portion **400b**, i.e., the eighth region of the intermediate layer **420**, is disposed on the pixel-defining film **180** where the pixel electrode **210** is not disposed, light may not be emitted even when an electric signal is applied to the counter electrode **430** of the second stacked structure **400**.

The third stacked structure **500** may have the third pattern **S3** including the third emission pattern portions **500a** and the third connection pattern portions **500b**. Each of the third emission pattern portions **500a** may be disposed on the third emission portion **R3**, and the third connection pattern portions **500b** may be disposed on the non-emission portion **NR** to connect the third emission pattern portions **500a**.

The third stacked structure **500** may include the intermediate layer **520** and the counter electrode **530** stacked on the intermediate layer **520**, and the intermediate layer **520** may include a first intermediate layer **521**, an organic emission

layer **522** emitting a blue light, and a second intermediate layer **523**, which are sequentially stacked on each other.

The first intermediate layer **521** may have a single layer or a multi-layer structure. For example, when the first intermediate layer **521** is formed of a high molecular weight material, the first intermediate layer **521** may be an HTL having a single layer structure and formed of PEDOT or PANI. When the first intermediate layer **521** is formed of a low molecular weight material, the first intermediate layer **521** may include an HIL and an HTL.

The organic emission layer **522** may be disposed on the first intermediate layer **521**. According to an exemplary embodiment, the organic emission layer **522** may include, as a host material, an anthracene derivative or a carbazole-based compound, and may include, as a dopant material, a phosphor including F_2Irpic , $(F_2ppy)_2Ir(tmd)$, or $Ir(dfppz)_3$. According to an exemplary embodiment, the organic emission layer **522** may include a fluorescent material including one of, for example, DPVBi, spiro-DPVBi, spiro-6P, distyrylbenzene (DSB), distyrylarylene (DSA), PFO-based polymer, and PPV-based polymer.

The second intermediate layer **523** may be disposed on the organic emission layer **522**. The second intermediate layer **523** may be omitted in some embodiments. For example, when the first intermediate layer **521** and the organic emission layer **522** are formed of a high molecular weight material, the second intermediate layer **523** may be omitted. When the first intermediate layer **521** and the organic emission layer **522** are formed of a low molecular material, the second intermediate layer **523** may be formed such that light-emitting characteristic is increased. The second intermediate layer **523** may have a single layer or a multi-layer structure, and may include an ETL and/or an EIL.

The counter electrode **530** may be a (semi-)transparent electrode having translucency or a reflective electrode. According to an exemplary embodiment, when the counter electrode **530** is a (semi-)transparent electrode, the counter electrode **530** may include a semi-transmissive metal layer including Ag and Mg. For example, the counter electrode **430** may be formed of an Ag—Mg alloy in which an amount of Ag is higher than an amount of Mg. According to an exemplary embodiment, the counter electrode **530** may include a layer formed of Li, Ca, LiF/Ca, LiF/Al, Al, Mg, or a compound thereof, and another layer disposed on the layer and formed of a (semi-) transparent material, such as ITO, IZO, ZnO, or In_2O_3 .

When the counter electrode **530** is a reflective electrode, the reflective electrode may be formed by forming a layer including, for example, at least one of Li, Ca, LiF/Ca, LiF/Al, Al, Ag, and Mg. In an embodiment, a structure and material of the counter electrode **530** may vary; for example, the counter electrode **530** may be formed of another material and may have a multi-layer structure.

The counter electrode **530** may be patterned to be disposed on the third emission portions R3 and a part of the non-emission portion NR (for example, a portion of the top surface of the pixel-defining film **180**), resistance may be reduced, and IR drop caused by the resistance of the counter electrode **530** and consequent luminance deviation may be reduced or prevented.

The third stacked structure **500** may include the intermediate layer **520** and the counter electrode **530** disposed on the intermediate layer **520**, and the intermediate layer **520** and the counter electrode **530** may have substantially the same pattern. For example, the intermediate layer **520** and the counter electrode **530** may have the third pattern S3. For

example, the counter electrode **530** may include regions (hereinafter, referred to as ninth regions) corresponding to the third emission pattern portions **500a** and disposed in the third emission portion R3, and a region (hereinafter, referred to as a tenth region) corresponding to the third connection pattern portion **500b** and disposed on a portion of the top surface of the pixel-defining film **180** to connect the ninth regions. The intermediate layer **520** may include regions (hereinafter, referred to as eleventh regions) corresponding to the third emission pattern portions **500a** and disposed in the third emission portion R3, and a region (hereinafter, referred to as a twelfth region) corresponding to the third connection pattern portion **500b** and disposed on a portion of the top surface of the pixel-defining film **180** to connect the eleventh regions. The ninth region of the counter electrode **530** and the eleventh region of the intermediate layer **520** may overlap each other, and the tenth region of the counter electrode **530** and the twelfth region of the intermediate layer **520** may overlap each other.

Since the intermediate layer **520** of the third emission pattern portion **500a**, i.e., the eleventh region of the intermediate layer **520**, is disposed between the pixel electrode **210** and the counter electrode **530**, when an electric signal is applied to each of the pixel electrode **210** and the counter electrode **530**, excitons generated as holes and electrons discharged from the pixel electrode **210** and the counter electrode **530** that may combine at the organic emission layer **522** may change from an excited state to a ground state to generate a blue light. Since the intermediate layer **520** of the third connection pattern portion **500b**, i.e., the twelfth region of the intermediate layer **520**, is disposed on the pixel-defining film **180** where the pixel electrode **210** is not disposed, light may not be emitted even when an electric signal is applied to the counter electrode **530** of the third stacked structure **500**.

Since the first through third stacked structures **300** through **500** may be independently and separately patterned, at least two connection pattern portions may overlap on the non-emission portion NR, i.e., on a portion of the top surface of the pixel-defining film **180**. As shown in FIG. 1, the line B-B' of FIG. 2, and FIG. 3, the first connection pattern portion **300b** of the first stacked structure **300** and the third connection pattern portion **500b** of the third stacked structure **500** may overlap on the pixel-defining film **180**, the second connection pattern portion **400b** of the second stacked structure and the third connection pattern portion **500b** of the third stacked structure **500** may overlap on the pixel-defining film **180**, or the first connection pattern portion **300b** of the first stacked structure **300** and the second connection pattern portion **400b** of the second stacked structure **400** may overlap on the pixel-defining film **180**.

In the current embodiment, two connection pattern portions overlap on the non-emission portion NR, i.e., on the pixel-defining film **180**. In an exemplary embodiment, three connection pattern portions may overlap on the non-emission portion NR, i.e., on the pixel-defining film **180**.

The counter electrodes **330** through **530** of the first through third stacked structures **300** through **500** may receive an electric signal by contacting an external electrode power supply line. According to an exemplary embodiment, electric signals may be individually transmitted to the counter electrodes **330** through **530** of the first through third stacked structures **300** through **500**. According to an exemplary embodiment, electric signals may be simultaneously transmitted to the counter electrodes **330** through **530** of the first through third stacked structures **300** through **500**.

FIG. 4 illustrates a schematic top view of an organic light-emitting display device according to an exemplary embodiment.

In an exemplary embodiment, the organic light-emitting display device described above with reference to FIGS. 1 through 3 may include the first through third emission portions R1 through R3 that emit different lights and may be arranged in a matrix form.

Referring to FIG. 4, at least one of the first through third emission portions R1 through R3 may be arranged in a diamond form, or in one of various forms, such as a pentile form.

FIGS. 5 through 15 illustrate views for describing a method of manufacturing an organic light-emitting display device, according to an exemplary embodiment.

FIG. 5 illustrates a schematic side view of the substrate 100 on which the plurality of emission portions, i.e., the first through third emission portions R1 through R3 are disposed, and FIG. 6 illustrates a top view of FIG. 5.

Referring to FIGS. 5 and 6, the pixel circuit PC may be formed on the substrate 100. The pixel circuit PC may include the TFT and the capacitor. Before forming the pixel circuit PC, the buffer layer may be formed on the substrate 100 to prevent impurities from penetrating into the substrate 100.

The pixel circuit PC may be formed according to the first through third emission portions R1 through R3 corresponding to a pixel, and covered by the insulating film 150 having an approximately flat top surface.

Then, a metal film may be formed on the insulating film 150 and then patterned to form the pixel electrode 210 according to the first through third emission portions R1 through R3. The pixel electrodes 210 may be patterned in island types to be separated from each other correspondingly to the first through third emission portions R1 through R3, and a material of the pixel electrode 210 has been described above with reference to FIGS. 1 through 3.

An organic insulating film may be formed on the substrate 100 on which the pixel electrode 210 is formed, and then patterned to form the pixel-defining film 180. The pixel-defining film 180 may have the opening OP exposing at least a portion of the top surface of the pixel electrode 210. The openings OP of the pixel-defining film 180 respectively may correspond to the first through third emission portions R1 through R3, and a region where the pixel-defining film 180 is disposed may correspond to the non-emission portion NR.

FIGS. 7 and 8 illustrate cross-sectional views for describing a process of forming the first stacked structure R1 having the first pattern S1, and FIG. 9 illustrates a top view of FIG. 8.

Referring to FIG. 7, a first masking pattern M1 may be formed to cover an entire surface of the substrate 100 except the first emission portions R1 and a first region (hereinafter, referred to as a first non-emission portion) NR1 of the non-emission portion NR for connecting the first emission portions R1. A reference numeral O1 of FIG. 7 denotes an opening of the first masking pattern M1, which may expose the first emission portion R1 and the first non-emission portion NR1. The first non-emission portion NR1 may be a region corresponding to the first connection pattern portion 300b of the first stacked structure 300, which may be formed via a lift-off process described later.

The first masking pattern M1 may be formed of a polymer material. In an embodiment, the polymer material should satisfactorily dissolve in a solvent during the lift-off process and barely affect the intermediate layer 320.

Then, the intermediate layer 320 and the counter electrode 330 may be sequentially formed on the substrate 100 on which the first masking pattern M1 is formed. The intermediate layer 320 may include the first intermediate layer 321, the organic emission layer 322 realizing red, and the second intermediate layer 323. The first intermediate layer 321, the organic emission layer 322, the second intermediate layer 323, and the counter electrode 330 have been described above with reference to FIGS. 1 through 3.

According to an exemplary embodiment, a thickness of the first masking pattern M1 may be thicker than a sum of thicknesses of the intermediate layer 320 and the counter electrode 330. The intermediate layer 320 and the counter electrode 330, which may be formed on the first emission portions R1 and the first non-emission portion NR1 for connecting the first emission portions R1, may be discontinuous from the intermediate layer 320 and the counter electrode 330, which may be formed on the first masking pattern M1.

Referring to FIGS. 8 and 9, the first masking pattern M1 may be removed with the lift-off process. The first stacked structure 300 having the first pattern S1 may be formed on the substrate 100 when the first masking pattern M1 is removed.

As shown in FIGS. 8 and 9, the first stacked structure 300 may include the first emission pattern portions 300a respectively corresponding to the first emission portions R1, and the first connection pattern portions 300b connecting the first emission pattern portions 300a, wherein the first emission pattern portions 300a and the first connection pattern portions 300b form the first pattern S1. The first emission pattern portion 300a of the first stacked structure 300 may be disposed on the pixel electrode 210 that is exposed through the opening OP of the pixel-defining film 180, and the first connection pattern portion 300b of the first stacked structure 300 may be disposed on a portion of the top surface of the pixel-defining film 180.

Since the intermediate layer 320 of the first emission pattern portion 300a is disposed between the pixel electrode 210 and the counter electrode 330, when an electric signal is applied to each of the pixel electrode 210 and the counter electrode 330, excitons generated as holes and electrons discharged from the pixel electrode 210 and the counter electrode 330 that may combine at the organic emission layer 322 may change from an excited state to a ground state to generate a red light. Since the intermediate layer 320 of the first connection pattern portion 300b is disposed on the pixel-defining film 180 where the pixel electrode 210 is not disposed, light may not be emitted even when an electric signal is applied to the counter electrode 330 of the first stacked structure 300.

FIGS. 10 and 11 illustrate cross-sectional views for describing a process of forming the second stacked structure 400 having the second pattern S2, and FIG. 12 illustrates a top view of FIG. 11.

Referring to FIG. 10, a second masking pattern M2 may be formed to cover an entire surface of the substrate 100 except the second emission portions R2 and a second region (hereinafter, referred to as a second non-emission portion) NR2 of the non-emission portion NR for connecting the second emission portions R2. A reference numeral O2 of FIG. 10 denotes an opening of the second masking pattern M2, which may expose the second emission portion R2 and the second non-emission portion NR2. The second non-emission portion NR2 may be a region corresponding to the

15

second connection pattern portion **400b** of the second stacked structure **400**, which may be formed via a lift-off process described later.

The second masking pattern **M2** may be formed of a polymer material. In an embodiment, the polymer material should satisfactorily dissolve in a solvent during the lift-off process and barely affect the intermediate layer **420**.

Then, the intermediate layer **420** and the counter electrode **430** may be sequentially formed on the substrate **100** on which the second masking pattern **M2** is formed. The intermediate layer **420** may include the first intermediate layer **421**, the organic emission layer **422** realizing green, and the second intermediate layer **423**. The first intermediate layer **421**, the organic emission layer **422**, the second intermediate layer **423**, and the counter electrode **430** have been described above with reference to FIGS. 1 through 3.

According to an exemplary embodiment, a thickness of the second masking pattern **M2** may be thicker than a sum of thicknesses of the intermediate layer **420** and the counter electrode **430**. The intermediate layer **420** and the counter electrode **430**, which may be formed on the second emission portions **R2** and the second non-emission portion **NR2** for connecting the second emission portions **R2**, may be discontinuous from the intermediate layer **420** and the counter electrode **430**, which may be formed on the second masking pattern **M2**.

Referring to FIGS. 11 and 12, the second masking pattern **M2** may be removed with the lift-off process. The second stacked structure **400** having the second pattern **S2** may be formed on the substrate **100** when the second masking pattern **M2** is removed.

As shown in FIGS. 11 and 12, the second stacked structure **400** may have the second pattern **S2** including the second emission pattern portions **400a** respectively corresponding to the second emission portions **R2**, and the second connection pattern portions **400b** connecting the second emission pattern portions **400a**. The second emission pattern portion **400a** of the second stacked structure **400** may be disposed on the pixel electrode **210** that is exposed through the opening **OP** of the pixel-defining film **180**, and the second connection pattern portion **400b** of the second stacked structure **400** may be disposed on a portion of the top surface of the pixel-defining film **180**.

Since the intermediate layer **420** of the second emission pattern portion **400a** is disposed between the pixel electrode **210** and the counter electrode **430**, when an electric signal is applied to each of the pixel electrode **210** and the counter electrode **430**, excitons generated as holes and electrons discharged from the pixel electrode **210** and the counter electrode **430** that may combine at the organic emission layer **422** may change from an excited state to a ground state to generate a green light. Since the intermediate layer **420** of the second connection pattern portion **400b** is disposed on the pixel-defining film **180** where the pixel electrode **210** is not disposed, light may not be emitted even when an electric signal is applied to the counter electrode **430** of the second stacked structure **400**.

FIGS. 13 and 14 illustrate cross-sectional views for describing a process of forming the third stacked structure **500** having the third pattern **S3**, and FIG. 15 illustrates a top view of FIG. 14.

Referring to FIG. 13, a third masking pattern **M3** may be formed to cover an entire surface of the substrate **100** except the third emission portions **R3** and a third region (hereinafter, referred to as a third non-emission portion) **NR3** of the non-emission portion **NR** for connecting the third emission portions **R3**. A reference numeral **O3** of FIG. 13 denotes an

16

opening of the third masking pattern **M3**, which may expose the third emission portion **R3** and the third non-emission portion **NR3**. The third non-emission portion **NR3** may be a region corresponding to the third connection pattern portion **500b** of the third stacked structure **500**, which may be formed via a lift-off process described later.

The third masking pattern **M3** may be formed of a polymer material. In an embodiment, the polymer material should satisfactorily dissolve in a solvent during the lift-off process and barely affect the intermediate layer **520**.

Then, the intermediate layer **520** and the counter electrode **530** may be sequentially formed on the substrate **100** on which the third masking pattern **M3** is formed. The intermediate layer **520** may include the first intermediate layer **521**, the organic emission layer **522** realizing blue, and the second intermediate layer **523**. The first intermediate layer **521**, the organic emission layer **522**, the second intermediate layer **523**, and the counter electrode **530** have been described above with reference to FIGS. 1 through 3.

According to an exemplary embodiment, a thickness of the third masking pattern **M3** may be thicker than a sum of thicknesses of the intermediate layer **520** and the counter electrode **530**. The intermediate layer **520** and the counter electrode **530**, which may be formed on the third emission portions **R3** and the third non-emission portion **NR3** for connecting the third emission portions **R3**, may be discontinuous from the intermediate layer **520** and the counter electrode **530**, which may be formed on the third masking pattern **M3**.

Referring to FIGS. 14 and 15, the third masking pattern **M3** may be removed with the lift-off process. The third stacked structure **500** having the third pattern **S3** may be formed on the substrate **100** when the third masking pattern **M3** is removed.

As shown in FIGS. 14 and 15, the third stacked structure **500** may include the third emission pattern portions **500a** respectively corresponding to the third emission portions **R3**, and the third connection pattern portions **500b** connecting the third emission pattern portions **500a**, wherein the third emission pattern portions **500a** and the third connection pattern portions **500b** form the third pattern **S3**. The third emission pattern portion **500a** of the third stacked structure **500** may be disposed on the pixel electrode **210** that is exposed through the opening **OP** of the pixel-defining film **180**, and the third connection pattern portion **500b** of the third stacked structure **500** may be disposed on a portion of the top surface of the pixel-defining film **180**.

Since the intermediate layer **520** of the third emission pattern portion **500a** is disposed between the pixel electrode **210** and the counter electrode **530**, when an electric signal is applied to each of the pixel electrode **210** and the counter electrode **530**, excitons generated as holes and electrons discharged from the pixel electrode **210** and the counter electrode **530** that may combine at the organic emission layer **522** may change from an excited state to a ground state to generate a blue light. Since the intermediate layer **520** of the third connection pattern portion **500b** is disposed on the pixel-defining film **180** where the pixel electrode **210** is not disposed, light may not be emitted even when an electric signal is applied to the counter electrode **530** of the third stacked structure **500**.

In an embodiment, the first through third stacked structures **300** through **500** may be sequentially formed in FIGS. 5 through 15. Since the first through third stacked structures **300** through **500** may be independently, for example, individually, patterned, a patterning order may be changed.

According to one or more exemplary embodiments, the intermediate layers 320 through 520 and the counter electrodes 330 through 530 of the first through third stacked structures 300 through 500 may be patterned together, and separate processes for patterning the counter electrodes 330 through 530 may not be required. Since top surfaces of the intermediate layers 320 through 520 may be patterned while being covered by the counter electrodes 330 through 530, the top surfaces of the intermediate layers 320 through 520 may be protected by the counter electrodes 330 through 530, and a possibility of impurities being disposed between the intermediate layers 320 through 520 and the counter electrodes 330 through 530 may be reduced.

FIG. 16 illustrates a schematic cross-sectional view of an organic light-emitting display device according to an exemplary embodiment.

Referring to FIG. 16, a protection film 600 may be disposed on at least one of the counter electrodes 330 through 530 of the first through third stacked structures 300 through 500. According to some exemplary embodiments, when the counter electrodes 330 through 530 are a (semi-) transparent electrode including a metal, such as an Ag—Mg alloy, transmissivity may be decreased as the counter electrodes 330 through 530 are exposed to oxygen and oxidized, but when the protection film 600 is disposed on the counter electrodes 330 through 530, oxidization of the counter electrodes 330 through 530 may be prevented.

The protection film 600 may include a conductive material or a nonconductive (insulating) material. According to an exemplary embodiment, when the organic light-emitting display device is a top-emission type, the protection film 600 may include an organic material and/or an inorganic material having transparency. According to an exemplary embodiment, when the organic light-emitting display device is a bottom-emission type, the protection film 600 may include an opaque material.

While manufacturing the first through third stacked structures 300 through 500, the protection film 600 may be patterned together with the intermediate layers 320 through 520 and the counter electrodes 330 through 530. The protection film 600 may have substantially the same pattern as the intermediate layers 320 through 520 and the counter electrodes 330 through 530.

FIG. 17 illustrates a schematic cross-sectional view of an organic light-emitting display device according to an exemplary embodiment.

Referring to FIG. 17, a protection film 600' may be disposed on the substrate 100 to cover the first through third stacked structures 300 through 500. For example, the protection film 600' may be formed on the substrate 100 to integrally cover all of the first through third stacked structures 300 through 500.

The protection film 600' may include a conductive material or a nonconductive (insulating) material. According to an exemplary embodiment, when the organic light-emitting display device is a top-emission type, the protection film 600' may include an organic material and/or an inorganic material having transparency. According to an exemplary embodiment, when the organic light-emitting display device is a bottom-emission type, the protection film 600' may include an opaque material.

The protection film 600' may be formed via a process separate from the first through third stacked structures 300 through 500. For example, the protection film 600' may be formed to cover the entire surface of the substrate 100 after the first through third stacked structures 300 through 500 are formed.

As described above, according to one or more exemplary embodiments, an organic light-emitting display device in which occurrence of luminance deviation is suppressed by reducing an IR drop may be provided.

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 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 display device, comprising:
 - a substrate;
 - a pixel-defining film disposed on the substrate, the pixel-defining film defining a plurality of first emission portions and a plurality of second emission portions;
 - a plurality of pixel electrodes that are separated from each other and respectively correspond to the plurality of first emission portions;
 - a first stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer of the first stacked structure including an organic emission layer emitting a first color light; and
 - a second stacked structure including an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer of the second stacked structure including an organic emission layer emitting a second color light, wherein
 - the first stacked structure further includes first emission pattern portions respectively corresponding to the plurality of first emission portions, and first connection pattern portions on the pixel-defining film, the first connection pattern portions connecting the first emission pattern portions.
2. The organic light-emitting display device as claimed in claim 1, wherein the first connection pattern portions are on a portion of a top surface of the pixel-defining film.
3. The organic light-emitting display device as claimed in claim 1, wherein the counter electrode of the first stacked structure includes:
 - first regions that face the pixel electrodes respectively corresponding to the plurality of first emission portions; and
 - a second region that connects the first regions.
4. The organic light-emitting display device as claimed in claim 1, wherein the intermediate layer of the first stacked structure includes:
 - third regions that are on the pixel electrodes respectively corresponding to the plurality of first emission portions; and
 - a fourth region that connects the third regions.
5. The organic light-emitting display device as claimed in claim 4, wherein:
 - the pixel-defining film includes openings corresponding to the plurality of first emission portions, and
 - the third regions are at locations respectively corresponding to the openings, and the fourth region is on a portion of a top surface of the pixel-defining film.

19

6. The organic light-emitting display device as claimed in claim 1, wherein the intermediate layer of the first stacked structure and the counter electrode of the first stacked structure have a substantially same pattern.

7. An organic light-emitting display device, comprising:
 a plurality of pixel electrodes that are separated from each other and respectively correspond to a plurality of first emission portions and a plurality of second emission portions;
 a pixel-defining film disposed on the plurality of pixel electrodes, the pixel-defining film defining the plurality of first emission portions and the plurality of second emission portions; and
 a first stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer of the first stacked structure including an organic emission layer emitting a first color light, wherein
 the first stacked structure includes first emission pattern portions respectively corresponding to the plurality of first emission portions, and first connection pattern portions on the pixel-defining film, the first connection pattern portions connecting the first emission pattern portions, wherein:
 the intermediate layer of the first stacked structure further includes a first intermediate layer that is below the organic emission layer of the first stacked structure in a direction away from the counter electrode of the first stacked structure, and
 the organic emission layer of the first stacked structure is between the counter electrode of the first stacked structure and the first intermediate layer.

8. The organic light-emitting display device as claimed in claim 7, wherein the first intermediate layer includes a hole transport layer.

9. The organic light-emitting display device as claimed in claim 1,

wherein the second stacked structure further includes second emission pattern portions respectively corresponding to the plurality of second emission portions, and second connection pattern portions on the pixel-defining film, the second connection pattern portions connecting the second emission pattern portions.

10. The organic light-emitting display device as claimed in claim 9, wherein the second connection pattern portions are on a portion of a top surface of the pixel-defining film.

11. The organic light-emitting display device as claimed in claim 10, wherein at least one of the first connection pattern portions and at least one of the second connection pattern portions overlap each other on the portion of the top surface of the pixel-defining film.

12. The organic light-emitting display device as claimed in claim 9, wherein the counter electrode of the second stacked structure includes:

fifth regions that face the pixel electrodes respectively corresponding to the plurality of second emission portions; and
 a sixth region that connects the fifth regions.

13. The organic light-emitting display device as claimed in claim 9, wherein the intermediate layer of the second stacked structure includes:

seventh regions that are on the pixel electrodes respectively corresponding to the plurality of second emission portions; and
 an eighth region that connects the seventh regions.

14. The organic light-emitting display device as claimed in claim 9, wherein the intermediate layer of the second

20

stacked structure and the counter electrode of the second stacked structure have a substantially same pattern.

15. The organic light-emitting display device as claimed in claim 1, further comprising a protection film on the counter electrode of the first stacked structure.

16. The organic light-emitting display device as claimed in claim 15, wherein the protection film has a substantially same pattern as the intermediate layer and the counter electrode of the first stacked structure.

17. The organic light-emitting display device as claimed in claim 15, wherein:

the counter electrode of the first stacked structure includes a semi-transmissive metal layer, and
 the protection film is transparent.

18. A method of manufacturing an organic light-emitting display device, the method comprising:

preparing a substrate;

forming, on the substrate, a plurality of pixel electrodes having an island shape so as to be separated from each other and respectively correspond to a plurality of first emission portions;

forming, on the substrate, a pixel-defining film that includes openings corresponding to the plurality of first emission portions and a plurality of second emission portions;

forming a first stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer including an organic emission layer emitting a first color light; and

forming a second stacked structure that includes an intermediate layer and a counter electrode on the intermediate layer, the intermediate layer including an organic emission layer emitting a second color light, wherein:
 the first stacked structure further includes first emission pattern portions respectively corresponding to the plurality of first emission portions, and first connection pattern portions on the pixel-defining film, the first connection pattern portions connecting the first emission pattern portions.

19. The method as claimed in claim 18, wherein the first connection pattern portions of the first stacked structure are on a portion of a top surface of the pixel-defining film.

20. The method as claimed in claim 18, wherein the intermediate layer of the first stacked structure and the counter electrode of the first stacked structure have a substantially same pattern.

21. The method as claimed in claim 18, wherein forming the first stacked structure includes:

forming, on the substrate, a masking pattern that includes an opening exposing the plurality of first emission portions, and a first non-emission portion connecting the plurality of first emission portions, the first non-emission portion corresponding to a portion of a top surface of the pixel-defining film;

forming the intermediate layer including the organic emission layer of the first stacked structure emitting the first color light, on an entire surface of the substrate on which the masking pattern is formed;

forming the counter electrode of the first stacked structure on the intermediate layer of the first stacked structure; and

removing the masking pattern such that the first emission pattern portions respectively corresponding to the plurality of first emission portions remain, and the first connection pattern portions that correspond to the first non-emission portion and connect the first emission pattern portions remain.

21

22. The method as claimed in claim 18, wherein:
the intermediate layer of the first stacked structure further
includes a first intermediate layer that is below the
organic emission layer of the first stacked structure in
a direction away from the counter electrode of the first
stacked structure, and
the organic emission layer of the first stacked structure is
between the counter electrode of the first stacked
structure and the first intermediate layer.
23. The method as claimed in claim 22, wherein the first
intermediate layer includes a hole transport layer.
24. The method as claimed in claim 18,
wherein the second stacked structure further includes
second emission pattern portions respectively corre-
sponding to the plurality of second emission portions,
and second connection pattern portions on the pixel-
defining film, the second connection pattern portions
connecting the second emission pattern portions.

22

25. The method as claimed in claim 24, wherein at least
one of the second connection pattern portions and at least
one of the first connection pattern portions overlap each
other on a portion of a top surface of the pixel-defining film.
26. The method as claimed in claim 24, wherein the
intermediate layer of the second stacked structure and the
counter electrode of the second stacked structure have a
substantially same pattern.
27. The method as claimed in claim 18, further compris-
ing forming a protection film on the counter electrode of the
first stacked structure.
28. The method as claimed in claim 27, wherein the
protection film has a substantially same pattern as the
intermediate layer and the counter electrode of the first
stacked structure.

* * * * *

专利名称(译)	有机发光显示装置及其制造方法		
公开(公告)号	US9859344	公开(公告)日	2018-01-02
申请号	US14/838390	申请日	2015-08-28
[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DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
[标]发明人	CHOUNG JIYOUNG PARK JUNGSUN SHIN MINSOO HWANG INSUNG		
发明人	CHOUNG, JIYOUNG PARK, JUNGSUN SHIN, MINSOO HWANG, INSUNG		
IPC分类号	H01L27/32 H01L51/52		
CPC分类号	H01L27/3246 H01L27/3211 H01L51/5225 H01L27/3218 H01L27/3216 H01L21/77 H01L27/32 H01L27/3241 H01L27/3209 H01L27/3248 H01L51/56 H01L2227/32 H01L2251/56		
优先权	1020150025911 2015-02-24 KR		
其他公开文献	US20160247863A1		
外部链接	Espacenet USPTO		

摘要(译)

一种有机发光显示装置，包括：基板，包括实现第一颜色的多个第一发光部分；以及多个实现第二颜色的第二发光部分；像素限定膜，其限定多个第一发射部分和多个第二发射部分；多个像素电极彼此分离并分别对应于多个第一发光部分；第一堆叠结构，包括中间层上的中间层和对电极，所述中间层包括发射第一颜色光的有机发光层，所述第一堆叠结构还包括分别对应于所述多个第一发光图案部分的第一发光图案部分。第一发射部分和像素限定膜上的第一连接图案部分，第一连接图案部分连接第一发射图案部分。

