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Lee et al.

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(54) **ORGANIC LIGHT EMITTING DISPLAY (OLED) AND ITS METHOD OF FABRICATION**

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H01L 51/50 (2006.01)

(52) **U.S. Cl.**
USPC **313/504**; 313/506; 445/24

(58) **Field of Classification Search**
USPC 313/503
See application file for complete search history.

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(57) **ABSTRACT**

An Organic Light Emitting Display (OLED) and a method of fabricating the OLED includes: a substrate including a pixel region and a non-pixel region; a gate electrode arranged in the non-pixel region of the substrate; a first insulating layer arranged on the substrate having the gate electrode formed thereon, and having an open groove on an upper surface of a region opposite to the gate electrode; a semiconductor layer buried in the groove and including a source region, a channel region and a drain region; and an organic thin film layer arranged in the pixel region of the substrate. A common electrode is arranged between the drain region of the semiconductor layer and the organic thin film layer to electrically couple the drain region to the organic thin film layer.

9 Claims, 3 Drawing Sheets

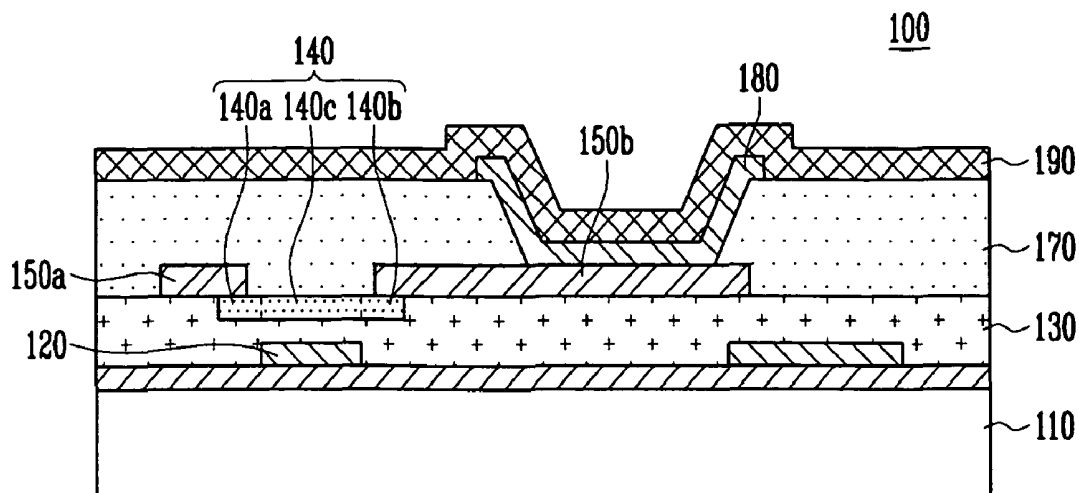


FIG. 1

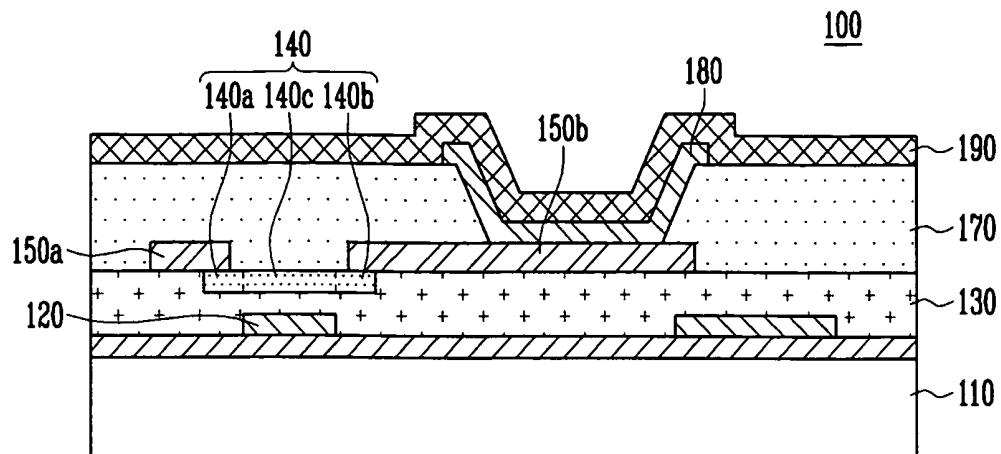


FIG. 2A

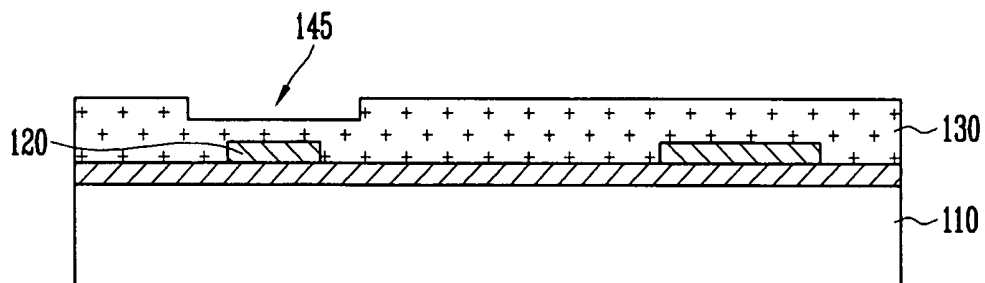


FIG. 2B

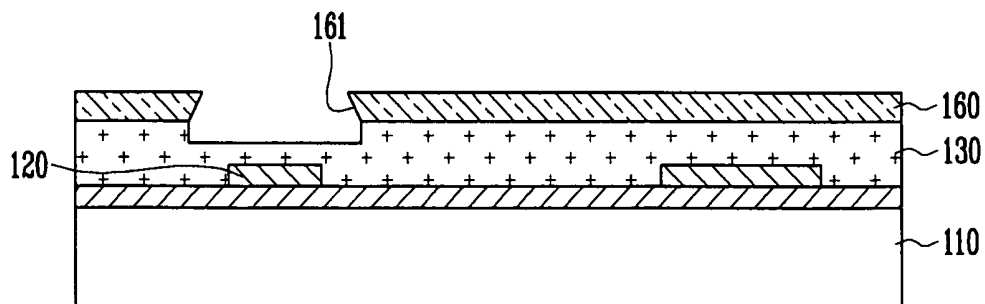


FIG. 2C

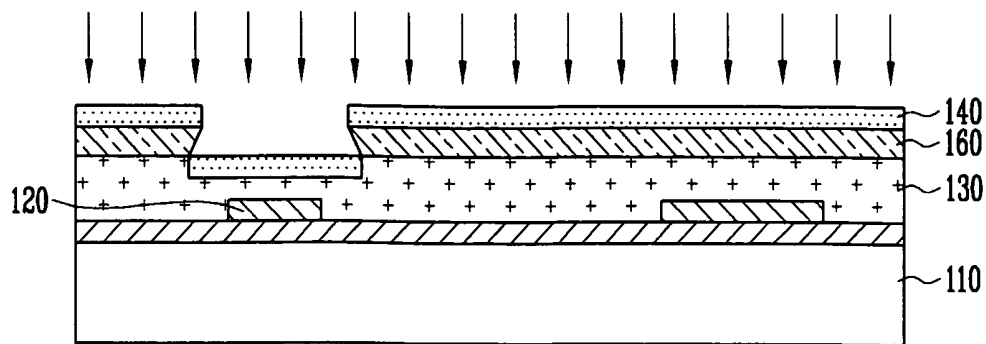


FIG. 2D

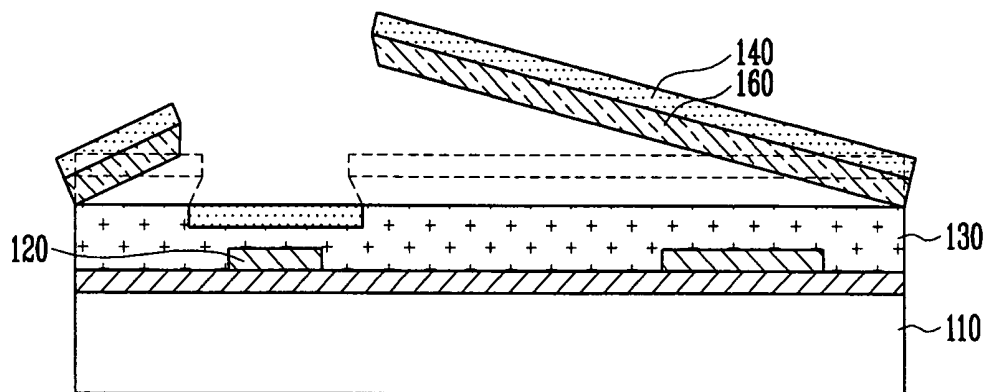


FIG. 2E

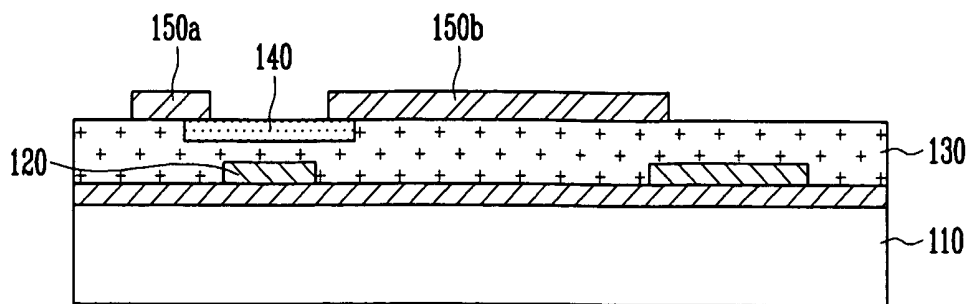
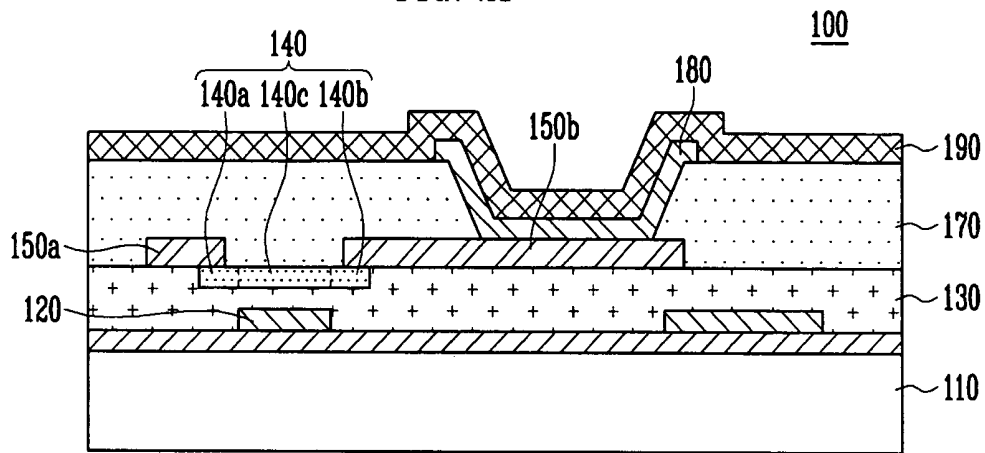


FIG. 2F



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ORGANIC LIGHT EMITTING DISPLAY (OLED) AND ITS METHOD OF FABRICATION

CLAIM OF PRIORITY

This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application for ORGANIC LIGHT EMITTING DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME earlier filed in the Korean Intellectual Property Office on 7 Apr. 2008 and there duly assigned Serial No. 10-2008-0032081.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an Organic Light Emitting Display (OLED) and its method of fabrication, and more particularly, the present invention relates to an OLED and its method of fabrication using fewer masks.

2. Description of the Related Art

In general, a Thin Film Transistor (TFT) includes a semiconductor layer including a gate electrode, source and drain regions formed on the gate electrode, a channel region disposed between the source and drain regions; and source and drain electrodes that come in contact with the source and drain regions of the semiconductor layer.

The semiconductor layer of the TFT configured as described above is generally formed of amorphous silicon or poly-silicon. If the semiconductor layer is formed of amorphous silicon, mobility is low so that it is difficult for a driving circuit to operate at a high speed. On the other hand, if the semiconductor layer is formed of poly-silicon, mobility is high whereas a threshold voltage is non-uniform. Therefore, a separate compensating circuit must be added.

In a conventional method of fabricating a TFT using Low Temperature Poly-Silicon (LTPS), a high-cost process, such as a laser heating treatment, is needed, and it is not easy to control characteristics. Therefore, it is difficult to apply the conventional method of fabricating a TFT using LTPS to a large-area substrate.

In order to solve these problems, studies for using an oxide semiconductor as a semiconductor layer have been recently conducted.

Japanese Patent Publication No. 2004-273614 teaches a TFT using an oxide semiconductor, which is made of zinc oxide (ZnO) or includes ZnO as a main element, as a semiconductor layer.

However, if such a TFT is applied to an OLED, the following processes are added. In order to planarize a substrate on which a TFT is disposed, a planarization layer must be formed on the entire surface of the substrate on which the TFT is disposed. Furthermore, in order to electrically connect the TFT to the OLED, a contact hole is to be formed on the planarization layer. Therefore, processes of fabricating an OLED may be complicated, and the number of processes using a mask may be increased.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an Organic Light Emitting Display (OLED) and its method of fabrication that uses fewer masks in fabricating the OLED.

According to an aspect of the present invention, an Organic Light Emitting Display (OLED) includes: a substrate includ-

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ing a pixel region and a non-pixel region; a gate electrode arranged in the non-pixel region of the substrate; a first insulating layer arranged on the substrate having the gate electrode formed thereon, and having an open groove on an upper surface of a region opposite to the gate electrode; a semiconductor layer buried in the groove and including a source region, a channel region and a drain region; and an organic thin film layer arranged in the pixel region of the substrate. A common electrode is arranged between the drain region of the semiconductor layer and the organic thin film layer to electrically couple the drain region to the organic thin film layer.

The common electrode may be electrically coupled to a drain electrode of the semiconductor layer and extend to the pixel region of the substrate. The semiconductor layer may be zinc oxide (ZnO). The semiconductor layer may be doped with at least one of indium (In), gallium (Ga) or stannum (Sn). The first insulating layer may be at least one material selected from the group consisting of polyimide, polyacryl, photoresist and benzocyclobutene (BCB).

According to another aspect of the present invention, a method of fabricating an Organic Light Emitting Display (OLED) includes: dividing a substrate into a pixel region and a non-pixel region; forming a gate electrode in the non-pixel region of the substrate; forming a first insulating layer on the entire surface of the substrate having the gate electrode formed thereon; patterning the first insulating layer to form a groove in a region opposite to the gate electrode; forming a semiconductor layer buried in the groove and including a source region, a channel region and a drain region; forming a source electrode in contact with the source region of the semiconductor layer; forming a common electrode in contact with the drain region of the semiconductor layer and extending to the pixel region of the substrate; and forming an organic thin film layer on the common electrode.

The semiconductor layer may be formed using any one of lift-off, inkjet and etching methods. The lift-off method of forming the semiconductor layer may include: coating a photoresist on the entire surface of the first insulating layer having the groove formed therein; removing the photoresist coated on the groove; coating a semiconductor material on the groove and the photoresist; and removing the photoresist. The inkjet method of forming the semiconductor layer may be performed by disposing a semiconductor material in the groove.

As described above, according to the present invention, a drain electrode and an anode electrode share a common electrode, so that the number of masks used to fabricate an OLED can be decreased. Accordingly, productivity of the OLED is improved, and a process margin can be secured.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a cross-sectional view of an OLED according to an embodiment of the present invention.

FIGS. 2A to 2F are cross-sectional views of a method of fabricating an OLED according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description, only certain exemplary embodiments of the present invention have been shown

and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. In addition, when an element is referred to as being "on" another element, it can be directly on the element or be indirectly on the element with one or more intervening elements interposed therebetween. Also, when an element is referred to as being "connected to" another element, it can be directly connected to the element or be indirectly connected to the element with one or more intervening elements interposed therebetween. Hereinafter, like reference numerals refer to like elements.

FIG. 1 is a cross-sectional view of an OLED according to an embodiment of the present invention.

Referring to FIG. 1, the OLED 100 includes a bottom-gate-type thin film transistor (TFT) and an organic light emitting device electrically coupled to the TFT.

Generally, an OLED includes a TFT having a gate electrode, a semiconductor layer, and source/drain electrodes, and an anode electrode coupled to the drain electrode of the TFT. In an OLED with such a structure, a via hole is formed to connect the drain electrode of the TFT to the anode electrode. However, a separate mask is used to form a via hole. In this embodiment, the number of masks is decreased by eliminating a process of forming a via hole.

A substrate 110 has a non-pixel region in which the TFT is disposed and a pixel region in which the organic light emitting device electrically coupled to the TFT is disposed. A gate electrode 120 is disposed in the non-pixel region of the substrate 110. A first insulating layer 130 is disposed on the entire surface of the substrate 110 where the gate electrode 120 is disposed. The first insulating layer 130 has a groove 145 (see FIG. 2A) opened on an upper surface of a region opposite to the gate electrode 120. The first insulating layer 130 insulates the gate electrode 120 from a semiconductor layer 140 and planarizes the substrate 110 having the gate electrode 120 and the semiconductor layer 140. The first insulating layer 130 may be formed of an organic layer, and may include a material selected from the group consisting of polyimide, polyacryl, photoresist, and benzocyclobutene (BCB).

The semiconductor layer 140 is buried in the groove 145 to be exposed to a surface of the first insulating layer 130. As such, the structure in which the semiconductor layer 140 is buried in the first insulating layer 130 is referred to as an "embedded structure". The semiconductor layer 140 includes a source region 140a, a drain region 140b and a channel region 140c disposed between the source and drain regions 140a and 140b. The channel region 140c of the semiconductor layer 140 is formed at the same position opposite to the gate electrode 120. As such, the semiconductor layer 140 is buried in the groove 145 of the first insulating layer 130 to planarize the top surface of the insulating layer 130. That is, in other OLEDs, a first insulating layer is formed to insulate a gate electrode from a semiconductor layer, and a second insulating layer is formed to planarize a substrate where a TFT is disposed. However, in this embodiment, the gate electrode 120 and the semiconductor layer 140 are insulated from each other using the first insulating layer 130. Accordingly, in the OLED in accordance with an embodiment of the present invention, the substrate 110 where the TFT is disposed is planarized, so that the number of insulating layers can be decreased by one as compared with that of insulating layers in other OLEDs.

The semiconductor layer 140 may be formed of a semiconductor material using zinc oxide (ZnO) as a main component.

Alternatively, the semiconductor layer 140 may be formed of a semiconductor layer in which zinc oxide (ZnO) is doped with an ion material, such as indium (In), gallium (Ga) or stannum (Sn), e.g., InZnO (IZO), GaInZnO (GIZO) or the like. As such, the semiconductor layer 140 is formed of an oxide semiconductor using zinc oxide (ZnO) as a main component to provide a TFT with improved mobility, uniformity and reliability than a conventional TFT formed of amorphous silicon or poly-silicon. Furthermore, if the semiconductor layer 140 is formed of an oxide semiconductor layer, a process of forming the semiconductor layer 140 can be performed at a low temperature of 300 degrees or less using available Low Temperature Poly-Silicon (LTPS) equipment.

A source electrode 150a electrically coupled to the source region 140a of the semiconductor layer 140 and a common electrode 150b electrically coupled to the drain region 140b of the semiconductor layer 140 are disposed on the first insulating layer 130 having the semiconductor layer 140. The common electrode 150b is extended from the non-pixel region to the pixel region. The common electrode 150b is in contact with the drain region 140b of the semiconductor layer 140 and an organic thin film layer 180 so that the semiconductor layer 140 is electrically coupled to the organic thin film layer 180 using the common electrode 150b, so that the number of masks used for forming contact holes is decreased. That is, a contact hole is generally formed in a planarized layer disposed between a drain electrode and an anode electrode so that a semiconductor layer is electrically coupled to an organic thin film layer. In this embodiment, however, the drain electrode and the anode electrode are formed as one electrode (the common electrode 150b), so that fewer masks are used to form contact holes.

A second insulating layer 170 is disposed on the entire surface of the first insulating layer 130 having the common electrode 150b formed thereon. The second insulating layer 170 includes an opening that allows the common electrode 150b to be partially exposed. The organic thin film layer 180 is disposed on the common electrode 150b exposed through the opening and the second insulating layer 170. The organic thin film layer 180 is disposed in the pixel region. A cathode electrode 190 is disposed on the organic thin film layer 180 and the second insulating layer 170. The common electrode 150b is formed of a material selected from the group consisting of Indium Tin Oxide (ITO), Indium Zinc Oxide (IZO), Indium Zinc Tin Oxide (IZTO), Indium Cesium Oxide (ICO) and Indium Tungsten Oxide (IWO), so that light can be emitted transparently or through the rear of the OLED 100.

FIGS. 2A to 2F are cross-sectional views of a method of fabricating an OLED according to an embodiment of the present invention.

Referring to FIG. 2A, a metallic material is deposited on a substrate 110, and a gate electrode 120 is formed through a mask process.

The mask process is a photolithography process. The mask process refers to a process of coating a photoresist on a thin film in which a pattern is to be formed, exposing the photoresist to ultraviolet light using a mask to have a desired thin-film shape, etching the exposed coated photoresist, and then removing the photoresist.

A first insulating layer 130 is formed by coating an organic material on the entire surface of the substrate 110 having the gate electrode 120 formed thereon, thereby forming a first insulating layer 130. The organic material is a material selected from the group consisting of polyimide, polyacryl, photoresist, and benzocyclobutene (BCB). A groove 145 is

formed through a mask process so as to bury a semiconductor layer **140** (see FIG. 2E) on a top surface of the first insulating layer **130**. The groove **145** is formed on the top surface of the first insulating layer **130** opposite to the gate electrode **120**.

Referring to FIG. 2B, a photoresist **160** is coated on the entire surface of the first insulating layer having the groove **145** formed therein, and the photoresist **160** with different heights is then formed through an exposure process using a half-tone mask or dummy diffraction mask. Specifically, the photoresist **160** formed on the groove **145** is totally exposed using a half-tone mask, and the photoresist **160** formed on the first insulating layer **130** is exposed to a depth corresponding to the height of the groove **145**. Therefore, the groove **145** is exposed to the outside, and the photoresist **160** remains on the first insulating layer **130**. Furthermore, the photoresist **160** adjacent to the groove **145** has an undercut shape to prevent a semiconductor material from being coated on a side surface **161** of the photoresist adjacent to the groove **145**.

Referring to FIG. 2C, a semiconductor material is coated on the entire surface of the groove **145** and the photoresist **160** so as to bury the semiconductor layer **140** in the groove **145**. The semiconductor material is either zinc oxide (ZnO) or zinc oxide (ZnO) doped with at least one of indium (In), gallium (Ga) and stannum (Sn). Thus, the semiconductor layer **140** is formed on the entire surface of the groove **145** and the photoresist **160**.

Referring to FIG. 2D, the photoresist **160** is lifted off from the first insulating layer **130**, and therefore the first insulating layer **130** and the semiconductor layer **140** buried in the groove **145** are exposed to the outside.

Referring to FIG. 2E, a metallic material is deposited on the entire surface of the first insulating layer **130** having the semiconductor layer **140**, and source and common electrodes **150a** and **150b** that are respectively in contact with source and drain regions **140a** and **140b** (see FIG. 2F) of the semiconductor layer **140** are then formed through a mask process. The common electrode **150b** is patterned to extend to the pixel region so that the common electrode **150b** is in contact with an organic thin film layer **180**.

Referring to FIG. 2F, a second insulating layer **170** is formed on the entire surface of the first insulating layer **130** where the source and common electrodes **150a** and **150b** are formed. A mask process is performed with respect to the second insulating layer **170** so that the common electrode **150b** disposed in the pixel region is partially exposed. The method of performing the mask process is the same as the method described above. The organic thin film layer **180** is formed on the common electrode **150b** exposed through the mask process and the second insulating layer **170**. A cathode electrode **190** is formed on the organic thin film layer **180** and the second insulating layer **170**.

In the aforementioned embodiment, the semiconductor layer has been formed through a lift-off method. However, the semiconductor layer **140** may be formed using an inkjet method and an etching method. The inkjet method is performed by disposing a semiconductor material in the groove **145**. The number of processes when forming the semiconductor layer **140** using the inkjet method is less than the number of processes when forming the semiconductor layer **140** using the lift-off method.

While the present invention has been described in connection with certain exemplary embodiments, it is to be understood that the present invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. An Organic Light Emitting Display (OLED) comprising:
 - a substrate including a pixel region and a non-pixel region;
 - a gate electrode arranged in the non-pixel region of the substrate;
 - a first insulating layer arranged on the substrate where the gate electrode is formed, and having an open groove on an upper surface of a region opposite to the gate electrode, said insulating layer in direct contact with the gate electrode and substrate;
 - a semiconductor layer buried in the groove and including a source region, a channel region, and a drain region; and
 - an organic thin film layer arranged in the pixel region of the substrate; and
 - a common electrode arranged between the drain region of the semiconductor layer and the organic thin film layer to electrically couple the drain region to the organic thin film layer, and the common electrode directly making contact with the drain region of the semiconductor layer.
2. The OLED as claimed in claim 1, wherein the common electrode is electrically coupled to the drain region of the semiconductor layer and extends to the pixel region of the substrate.
3. The OLED as claimed in claim 1, wherein the semiconductor layer comprises zinc oxide (ZnO).
4. The OLED as claimed in claim 3, wherein the semiconductor layer is doped with at least one of indium (In), gallium (Ga) or stannum (Sn).
5. The OLED as claimed in claim 1, wherein the first insulating layer is at least one material selected from the group consisting of polyimide, polyacryl, photoresist, and benzocyclobutene (BCB).
6. A method of fabricating an Organic Light Emitting Display (OLED), the method comprising:
 - dividing a substrate into a pixel region and a non-pixel region;
 - forming a gate electrode in the non-pixel region of the substrate;
 - forming a first insulating layer on an entire surface of the substrate where the gate electrode is formed, said insulating layer in direct contact with the gate electrode and substrate;
 - patterning the first insulating layer to form a groove in a region opposite to the gate electrode;
 - forming a semiconductor layer buried in the groove and including a source region, a channel region and a drain region;
 - forming a source electrode in contact with the source region of the semiconductor layer;
 - forming a common electrode directly making contact with the drain region of the semiconductor layer and extending to the pixel region of the substrate; and
 - forming an organic thin film layer on the common electrode.
7. The method as claimed in claim 6, wherein the semiconductor layer is formed by any one of lift-off, inkjet and etching methods.
8. The method as claimed in claim 7, wherein the lift-off method of forming the semiconductor layer comprises:
 - coating a photoresist on an entire surface of the first insulating layer where the groove is formed;
 - removing the photoresist coated on the groove;
 - coating a semiconductor material on the groove and the photoresist; and
 - removing the photoresist.
9. The method as claimed in claim 7, wherein the inkjet method of forming the semiconductor layer is performed by disposing a semiconductor material in the groove.

专利名称(译)	有机发光显示器 (OLED) 及其制造方法		
公开(公告)号	US8598781	公开(公告)日	2013-12-03
申请号	US12/315000	申请日	2008-12-19
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IPC分类号	H01L51/50		
CPC分类号	H01L27/1214 H01L27/1225 H01L27/3248 H01L27/3262 H01L29/7869 H01L27/1288		
优先权	1020080032081 2008-04-07 KR		
其他公开文献	US20090251047A1		
外部链接	Espacenet USPTO		

摘要(译)

有机发光显示器 (OLED) 和制造OLED的方法包括：包括像素区域和非像素区域的基板;栅电极，设置在基板的非像素区域中;第一绝缘层，设置在其上形成有栅电极的基板上，并且与栅电极相对的区域的上表面上具有开口槽;半导体层，埋入沟槽中，包括源区，沟道区和漏区;和有机薄膜层，设置在基板的像素区域中。公共电极布置在半导体层的漏极区域和有机薄膜层之间，以将漏极区域电耦合到有机薄膜层。

