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

(71) Applicant: **Samsung Display Co., Ltd.**, Yongin-si (KR)

(72) Inventors: **Younggil KWON**, Yongin-si (KR); **Jiyoung CHOUNG**, Yongin-si (KR); **Seul LEE**, Yongin-si (KR); **Jinbaek CHOI**, Yongin-si (KR)

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(57) **ABSTRACT**

A method of manufacturing an organic light-emitting display apparatus includes the step of forming a first pixel electrode and a second pixel electrode on a substrate, forming a pixel-defining film on the first pixel electrode and the second pixel electrode, the pixel-defining film having an opening through which each of the first pixel electrode and the second pixel electrode is exposed, forming a first masking pattern on the pixel-defining film having a first opening portion through which the first pixel electrode is exposed, sequentially forming a first intermediate layer including a first emission layer, a first counter electrode, a first protective layer, and a first anti-decapping layer on the first pixel electrode and the first masking pattern, and removing the first masking pattern along with the first intermediate layer, the first counter electrode, the first protective layer, and the first anti-decapping layer disposed on the first masking pattern.

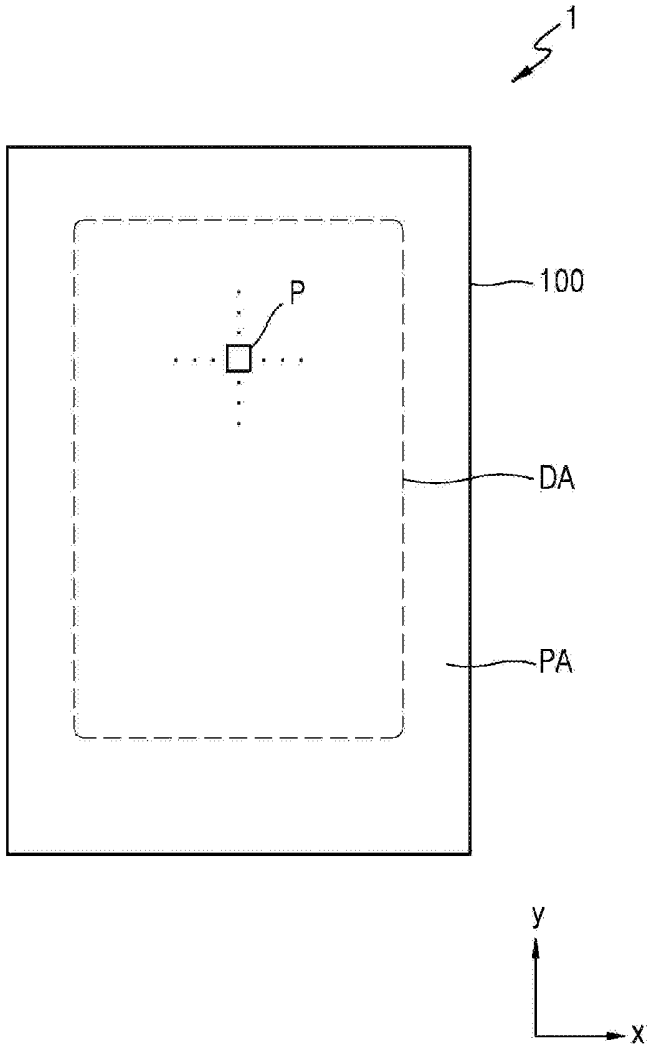


FIG. 1

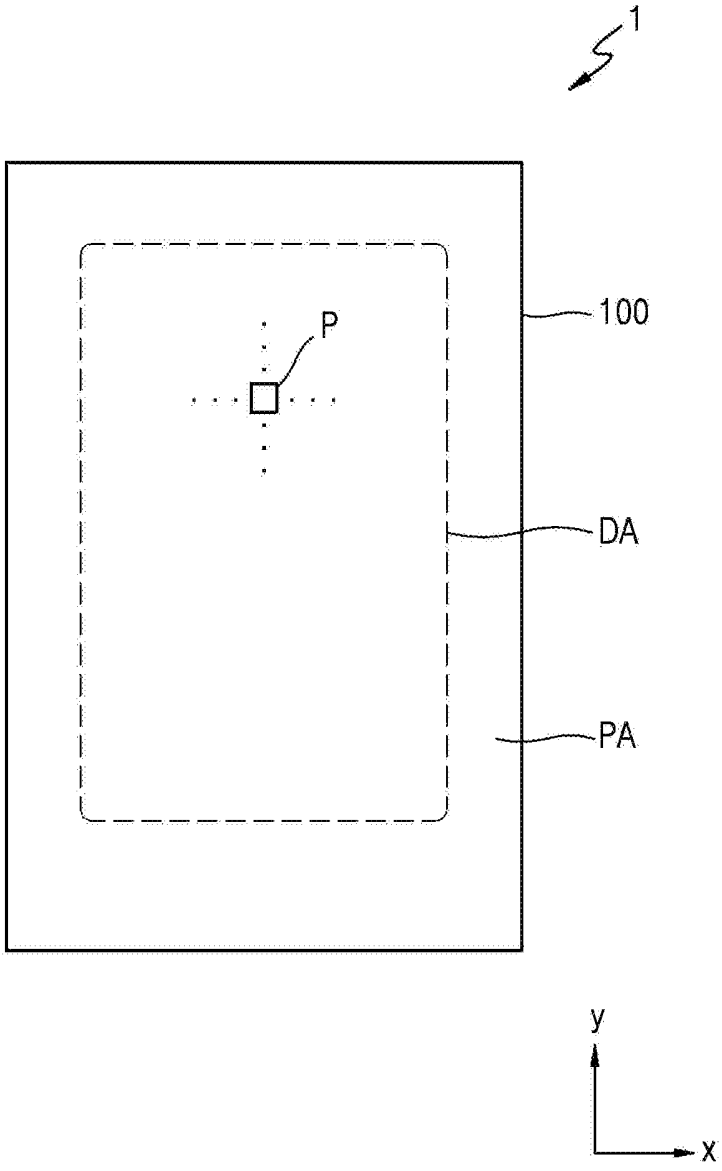


FIG. 2

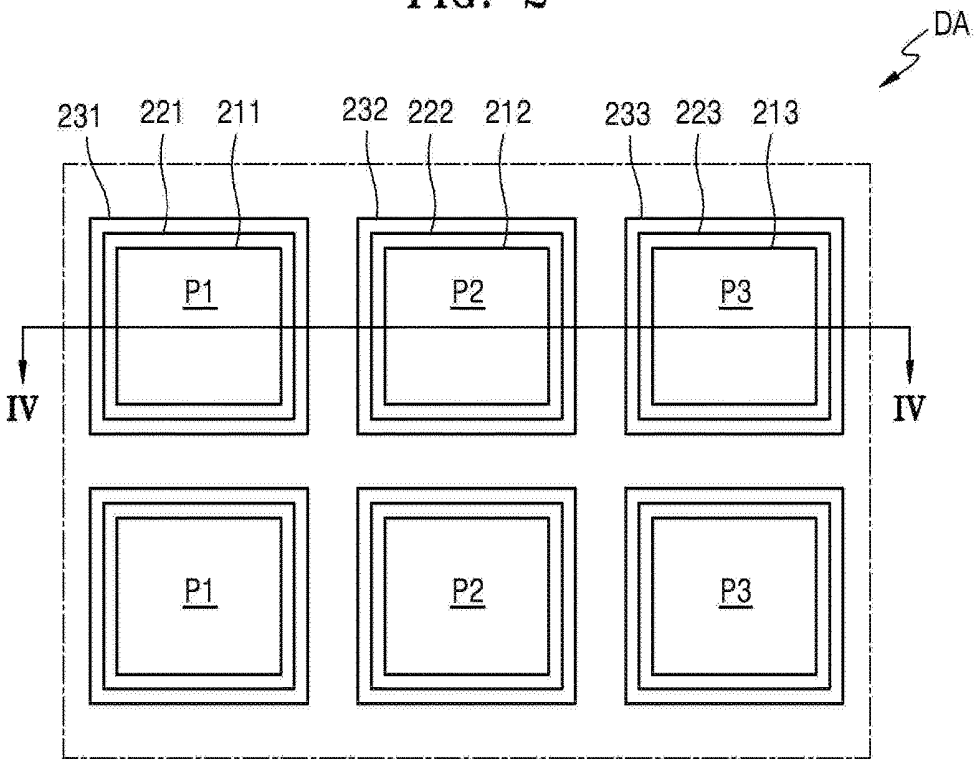
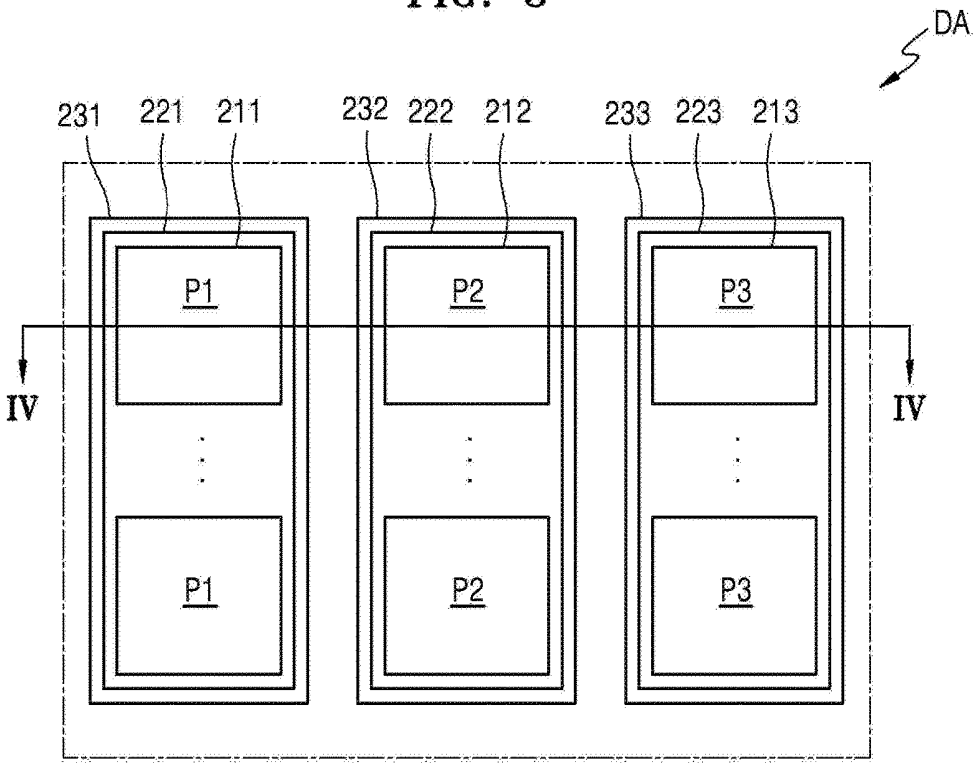

DA
231
221
211
232
222
212
233
223
213
P1
P2
P3
IV
IV

FIG. 3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222
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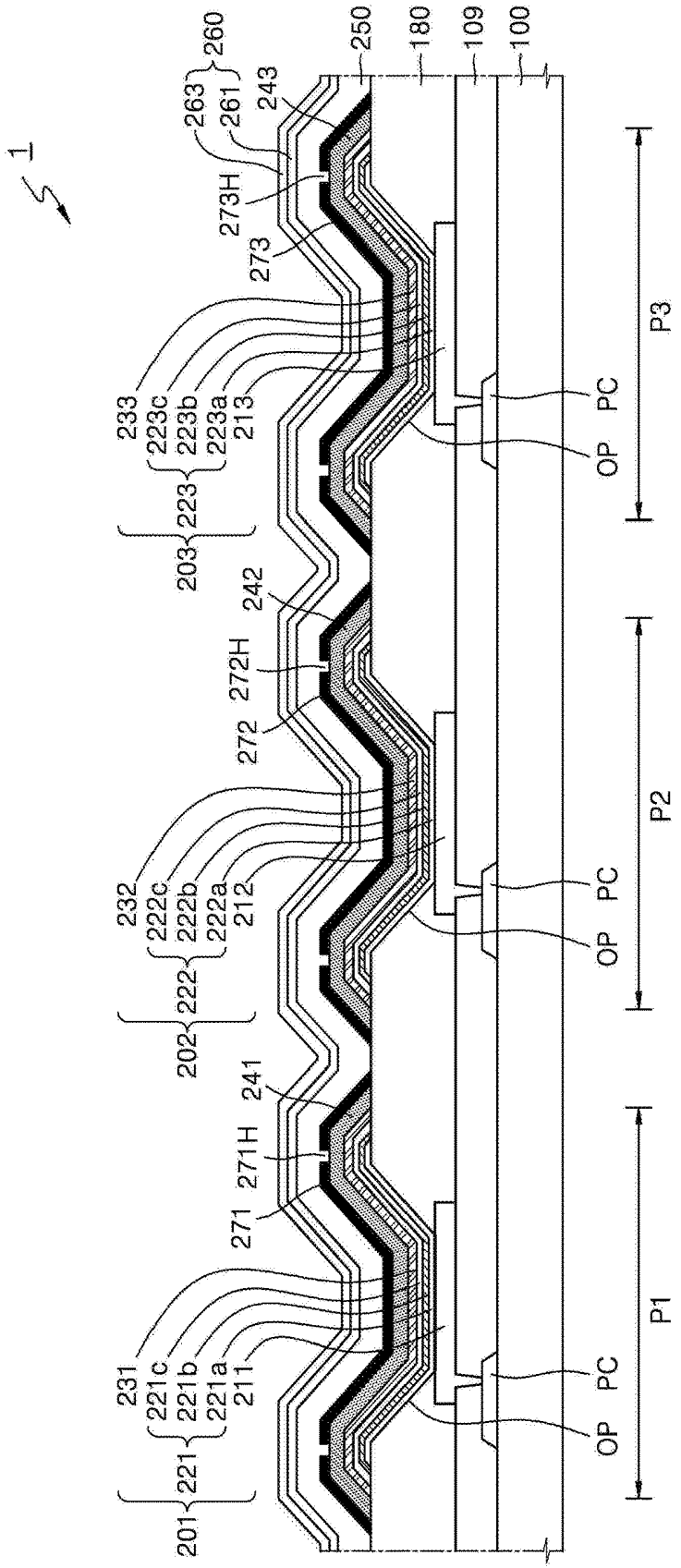
233
223
213
P1
P2
P3
IV
IV

FIG. 4


1
250
180
109
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260
263
261
243
273H
273
233
223c
223b
223a
213
223
203
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272H
272
232
222c
222b
222a
212
222
202
241
271H
271
231
221c
221b
221a
211
221
201
OP
PC
P3
P2
P1

FIG. 5A

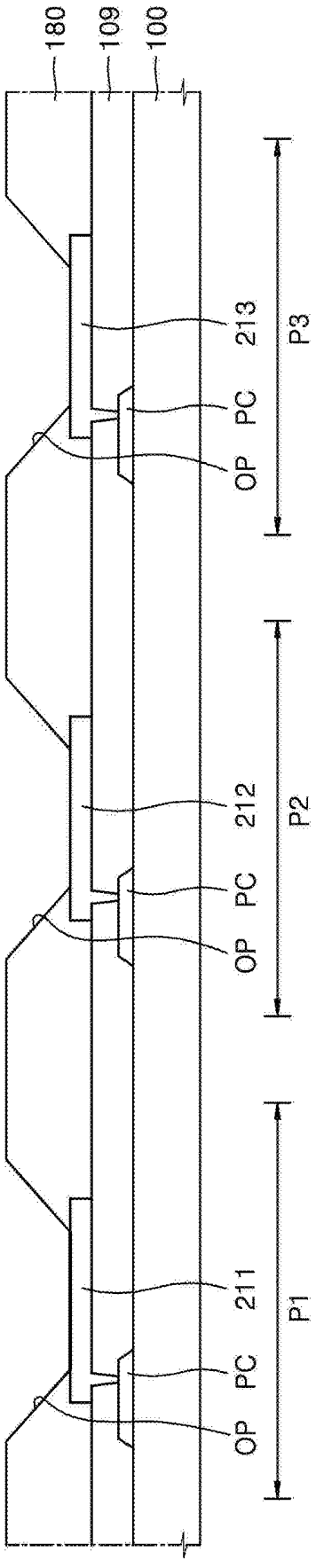


FIG. 5B

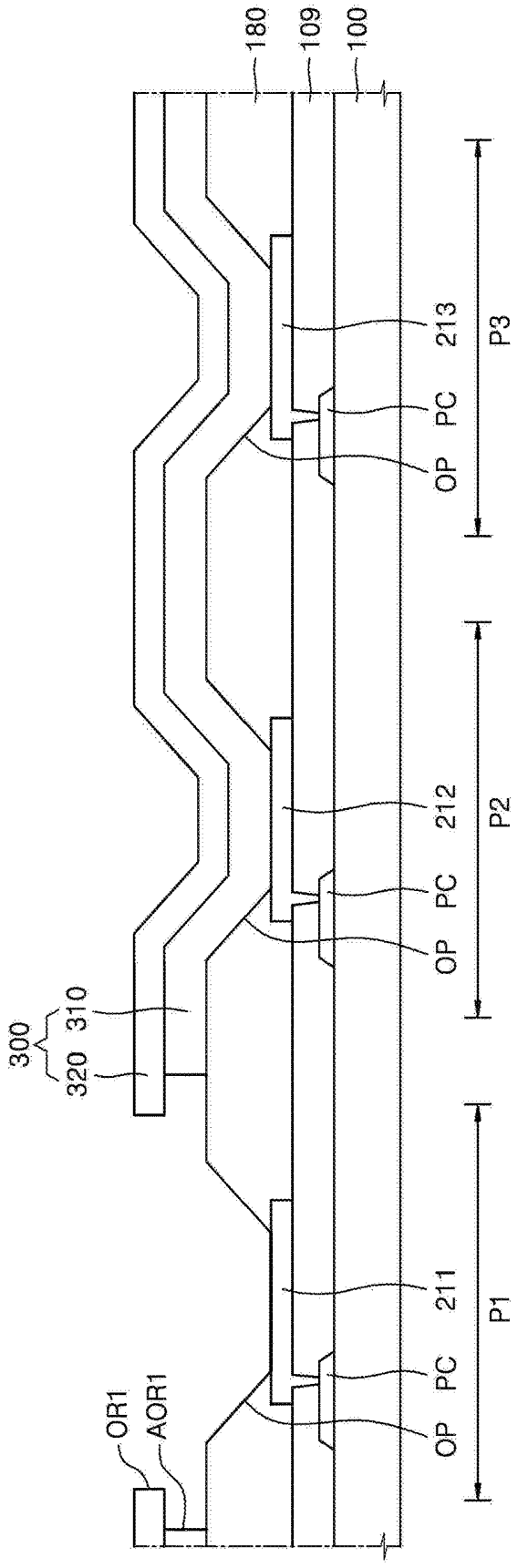
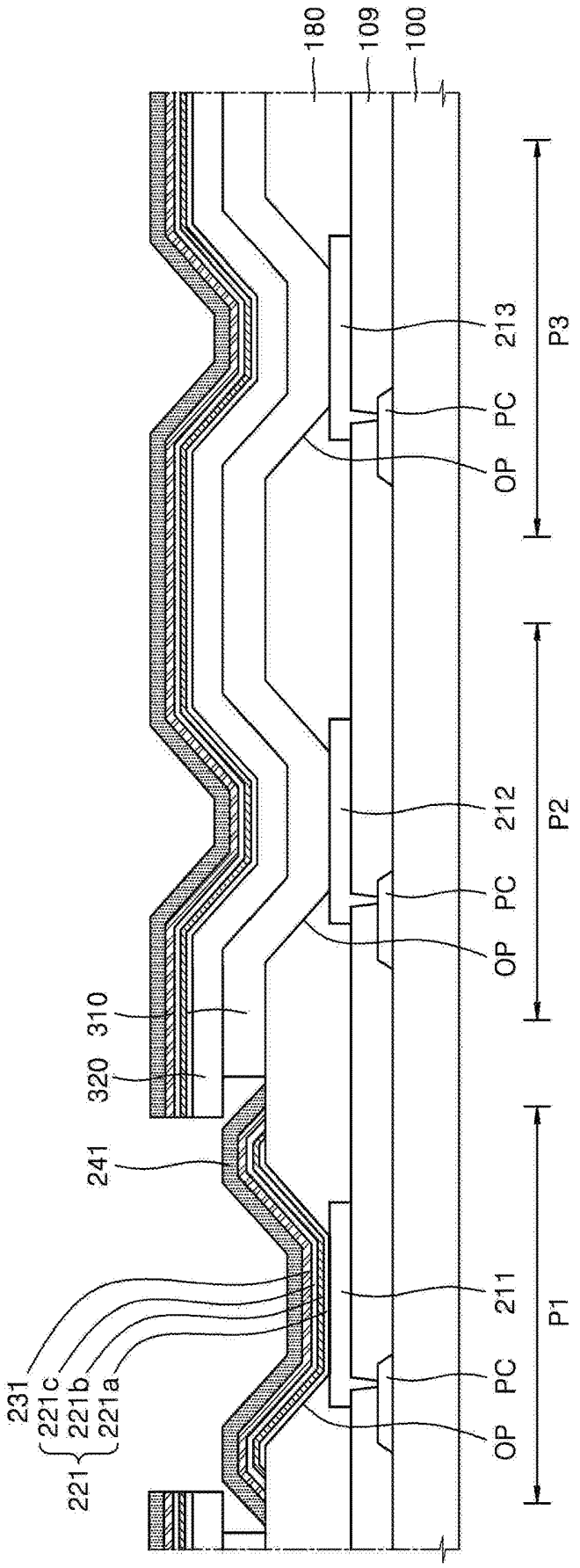

180
109
100
213
P3
PC
OP
212
P2
PC
OP
300
310
320
211
P1
PC
OP
OR1
AOR1

FIG. 5C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P3
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212
P2
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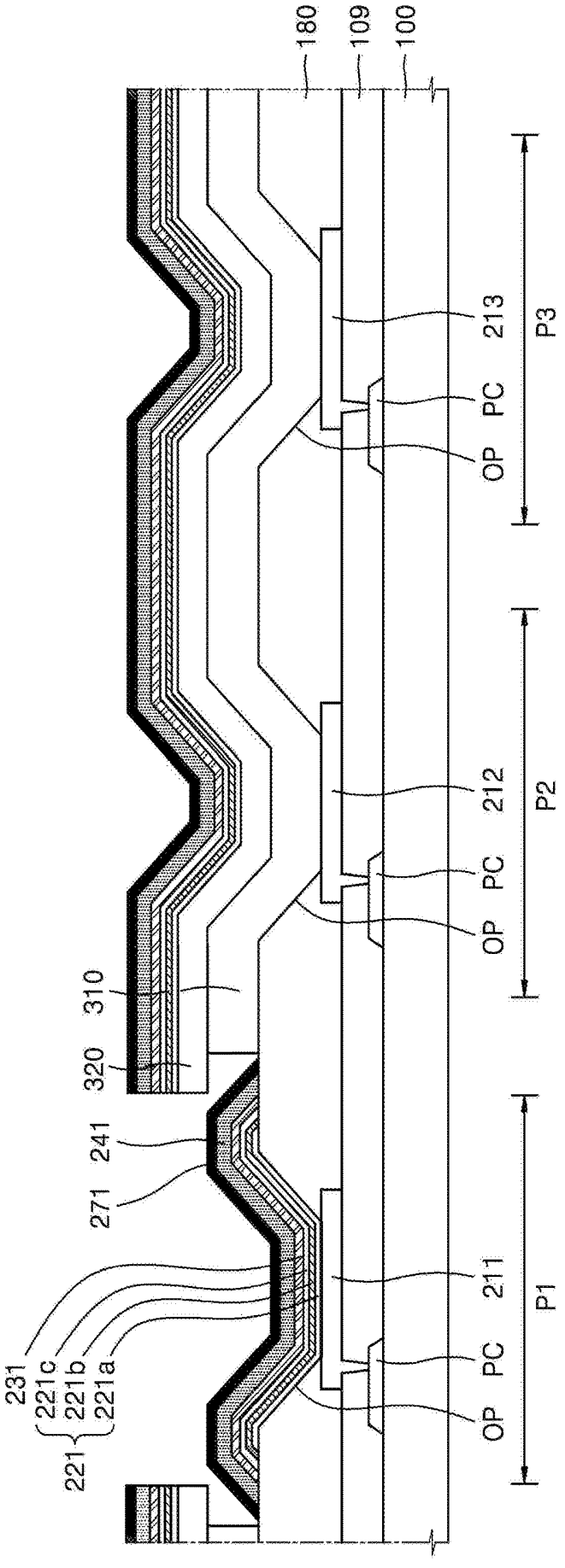
PC
310
320
241
211
P1
OP
PC
231
221c
221b
221a
221

FIG. 5D


180
109
100
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PC
OP
P3
212
PC
OP
P2
310
320
241
271
211
PC
OP
P1
231
221c
221b
221a
221

FIG. 5E

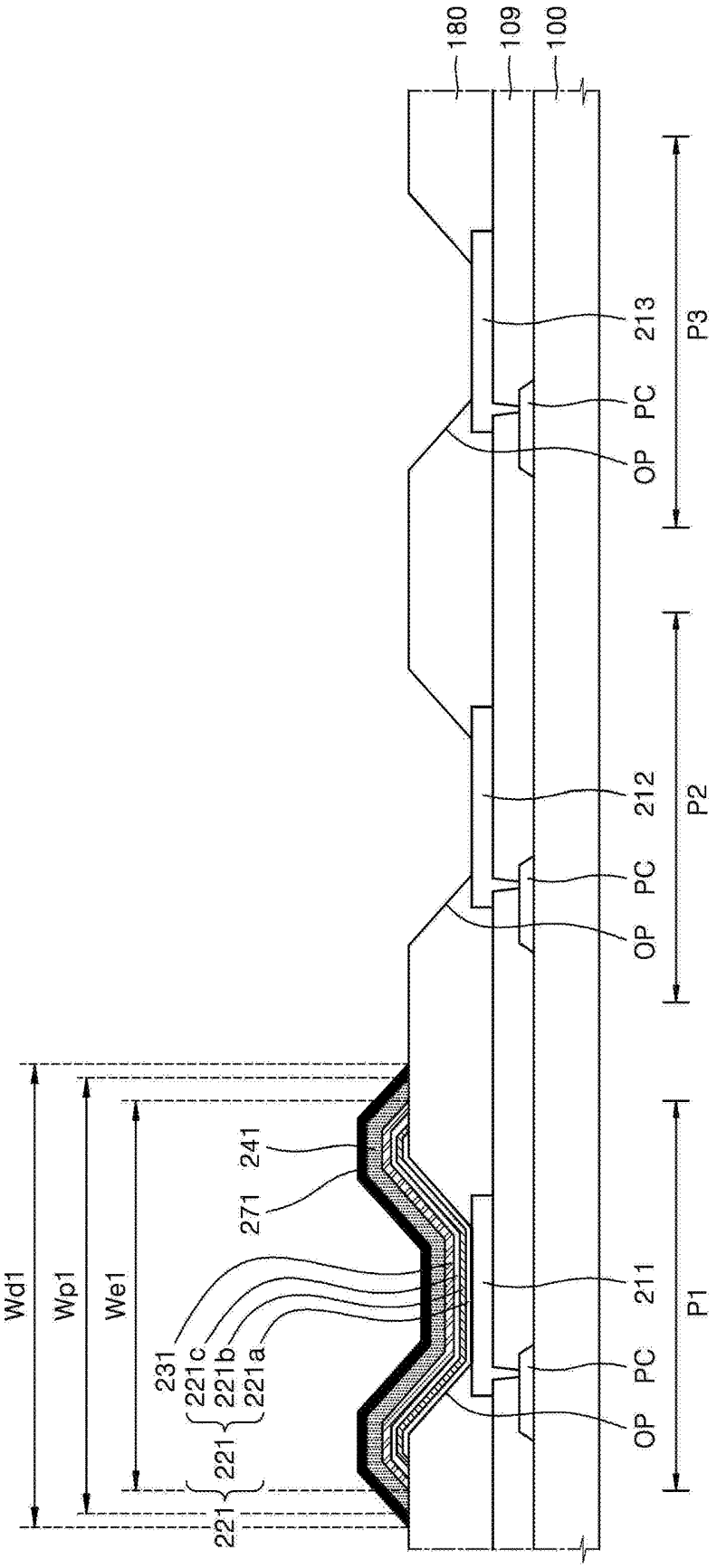

180
109
100
213
PC
OP
P3
212
PC
OP
P2
211
PC
OP
P1
241
271
231
221c
221b
221a
221
Wd1
Wp1
We1
221

FIG. 5F

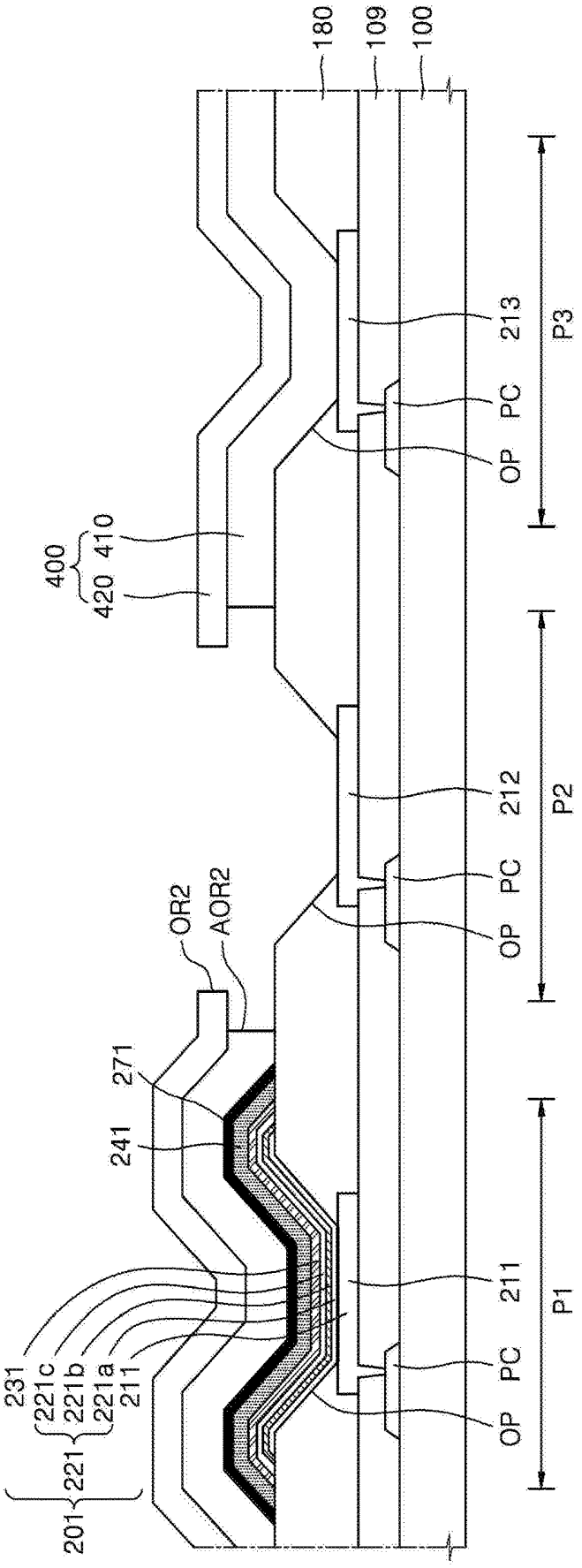
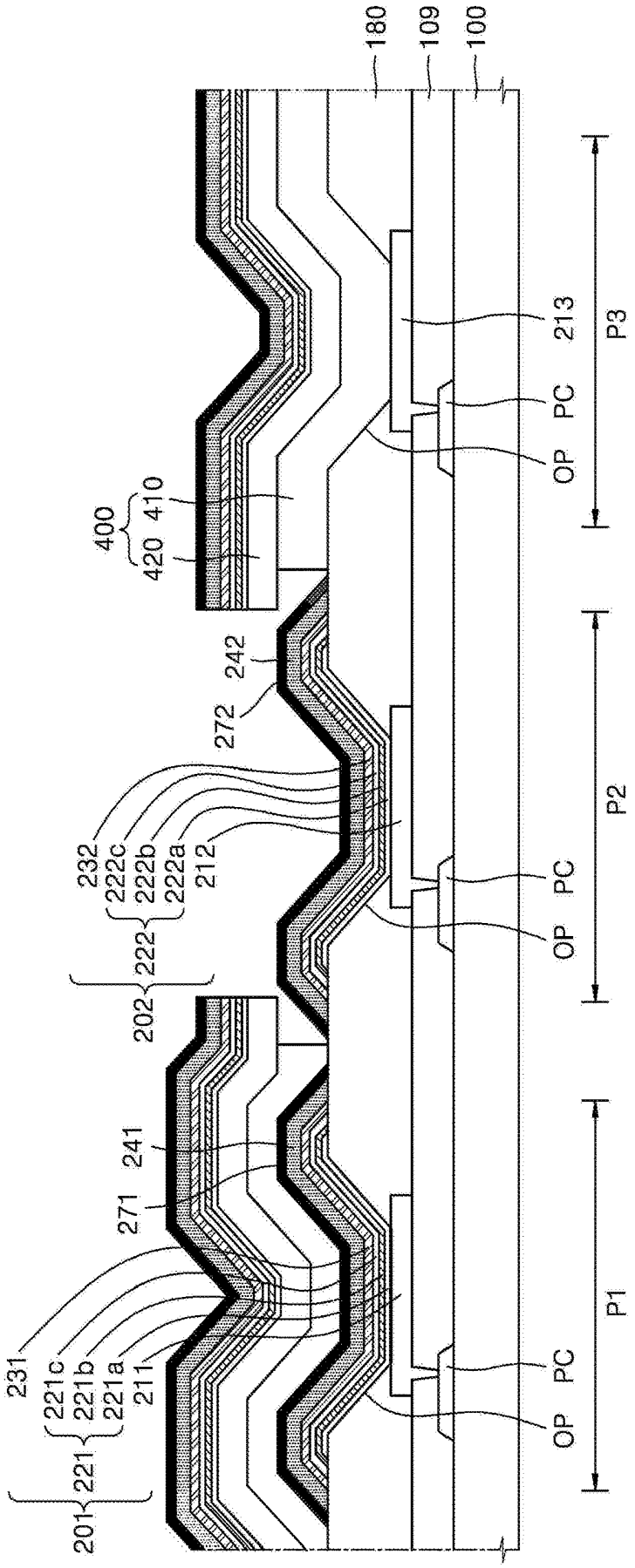

180
109
100
213
P3
PC
OP
400
410
420
212
P2
OR2
AOR2
271
241
211
P1
231
221c
221b
221a
221
201

FIG. 5G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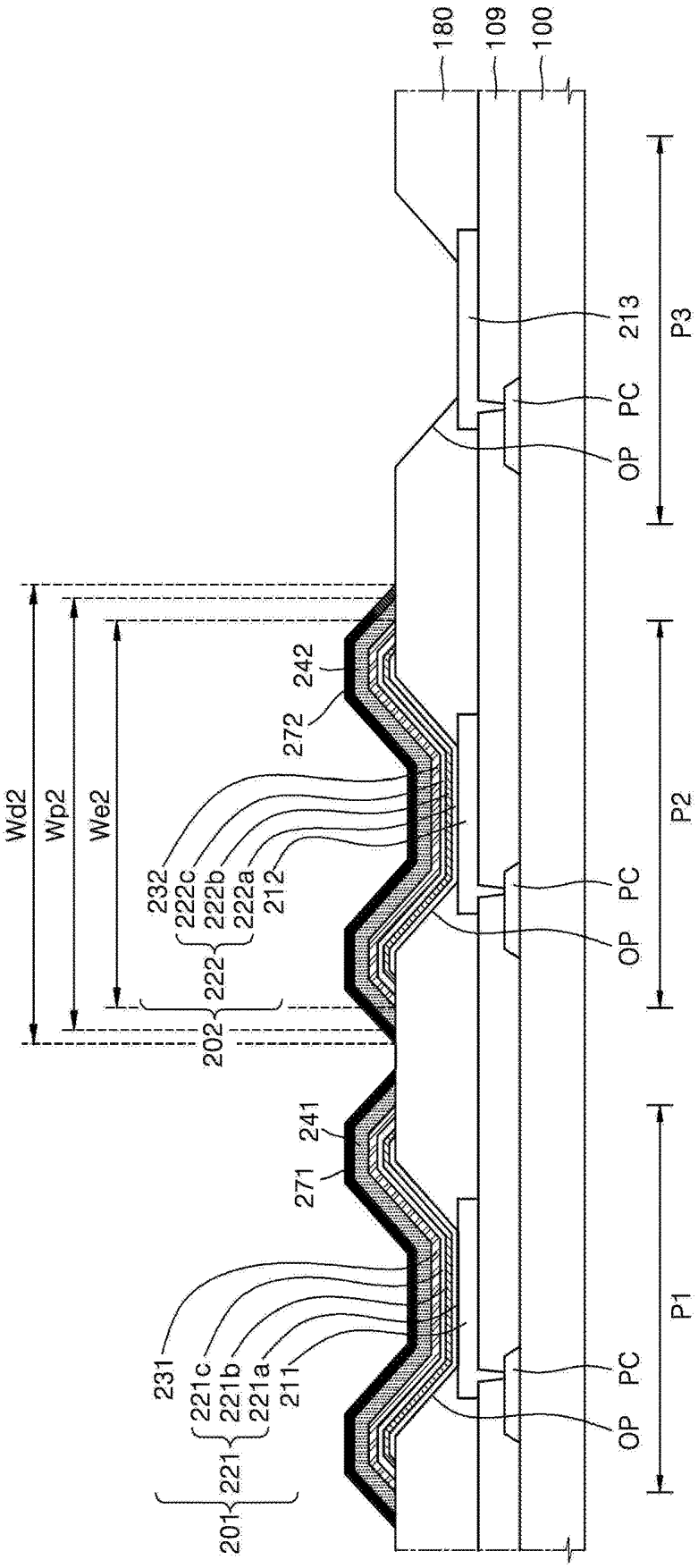
109
100
213
P3
PC
OP
400
410
420
242
272
232
222c
222b
222a
212
222
202
P2
PC
OP
241
271
231
221c
221b
221a
211
221
201
P1
PC
OP

FIG. 5H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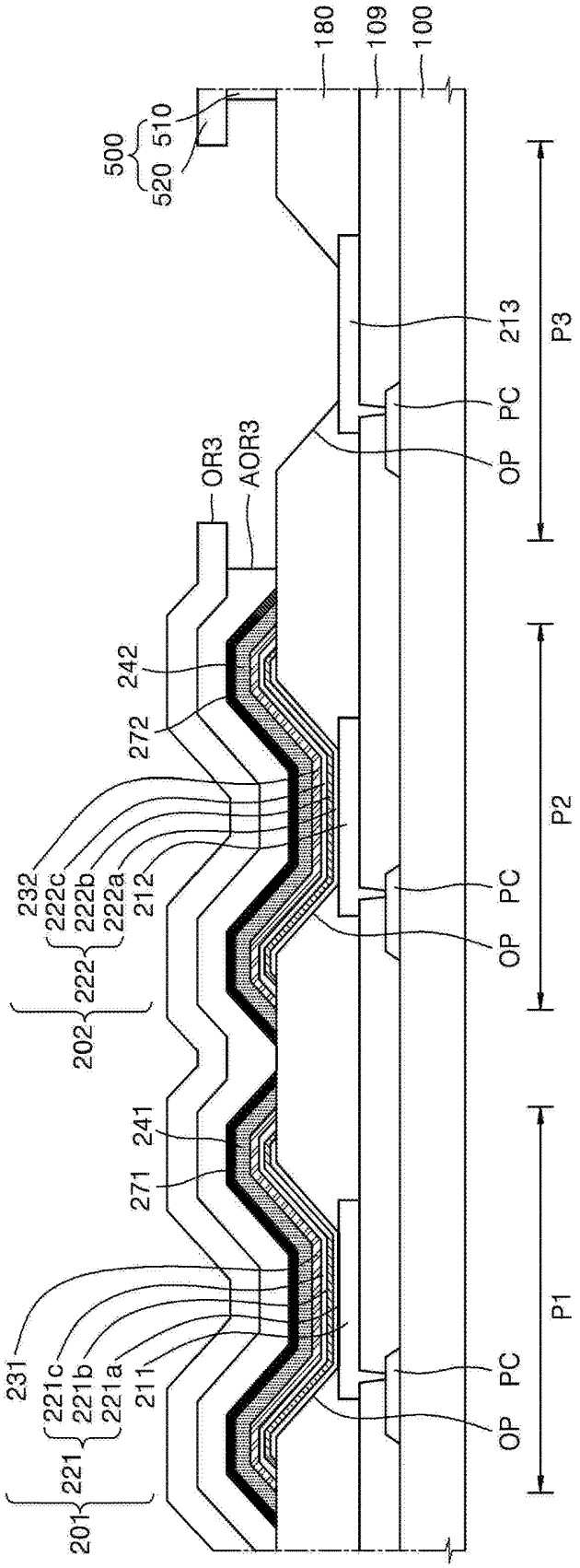
OP
242
272
Wd2
Wp2
We2
232
222c
222b
222a
212
222
202
P2
241
271
231
221c
221b
221a
211
221
201
P1

FIG. 5I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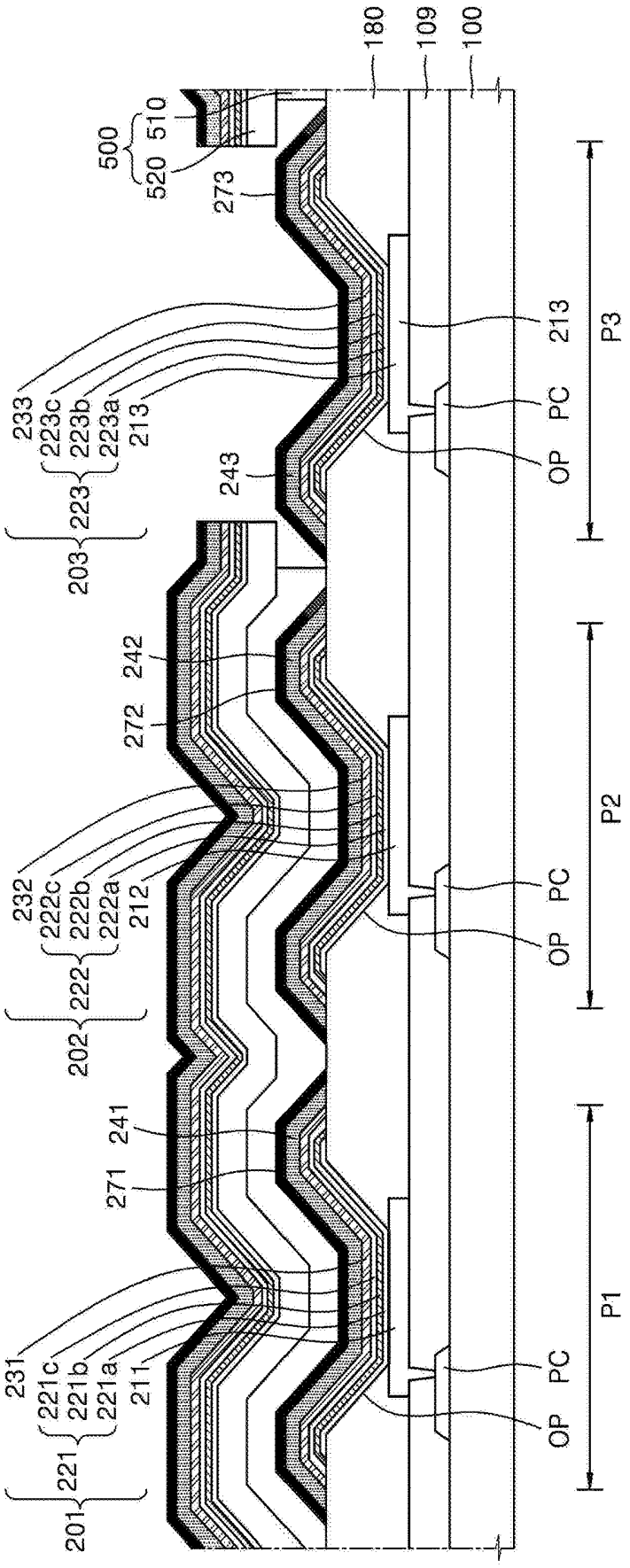
520
213
P3
PC
OP
OR3
AOR3
242
272
232
222c
222b
222a
212
222
202
P2
241
271
231
221c
221b
221a
211
221
201
P1

FIG. 5J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500
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223c
223b
223a
213
223
203
243
213
OP
PC
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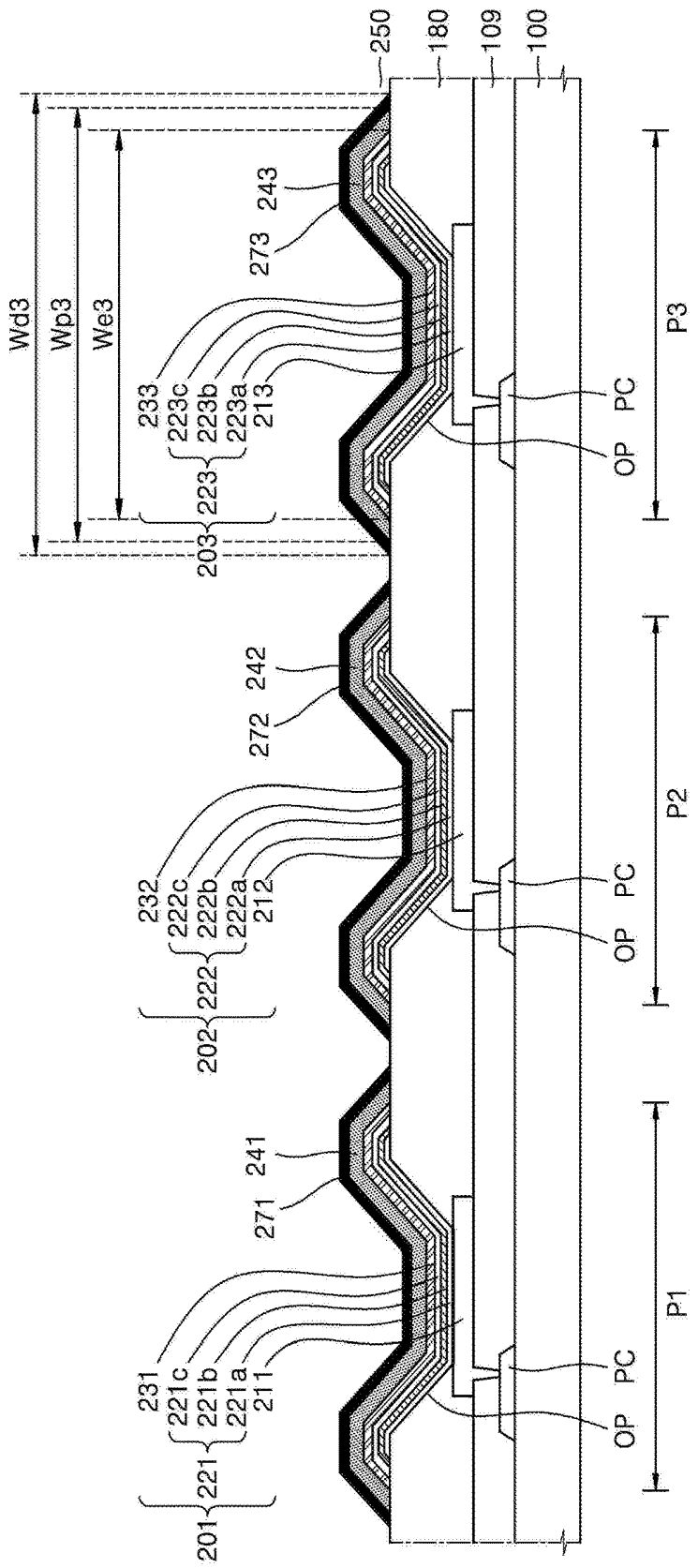
222c
222b
222a
212
222
202
OP
PC
P2
241
271
231
221c
221b
221a
211
221
201
OP
PC
P1

FIG. 5K


250
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109
100
Wd3
Wp3
We3
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223c
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213
223
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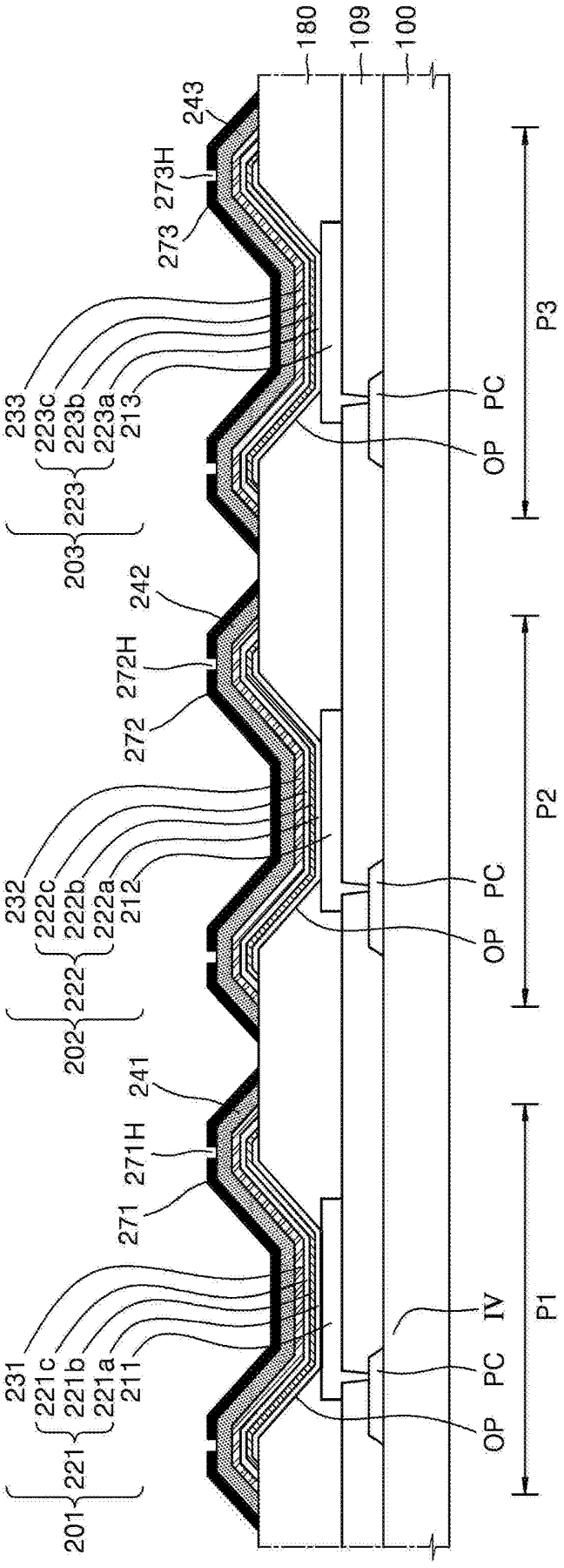
242
272
232
222c
222b
222a
212
222
202
PC
OP
P2
241
271
231
221c
221b
221a
211
221
201
PC
OP
P1

FIG. 5L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272H
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232
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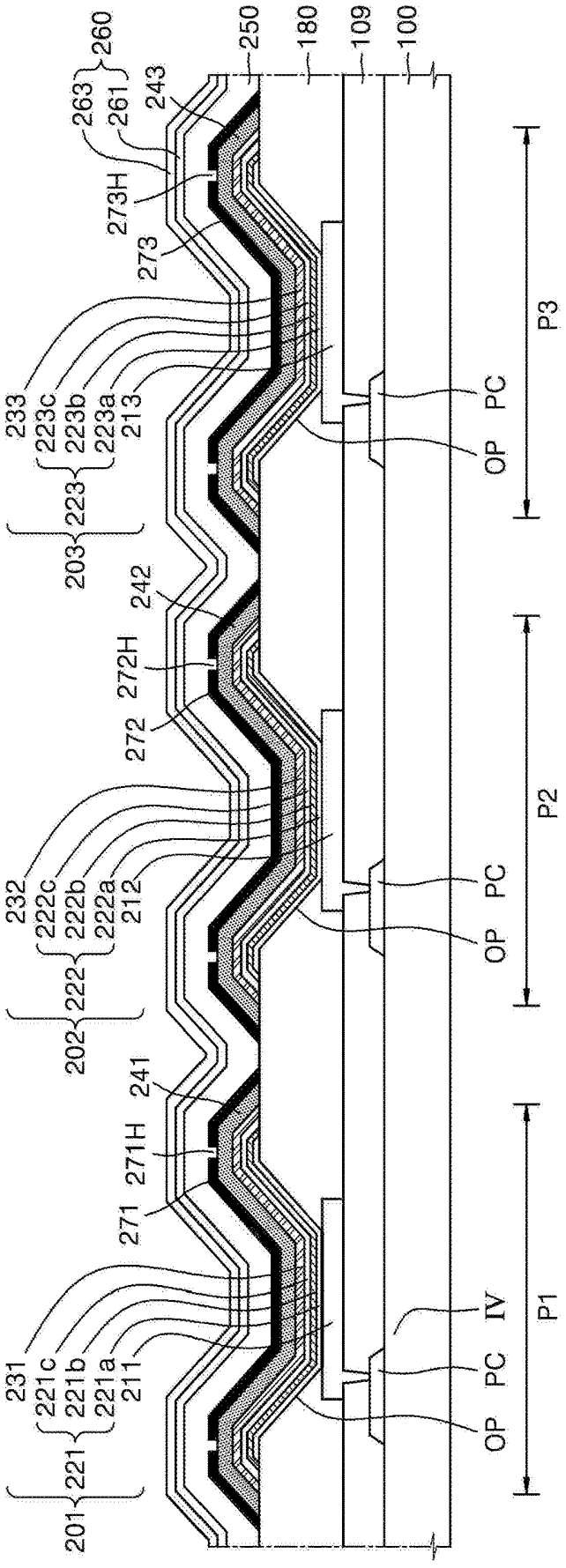
222b
222a
212
222
202
241
271H
271
231
221c
221b
221a
211
221
201
PC
OP
P3
P2
P1
IV

FIG. 5M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242
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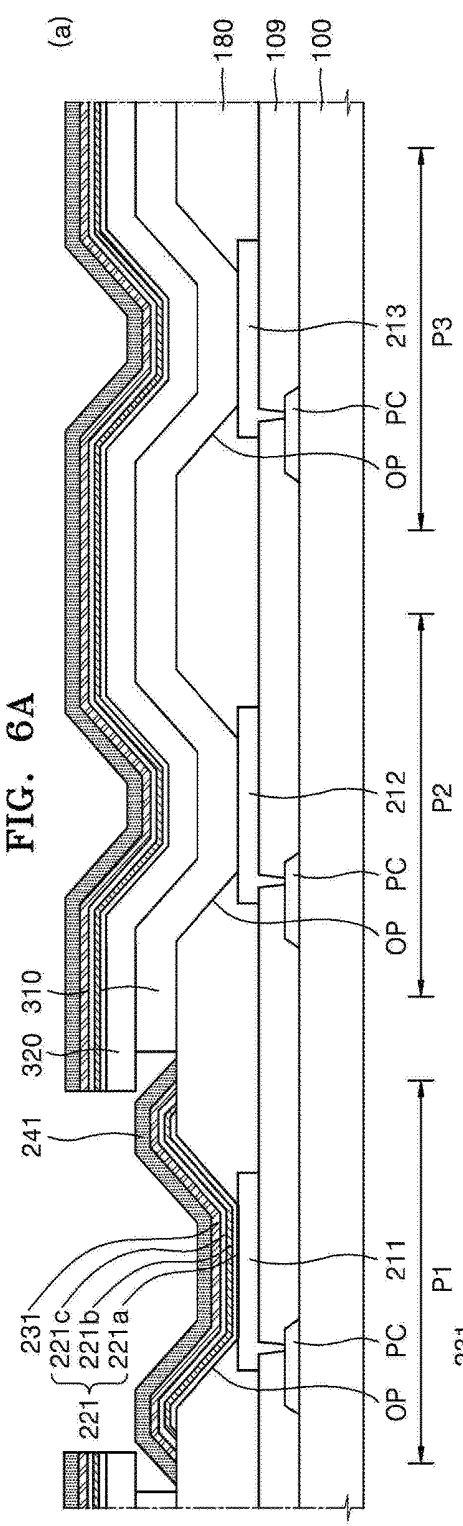
272
232
222c
222b
222a
212
222
202
241
271H
271
231
221c
221b
221a
211
221
201
OP
PC
P3
OP
PC
P2
OP
PC
IV
P1


(a)
180
109
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P3
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212
P2
211
P1
241
320
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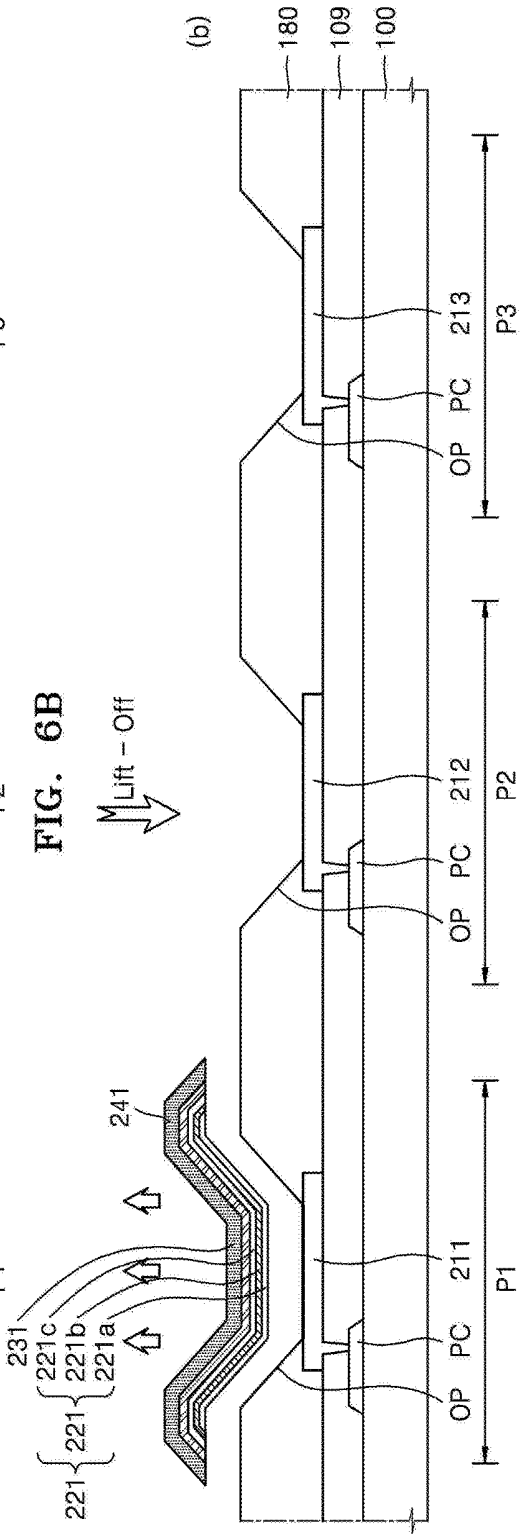
221c
221b
221a
221

FIG. 6A


(b)
180
109
100
213
P3
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PC
212
P2
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P1
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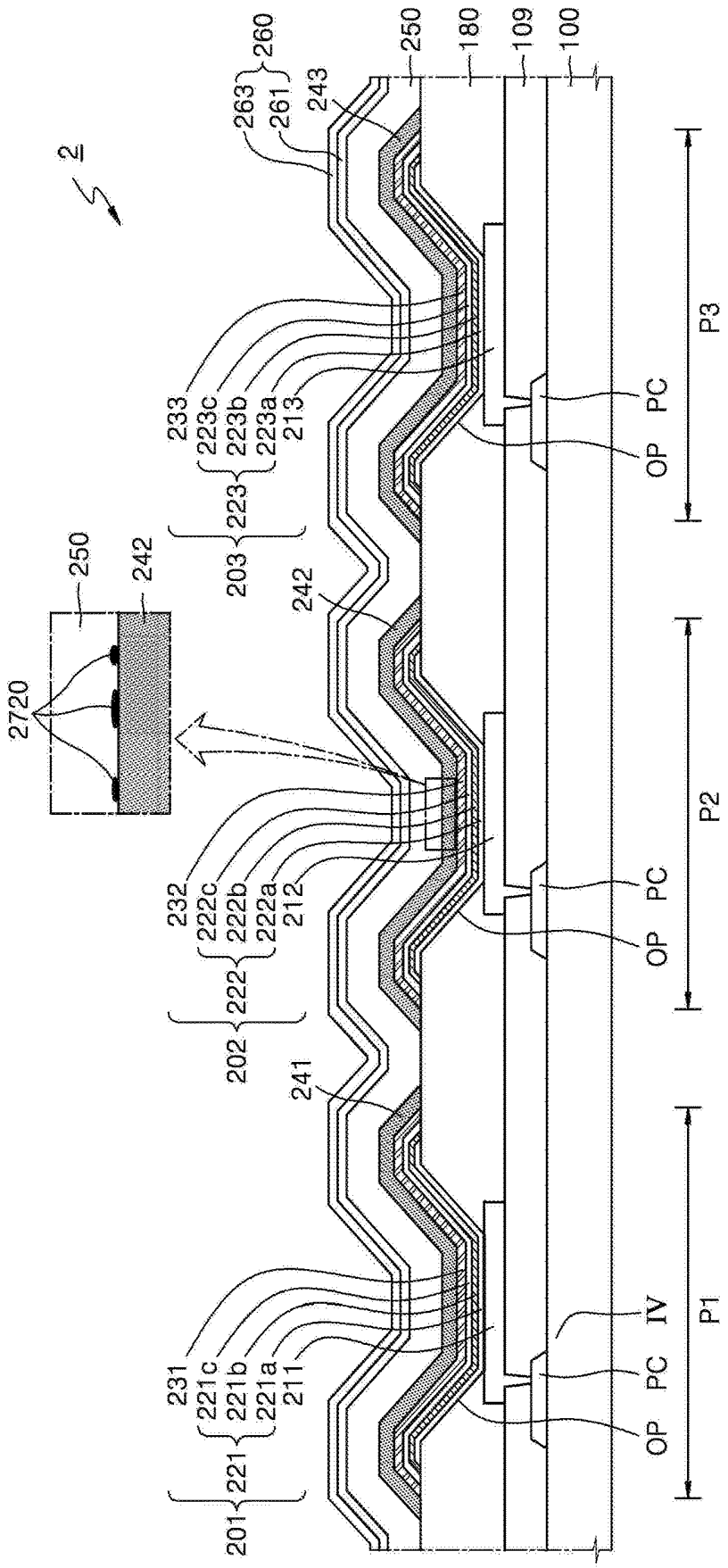
231
221c
221b
221a
221
Lift - Off

FIG. 6B

FIG. 7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222a
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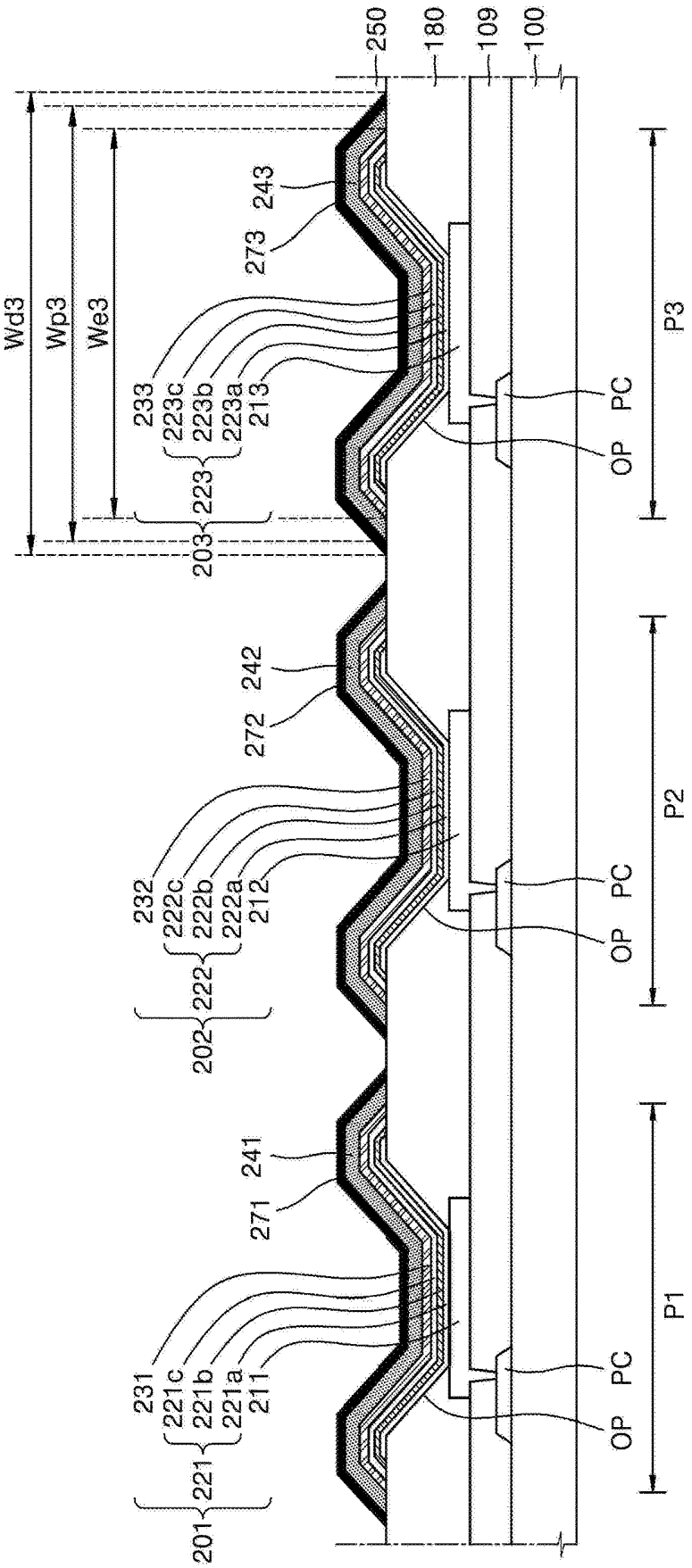
203
223
233
223c
223b
223a
213
242
263
261
260
243
250
180
109
100
IV
PC
OP
P1
P2
P3

FIG. 8A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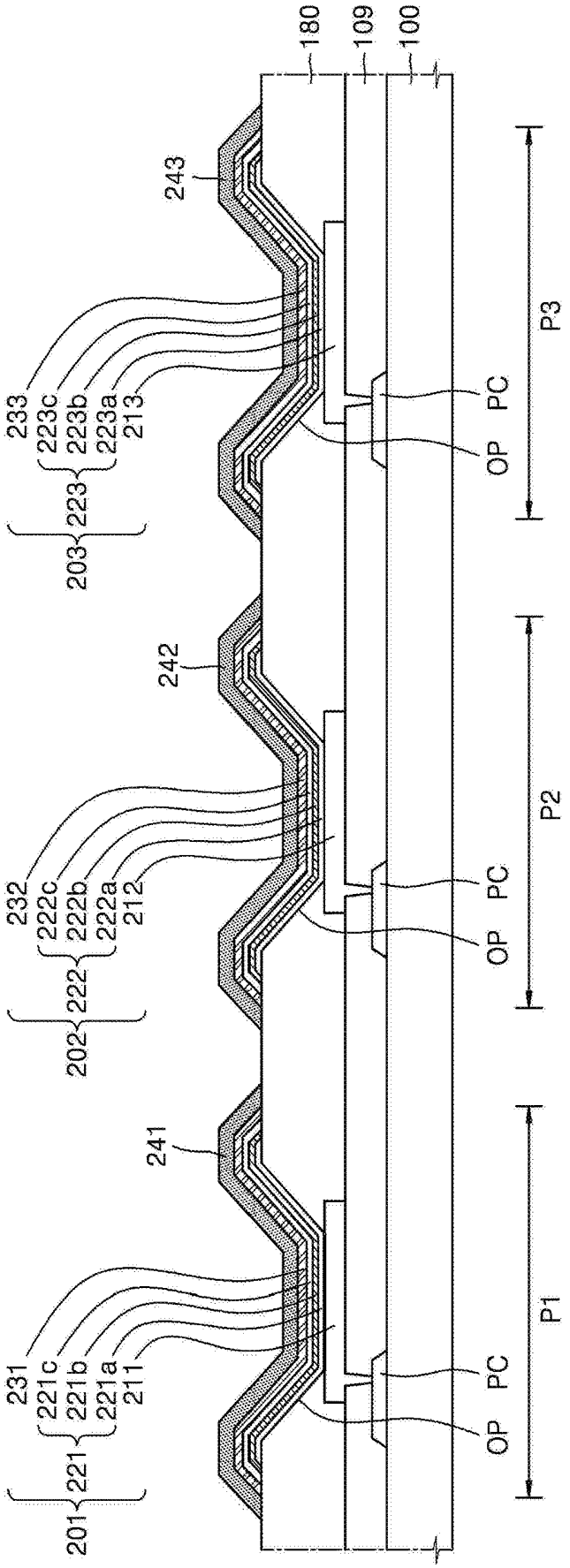
P3
242
272
232
222c
222b
222a
212
222
202
PC
OP
P2
241
271
231
221c
221b
221a
211
221
201
PC
OP
P1

FIG. 8B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212
222
202
OP
PC
P2
241
231
221c
221b
221a
211
221
201
OP
PC
P1

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

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from and the benefit of Korean Patent Application No. 10-2017-0030311, filed on Mar. 10, 2017, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

Field

[0002] The invention relates generally to organic light-emitting display apparatuses, and more particularly, to organic light-emitting display apparatuses and methods of manufacturing organic light-emitting apparatuses that may be produced at reduced manufacturing costs and can simplify the overall manufacturing process.

Discussion of the Background

[0003] Organic light-emitting display apparatuses are widely used as next generation display apparatuses because of their wide viewing angle, short response time, and low power consumption as well as thin and light design.

[0004] In an organic light-emitting display apparatus capable of displaying a full color image, light having different colors is emitted from pixel regions and an organic emission layer of each pixel is formed using a deposition mask. As the organic light-emitting display apparatus has higher resolution, the widths of open slits of fine metal masks used during deposition processes have become narrower and the spacing between the open slits are required to be further reduced. Also, in order to manufacture organic light-emitting display apparatuses having even higher resolutions, it is necessary to reduce or remove shadow effects. Accordingly, methods of performing deposition processes with substrates and masks in close contact may be used.

[0005] Applicants discovered that when a deposition process is performed in a state where a substrate and a mask are in close contact, the mask may inappropriately contact the substrate. In order to prevent this problem, a method involving locating a spacer on a pixel-defining film is used. However, in this case, an additional manufacturing step is added, and a thickness of an organic light-emitting display apparatus is increased due to the spacer.

[0006] The above information disclosed in this Background section is only for enhancement of understanding of the background of the inventive concepts, and, therefore, it may contain information that does not constitute prior art.

SUMMARY

[0007] Organic light-emitting display apparatuses and manufacturing methods thereof according to the principles of the invention employ a lift-off process without using a fine metal mask that prevents a deposition mask from inappropriately touching a substrate, thereby reducing manufacturing costs, and simplifying the overall manufacturing process.

[0008] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the disclosure, or may be learned by practice of the inventive concepts.

[0009] According to one aspect of the invention, a method of manufacturing an organic light-emitting display apparatus includes the steps of forming a first pixel electrode and a second pixel electrode on a substrate, forming a pixel-defining film on the first pixel electrode and the second pixel electrode, the pixel-defining film having an opening through which each of the first pixel electrode and the second pixel electrode is exposed, forming a first masking pattern on the pixel-defining film having a first opening portion through which the first pixel electrode is exposed, sequentially forming a first intermediate layer including a first emission layer, a first counter electrode, a first protective layer, and a first anti-decapping layer on the first pixel electrode and the first masking pattern, and removing the first masking pattern along with the first intermediate layer, the first counter electrode, the first protective layer, and the first anti-decapping layer disposed on the first masking pattern.

[0010] The first anti-decapping layer may be formed of a material including fluorine.

[0011] The first protective layer may be formed of a material including transparent conductive oxide.

[0012] The first protective layer may be formed to have a width greater than a width of the first counter electrode.

[0013] The first protective layer may be formed to have an end portion directly contacting the pixel-defining film.

[0014] The first masking pattern may include a material other than fluorine.

[0015] The first masking pattern may be formed using a photolithography process.

[0016] The first intermediate layer may be formed using a deposition process.

[0017] The first anti-decapping layer may be formed to have a width greater than a width of the first protective layer.

[0018] The method may further include the step of forming a second masking pattern on the first anti-decapping layer and the pixel-defining film, the second masking pattern having a second opening portion through which the second pixel electrode is exposed, sequentially forming a second intermediate layer including a second emission layer, a second counter electrode, a second protective layer, and a second anti-decapping layer on the second pixel electrode and the second masking pattern, and removing the second masking pattern along with the second intermediate layer, the second counter electrode, the second protective layer, and the second anti-decapping layer disposed on the second masking pattern.

[0019] The method may further include the step of respectively forming through-holes in the first anti-decapping layer and the second anti-decapping layer, and forming a connection layer on the first anti-decapping layer and the second anti-decapping layer to cover the first anti-decapping layer and the second anti-decapping layer.

[0020] The through-holes may be formed to expose top surfaces of the first protective layer and the second protective layer.

[0021] The method may further include the steps of removing the first anti-decapping layer and the second anti-decapping layer, and forming a connection layer on the first protective layer and the second protective layer to cover the first protective layer and the second protective layer.

[0022] The first anti-decapping layer and the second anti-decapping layer may be removed using plasma treatment.

[0023] According to another aspect of the invention, an organic light-emitting display apparatus includes a first pixel electrode and a second pixel electrode disposed on a substrate, a pixel-defining film disposed on the first pixel electrode and the second pixel electrode and having openings through which the first pixel electrode and the second pixel electrode are exposed, a first intermediate layer and a second intermediate layer respectively disposed on the first pixel electrode and the second pixel electrode, the first pixel electrode and the second pixel electrode respectively including a first emission layer and a second emission layer, a first counter electrode and a second counter electrode respectively disposed on the first intermediate layer and the second intermediate layer and having island-type patterns, a first protective layer and a second protective layer respectively disposed on the first counter electrode and the second counter electrode and having island-type patterns; a first anti-decapping layer and a second anti-decapping layer respectively disposed on the first protective layer and the second protective layer, and a connection layer disposed on the first anti-decapping layer and the second anti-decapping layer and electrically connected to the first counter electrode and the second counter electrode.

[0024] Each of the first anti-decapping layer and the second anti-decapping layer may include fluorine.

[0025] Each of the first protective layer and the second protective layer may include a transparent conductive oxide.

[0026] The first protective layer may have a width greater than a width of the first counter electrode, and the second protective layer may have a width greater than a width of the second counter electrode.

[0027] An end portion of each of the first protective layer and the second protective layer may directly contact the pixel-defining film.

[0028] The first anti-decapping layer and the second anti-decapping layer may have island-type patterns covering the first protective layer and the second protective layer.

[0029] The first anti-decapping layer and the second anti-decapping layer may have through-holes through which top surfaces of the first protective layer and the second protective layer are exposed. The first protective layer and the second protective layer may directly contact the connection layer through the through-holes.

[0030] The first anti-decapping layer may have a width greater than a width of the first protective layer, and the second anti-decapping layer may have a width greater than a width of the second protective layer.

[0031] The first anti-decapping layer and the second anti-decapping layer may be disposed on the first protective layer and the second protective layer, and each may include distributed particles.

[0032] The first protective layer and the second protective layer may directly contact the connection layer through spaces between the distributed particles of the first anti-decapping layer and the second anti-decapping layer.

[0033] The connection layer may integrally cover the first protective layer and the second protective layer.

[0034] The foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The accompanying drawings, which are included to provide a further understanding of the inventive concepts, and are incorporated in and constitute a part of this specification, illustrate exemplary embodiments of the inventive concepts, and, together with the description, serve to explain principles of the inventive concepts.

[0036] FIG. **1** is a schematic plan view of an embodiment of an organic light-emitting display apparatus constructed according to the principles of the invention.

[0037] FIG. **2** is a schematic plan view of a part of a display area of the organic light-emitting display apparatus of FIG. **1**.

[0038] FIG. **3** is a schematic plan view of another embodiment of a part of a display area of the organic light-emitting display apparatus of FIG. **1**.

[0039] FIG. **4** is a schematic cross-sectional view of a first embodiment of the organic light-emitting display apparatus taken along sectional line IV-IV of FIGS. **2** and **3**.

[0040] FIGS. **5**A through **5**M are schematic cross-sectional views of an organic light-emitting display apparatus illustrating an exemplary method of manufacturing the organic light-emitting display apparatus according to the principles of the invention.

[0041] FIGS. **6**A and **6**B are schematic cross-sectional views of an organic light-emitting display apparatus showing a stripping process that may be employed without a first anti-decapping layer.

[0042] FIG. **7** is a schematic cross-sectional view of a second embodiment of an organic light-emitting display apparatus constructed according to the principles of the invention.

[0043] FIGS. **8**A and **8**B are schematic cross-sectional views of the organic light-emitting display apparatus of FIG. **7** illustrating a part of an exemplary method of manufacturing the organic light-emitting display apparatus.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0044] In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of various exemplary embodiments. It is apparent, however, that various exemplary embodiments may be practiced without these specific details or with one or more equivalent arrangements. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring various exemplary embodiments.

[0045] In the accompanying figures, the size and relative sizes of layers, films, panels, regions, etc., may be exaggerated for clarity and descriptive purposes. Also, like reference numerals denote like elements.

[0046] When an element or layer is referred to as being "on," "connected to," or "coupled to" another element or layer, it may be directly on, connected to, or coupled to the other element or layer or intervening elements or layers may be present. When, however, an element or layer is referred to as being "directly on," "directly connected to," or "directly coupled to" another element or layer, there are no intervening elements or layers present. For the purposes of this disclosure, "at least one of X, Y, and Z" and "at least one selected from the group consisting of X, Y, and Z" may be construed as X only, Y only, Z only, or any combination of

two or more of X, Y, and Z, such as, for instance, XYZ, XYY, YZ, and ZZ. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0047] Although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers, and/or sections, these elements, components, regions, layers, and/or sections should not be limited by these terms. These terms are used to distinguish one element, component, region, layer, and/or section from another element, component, region, layer, and/or section. Thus, a first element, component, region, layer, and/or section discussed below could be termed a second element, component, region, layer, and/or section without departing from the teachings of the present disclosure.

[0048] Spatially relative terms, such as "beneath," "below," "lower," "above," "upper," and the like, may be used herein for descriptive purposes, and, thereby, to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the drawings. Spatially relative terms are intended to encompass different orientations of an apparatus in use, operation, and/or manufacture in addition to the orientation depicted in the drawings. For example, if the apparatus in the drawings is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" can encompass both an orientation of above and below. Furthermore, the apparatus may be otherwise oriented (e.g., rotated 90 degrees or at other orientations), and, as such, the spatially relative descriptors used herein interpreted accordingly.

[0049] The terminology used herein is for the purpose of describing particular embodiments and is not intended to be limiting. 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. Moreover, the terms "comprises," "comprising," "includes," and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, components, and/or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0050] Various exemplary embodiments are described herein with reference to sectional illustrations that are schematic illustrations of idealized exemplary embodiments and/or intermediate structures. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, exemplary embodiments disclosed herein should not be construed as limited to the particular illustrated shapes of regions, but are to include deviations in shapes that result from, for instance, manufacturing. For example, an implanted region illustrated as a rectangle will, typically, have rounded or curved features and/or a gradient of implant concentration at its edges rather than a binary change from implanted to non-implanted region. Likewise, a buried region formed by implantation may result in some implantation in the region between the buried region and the surface through which the implantation takes place. Thus, the regions illustrated in the drawings are schematic in nature and their shapes are not intended to illustrate the actual shape of a region of a device and are not intended to be limiting.

[0051] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure is a part. Terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense, unless expressly so defined herein.

[0052] FIG. **1** is a schematic plan view of an embodiment of an organic light-emitting display apparatus constructed according to the principles of the invention.

[0053] Referring to FIG. **1**, the organic light-emitting display apparatus **1** includes a substrate **100**. The substrate **100** includes a display area DA and a peripheral area PA outside the display area DA.

[0054] Pixels P including an organic light-emitting device (OLED) may be located in the display area DA of the substrate **100**. Various wirings for transmitting an electrical signal to be applied to the display area DA may be located in the peripheral area PA of the substrate **100** that is an area where an image is not displayed.

[0055] FIG. **2** is a schematic plan view of a part of a display area of the organic light-emitting display apparatus of FIG. **1**. FIG. **3** is a schematic plan view of another embodiment of a part of a display area of the organic light-emitting display apparatus of FIG. **1**. FIG. **4** is a schematic cross-sectional view of a first embodiment of the organic light-emitting display apparatus taken along sectional line IV-IV of FIGS. **2** and **3**.

[0056] Referring to FIGS. **2** through **4**, the display area DA includes pixels P**1**, P**2**, and P**3** that emit light of different colors. For descriptive convenience, the pixels P**1**, P**2**, and P**3**, which may emit light of different colors, are respectively referred to as a first pixel, a second pixel, and a third pixel.

[0057] In an exemplary embodiment, the first pixel P**1** may emit red light, the second pixel P**2** may emit green light, and the third pixel P**3** may emit blue light. Although three pixels, the first through third pixels P**1**, P**2**, and P**3**, are located in the display area DA in the illustrated embodiment, the inventive concepts are not limited thereto. In another exemplary embodiment, a fourth pixel that emits white light may be further included in addition to the first through third pixels P**1**, P**2**, and P**3**.

[0058] The first through third pixels P**1**, P**2**, and P**3** respectively include pixel circuits PC and first through third OLEDs **201**, **202** and **203** (see FIG. **4**) electrically connected to the pixel circuits PC.

[0059] The pixel circuits PC are connected to first through third pixel electrodes **211**, **212**, and **213** of the first through third OLEDs **201**, **202**, and **203**, respectively, through contact holes formed in an insulating layer **109**.

[0060] The first OLED **201** includes the first pixel electrode **211**, a first intermediate layer **221**, and a first counter electrode **231**.

[0061] Each of the first pixel electrode **211**, the first intermediate layer **221**, and the first counter electrode **231** has an island-type pattern. An island-type pattern indicates that a certain portion is distinguished from portions around it. As shown in FIG. **2**, each of the first pixel electrode **211**, the first intermediate layer **221**, and the first counter elec-

trode **231** may be patterned into an island shape in each first pixel P**1**, or as shown in FIG. **3**, the first intermediate layer **221** and the first counter electrode **231** may be commonly patterned into a strip shape to include a plurality of the first pixels P**1**.

[0062] The first intermediate layer **221** may include a first emission layer **221***b* that emits red light, and may further include first and second functional layers **221***a* and **221***c* located over and/or under the first emission layer **221***b*. The first functional layer **221***a* may include a hole injection layer (HIL) and/or a hole transport layer (HTL), and the second functional layer **221***c* may include an electron transport layer (ETL) and/or an electron injection layer (EIL). The first intermediate layer **221** may selectively include the first and/or second functional layers **221***a* and **221***c*.

[0063] The second OLED **202** includes the second pixel electrode **212**, a second intermediate layer **222**, and a second counter electrode **232**.

[0064] Each of the second pixel electrode **212**, the second intermediate layer **222**, and the second counter electrode **232** has an island-type pattern. As shown in FIG. **2**, each of the second pixel electrode **212**, the second intermediate layer **222**, and the second counter electrode **232** may be patterned into an island shape in each second pixel P**2**, or as shown in FIG. **3**, the second intermediate layer **222** and the second counter electrode **232** may be commonly patterned into a strip shape to include a plurality of the second pixels P**2**.

[0065] The second intermediate layer **222** may include a second emission layer **222***b* that emits green light, and may further include first and second functional layers **222***a* and **222***c* located over and/or under the second emission layer **222***b*. The first functional layer **222***a* may include an HIL and/or an HTL, and the second functional layer **222***c* may include an ETL and/or an EIL. The second intermediate layer **222** may selectively include the first and/or second functional layers **222***a* and **222***c*.

[0066] The third OLED **203** includes the third pixel electrode **213**, a third intermediate layer **223**, and a third counter electrode **233**.

[0067] Each of the third pixel electrode **213**, the third intermediate layer **223**, and the third counter electrode **233** has an island-type pattern. As shown in FIG. **2**, each of the third pixel electrode **213**, the third intermediate layer **223**, and the third counter electrode **233** may be patterned into an island shape in each third pixel P**3**, or as shown in FIG. **3**, the third intermediate layer **223** and the third counter electrode **233** may be commonly patterned into a strip shape to include a plurality of the third pixels P**3**.

[0068] The third intermediate layer **223** may include a third emission layer **223***b* that emits blue light, and may further include first and second functional layers **223***a* and **223***c* located over and/or under the third emission layer **223***b*. The first functional layer **223***a* may include an HIL and/or an HTL, and the second functional layer **223***c* may include an ETL and/or an EIL. The third intermediate layer **223** may selectively include the first and/or second functional layers **223***a* and **223***c*.

[0069] The first through third pixel electrodes **211**, **212**, and **213** may be reflective electrodes or transmissive electrodes.

[0070] When the first through third pixel electrodes **211**, **212**, and **213** are reflective electrodes, each of the first through third pixel electrodes **211**, **212**, and **213** may include a reflective film 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. Alternatively, each of the first through third pixel electrodes **211**, **212**, and **213** may include a reflective film and a transparent conductive oxide (TCO) film located over and/or under the reflective film.

[0071] When the first through third pixel electrodes **211**, **212**, and **213** are transmissive electrodes, each of the first through third pixel electrodes **211**, **212**, and **213** may be a TCO layer. Alternatively, each of the first through third pixel electrodes **211**, **212**, and **213** may be a metal thin film including Ag or an Ag alloy, or may have a multi-layer structure including a TCO layer formed on a metal thin film. In an exemplary embodiment, each of the first through third pixel electrodes **211**, **212**, and **213** may have a three-layer structure in which indium tin oxide (ITO), Ag, and ITO respectively having thicknesses of 70 Å, 850 Å, and 50 Å are sequentially stacked.

[0072] The first through third counter electrodes **231**, **232**, and **233** may be transmissive electrodes or reflective electrodes. Each of the first through third counter electrodes **231**, **232**, and **233** may be a metal thin film or a metal thick film including at least material selected from the group of silver (Ag), magnesium (Mg), aluminum (Al), ytterbium (Yb), calcium (Ca), lithium (Li), and gold (Au).

[0073] For example, each of the first through third counter electrodes **231**, **232**, and **233** may have a single-layer structure or a multi-layer structure including at least one of Ag, Mg, Al, Yb, Ca, LiF/Ca, LiF/Al, Al, and Au. In an exemplary embodiment, each of the first through third counter electrodes **231**, **232**, and **233** may include a metal thin film including Ag and Mg, wherein Ag content may be greater than Mg content.

[0074] Each of the first through third counter electrodes **231**, **232**, and **233** including the above materials may be formed as a transmissive electrode by reducing a thickness thereof or may be formed as a reflective electrode by increasing a thickness thereof. For example, a metal electrode including Ag and Mg may be formed having a thickness ranging from about 10 Å to about 15 Å to be used as a transmissive electrode, or may be formed having a thickness of about 50 nm or more to be used as a reflective electrode.

[0075] The first through third intermediate layers **221**, **222**, and **223** and the first through third counter electrodes **231**, **232**, and **233** may be manufactured using a lift-off process. For example, the lift-off process may be performed on each of first through third pixels P**1**, P**2**, and P**3** and a photoresist may be used during the lift-off process. When a material included in the photoresist, for example, propylene glycol monomethyl ether acetate (PGMEA) or a material such as tetramethylammonium hydroxide (TMAH) included in a developing solution used during the photoresist penetrates into an OLED, the OLED may be damaged or deteriorated. In order to prevent this problem, first through third protective layers **241**, **242**, and **243** respectively covering the first through third OLEDs **201**, **202**, and **203** are formed on the first through third OLEDs **201**, **202**, and **203**.

[0076] Each of the first through third protective layers **241**, **242**, and **243** may include TCO. For example, each of the first through third protective layers **241**, **242**, and **243** may include indium tin oxide (ITO), indium tin oxide nitride

(ITON), indium zinc oxide (IZO), indium zinc oxide nitride (IZON), indium zinc tin oxide (IZTO), or aluminum zinc oxide (AZO).

[0077] The first through third protective layers **241**, **242**, and **243** have island-type patterns in the first through third pixels P1, P2, and P3. The first through third protective layers **241**, **242**, and **243** have widths greater than widths of the first through third counter electrodes **231**, **232**, and **233** located under the first through third protective layers **241**, **242**, and **243**. End portions of the first through third protective layers **241**, **242**, and **243** may directly contact a pixel-defining film **180** along end portions of the first through third counter electrodes **231**, **232**, and **233**.

[0078] Each of the first through third protective layers **241**, **242**, and **243** may be manufactured using a lift-off process. For example, the lift-off process may be performed on each of the first through third pixels P1, P2, and P3. In a stripping process to remove a lift-off layer formed of an organic material, the first through third protective layers **241**, **242**, and **243** each including TCO may fail to cap the first through third OLEDs **201**, **202**, and **203** due to a strong interaction with a stripping solvent that is an organic solvent and may decap from the first through third OLEDs **201**, **202**, and **203**. Alternatively, the first through third protective layers **241**, **242**, and **243** may decap from the first through third pixels P1, P2, and P3 along with the first through third OLEDs **201**, **202**, and **203** (see FIG. **6**B). As such, in order to prevent deterioration of the first through third OLEDs **201**, **202**, and **203** due to decapping of the first through third protective layers **241**, **242**, and **243**, first through third anti-decapping layers **271**, **272**, and **273** respectively covering the first through third protective layers **241**, **242**, and **243** are formed on the first through third protective layers **241**, **242**, and **243**.

[0079] Each of the first through third anti-decapping layers **271**, **272**, and **273** may be formed of a resin including fluorine. For example, a resin including fluorine having low surface energy may block a strong interaction between a stripping solvent that is an organic solvent and the first through third protective layers **241**, **242**, and **243** each including TCO.

[0080] The first through third anti-decapping layers **271**, **272**, and **273** include first through third through-holes **271**H, **272**H, and **273**H through which top surfaces of the first through third protective layers **241**, **242**, and **243** are exposed. The first through third through-holes **271**H, **272**H, and **273**H formed in the first through third anti-decapping layers **271**, **272**, and **273**, each formed of a non-conductive material, function as paths through which the first through third counter electrodes **231**, **232**, and **233** and the first through third protective layers **241**, **242**, and **243**, each formed of a conductive material, are electrically connected to a connection layer **250**.

[0081] The first through third anti-decapping layers **271**, **272**, and **273** have island-type patterns in the first through third pixels P1, P2, and P3. The first through third anti-decapping layers **271**, **272**, and **273** may have widths greater than widths of the first through third protective layers **241**, **242**, and **243** located under the first through third anti-decapping layers **271**, **272**, and **273**. End portions of the first through third anti-decapping layers **271**, **272**, and **273** may directly contact the pixel-defining film **180**.

[0082] The connection layer **250** is integrally formed to cover the first through third anti-decapping layers **271**, **272**, and **273**. The connection layer **250** contacts the first through third protective layers **241**, **242**, and **243** including TCO through the first through third through-holes **271**H, **272**H, and **273**H, and is electrically connected to the first through third counter electrodes **231**, **232**, and **233**. The connection layer **250** may prevent a voltage drop in a common voltage applied to the first through third OLEDs **201**, **202**, and **203**.

[0083] The connection layer **250** is formed of a conductive material. In an exemplary embodiment, when the first through third pixel electrodes **211**, **212**, and **213** are reflective electrodes and the first through third counter electrodes **231**, **232**, and **233** are transmissive electrodes, the connection layer **250** may be formed of TCO. In another exemplary embodiment, when the first through third pixel electrodes **211**, **212**, and **213** are transmissive electrodes and the first through third counter electrodes **231**, **232**, and **233** are reflective electrodes, the connection layer **250** may be formed of any conductive material including TCO and a metal.

[0084] An encapsulation thin film **260** may be disposed on the connection layer **250**. The encapsulation thin film **260** may include at least one organic layer **261** and at least one inorganic layer **263**. The organic layer **261** may include a polymer-based material such as polymethylmethacrylate (PMMA), polycarbonate (PC), polystyrene (PS), acrylic resin, epoxy resin, polyimide, or polyethylene. The inorganic layer **263** may include at least one of aluminum nitride (AlN), aluminum oxide (Al_2O_3), titanium nitride (TiN), titanium oxide (TiO_2), silicon oxynitride (SiON), silicon nitride (SiNx), and silicon oxide (SiOx).

[0085] Although the inorganic layer **263** is disposed over the organic layer **261** in FIG. **4**, the inventive concepts not limited thereto. In another exemplary embodiment, positions of the organic layer **261** and the inorganic layer **263** may be changed, and a stacking order and the number of layers may be varied.

[0086] FIGS. **5**A through **5**M are schematic cross-sectional views of an organic light-emitting display apparatus illustrating an exemplary method of manufacturing the organic light-emitting display apparatus according to the principles of the invention.

[0087] Referring to FIG. **5**A, the pixel circuits PC, and the first through third pixel electrodes **211**, **212**, and **213** electrically connected to the pixel circuits PC are formed on the substrate **100**, and the pixel-defining film **180** having openings OP through which the first through third pixel electrodes **211**, **212**, and **213** are exposed is formed.

[0088] The substrate **100** may include various materials such as a glass material or a plastic material (e.g., polyethylene terephthalate (PET), polyethylene naphthalate (PEN), or polyimide). Flexibility when the substrate **100** is formed of a plastic material may be greater than that when the substrate **100** is formed of a glass material. A buffer layer formed of SiOx and/or SiNx to prevent penetration of impurities may be formed on the substrate **100**.

[0089] After the pixel circuits PC are formed on the substrate **100**, contact holes are formed by patterning the insulating layer **109** that covers the pixel circuits PC. Next, a conductive material layer is formed and then the first through third pixel electrodes **211**, **212**, and **213** are formed by patterning the conductive material layer.

[0090] The conductive material layer may include a reflective film formed of Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, or a compound thereof, or may include a TCO film located over

or under the reflective film. Alternatively, the conductive material layer may be a thin film including Ag, or an Ag alloy, or may include a TCO film formed on a thin film. The first through third pixel electrodes **211**, **212**, and **213** may be reflective electrodes or transmissive electrodes according to the conductive material layer, and their detailed configuration is substantially the same as that described with reference to FIG. **4**.

[0091] Thereafter, an organic insulating film is formed and the pixel-defining film **180** is formed by patterning the organic insulating film. The pixel-defining film **180** has the openings OP through which the first through third pixel electrodes **211**, **212**, and **213** are exposed. Although the pixel-defining film **180** is formed of an organic insulating material in the illustrated embodiment, the inventive concepts are not limited thereto. In another exemplary embodiment, the pixel-defining film **180** may be formed of an organic insulating material and an inorganic insulating material, or an inorganic insulating material, and may have a single-layer structure or a multi-layer structure including the above materials.

[0092] Referring to FIG. **5**B, a first masking pattern **300** including a first photosensitive pattern layer **320** is formed on the pixel-defining film **180**. The first masking pattern **300** may further include a first auxiliary layer **310** located between the first photosensitive pattern layer **320** and the pixel-defining film **180**.

[0093] In an exemplary embodiment, the first masking pattern **300** may be formed using the following process.

[0094] A non-photosensitive organic material layer is formed on the substrate **100** and the pixel-defining film **180**, and a photoresist layer is formed on the non-photosensitive organic material layer. When the non-photosensitive organic material layer includes a fluorine-based material, an etching solution for etching the non-photosensitive organic material layer has to include a fluorine-based material. As a fluorine-based material is used for the non-photosensitive organic material layer, manufacturing costs may be high and a fluorine residue may remain. In the illustrated embodiment, a fluorine-based material is not used for the non-photosensitive organic material layer. The photoresist layer may include a positive photosensitive material.

[0095] Thereafter, the first photosensitive pattern layer **320** having a first opening portion OR**1** is formed by exposing and developing a portion of the photoresist layer corresponding to the first pixel P**1**. A first auxiliary opening portion AOR**1** is formed by etching a portion of the non-photosensitive organic material layer exposed through the first opening portion OR**1**. The first auxiliary opening portion AOR**1** of the first auxiliary layer **310** is formed by etching to be greater than the first opening portion OR**1**.

[0096] Referring to FIG. **5**C, the first intermediate layer **221**, the first counter electrode **231**, and the first protective layer **241** are sequentially formed on the substrate **100** and the first masking pattern **300**. The first intermediate layer **221** may include the first emission layer **221***b* that emits red light, and may include the first and second functional layers **221***a* and **222***c* located over or/and under the first emission layer **221***b*.

[0097] The first intermediate layer **221** and the first counter electrode **231** may be formed using thermal evaporation. Deposition materials for forming the first intermediate layer **221** and the first counter electrode **231** may move toward the substrate **100** in a direction perpendicular or oblique to the substrate **100**. Accordingly, an end portion of the first intermediate layer **221** and an end portion of the first counter electrode **231** may extend into a space under the first photosensitive pattern layer **320** without contacting the first auxiliary layer **310**. As the deposition materials are deposited in the oblique direction, the end portions of the first intermediate layer **221** and the first counter electrode **231** may have forward tapered shapes. The first intermediate layer **221** and the first counter electrode **231** include substantially the same material as that described with reference to FIG. **4**, and thus a description thereof will not be given to avoid redundancy.

[0098] The first protective layer **241** may include TCO. For example, the first protective layer **241** may include at least one of ITO, ITON, IZO, IZON, IZTO, and AZO.

[0099] The first protective layer **241** may be formed using sputtering. Materials for forming the first protective layer **241** may move toward the substrate **100** in a direction perpendicular or oblique to the substrate **100**. Accordingly, an end portion of the first protective layer **241** may extend into a space under the first photosensitive patter layer **320** without contacting the first auxiliary layer **310**. As shown in FIG. **5**E, the first protective layer **241** may have a width Wp**1** that is greater than a width We**1** of the first counter electrode **231** to entirely cover the first counter electrode **231**, and the end portion of the first protective layer **241** having a forward tapered shape may directly contact the first pixel-defining film **180**.

[0100] Referring to FIG. **5**D, the first anti-decapping layer **271** is formed on the first protective layer **241** in a state where the first masking pattern **300** is formed. The first anti-decapping layer **271** may be formed of a resin including fluorine and may block a strong interaction between an organic solvent and the first through third protective layers **241**, **242**, and **243** during a stripping process of a lift-off process.

[0101] The first anti-decapping layer **271** may be formed using thermal evaporation. Materials for forming the first anti-decapping layer **271** may move toward the substrate **100** in a direction perpendicular or oblique to the substrate **100**. Accordingly, an end portion of the first anti-decapping layer **271** may extend into a space under the first photosensitive pattern layer **320** without contacting the first auxiliary layer **310**. As shown in FIG. **5**E, the first anti-decapping layer **271** may have a width Wd**1** that is greater than the width Wp**1** of the first protective layer **241** to entirely cover the first protective layer **241**, and the end portion of the first anti-decapping layer **271** having a forward tapered shape may directly contact the pixel-defining film **180**.

[0102] Referring to FIG. **5**E, the first masking pattern **300** is removed using a lift-off process. In an exemplary embodiment, when the first auxiliary layer **310** is formed of a non-photosensitive organic material not including a fluorine-based material, the first auxiliary layer **310** may be removed using a general organic solvent.

[0103] As the first auxiliary layer **310** is removed, the first photosensitive pattern layer **320** located on the first auxiliary layer **310**, portions of the first intermediate layer **221**, the first counter electrode **231**, the first protective layer **241**, and the first anti-decapping layer **271** stacked on the first photosensitive pattern layer **320** are also removed. The first intermediate layer **221**, the first counter electrode **231**, the

first protective layer **241**, and the first anti-decapping layer **271** each having an island-type pattern remain in the first pixel P**1**.

[0104] Referring to FIGS. **6**A and **6**B, when the first anti-decapping layer **271** is not formed, in a stripping process to remove a lift-off layer formed of an organic material, the first protective layer **241** including TCO may fail to cap the first OLED **201** due to a strong interaction with a stripping solvent that is an organic solvent and may decap from the first OLED **201**. Alternatively, the first protective layer **241** may decap from the first pixel P**1** along with the first OLED **201**. However, in the illustrated embodiment, the first anti-decapping layer **271** including fluorine may block a strong interaction between an organic solvent and the first protective layer **241** including TCO during a stripping process of a lift-off process.

[0105] Referring to FIG. **5**F, a second masking pattern **400** including a second photosensitive pattern layer **420** is formed on the first anti-decapping layer **271** and the pixel-defining film **180**. The second masking pattern **400** may further include a second auxiliary layer **410** located between the second photosensitive pattern layer **420** and the pixel-defining film **180**.

[0106] The second masking pattern **400** may be formed using substantially the same method as that used to form the first masking pattern **300**.

[0107] For example, a non-photosensitive organic material layer is formed on the substrate **100** including the first OLED **201**, the first protective layer **241**, and the first anti-decapping layer **271**, and a photoresist layer is formed on the non-photosensitive organic material layer. The non-photosensitive organic material may not include a fluorine-based material and the photoresist layer may include a positive photosensitive material.

[0108] The second photosensitive pattern layer **420** having a second opening portion OR**2** is formed by exposing and developing a portion of the photoresist layer corresponding to the second pixel P**2**. The second auxiliary layer **410** having a second auxiliary opening portion AOR**2** that is greater than the second opening portion OR**2** is formed by etching a portion of the non-photosensitive organic material layer exposed through the second opening portion OR**2**.

[0109] Referring to FIG. **5**G, the second intermediate layer **222**, the second counter electrode **232**, the second protective layer **242**, and the second anti-decapping layer **272** are sequentially formed on the substrate **100** and the second masking pattern **400**. The second intermediate layer **222** and the second counter electrode **232** may be formed using thermal evaporation, the second protective layer **242** may be formed using sputtering, and the second anti-decapping layer **272** may be formed using thermal evaporation. Materials of the second intermediate layer **222** and the second counter electrode **232** and materials of the second protective layer **242** and the second anti-decapping layer **272** are substantially the same as those described with reference to FIG. **4**, and thus a description thereof will not be given to avoid redundancy.

[0110] Deposition materials of the second intermediate layer **222**, the second counter electrode **232**, the second protective layer **242**, and the second anti-decapping layer **272** may move toward the substrate **100** in a direction perpendicular or oblique to the substrate **100**, and thus end portions of the second intermediate layer **222**, the second counter electrode **232**, the second protective layer **242**, and the second anti-decapping layer **272** may extend into a space under the second photosensitive patter layer **420** without contacting the second auxiliary layer **410**. As shown in FIG. **5**H, the second protective layer **242** may have a width Wp**2** that is greater than a width We**2** of the second counter electrode **232** to entirely cover the second counter electrode **232**, and the end portion of the second protective layer **242** having a forward tapered shape may directly contact the pixel-defining film **180**. Also, the second anti-decapping layer **272** may have a width Wd**2** that is greater than the width Wp**2** of the second protective layer **242** to entirely cover the second protective layer **242**, and the end portion of the second anti-decapping layer **272** having a forward tapered shape may directly contact the pixel-defining film **180**.

[0111] Referring to FIG. **5**H, the second masking pattern **400** is removed by using a lift-off process. In an exemplary embodiment, when the second auxiliary layer **410** is formed of a non-photosensitive organic material not including a fluorine-based material, the second auxiliary layer **410** may be removed using a general organic solvent.

[0112] As the second auxiliary layer **410** is removed, the second photosensitive pattern layer **420** located on the second auxiliary layer **410**, portions of the second intermediate layer **222**, the second counter electrode **232**, the second protective layer **242**, and the second anti-decapping layer **272** stacked on the second photosensitive pattern layer **420** are also removed. The second intermediate layer **222**, the second counter electrode **232**, the second protective layer **242**, and the second anti-decapping layer **272** each having an island-type pattern remain in the second pixel P**2**.

[0113] The first protective layer **241** may prevent materials such as PGMEA included in the second masking pattern **400** on the first OLED **201** or TMAH used to develop the second masking pattern **400** from penetrating into the first OLED **201**. Also, the first and second protective layers **241** and **242** may protect the first and second OLEDs **201** and **202** during a lift-off process. For example, the first and second protective layers **241** and **242** may prevent a material included in a solvent for removing the second auxiliary layer **410** from penetrating into the first and second OLEDs **201** and **202** or may prevent the first and second OLEDs **201** and **202** from being damaged due to the material. The second anti-decapping layer **272** including fluorine may block a strong interaction between an organic solvent and the second protective layer **242** during a stripping process of a lift-off process.

[0114] Referring to FIG. **5**I, a third masking pattern **500** including a third photosensitive pattern layer **520** is formed on the first and second anti-decapping layers **271** and **272** and the pixel-defining film **180**. The third masking pattern **500** may further include a third auxiliary layer **510** located between the third photosensitive pattern layer **520** and the pixel-defining film **180**.

[0115] The third masking pattern **500** may be formed using substantially the same method as that used to form the first and second masking patterns **300** and **400**.

[0116] For example, a non-photosensitive organic material layer is formed on the substrate **100**, a photoresist layer is formed on the non-photosensitive organic material layer, and the third photosensitive pattern layer **520** having a third opening portion OR**3** is formed by using exposure and development. The third auxiliary layer **510** having a third auxiliary opening portion AOR**3** that is greater than the third opening portion OR**3** is formed by etching a portion of the

non-photosensitive organic material layer exposed through the third opening portion OR3.

[0117] Referring to FIG. **5**J, the third intermediate layer **223**, the third counter electrode **233**, the third protective layer **243**, and the third anti-decapping layer **273** are sequentially formed on the substrate **100** and the third masking pattern **500**. The third intermediate layer **223** and the third counter electrode **233** may be formed using thermal evaporation, the third protective layer **243** may be formed using sputtering, and the third anti-decapping layer **273** may be formed using thermal evaporation. Materials of the third intermediate layer **223** and the third counter electrode **233**, a material of the third protective layer **243**, and a material of the third anti-decapping layer **273** are substantially the same as those described with reference to FIG. **4**, and thus a description thereof will not be given to avoid redundancy.

[0118] Deposition materials of the third intermediate layer **223**, the third counter electrode **233**, the third protective layer **243**, and the third anti-decapping layer **273** may move toward the substrate **100** in a direction perpendicular or oblique to the substrate **100**, and thus end portions of the third intermediate layer **223**, the third counter electrode **233**, the third protective layer **243**, and the third anti-decapping layer **273** may extend into a space under the third photosensitive pattern layer **520** without contacting the third auxiliary layer **510**. As shown in FIG. **5**K, the third protective layer **243** may have a width Wp**3** that is greater than a width We**3** of the third counter electrode **233** to entirely cover the third counter electrode **233**, and the end portion of the third protective layer **243** having a forward tapered shape may directly contact the pixel-defining film **180**. Also, the third anti-decapping layer **273** may have a width Wd**3** that is greater than the width Wp**3** of the third protective layer **243** to entirely cover the third protective layer **243**, and the end portion of the third anti-decapping layer **273** having a forward tapered shape may directly contact the pixel-defining film **180**.

[0119] Referring to FIG. **5**K, the third masking pattern **500** is removed using a lift-off process. In an exemplary embodiment, when the third auxiliary layer **510** is formed of a non-photosensitive organic material not including a fluorine-based material, the third auxiliary layer **510** may be removed using a general organic solvent.

[0120] As the third auxiliary layer **510** is removed, the third photosensitive pattern layer **520** located on the third auxiliary layer **510**, portions of the third intermediate layer **223**, the third counter electrode **233**, the third protective layer **243**, and the third anti-decapping layer **273** located on the third photosensitive pattern layer **520** are also removed. The third intermediate layer **223**, the third counter electrode **233**, the third protective layer **243**, and the third anti-decapping layer **273** each having an island-type pattern remain in the third pixel P**3**.

[0121] The first protective layer **241** and the second protective layer **242** may prevent materials such as PGMEA included in the third masking pattern **500** on the first and second OLEDs **201** and **202** or TMAH used to develop the third masking pattern **500** from penetrating into the first and second OLEDs **201** and **202**. Also, the first through third protective layers **241**, **242**, and **243** may protect the first through third OLEDs **201**, **202**, and **203** during a lift-off process. For example, the first through third protective layers **241**, **242**, and **243** may prevent a material included in a solvent for removing the third auxiliary layer **510** from penetrating into the first through third OLEDs **201**, **202**, and **203** or may prevent the first through third OLEDs **201**, **202**, and **203** from being damaged due to the material. The third anti-decapping layer **273** including fluorine may block a strong interaction between an organic solvent and the third protective layer **243** during a stripping process of a lift-off process.

[0122] Referring to FIG. **5**L, the first through third through-holes **271**H, **272**H, and **273**H through which the top surfaces of the first through third protective layers **241**, **242**, and **243** are exposed are formed on top surfaces of the first through third anti-decapping layers **271**, **272**, and **273**.

[0123] The first through third through-holes **271**H, **272**H, and **273**H formed in the first through third anti-decapping layers **271**, **272**, and **273** formed of a non-conductive material function as paths through which the first through counter electrodes **231**, **232**, and **233** and the first through third protective layers **241**, **242**, and **243** formed of a conductive material are electrically connected to the connection layer **250**.

[0124] Referring to FIG. **5**M, the connection layer **250** is formed on the substrate **100** including the first through third anti-decapping layers **271**, **272**, and **273**. The connection layer **250** is integrally formed on the substrate **100** to entirely cover the first through third pixels P**1**, P**2**, and P**3**. The connection layer **250** includes a conductive material. A material used for the connection layer **250** is substantially the same as that described with reference to FIG. **4**.

[0125] Thereafter, the encapsulation thin film **260** is formed on the connection layer **250**. The encapsulation thin film **260** may include at least one organic layer **261** and at least one inorganic layer **263**.

[0126] The organic layer **261** may include a polymer-based material. In an exemplary embodiment, the organic layer **261** may be formed by depositing a liquid (or gaseous) monomer and curing a deposit including the monomer using light such as ultraviolet rays or heat. The inorganic layer **263** may include at least one of SiON, SiNx, and SiOx. The inorganic layer **263** may be formed using plasma-enhanced chemical vapor deposition (PECVD).

[0127] Although the inorganic layer **263** is located over the organic layer **261** in the illustrated embodiment, the inventive concepts are not limited thereto. In another exemplary embodiment, positions of the organic layer **261** and the inorganic layer **263** may be changed and the stacking order and the number of layers may be varied.

[0128] Although the first through third masking patterns **300**, **400**, and **500** respectively include the first through third auxiliary layers **310**, **410**, and **510** in FIGS. **5**A through **5**M, the inventive concepts are not limited thereto. The first through third masking patterns **300**, **400**, and **500** may include only the first through third photosensitive pattern layers **320**, **420**, and **520** without the first through third auxiliary layers **310**, **410**, and **510**.

[0129] FIG. **7** is a schematic cross-sectional view of a second embodiment of an organic light-emitting display apparatus constructed according to the principles of the invention. FIGS. **8**A and **8**B are schematic cross-sectional views of the organic light-emitting display apparatus of FIG. **7** illustrating a part of an exemplary method of manufacturing the organic light-emitting display apparatus.

[0130] Referring to FIG. **7**, the organic light-emitting display apparatus **2** according to the second embodiment is substantially the same as the organic light-emitting display

apparatus **1** of FIG. **4** except for anti-decapping particles **2720**, and thus the following description will focus on the differences.

[0131] The first through third pixels P**1**, P**2**, and P**3** include the pixel circuits PC and the first through third OLEDs **201**, **202**, and **203** electrically connected to the pixel circuits PC, and the first through third pixel electrodes **211**, **212**, and **213**, the first through third intermediate layers **221**, **222**, and **223**, and the first through third counter electrodes **231**, **232**, and **233** constituting the first through third OLEDs **201**, **202**, and **203** are substantially the same as those described in the first embodiment. Also, the first through third protective layers **241**, **242**, and **243** located on the first through third counter electrodes **231**, **232**, and **233** are also substantially the same as those described in the first embodiment.

[0132] However, unlike in the first embodiment, the first through third anti-decapping layers **271**, **272**, and **273** (see FIG. **4**) including island-type patterns and covering the first through third protective layers **241**, **242**, and **243** are not provided on the first through third protective layers **241**, **242**, and **243** according to the second embodiment. Instead, the anti-decapping particles **2720** may exist as distributed particles on the first through third protective layers **241**, **242**, and **243**.

[0133] Since the anti-decapping layer **2720** is provided as distributed particles, unlike in the first embodiment, the first through third through-holes **271**H, **272**H, and **273**H do not need to be formed in the first through third anti-decapping layers **271**, **272**, and **273** (see FIG. **4**) that are non-conductive in order to electrically connect the connection layer **250** to the first through third protective layers **241**, **242**, and **243** that are conductive.

[0134] Through spaces between the distributed particles, the connection layer **250** directly contacts the first through third protective layers **241**, **242**, and **243** that are conductive and the first through third protective layers **241**, **242**, and **243** directly contact the first through third counter electrodes **231**, **232**, and **233**, thereby preventing a voltage drop in a common voltage applied to the first through third OLEDs **201**, **202**, and **203**.

[0135] A state in FIG. **8**A is substantially the same as that in FIG. **5**K of the first embodiment. That is, in a state where operations of FIGS. **5**A through **5**J are finished and the first through third masking patterns **300**, **400**, and **500** are formed, the first through third pixel electrodes **211**, **212**, and **213**, the first through third intermediate layers **221**, **222**, and **223**, the first through third counter electrodes **231**, **232**, and **233**, the first through third protective layers **241**, **242**, and **243**, and the first through third anti-decapping layers **271**, **272**, and **273** are sequentially stacked in the first through third pixels P**1**, P**2**, and P**3**.

[0136] Referring to FIG. **8**B, unlike in FIG. **5**L of the first embodiment, instead of forming through-holes in top surfaces of the first through third anti-decapping layers **271**, **272**, and **273**, the first through third anti-decapping layers **271**, **272**, and **273** respectively formed on the first through third protective layers **241**, **242**, and **243** are removed.

[0137] In a state where the first through third masking patterns **300**, **400**, and **500** are formed, the first through third anti-decapping layers **271**, **272**, and **273**, each formed of a resin including fluorine, are formed to block a strong interaction between a stripping solvent that is an organic solvent and the first through third protective layers **241**, **242**, and **243** including TCO. The first through third anti-decapping layers **271**, **272**, and **273** are removed thereafter.

[0138] The first through third anti-decapping layers **271**, **272**, and **273** may be removed by using plasma treatment. However, since it is difficult to completely remove the first through third anti-decapping layers **271**, **272**, and **273**, the anti-decapping particles **2720** may remain as distributed particles on the first through third protective layers **241**, **242**, and **243**.

[0139] Since an organic light-emitting display apparatus constructed according to the principles of the invention is not formed in a state where a deposition mask formed of INVAR or the like is in close contact with a substrate, the deposition mask may be prevented from inappropriately touching the substrate. Also, an additional spacer for supporting the deposition mask does not need to be formed on a pixel-defining film or the pixel-defining film does not need to be formed to have a large thickness ranging from about 2.5 μm to about 3.5 μm. That is, since the pixel-defining film may be formed to have a small thickness of about 100 nm or less, processes may be simplified and manufacturing costs may be reduced.

[0140] According to an exemplary embodiment, since an emission layer is formed using a lift-off process without using a fine metal mask (FMM), a high-resolution display panel may be formed.

[0141] Also, a protective layer including TCO may prevent damage to an OLED, and using a general organic resin instead of fluorine that is expensive as a pattern forming material in a masking pattern process may reduce manufacturing costs.

[0142] An anti-decapping layer including fluorine that has low surface energy may prevent the protective layer from decapping when stripping a lift-off layer, thereby reducing or preventing damage to the OLED.

[0143] Although certain exemplary embodiments and implementations have been described herein, other embodiments and modifications will be apparent from this description. Accordingly, the inventive concepts are not limited to such embodiments, but rather to the broader scope of the presented claims and various obvious modifications and equivalent arrangements.

What is claimed is:

1. A method of manufacturing an organic light-emitting display apparatus, the method comprising the steps of:

forming a first pixel electrode and a second pixel electrode on a substrate;

forming a pixel-defining film on the first pixel electrode and the second pixel electrode, the pixel-defining film having an opening through which each of the first pixel electrode and the second pixel electrode is exposed;

forming a first masking pattern on the pixel-defining film having a first opening portion through which the first pixel electrode is exposed;

sequentially forming a first intermediate layer comprising a first emission layer, a first counter electrode, a first protective layer, and a first anti-decapping layer on the first pixel electrode and the first masking pattern; and

removing the first masking pattern along with the first intermediate layer, the first counter electrode, the first protective layer, and the first anti-decapping layer disposed on the first masking pattern.

2. The method of claim **1**, wherein the first anti-decapping layer is formed of a material comprising fluorine.

3. The method of claim 1, wherein the first protective layer is formed of a material comprising transparent conductive oxide.

4. The method of claim 1, wherein the first protective layer is formed to have a width greater than a width of the first counter electrode.

5. The method of claim 4, wherein the first protective layer is formed to have an end portion directly contacting the pixel-defining film.

6. The method of claim 1, wherein the first masking pattern comprises a material other than fluorine.

7. The method of claim 1, wherein the first masking pattern is formed using a photolithography process.

8. The method of claim 1, wherein the first intermediate layer is formed using a deposition process.

9. The method of claim 1, wherein the first anti-decapping layer is formed to have a width greater than a width of the first protective layer.

10. The method of claim 1, the method further comprising the steps of:

forming a second masking pattern on the first anti-decapping layer and the pixel-defining film, the second masking pattern having a second opening portion through which the second pixel electrode is exposed;

sequentially forming a second intermediate layer comprising a second emission layer, a second counter electrode, a second protective layer, and a second anti-decapping layer on the second pixel electrode and the second masking pattern; and

removing the second masking pattern along with the second intermediate layer, the second counter electrode, the second protective layer, and the second anti-decapping layer disposed on the second masking pattern.

11. The method of claim 10, the method further comprising the steps of:

respectively forming through-holes in the first anti-decapping layer and the second anti-decapping layer; and

forming a connection layer on the first anti-decapping layer and the second anti-decapping layer to cover the first anti-decapping layer and the second anti-decapping layer.

12. The method of claim 11, wherein the through-holes are formed to expose top surfaces of the first protective layer and the second protective layer.

13. The method of claim 10, the method further comprising the steps of:

removing the first anti-decapping layer and the second anti-decapping layer; and

forming a connection layer on the first protective layer and the second protective layer to cover the first protective layer and the second protective layer.

14. The method of claim 13, wherein the first anti-decapping layer and the second anti-decapping layer are removed using plasma treatment.

15. An organic light-emitting display apparatus comprising:

a first pixel electrode and a second pixel electrode disposed on a substrate;

a pixel-defining film disposed on the first pixel electrode and the second pixel electrode and having openings through which the first pixel electrode and the second pixel electrode are exposed;

a first intermediate layer and a second intermediate layer respectively disposed on the first pixel electrode and the second pixel electrode, the first pixel electrode and the second pixel electrode respectively comprising a first emission layer and a second emission layer;

a first counter electrode and a second counter electrode respectively disposed on the first intermediate layer and the second intermediate layer and having island-type patterns;

a first protective layer and a second protective layer respectively disposed on the first counter electrode and the second counter electrode and having island-type patterns;

a first anti-decapping layer and a second anti-decapping layer respectively disposed on the first protective layer and the second protective layer; and

a connection layer disposed on the first anti-decapping layer and the second anti-decapping layer and electrically connected to the first counter electrode and the second counter electrode.

16. The organic light-emitting display apparatus of claim 15, wherein each of the first anti-decapping layer and the second anti-decapping layer comprises fluorine.

17. The organic light-emitting display apparatus of claim 15, wherein each of the first protective layer and the second protective layer comprises a transparent conductive oxide.

18. The organic light-emitting display apparatus of claim 15, wherein the first protective layer has a width greater than a width of the first counter electrode, and the second protective layer has a width greater than a width of the second counter electrode.

19. The organic light-emitting display apparatus of claim 18, wherein an end portion of each of the first protective layer and the second protective layer directly contacts the pixel-defining film.

20. The organic light-emitting display apparatus of claim 15, wherein the first anti-decapping layer and the second anti-decapping layer have island-type patterns covering the first protective layer and the second protective layer.

21. The organic light-emitting display apparatus of claim 20, wherein the first anti-decapping layer and the second anti-decapping layer have through-holes through which top surfaces of the first protective layer and the second protective layer are exposed,

wherein the first protective layer and the second protective layer directly contact the connection layer through the through-holes.

22. The organic light-emitting display apparatus of claim 20, wherein the first anti-decapping layer has a width greater than a width of the first protective layer, and the second anti-decapping layer has a width greater than a width of the second protective layer.

23. The organic light-emitting display apparatus of claim 15, wherein the first anti-decapping layer and the second anti-decapping layer are disposed on the first protective layer and the second protective layer, and each comprises distributed particles.

24. The organic light-emitting display apparatus of claim 23, wherein the first protective layer and the second protective layer directly contact the connection layer through spaces between the distributed particles of the first anti-decapping layer and the second anti-decapping layer.

25. The organic light-emitting display apparatus of claim **15**, wherein the connection layer integrally covers the first protective layer and the second protective layer.

* * * * *

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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DISPLAY CO.，LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	KWON YOUNGGIL CHOUNG JIYOUNG LEE SEUI CHOI JINBAEK		
发明人	KWON, YOUNGGIL CHOUNG, JIYOUNG LEE, SEUI CHOI, JINBAEK		
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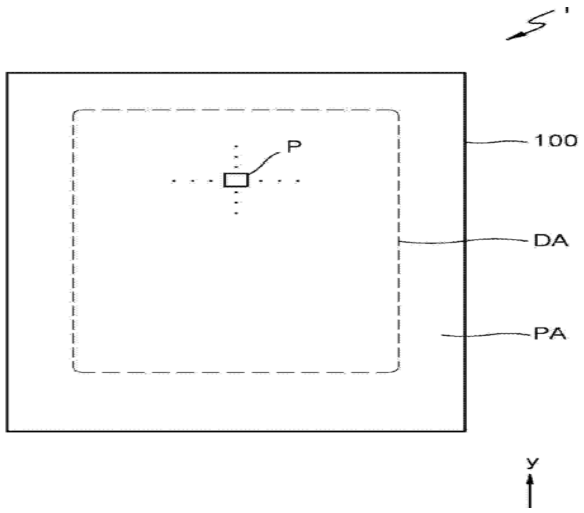
一种制造有机发光显示装置的方法，包括在基板上形成第一像素电极和第二像素电极，在第一像素电极和第二像素电极上形成像素限定膜的步骤，像素限定具有开口的薄膜，通过该开口暴露第一像素电极和第二像素电极中的每一个，在具有第一开口部分的像素限定膜上形成第一掩模图案，第一像素电极通过第一开口部分暴露，顺序形成第一中间体层，包括第一发光层，第一对电极，第一保护层，以及第一防伪层，在第一像素电极和第一掩模图案上，并去除第一掩模图案和第一中间层，第一对电极，第一保护层和设置在第一掩模图案上的第一抗去覆盖层。