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

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(57) **ABSTRACT**

An organic light-emitting display apparatus including: a substrate; a thin-film transistor (TFT) formed on the substrate and including a gate electrode, a source electrode, a drain electrode, and an active layer; a first electrode formed on the substrate and electrically connected to the drain electrode; an intermediate layer formed on the first electrode and including an organic light-emitting layer; a second electrode formed on the intermediate layer; and an insertion layer formed between the first electrode and the intermediate layer and including an oxide.

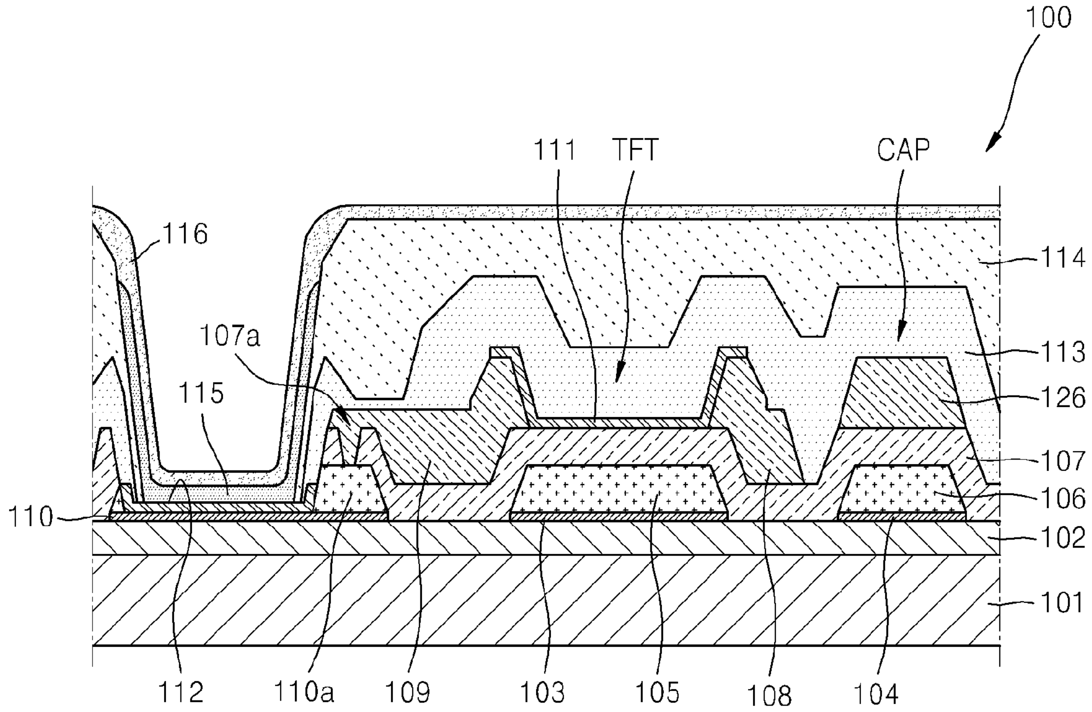


FIG. 1

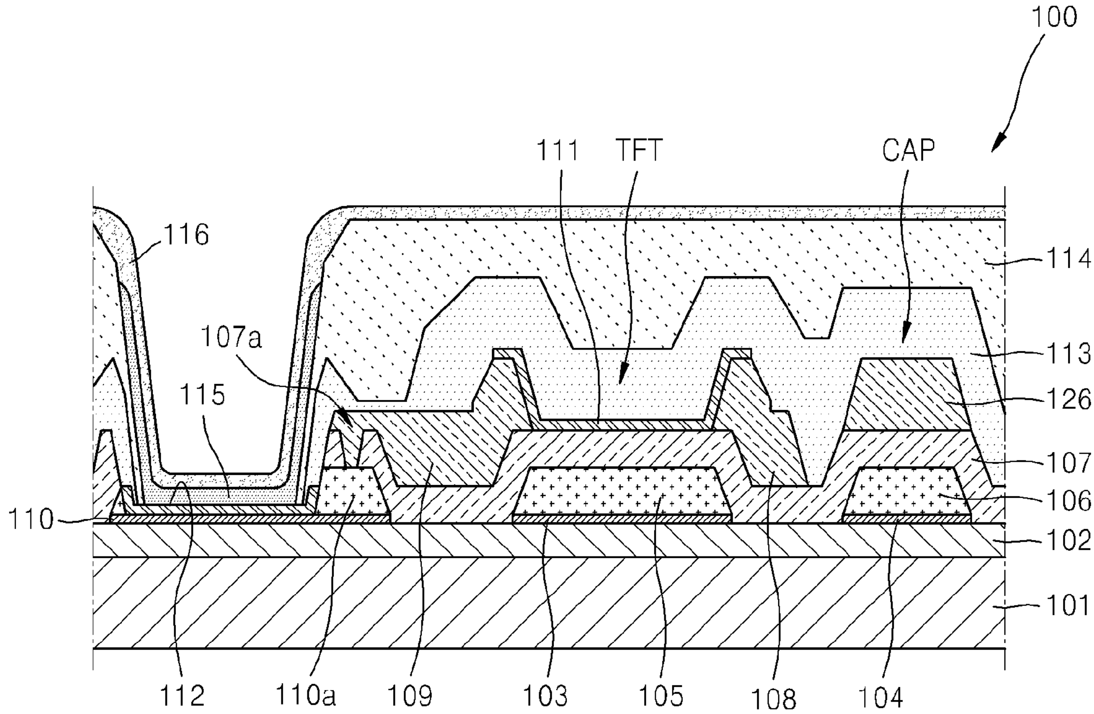

100
111
TFT
CAP
116
114
107a
113
115
126
107
106
110
102
101
112
110a
109
103
105
108
104

FIG. 2A

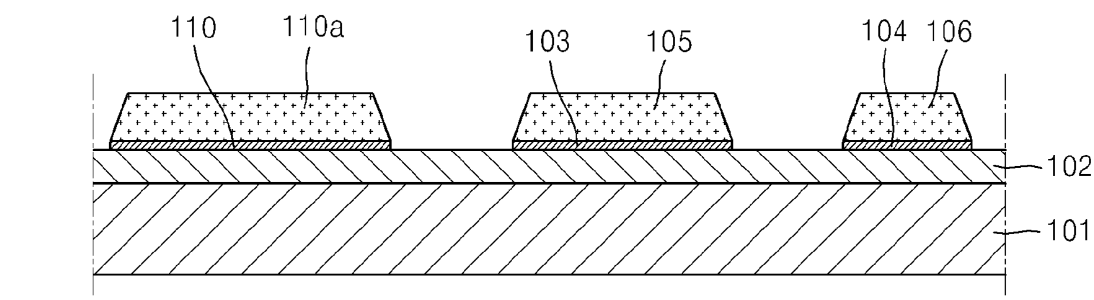

110
110a
103
105
104
106
102
101

FIG. 2B

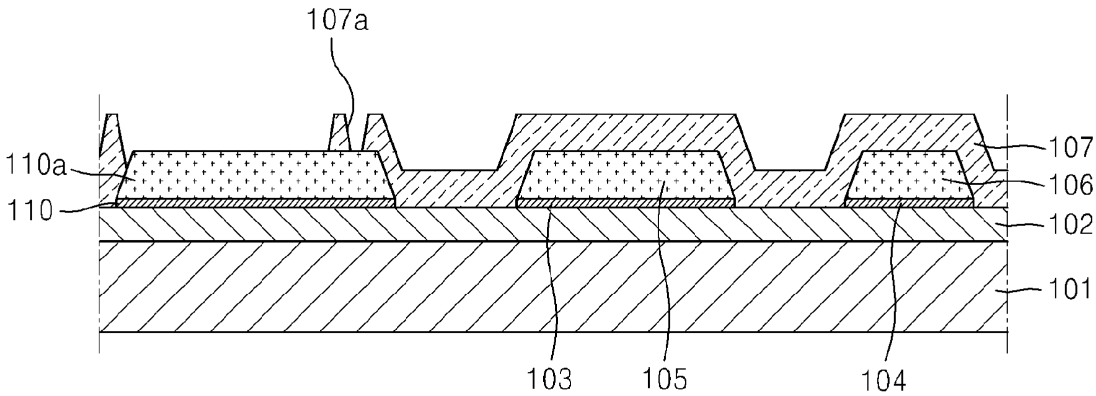

107a
110a
110
107
106
102
101
103
105
104

FIG. 2C

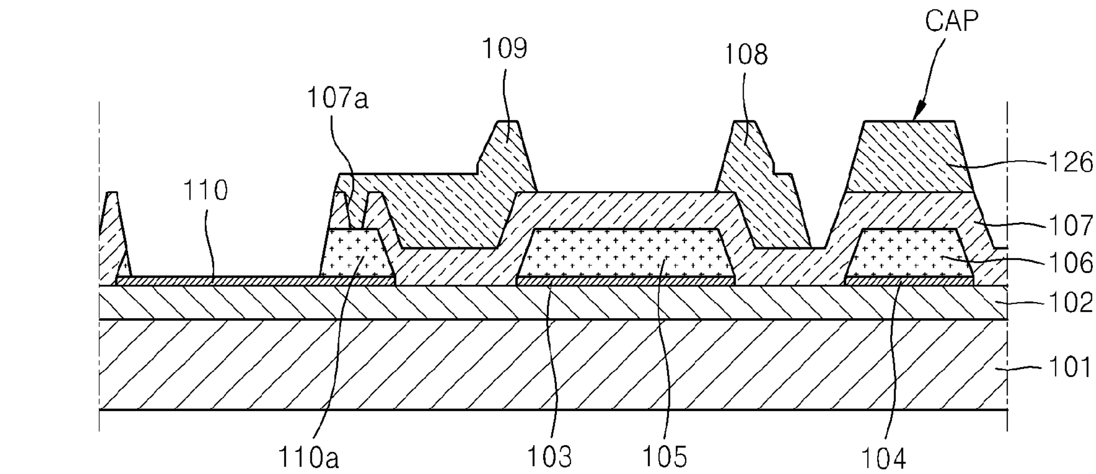

CAP
109
108
107a
110
126
107
106
102
101
110a
103
105
104

FIG. 2D

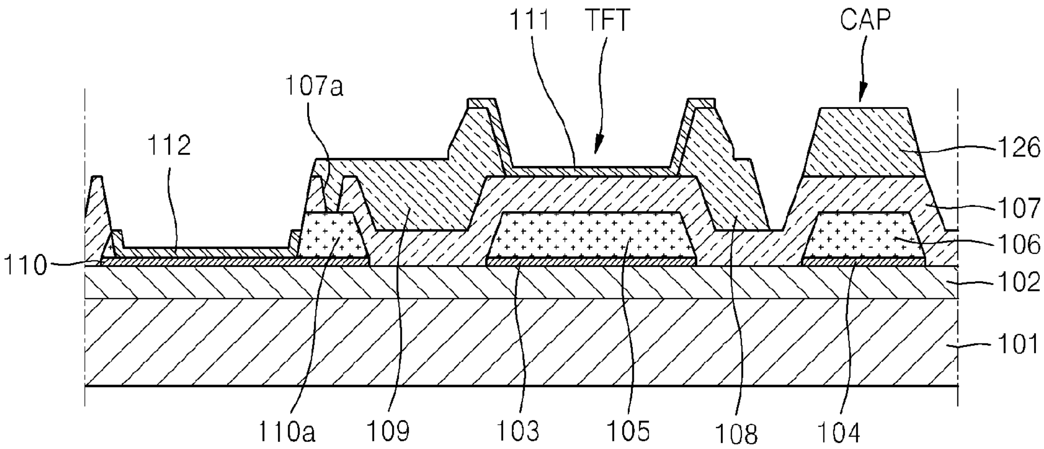

111
TFT
CAP
107a
112
126
107
106
110
102
101
110a
109
103
105
108
104

FIG. 2E

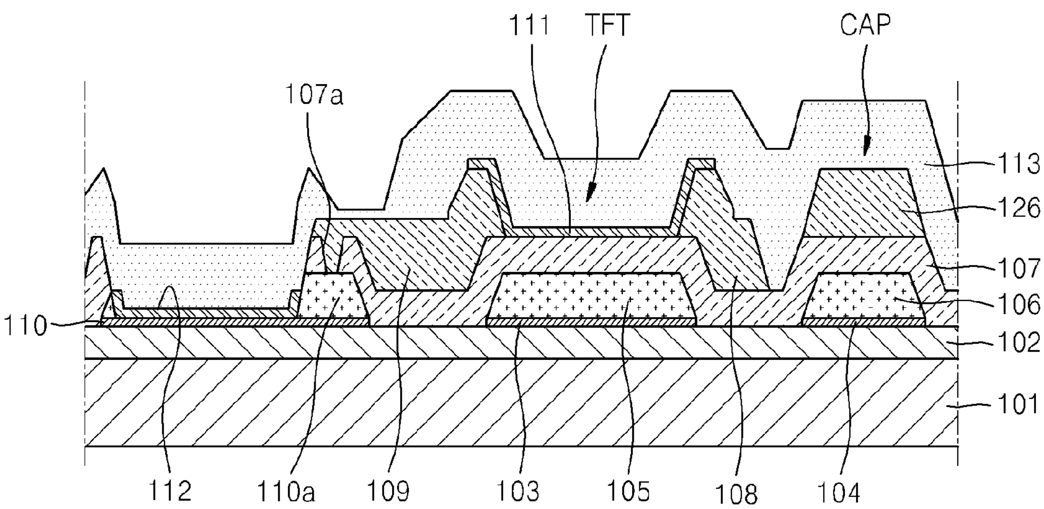

111
TFT
CAP
107a
113
126
107
106
110
102
101
112
110a
109
103
105
108
104

FIG. 2F

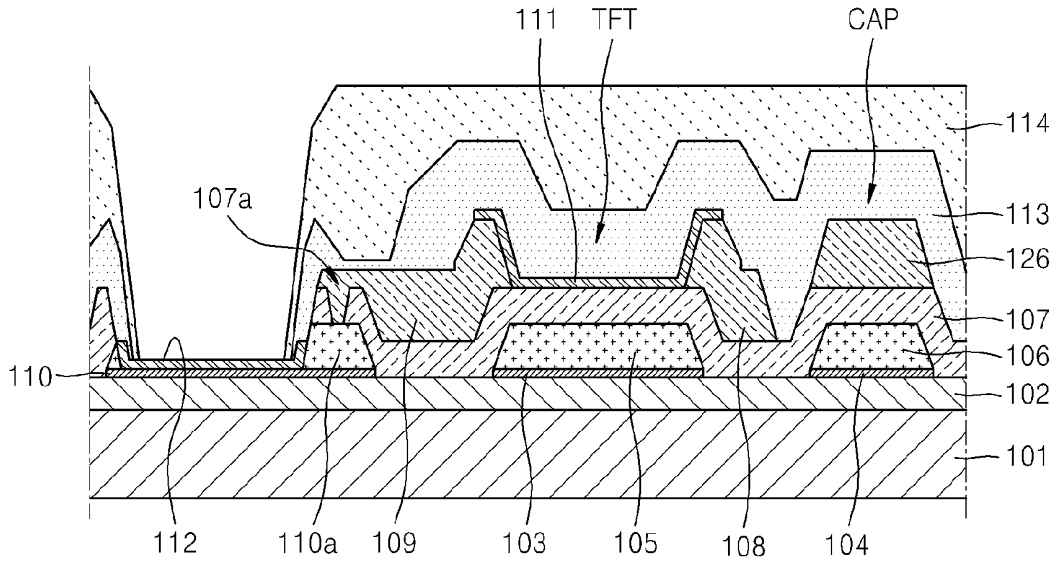
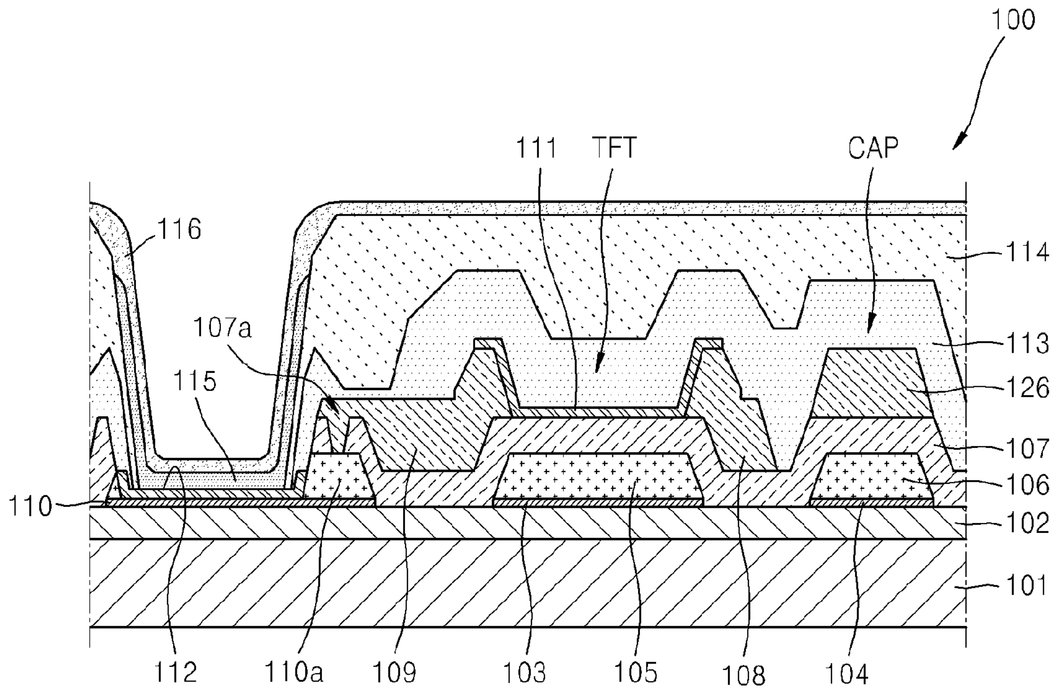

111
TFT
CAP
114
107a
113
126
107
106
110
102
101
112
110a
109
103
105
108
104

FIG. 2G


100
111
TFT
CAP
116
114
107a
113
115
126
107
106
110
102
101
112
110a
109
103
105
108
104

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

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 10-2011-0046939, filed on May 18, 2011, the disclosure of which is incorporated herein by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] One or more aspects of the present invention relate to an organic light-emitting display apparatus and a method of manufacturing the same.

[0004] 2. Discussion of the Background

[0005] Among flat panel display apparatuses, an organic light-emitting diode (OLED) display apparatus is an emissive display that has a large viewing angle, excellent contrast, and a rapid response. Thus, OLED display apparatuses are drawing attention as the next-generation of display apparatus.

[0006] An OLED display apparatus includes an intermediate layer, a first electrode, and a second electrode. The intermediate layer includes an organic light-emitting layer. When a voltage is applied to the first and second electrodes, the organic light-emitting layer emits visible light.

[0007] Due to limitations on electrical characteristics, such as a limitation on recouping characteristics of electrons and holes in the organic light-emitting layer, a limitation on characteristics of effective voltage application to the first and second electrodes, and the like, image characteristics of the organic light-emitting display apparatus may deteriorate. Therefore, power consumption may be increased, in order to obtain a desired image quality. As a result, there is a need for an OLED display apparatus having stable and efficient electrical characteristics.

SUMMARY OF THE INVENTION

[0008] One or more exemplary embodiments of the present invention provide an organic light-emitting display apparatus having improved electrical characteristics and a method of manufacturing the same.

[0009] Additional features of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention.

[0010] According to an aspect of the present invention, there is provided an organic light-emitting display apparatus including: a substrate; a thin-film transistor (TFT) formed on the substrate and including a gate electrode, a source electrode, a drain electrode, and an active layer; a first electrode formed on the substrate and electrically connected to the drain electrode; an intermediate layer formed over the first electrode and including an organic light-emitting layer; a second electrode formed on the intermediate layer; and an insertion layer formed between the first electrode and the intermediate layer and includes an oxide.

[0011] According to another aspect of the present invention, there is provided a method of manufacturing an organic light-emitting display apparatus, the method including: forming a thin-film transistor (TFT) that includes a gate electrode, a source electrode, a drain electrode, and an active layer, on a substrate; forming a first electrode electrically connected to the drain electrode on the substrate; forming an intermediate layer including an organic light-emitting layer on the first electrode; forming a second electrode on the intermediate layer; and forming an insertion layer that is disposed between the first electrode and the intermediate layer and includes an oxide.

[0012] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention, and together with the description serve to explain the principles of the invention.

[0014] FIG. **1** is a schematic cross-sectional view of an organic light-emitting display apparatus according to an exemplary embodiment of the present invention.

[0015] FIGS. **2**A, **2**B, **2**C, **2**D, **2**E, **2**F, and **2**G are schematic cross-sectional views sequentially illustrating a method of manufacturing the organic light-emitting display apparatus of FIG. **1**, according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0016] The invention is described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure is thorough, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity. Like reference numerals in the drawings denote like elements.

[0017] It will be understood that when an element or layer is referred to as being "on" or "connected to" another element or layer, it can be directly on or directly connected to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on" or "directly connected to" another element or layer, there are no intervening elements or layers present.

[0018] FIG. **1** is a schematic cross-sectional view of an organic light-emitting display apparatus **100** according to an embodiment of the present invention. Referring to FIG. **1**, the organic light-emitting display apparatus **100** includes a substrate **101**, a thin-film transistor (TFT), a first electrode **110**, an intermediate layer **115**, a second electrode **116**, an insertion layer **112**, and a capacitor CAP.

[0019] The TFT includes a gate electrode **105**, a source electrode **108**, a drain electrode **109**, and an active layer **111**. The capacitor CAP includes a first capacitor electrode **106** and a second capacitor electrode **126**.

[0020] The substrate **101** may be a transparent substrate formed of a glass having silicon dioxide (SiO_2) as a main component. However, the substrate **101** is not limited thereto, and may also be formed of a transparent plastic formed from various organic materials.

[0021] A buffer layer **102** is formed on the substrate **101**. The buffer layer **102** may contain silicon dioxide (SiO_2) or silicon nitride (SiN_x). The buffer layer planarizes the substrate **101** and blocks the flow of moisture and/or foreign substances.

[0022] The first electrode **110**, a first conductive pattern **103**, and a second conductive pattern **104** are formed on the buffer layer **102**. The first conductive pattern **103** and the second conductive pattern **104** may be formed of the same material as the first electrode **110**. The first electrode **110** generally includes a transparent conductive material such as indium tin oxide (ITO).

[0023] The gate electrode **105** is formed on the first conductive pattern **103**. The gate electrode **105** may include a metal or a metal alloy, such as molybdenum (Mo), molybdenum tungsten (MoW), an aluminum (Al) alloy, and the like. However, the gate electrode **105** is not limited thereto.

[0024] The first capacitor electrode **106** is formed on the second conductive pattern **104**. The first capacitor electrode **106** may be formed of the same material as the gate electrode **105**.

[0025] A conductive member **110*a*** is disposed on the first electrode **110** and particularly, along an edge of the first electrode **110**. The conductive member **110*a*** contains the same material as the gate electrode **105**.

[0026] A gate insulating layer **107** is formed on the gate electrode **105** and the first capacitor electrode **106**. The gate insulating layer **107** includes an opening **107*a*** through which a portion of the conductive member **110*a*** is exposed.

[0027] The source electrode **108** and the drain electrode **109** are formed on the gate insulating layer **107**. The drain electrode **109** is electrically connected to the first electrode **110**. Specifically, the drain electrode **109** is connected to the conductive member **110*a*** through the opening **107*a***. The source electrode **108** and the drain electrode may include a metal or a metal alloy, such as Mo, MoW, an Al alloy, and the like.

[0028] The second capacitor electrode **126** at least partially overlaps with the first capacitor electrode **106**. The second capacitor electrode **126** may be formed of the same material as the source electrode **108** and the drain electrode **109**.

[0029] The active layer **111** is a patterned layer formed on the source electrode **108** and the drain electrode **109**. The active layer **111** extends from a side of the source electrode **108** to an opposing side of the drain electrode **109**. The active layer **111** is also formed on an upper surface of the source electrode **108** and an upper surface of the drain electrode **109**. The active layer **111** overlaps with the gate electrode **105**.

[0030] The active layer **111** may contain an oxide semiconductor material. Specifically, the active layer **111** may contain gallium indium zinc oxide (GaInZnO) or hafnium indium zinc oxide (HfInZnO). The active layer **111** generally includes less than about 50 weight percent (wt %) indium (In) and Zinc (Zn), less than about 40 wt % gallium (Ga), and less than about 10 wt % hafnium (Hf).

[0031] The insertion layer **112** is formed on the first electrode **110**. The insertion layer **112** may contain an oxide semiconductor material and, specifically, is formed of the same material as the active layer **111**. That is, the insertion layer **112** contains GaInZnO or HfInZnO.

[0032] A passivation layer **113** is formed on the source electrode **108**, the drain electrode **109**, and the second capacitor electrode **126**. The passivation layer **113** is formed to at least partially expose an upper surface of the insertion layer **112**. The passivation layer **113** may include various insulating materials and protects the TFT.

[0033] A pixel-defining layer **114** is formed on the passivation layer **113**. The pixel-defining layer **114** is formed to cover the passivation layer **113** and to at least partially expose an upper surface of the insertion layer **112**.

[0034] The intermediate layer **115** may be formed on the exposed upper surface of the insertion layer **112**. The intermediate layer **115** includes an organic light-emitting layer (not illustrated).

[0035] The second electrode **116** is formed on the intermediate layer **115**. When a voltage is applied through the first electrode **110** and the second electrode **116**, the organic light-emitting layer emits visible light.

[0036] A sealing member (not illustrated) may be disposed on the second electrode **116**. The sealing member is formed to protect the intermediate layer **115** and other layers from external moisture and/or oxygen. The sealing member is formed of a transparent material. To this end, the sealing member may include multiple overlapping layers of glass, plastic, or organic and inorganic materials.

[0037] In the organic light-emitting display apparatus **100**, the insertion layer **112** is disposed between the first electrode **100** and the intermediate layer **115**. The insertion layer **112** contains GaInZnO or HfInZnO. GaInZnO or HfInZnO visible blue light or light having a wavelength shorter than visible blue light, according to the characteristics of an energy band, and then emits photoelectrons.

[0038] That is, when external light or light emitted from the intermediate layer **115** is radiated on the insertion layer **112**, the insertion layer **112** emits photoelectrons. The photoelectrons facilitate the injection and transport of holes from the first electrode **110** to the intermediate layer **115**. Particularly, when the first electrode **110** contains indium tin oxide (ITO), which has a low electrical conductivity, a barrier to the transport of holes is lowered, thereby decreasing a driving voltage for obtaining visible light from the organic light-emitting layer of the intermediate layer **115**. As a result, brightness characteristics of the organic light-emitting display apparatus **100** are improved, and power consumption is decreased.

[0039] In the TFT, the source electrode **108** and the drain electrode **109** are formed on the gate electrode **105**. The active layer **111** is formed on the source electrode and the drain electrode **109**. That is, the active layer **111** is formed right after the source electrode **108** and the drain electrode **109** are formed, without having to additionally form an insulating layer. Accordingly, a bottom surface of the active layer **111** may be directly connected to the source electrode **108** and the drain electrode **109**. Specifically, the active layer **111** contacts an upper surface and one side of both of the source electrode **108** and the drain electrode **109**.

[0040] When compared to a structure of connecting the active layer **111** to the source/drain electrodes **108** and **109** through a contact hole, that is, a structure in which an insulating layer having a contact hole is formed between the active layer **111** and the source/drain electrodes **108** and **109**, and the active layer **111** is connected to the source/drain electrodes **108** and **109**, the width of the TFT of the apparatus **100** may be reduced.

[0041] Thus, the organic light-emitting display apparatus **100** may be designed to have improved efficiency and electrical characteristics. Furthermore, by minimizing an area in which the gate electrode **105** overlaps with the source electrode **108** and the drain electrode **109**, a parasitic capacitance between the gate electrode **105** and the source/drain electrodes **108** and **109** may be reduced.

[0042] FIGS. **2**A through **2**G are schematic cross-sectional views sequentially illustrating a method of manufacturing the organic light-emitting display apparatus of FIG. **1**, according to an exemplary embodiment of the present invention. Referring to FIG. **2**A, a buffer layer **102** is formed on the substrate **101**. A first electrode **110**, a first conductive pattern **103**, and a second conductive pattern **104** are formed on the buffer layer **102**. A conductive member **110***a* is disposed on the first electrode **110**. A gate electrode **105** is formed on the first conductive pattern **103**. A first capacitor electrode **106** is formed on the second conductive pattern **104**.

[0043] The first electrode **110**, the first conductive pattern **103**, and the second conductive pattern **104** are formed of the same material. The conductive member **110***a*, the gate electrode **105**, and the first capacitor electrode **106** are formed of the same material.

[0044] A thin film containing a material for forming the first electrode **110**, that is, ITO is formed on the buffer layer **102**. Next, a thin film for containing a material for forming the gate electrode **105**, i.e., a metal or a metal alloy such as Mo, MoW, or an Al alloy, is formed on the thin film formed on the buffer layer **102**, without performing a patterning process. Then, the first electrode **110**, the first conductive pattern **103**, the second conductive pattern **104**, the conductive member **110***a*, the gate electrode **105**, and the first capacitor electrode **106** are formed, by performing one patterning process. As such, the patterning process may be performed using one mask.

[0045] Referring to FIG. **2**B, a gate insulating layer **107** is formed on the gate electrode **105**, the first capacitor electrode **106**, and the conductive member **110***a*. The gate insulating layer **107** is formed to expose a portion of the conductive member **110***a*. That is, the gate insulating layer **107** is formed to expose a central portion of the conductive member **110***a*. The gate insulating layer **107** includes an opening **107***a*. A portion of the conductive member **110***a* is exposed through the opening **107***a*.

[0046] Referring to FIG. **2**C, the source electrode **108** and the drain electrode **109** are formed on the gate insulating layer **107**. The first electrode **110** is exposed by removing a portion of the conductive member **110***a*. The portion of the conductive member **110***a* may be removed while simultaneously patterning the source electrode **108** and the drain electrode **109**.

[0047] The drain electrode **109** is connected to the conductive member **110***a* through the opening **107***a*. The drain electrode **109** is electrically connected to the first electrode **110** through the conductive member **110***a*. A second capacitor electrode **126** is formed to overlap with the first capacitor electrode **106**. By doing so, a capacitor CAP is manufactured that includes the first capacitor electrode **106**, the second capacitor electrode **126**, and the gate insulating layer **107**.

[0048] The second capacitor electrode **126** may be formed of the same material as the source electrode **108** and the drain electrode **109**. The second capacitor electrode **126** is patterned simultaneously with the source electrode **108** and the drain electrode **109**. That is, the source electrode **108**, the drain electrode **109**, and the second capacitor electrode **126** are formed simultaneously, using one mask.

[0049] Referring to FIG. **2**D, an active layer **111** is formed on the source electrode **108** and the drain electrode **109**. The active layer **111** is formed to overlap with the gate electrode **105**. In addition, the active layer **111** is formed on a side of the source electrode **108** and an opposing side of the drain electrode **109**. The active layer **111** is also formed on an upper surface of the source electrode **108** and an upper surface of the drain electrode **109**. The active layer **111** contains an oxide semiconductor material. Specifically, the active layer **111** may contain GaInZnO or HfInZnO.

[0050] An insertion layer **112** is formed on the first electrode **110**. The insertion layer **112** contains an oxide semiconductor material and, specifically, is formed of the same material as the active layer **111**. That is, the active layer contains GaInZnO or HfInZnO.

[0051] A thin film containing a material for forming the active layer **111**, that is, GaInZnO or HfInZnO, is formed on the source electrode **108**, the drain electrode **109**, and an upper part of the first electrode **110**, through sputtering, without an additional mask. Then, the active layer **111** and the insertion layer **112** are simultaneously patterned using a mask. As such, the insertion layer **112** may be easily formed without using an additional mask or performing an additional patterning process.

[0052] Referring to FIG. **2**E, a passivation layer **113** is formed on the source electrode **108**, the drain electrode **109**, the second capacitor electrode **126**, and the insertion layer **112**.

[0053] Referring to FIG. **2**F, a pixel-defining layer **114** is formed on the passivation layer **113**. The passivation layer **113** is patterned to at least partially expose an upper surface of the insertion layer **112**. The pixel-defining layer **114** is formed to cover the passivation layer **113** and to at least partially expose the upper surface of the insertion layer **112**. A patterning process may be performed to remove portions of the passivation layer **113** and the pixel-defining layer **114** that face the upper surface of the insertion layer **112**.

[0054] However, the present invention is not limited to the patterning process described above, and may use various processes. For example, the patterning process may include removing a portion of the pixel-defining layer **114** that corresponds to an upper surface of the insertion layer **112**, and then, removing a portion of the passivation layer **113** that corresponds to the upper surface of the insertion layer **112**, by using a pattern of the pixel-defining layer **114** and without using an additional mask.

[0055] Referring to FIG. **2**G, an intermediate layer **115** is formed on the exposed upper surface of the insertion layer **112**. The intermediate layer **115** includes an organic light-emitting layer (not illustrated).

[0056] A second electrode **116** is formed on the intermediate layer **115**. The second electrode **116** may be formed on all pixels (not illustrated) without having to perform an additional patterning process. A sealing member (not illustrated) may be disposed on the second electrode **116**. The sealing member is formed to protect the intermediate layer **115** and other layers from external moisture and/or oxygen. The sealing member is formed of a transparent material and may include multiple layers of glass, plastic, or organic and inorganic materials.

[0057] The method of manufacturing the organic light-emitting display apparatus **100** includes forming the insertion layer **112** between the first electrode **110** and the intermediate layer **115**. The insertion layer **112** and the active layer **111** are simultaneously patterned, without having to use an additional mask. As such, the insertion layer **112** is formed between the first electrode **110** and the intermediate layer **115**, without a delay caused by the use of an additional process. Thus, brightness characteristics of the organic light-emitting display apparatus **100** are improved and the power consumption thereof is decreased.

[0058] The method of manufacturing the organic light-emitting display apparatus **100**, according to the current exemplary embodiment, includes forming the first electrode **110**, the gate electrode **105**, and the first capacitor electrode **106** simultaneously, and forming the source electrode **108**, the drain electrode **109**, and the second capacitor electrode **126** simultaneously. Therefore, the manufacturing process may be simplified, and process defects may be minimized.

[0059] With regard to forming the passivation layer **113** and the pixel-defining layer **114**, when the pixel-defining layer **114** is patterned and the passivation layer **113** is formed by using the pattern of the pixel-defining layer **114**, an additional mask is not necessary for patterning the passivation layer **113**. As such, the process is simplified. An organic light-emitting display apparatus and a method of manufacturing the same, according to aspects of the present invention, may produce improved electrical characteristics.

[0060] It will be apparent to those skilled in the art that various modifications and variation can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An organic light-emitting display apparatus comprising:
a substrate;
a thin-film transistor (TFT) disposed on the substrate and comprising a gate electrode, a source electrode, a drain electrode, and an active layer;
a first electrode disposed on the substrate and electrically connected to the drain electrode;
an intermediate layer disposed on the first electrode and comprising an organic light-emitting layer;
a second electrode disposed on the intermediate layer; and
an insertion layer disposed between the first electrode and the intermediate layer and comprising an oxide.

2. The organic light-emitting display apparatus of claim **1**, wherein the oxide comprises indium (In), Zinc (Zn), and gallium (Ga), or In, Zn, and hafnium (Hf).

3. The organic light-emitting display apparatus of claim **1**, wherein the active layer comprises an oxide semiconductor material.

4. The organic light-emitting display apparatus of claim **1**, wherein the active layer and the insertion layer comprise the same type of material.

5. The organic light-emitting display apparatus of claim **1**, further comprising a first conductive pattern disposed between the substrate and the gate electrode, the first conductive pattern comprising the same type of material as the first electrode.

6. The organic light-emitting display apparatus of claim **5**, wherein the first conductive pattern and the first electrode are disposed directly on the same layer.

7. The organic light-emitting display apparatus of claim **1**, wherein:
the source electrode and the drain electrode are disposed on and insulated from the gate electrode, and
the active layer is disposed on the source electrode and the drain electrode.

8. The organic light-emitting display apparatus of claim **7**, wherein the active layer:
faces the gate electrode; and
is disposed directly on a side of the source electrode, an opposing side of the drain electrode, an upper surface of the source electrode, and an upper surface of the drain electrode.

9. The organic light-emitting display apparatus of claim **1**, further comprising a gate insulating layer disposed between the gate electrode and the source and drain electrodes, and
wherein the active layer is disposed directly on the gate insulating layer.

10. The organic light-emitting display apparatus of claim **1**, further comprising a capacitor disposed on the substrate and comprising a first capacitor electrode and a second capacitor electrode, wherein,
the first capacitor electrode comprises the same type of material as the gate electrode, and
the second capacitor electrode comprises the same type of material as the source electrode, the drain electrode, or both the source electrode and the drain electrode.

11. The organic light-emitting display apparatus of claim **10**, further comprising a second conductive pattern disposed between the substrate and the first capacitor electrode, the second conductive pattern comprising the same type of material as the first electrode.

12. A method of manufacturing an organic light-emitting display apparatus, the method comprising:
forming a thin-film transistor (TFT) on a substrate, the TFT comprising a gate electrode, a source electrode, a drain electrode, and an active layer;
forming a first electrode on the substrate and electrically connected to the drain electrode;
forming an intermediate layer on the first electrode and comprising an organic light-emitting layer;
forming a second electrode on the intermediate layer; and
forming an insertion layer, the insertion layer being disposed between the first electrode and the intermediate layer and comprising an oxide.

13. The method of claim **12**, wherein the active layer and the insertion layer are simultaneously formed using the same type of material.

14. The method of claim **12**, wherein the forming of the TFT and the forming of the first electrode comprise:
simultaneously forming the first electrode and the gate electrode through a patterning process.

15. The method of claim **12**, further comprising:
forming a passivation layer on the TFT; and
forming a pixel-defining layer on the passivation layer.

16. The method of claim **15**, wherein the passivation layer is patterned using the pixel-defining layer as a mask.

* * * * *

专利名称(译)	有机发光显示装置及其制造方法		
公开(公告)号	US20120292611A1	公开(公告)日	2012-11-22
申请号	US13/443406	申请日	2012-04-10
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星移动显示器有限公司.		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	HEO SEONG KWEON KIM MU GYEOM		
发明人	HEO, SEONG-KWEON KIM, MU-GYEOM		
IPC分类号	H01L51/52 H01L51/56		
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优先权	1020110046939 2011-05-18 KR		
外部链接	Espacenet USPTO		

摘要(译)

一种有机发光显示装置，包括：基板;薄膜晶体管（TFT），形成在基板上，包括栅电极，源电极，漏电极和有源层;第一电极形成在基板上并连接到漏电极;中间层，形成在第一电极上并包括有机发光层;形成在中间层上的第二电极;插入层形成在第一电极和中间层之间并包括氧化物。