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

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None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,890,406 B2 11/2014 Kang et al.
2004/0256979 A1 12/2004 Murakami et al.
2005/0116631 A1 6/2005 Kim et al.
2006/0017671 A1 1/2006 Yamada
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2004-192876 A 7/2004
JP 2006-038986 A 2/2006
(Continued)

OTHER PUBLICATIONS

Extended European Search Report issued in counterpart European
Patent Application No. 17194492.9 dated Apr. 17, 2018.

(Continued)

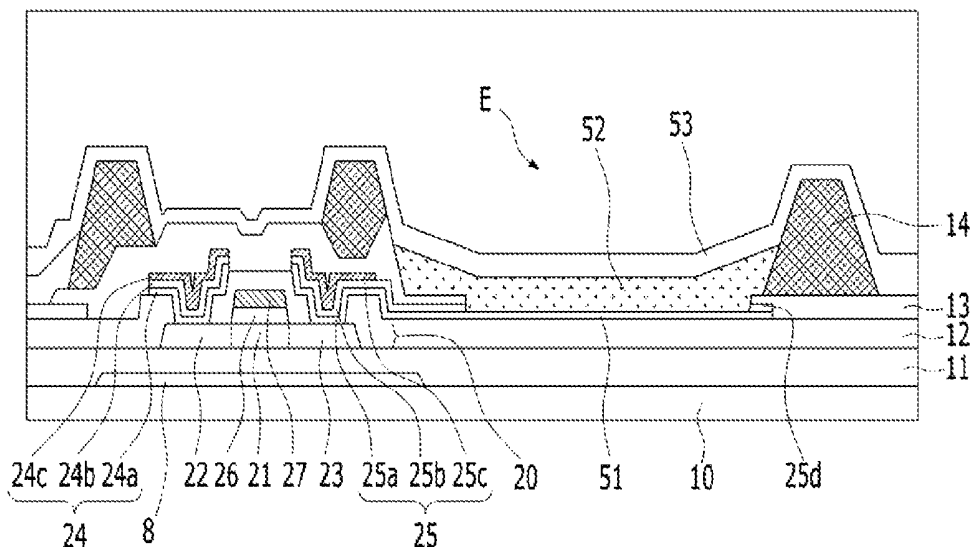
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(57) **ABSTRACT**

Disclosed are an organic light-emitting display device and a
method of manufacturing the same. The organic light-
emitting display device includes a thin-film transistor
including source and drain electrodes, a first electrode
formed by extending the source or drain electrode, a passiv-
ation layer and a bank insulation layer on the thin-film
transistor configured to expose the first electrode so as to
define an emission area, an organic light-emitting layer
provided on the first electrode, and a second electrode
configured to cover the organic light-emitting layer. The
source or drain electrode includes a plurality of layers and
the first electrode is integrally formed with any one layer
portion of the source or drain electrode.

8 Claims, 4 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

2007/0132365	A1	6/2007	Kang et al.	
2008/0042550	A1	2/2008	Matsuura et al.	
2008/0111484	A1	5/2008	Kwon et al.	
2008/0251785	A1*	10/2008	Noh	H01L 27/12 257/40
2009/0278131	A1	11/2009	Kwon et al.	
2010/0032186	A1*	2/2010	Gotou	G02F 1/13439 174/126.2
2014/0139102	A1	5/2014	Jeon et al.	
2015/0187948	A1	7/2015	Misaki	

FOREIGN PATENT DOCUMENTS

JP	2007-164183	A	6/2007
JP	2008-015293	A	1/2008
TW	201003924	A1	1/2010
WO	2014/017406	A1	1/2014

OTHER PUBLICATIONS

Office Action dated Sep. 11, 2018, from the Taiwanese Patent Office in related Taiwanese 106133209. Note: US 2008/0042550 cited therein is already of record.

Office Action dated Aug. 28, 2018, from the Japanese Patent Office in related Japanese 2017-198332. Note: US 2014/0139102 and US 2008/0111484 cited therein is already of record.

* cited by examiner

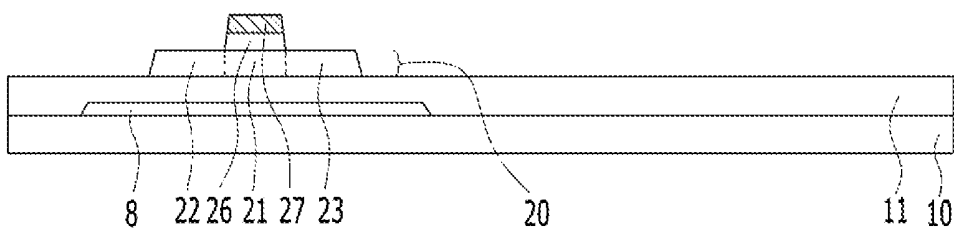


FIG. 2B

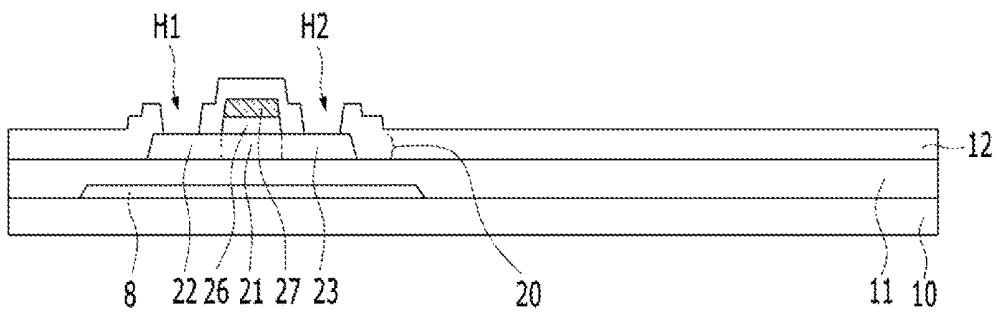
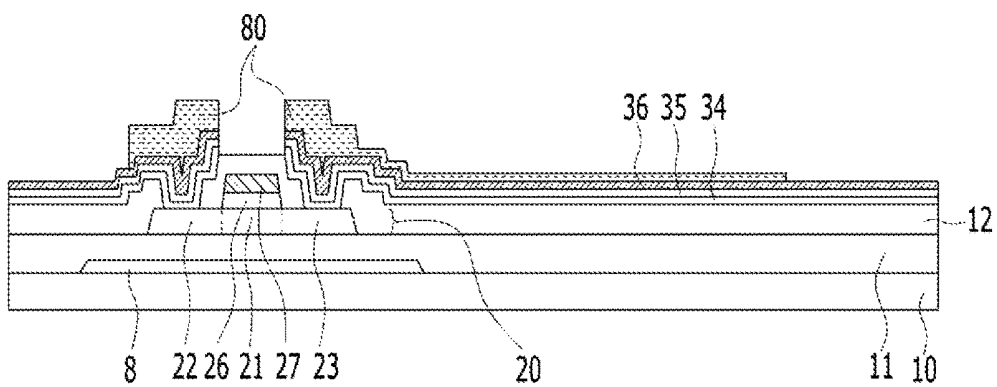
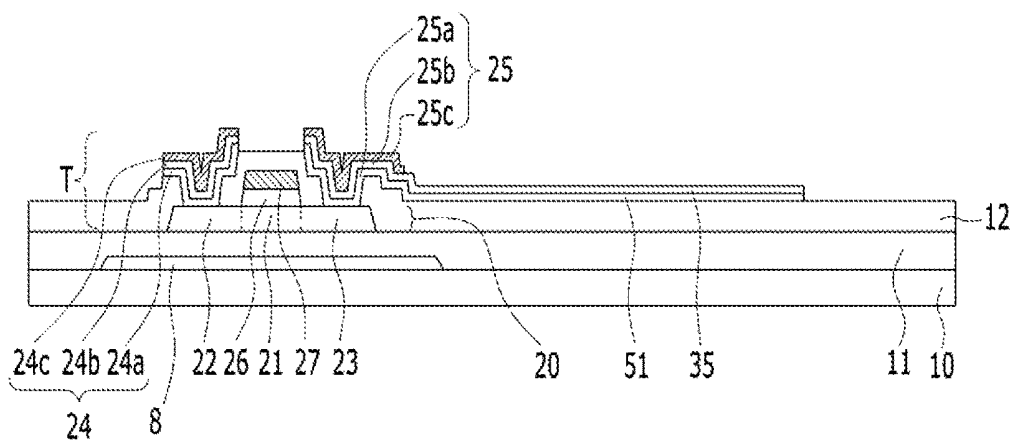


FIG. 2C





1

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

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Republic of Korea Patent Application No. 10-2016-0183980, filed on Dec. 30, 2016, which is hereby incorporated by reference in its entirety.

BACKGROUND

Technical Field

The present invention relates to an organic light-emitting display device and a method of manufacturing the same, and more particularly, to an organic light-emitting display device and a method of manufacturing the same, which may simplify a process by reducing the number of masks when forming the organic light-emitting display device, and may increase reliability when forming an organic light-emitting layer by a solution process.

Discussion of the Related Art

An image display device, which realizes various pieces of information on a screen, is a core technology of the information and communication age, and is being developed in the direction of becoming thinner, lighter, more portable, and having higher performance. In response, as a flat panel display device that is thinner and lighter than a cathode ray tube (CRT), for example, an organic light-emitting display device, which controls the amount of light emitted from an organic light-emitting layer to display an image, is in the spotlight.

In an organic light-emitting display device, a plurality of pixels is arranged in a matrix form to display an image. Here, each pixel includes a light-emitting element, and a pixel drive circuit including, for example, a plurality of transistors and storage capacitors to independently drive the light-emitting element. Here, each light-emitting element includes an organic light-emitting layer between a first electrode and a second electrode.

The organic light-emitting layer is configured such that a plurality of layers such as, for example, a hole injection layer, a hole transport layer, an emission layer, an electron transport layer, and an electron injection layer are stacked one above another. The organic light-emitting layer has been manufactured by depositing these layers via thermal deposition in different process chambers. However, this related art method of manufacturing the organic light-emitting layer entails high manufacturing costs and a complicated manufacturing process and is difficult to use to realize a large-area mask.

In order to solve the problems, a technique of forming an organic light-emitting layer using a solution process such as, for example, ink-jet printing or nozzle coating has been proposed.

The organic light-emitting layer formed using the solution process undergoes a pile-up phenomenon in which the organic light-emitting layer is relatively slowly cured in the edge portion thereof and begins to be cured from the central portion thereof, thus causing the edge portion of the organic light-emitting layer to be thicker than the central portion. In order to solve this problem, a technique of forming a bank layer, which defines a pixel portion, in double layers so that a lower layer forms a hydrophilic bank and an upper layer forms a hydrophobic bank in order to reduce the difference

2

in thickness between the central portion and the edge portion of the organic light-emitting layer has been proposed. However, when the bank layer is formed to have a double-layered structure, this may cause a complicated process and high manufacturing costs, and may also cause, for example, separation of the upper bank layer due to the low adhesive strength between the hydrophilic lower bank layer and the hydrophobic upper bank layer.

SUMMARY

Accordingly, the present invention is directed to an organic light-emitting display device and a method of manufacturing the same that substantially obviate one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide an organic light-emitting display device and a method of manufacturing the same, which may simplify a process by reducing the number of masks when forming the organic light-emitting display device, and may increase reliability when forming an organic light-emitting layer by a solution process.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, an organic light-emitting display device comprises a thin-film transistor including a source electrode and a drain electrode, a first electrode formed by extending one of the source electrode and the drain electrode, a passivation layer configured to cover the thin-film transistor and to expose the first electrode so as to define an emission area, a bank insulation layer provided on the passivation layer, an organic light-emitting layer provided on the first electrode, and a second electrode configured to cover the organic light-emitting layer.

In another aspect, a method of manufacturing an organic light-emitting display device comprises forming a semiconductor layer, forming a gate insulation layer and a gate electrode and forming a source area and a drain area by configuring the semiconductor layer as a conductor, and forming an interlayer insulation layer to cover the semiconductor layer, the interlayer insulation layer having first and second contact holes configured to expose the source area and the drain area.

The method further includes sequentially forming a first division layer and a second division layer using different transparent conductive materials and a third division layer using a metal material on the interlayer insulation layer, and forming a source electrode and a drain electrode by patterning the first to third division layers and extending the first and second division layers of one of the source electrode and the drain electrode to an emission area.

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

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incor-

porated in and constitute a part of this application, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention.

FIG. 1 is a view illustrating an organic light-emitting display device according to an embodiment of the present invention.

FIGS. 2A to 2G are views for explaining a method of manufacturing an organic light-emitting display device according to an embodiment of the present invention.

DETAILED DESCRIPTION

Hereinafter, exemplary embodiments of the present invention will be described with reference to the accompanying drawings. In the entire specification, the same or similar elements are denoted by the same reference numerals even though they are depicted in different drawings. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear. Also, the terms used in the following description are terms defined taking into consideration the functions obtained in accordance with the present invention, and may differ from the names of parts of actual products.

In the case of a description with reference to positional relations, when an element is referred to as being, for example, “on”, “above”, “under”, and “aside” another element, it may be directly on the other element or intervening elements may also be present.

Although terms such as, for example, “first” and “second” are used to describe various components, these components are not limited by these terms. These terms are merely used to distinguish any one component from another component. Thus, “a first component” mentioned below may be “a second component” within the technical spirit of the present invention.

In the drawings, the thickness and size of each component are illustrated for convenience of description, and the present invention is not necessary to be limited to the size and thickness of the illustrated component.

FIG. 1 is a cross-sectional view illustrating an organic light-emitting display device according to the present invention.

The organic light-emitting display device according to the present invention includes a thin-film transistor T, and a first electrode 51, an organic light-emitting layer 52, and a second electrode 53, which are electrically connected to the thin-film transistor T.

The organic light-emitting display device according to an embodiment of the present invention will be described below in more detail with reference to FIG. 1. Referring to FIG. 1, a buffer layer 11 is located on a first substrate 10. The buffer layer 11 serves to prevent the permeation of moisture or impurities through the first substrate 10 and to flatten the top of the first substrate 10. The buffer layer 10 may be formed of an inorganic insulation material such as, for example, SiNx or SiOx.

An active layer 20 is formed on the buffer layer 11 using semiconductors, such as, for example, silicon or a semiconductor oxide. A gate insulation layer 26 is located on the active layer 20, and a gate electrode 27 is located on the gate insulation layer 26. The gate electrode 27 is located to overlap a channel area 21 of the active layer 20 with the gate insulation layer 26 interposed therebetween. The gate electrode 27 may be formed in a single layer or in multiple layers using any one or an ally thereof selected from among

molybdenum (Mo), aluminum (Al), chrome (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) and copper (Cu).

A shield layer 8 is located below the area in which the thin-film transistor T is located. The shield layer 8 may serve to prevent light from being introduced into the active layer 20 and to reduce parasitic capacitance generated between the thin-film transistor T and various lines (not illustrated). The shield layer 8 may be formed of any one or an alloy thereof selected from among silver (Ag), nickel (Ni), gold (Au), platinum (Pt), aluminum (Al), copper (Cu), molybdenum (Mo), titanium (Ti) and neodymium (Nd).

An interlayer insulation layer 12 is located on the gate electrode 27. The interlayer insulation layer 12 extends from a display area and is located throughout one surface of the first substrate 10 including a lower pad portion of a pad area. The interlayer insulation layer 12 may be formed in a single layer or in multiple layers using an inorganic insulation material such as, for example, SiNx or SiOx.

The interlayer insulation layer 12 has a first contact hole H1, which exposes a source area 22 of the active layer 20, and a second contact hole H2, which exposes a drain area 23.

A source electrode 24 is connected to the source area 22 through the first contact hole H1, and a drain electrode 25 is connected to the drain area 23 through the second contact hole H2.

The source electrode 24 has a triple-layer structure including a lower layer portion 24a, a middle layer portion 24b, and an upper layer portion 24c. In the same manner as the source electrode 24, the drain electrode 25 also has a triple-layer structure including a lower layer portion 25a, a middle layer portion 25b, and an upper layer portion 25c.

The lower layer portions 24a and 25a, and the middle layer portions 24b and 25b are formed of different transparent conductive materials. For example, when the lower layer portions 24a and 25a are formed of ITO, the middle layer portions 24b and 25b may be formed of a transparent conductive material such as IZO or IGZO.

When the lower layer portions 24a and 25a is formed of a transparent conductive material such as IZO or IGZO, the middle layer portions 24b and 25b may be formed of ITO. This serves to ensure that the first electrode 51, which will be described below, is integrally formed with the lower layer portion 24a of the source electrode 24 or the lower layer portion 25a of the drain electrode 25 and the middle layer portion 24b or 25b covers the top of the first electrode 51 before the light-emitting layer 52 is formed, thereby protecting the surface of the first electrode 51 from impurities. Then, after the first electrode 51 is formed, the middle layer portion on the first electrode 51 is removed. A detailed description related to this will follow.

The upper layer portion 24c of the source electrode 24 and the upper layer portion 25c of the drain electrode 25 may be formed of a metal such as, for example, molybdenum (Mo), aluminum (Al), chrome (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) or copper (Cu).

In addition, the first electrode 51 is formed on the interlayer insulation layer 12 so as to be integrally formed with one of the lower layer portion 24a of the source electrode 24 and the lower layer portion 25a of the drain electrode 25. Although the embodiment of FIG. 1 illustrates the first electrode 51 as being integrally formed with the lower layer portion 25a of the drain electrode 25, in some cases, the first electrode 51 may be integrally formed with the lower layer portion 24a of the source electrode 24. Herein, the first electrode 51 will be described as being integrally formed with the lower layer portion 25a of the drain electrode 25.

A passivation layer **13** is provided on the thin-film transistor **T** so as to expose the first electrode **51**. The passivation layer **13** may be formed in a single inorganic layer or in multiple inorganic layers formed of a hydrophilic material such as, for example, SiOx or SiNx. In the present invention, the passivation layer **13** serves not only to protect the thin-film transistor **T**, but also to define an emission area **E**. That is, the passivation layer **13** is provided to cover the edge portion of the first electrode **51** and defines the emission area **E**.

A bank insulation layer **14** is formed on the passivation layer **13**. The bank insulation layer **14** may be formed using a hydrophobic organic insulation material. Examples of a constituent material of the bank insulation layer **14** may include any one or a mixture of two or more selected from among polyimide, styrene, methylmethacrylate, and polytetrafluoroethylene. Since the bank insulation layer is formed of a hydrophobic organic insulation material, the bank insulation layer **14** may serve as a barrier that prevents a liquid-phase material of the light-emitting layer from being sprayed to the emission area **E** due to, for example, equipment malfunction when the light-emitting layer **52** is formed. In addition, even if the liquid-phase material of the organic light-emitting layer **52** is sprayed onto the bank insulation layer **14** due to a processing error, the bank insulation layer **14** causes the liquid-phase material of the organic light-emitting layer **52** to fall down, thereby being located in the emission area **E**, rather than overflowing from the bank insulation layer **14**.

The organic light-emitting layer **52** is provided on the first electrode **51**. Here, the organic light-emitting layer **52** may include a hole injection layer (HIL), a hole transport layer (HTL), an emission layer (EML), an electron transport layer (ETL) and an electron injection layer (EIL). In addition, the organic light-emitting layer **52** may further include at least one functional layer configured to increase, for example, the luminous efficacy and lifespan of the emission layer, for example, a charge-generating layer, which generates a charge, an additional electron transport layer and an additional hole transport layer.

The organic light-emitting layer **52** is formed by a solution process such as inkjet printing or nozzle coating. The organic light-emitting layer formed using the solution process undergoes a pile-up phenomenon in which the organic light-emitting layer is relatively slowly cured in the edge portion thereof, which is in contact with the bank insulation layer **14** and begins to be cured from the central portion thereof, whereby the constituent material of the organic light-emitting layer **52** moves to the edge portion and the edge portion is finally cured, thus causing the edge portion of the organic light-emitting layer **52** to be thicker than the central portion. The edge portion of the organic light-emitting layer **52** is thicker than the central portion of the organic light-emitting layer **52**.

The organic light-emitting display device according to one embodiment is configured such that the passivation layer **13** extends to the bottom of the organic light-emitting layer **52**. Thereby, the organic light-emitting layer **52** has the area located on the passivation layer **13**, and due to the resulting stepped portion between the passivation layer **13** and the first electrode **51**, the passivation layer **13** causes the liquid-phase constituent material of the organic light-emitting layer **52** to gather at the central portion. Thereby, the organic light-emitting display device according to one embodiment may somewhat alleviate a phenomenon in which the organic light-emitting layer **52** is thicker in the portion thereof that is close to the bank insulation layer **14**.

It may reduce the thickness difference between the edge portion and the central portion of the organic light-emitting layer **52**.

The second electrode **53** is provided to cover the top of the organic light-emitting layer **52** and the bank insulation layer **14**. When the first electrode **51** serves as an anode electrode, the second electrode **53** serves as a cathode electrode. In a top-emission-type organic light-emitting display device, the second electrode **53** may be formed of a metallic material having a low work function to an extremely small thickness (e.g., about 200 Å or less) that allows the transmission of light, whereby light from the organic light-emitting layer **52** may penetrate the second electrode **53**, thus realizing top emission. The constituent material of the second electrode **53** may be at least one of, for example, silver (Ag), titanium (Ti), aluminum (Al), molybdenum (Mo), and an alloy of silver (Ag) and magnesium (Mg). In addition, when the second electrode **53** is formed of a transparent conductive material such as, for example, ITO, IZO, IGZO, or ZnO, the light from the organic light-emitting layer **52** may penetrate the second electrode **53**, thus realizing top emission.

Although a second substrate (not illustrated) may be bonded onto the second electrode **53** via an adhesive layer (not illustrated), the adhesive layer and the second substrate may be omitted according to design, and the second substrate may be replaced with an encapsulation member having the form of a thin layer.

Referring to FIG. 1, in the organic light-emitting display device according to the embodiment of the present invention, as described above, the lower layer portion **25a** of the drain electrode **25** extends to form the first electrode **51**, the middle layer portion **25b** of the drain electrode **25** is provided below the passivation layer **13** and extends to the bottom of the organic light-emitting layer **52**, and the side surface end of the middle layer portion **25b** of the drain electrode **25** is in contact with the organic light-emitting layer **52**. Meanwhile, a dummy conductive layer **25d** may further be provided below the passivation layer **13** at one side of the organic light-emitting layer **52** opposite the other side that is in contact with the middle layer portion **25b** of the drain electrode **25**.

Although the drain electrode **25** has been described in the embodiment of FIG. 1, in some designs, the lower layer portion **24a** of the source electrode **24** extends to form the first electrode **51**, the middle layer portion **24b** of the source electrode **24** is provided below the passivation layer **13** so that the side surface end of the middle layer portion **24b** of the source electrode **24** is in contact with the organic light-emitting layer **52**. Hereinafter, the example in which the lower layer portion **25a** of the drain electrode **25** forms the first electrode **51** will be continuously described.

The reason why the middle layer portion **25b** of the drain electrode **25** is formed so as to extend along the bottom of the passivation layer **13** and the dummy conductive layer **25d** is provided at one side of the organic light-emitting layer **52** opposite the other side that is in contact with the middle layer portion **25b** of the drain electrode **25** is that the middle layer portion **25b** of the drain electrode **25** remains on the first electrode **51** in order to protect the surface of the first electrode **51** until the bank insulation layer **14** is formed, and after the bank insulation layer **14** is formed, the middle layer portion **25b** of the drain electrode **25** on the first electrode **51** is patterned to expose the first electrode and a portion of the middle layer portion **25b** of the drain electrode **25** remains below the bank insulation layer **14**.

As a result, in the organic light-emitting display device according to the embodiment, impurities such as, for

example, particulates, which are generated in the process of forming the bank insulation layer **14** and are attached to the middle layer portion **25b** of the drain electrode **25**, are wholly removed in the process of patterning the middle layer portion **25b** of the drain electrode **25** and no impurities remain on the surface of the first electrode **51**, which may increase the adhesion strength between the first electrode **51** and the organic light-emitting layer **52**. Here, the lower layer portion **25a** and the middle layer portion **25b** of the drain electrode **25** are formed using different transparent conductive materials. For example, when the lower layer portion **25a** of the drain electrode **25** is formed of ITO, the middle layer portion **25b** may be formed of IZO or IGZO. Conversely, when the lower layer portion **25a** of the drain electrode **25** is formed of IZGO or IZO, the middle layer portion **25b** may be formed of ITO. This serves to allow the middle layer portion **25b** of the drain electrode **25** exposed on the top of the first electrode **51** to be selectively etched since the first electrode **51** and the middle layer portion **25b** of the drain electrode **25** extending to the top of the first electrode **51** are formed of different transparent conductive materials. This feature will be described below in detail when the method of manufacturing the organic light-emitting display device according to the present invention is described.

FIGS. 2A to 2G are schematic views for explaining the method of manufacturing the organic light-emitting display device according to the present invention.

Referring to FIG. 2A, first, the shield layer **8** is formed on the first substrate **10**, and then the buffer layer **11** is formed throughout one surface of the first substrate **10** via, for example, deposition so as to cover the top of the shield layer **8**. The shield layer **8** may be formed by depositing any one or an alloy thereof selected from among silver (Ag), nickel (Ni), gold (Au), platinum (Pt), aluminum (Al), copper (Cu), molybdenum (Mo), titanium (Ti) and neodymium (Nd), and then patterning the same. Then, the active layer **20** is formed on the buffer layer **11** using a semiconductor material. The gate insulation layer **26** and the gate electrode **27** are sequentially formed on the channel area **21** of the active layer **20**. The gate electrode **27** may be formed by depositing a second metal layer (not illustrated), which is formed in a single layer or in multiple layers using any one or an alloy thereof selected from among molybdenum (Mo), aluminum (Al), chrome (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) and copper (Cu), and then patterning the same.

Subsequently, the source area **22** and the drain area **23** are formed by doping the active layer **20** with impurities using the gate electrode **27** as a mask. When the active layer **20** is formed of a semiconductor oxide, opposite sides of the active layer **20** may be configured as conductors via, for example, plasma processing, whereby the source and drain areas **22** and **23** may be formed.

Subsequently, referring to FIG. 2B, the interlayer insulation layer **12** is formed on the entire surface of the first substrate **10** over the gate electrode **27**. The interlayer insulation layer **12** may be formed of an inorganic insulation material in the same manner as the buffer layer **11**. Then, the interlayer insulation layer **12** is patterned to form the first contact hole H1, which exposes the source area **22**, and the second contact hole H2, which exposes the drain area **23**.

Subsequently, referring to FIG. 2C, a first division layer **34** and a second division layer **35**, which are formed of different transparent conductive materials, and a third division layer **36**, which is formed of a metal material, are sequentially deposited on the entire surface of the substrate

10 having therein the first contact hole H1 and the second contact hole H2. Then, after a photoresist **80** is formed, the photoresist **80** is patterned using a halftone mask. At this time, the photoresist **80** is thickly formed on the area in which the source electrode **24** and the drain electrode **25** (see FIG. 1) are to be formed, and is thinly formed on the area in which the first electrode **51** (see FIG. 1) is to be located.

The first division layer **34** and the second division layer **35** are formed of different transparent conductive materials. For example, when the first division layer **34** is formed of ITO, the second division layer **35** may be formed of a transparent conductive material such as IZO or IGZO. In addition, when the first division layer **34** is formed of IZO or IGZO, the second division layer **35** may be formed of ITO. When the first and second division layers **34** and **35** are formed of different transparent conductive materials, this may allow only the second division layer **35** to be selectively etched, thereby forming the first electrode.

The third division layer **36** may be formed of a metal such as, for example, molybdenum (Mo), aluminum (Al), chrome (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) or copper (Cu).

Subsequently, the source electrode **24** and the drain electrode **25** are formed via a patterning process, as illustrated in FIG. 2D. Then, a portion of the photoresist **80** on the source electrode **24** and the drain electrode **25** is removed via, for example, ashing, and the photoresist **80** remaining on the third division layer **36** is removed.

Subsequently, as illustrated in FIG. 2E, the first electrode **51** is formed by patterning the third division layer in the area in which the first electrode **51** is to be located. The second division layer **35** still remains on the first electrode **51**.

Subsequently, as illustrated in FIG. 2F, after the passivation layer **13** is formed on the thin-film transistor T via a mask process, the bank insulation layer **14** is formed on the passivation layer **13** via a mask process.

The passivation layer **13** may be formed in a single inorganic layer or in multiple inorganic layers using a hydrophilic material such as, for example, SiOx or SiNx. The passivation layer **13** serves to protect the thin-film transistor T, and in the embodiment, also serves to define the emission area E.

Examples of a material that may constitute the bank insulation layer **14** may include any one or a mixture of two or more selected from among polyimide, styrene, methyl-methacrylate, and polytetrafluoroethylene.

Subsequently, the second division layer **35** located on the first electrode **51** is patterned to expose the first electrode **51**. Impurities scattered in the process of forming the passivation layer **13** and the bank insulation layer **14** may be attached to the second division layer **35**. In the organic light-emitting display device according to the present invention, since the second division layer **35** is removed after the passivation layer **13** and the bank insulation layer **14** are formed, the impurities attached to the second division layer **35** are removed, and the first electrode **51** has a clean surface having no impurities. Then, a portion of the second division layer **35** is provided as the middle layer portion **25b** of the drain electrode **25** and is exposed through the side surface of the passivation layer **13**.

Referring to FIG. 2G, the organic light-emitting layer **52** is provided on the first electrode **51**. Here, the organic light-emitting layer **52** may include a hole injection layer (HIL), a hole transport layer (HTL), an emission layer (EML), an electron transport layer (ETL) and an electron injection layer (EIL). In addition, the organic light-emitting layer **52** may further include at least one functional layer

configured to increase, for example, the luminous efficacy and lifespan of the emission layer, for example, a charge-generating layer, which generates a charge, an additional electron transport layer and an additional hole transport layer.

Here, the organic light-emitting layer **52** is formed by a solution process such as inkjet printing or nozzle coating. The organic light-emitting layer formed using the solution process undergoes a pile-up phenomenon in which the organic light-emitting layer is relatively slowly cured in the edge portion thereof, which is in contact with the bank insulation layer **14** and begins to be cured from the central portion thereof, whereby the constituent material of the organic light-emitting layer **52** moves to the edge portion and the edge portion is finally cured, thus causing the edge portion of the organic light-emitting layer **52** to be thicker than the central portion. Accordingly, in the organic light-emitting display device according to the embodiment, the edge portion of the organic light-emitting layer **52** is thicker than the central portion of the organic light-emitting layer **52**. However, in the embodiment, since the passivation layer **13** is located below the edge portion of the organic light-emitting layer **52**, the passivation layer **13** may guide a liquid-phase material, which is used to form the organic light-emitting layer **52**, to the central portion, which may reduce the extent to which the thickness of the edge portion of the organic light-emitting layer **52** is increased. In addition, the side surface of the organic light-emitting layer **52** is formed so as to come into contact with the middle layer portion **25b** of the drain electrode **25**. In addition, the dummy conductive layer **25d** may further be provided below the passivation layer **13** at one side of the organic light-emitting layer **52** opposite the drain electrode **25**. The dummy conductive layer **25b** is a portion that remains after the second division layer **35** is removed. The end of the dummy conductive layer **25d** is also in contact with the side surface of the organic light-emitting layer **52**.

Subsequently, the second electrode **53** is provided on the organic light-emitting layer **52**. The second electrode **53** is provided to cover the top of the organic light-emitting layer **52** and the bank insulation layer **14**.

As described above, in the organic light-emitting display device according to the present invention, since the organic light-emitting layer **52** is formed in a state in which impurities such as, for example, particulates, which are generated in the process of forming the bank insulation layer **14** and are attached to the middle layer portion **25b** of the drain electrode **25**, are wholly removed in the process of patterning the middle layer portion **25b** of the drain electrode **25** and no impurities remain on the surface of the first electrode **51**, the adhesion strength between the first electrode **51** and the organic light-emitting layer **52** may be increased.

In addition, since the passivation layer **13** serves as a hydrophilic bank in the organic light-emitting display device according to the embodiment, the organic light-emitting display device may be formed without forming an additional bank insulation layer or planarization layer. In addition, since the organic light-emitting layer **52** of the organic light-emitting display device according to the embodiment is formed using a solution process, it is unnecessary to provide a mask for a deposition process.

Accordingly, the organic light-emitting display device according to one embodiment may entail a simplified manufacturing process and reduced manufacturing costs by greatly reducing the number of masks, compared to the related art.

In addition, in the organic light-emitting display device according to one embodiment, since the passivation layer **13** extends to the bottom of the organic light-emitting layer **52** and forms a slope on the edge portion of the organic light-emitting layer **52**, a liquid-phase material that is to form the organic light-emitting layer is guided to gather to the central portion of the organic light-emitting layer **52**, which alleviates a pile-up phenomenon when the organic light-emitting layer **52** is formed by a solution process.

It will be apparent to those skilled in the art that various modifications and variations can be made in the organic light-emitting display device and the method of manufacturing the same of 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 device, comprising: a semiconductor layer on a substrate, the semiconductor layer including a source area, a drain area and a channel area;

a gate insulation layer on the channel area of the semiconductor layer, and a gate electrode on the gate insulation layer overlapping the channel area;

an interlayer insulation layer on the substrate and the gate electrode, the interlayer insulation layer having a first contact hole configured to expose the source area and a second contact hole configured to expose the drain area;

a source electrode connected to the source area through the first contact hole area, and a drain electrode connected to the drain area through the second contact hole;

a first electrode formed by extending a portion of one of the source electrode and the drain electrode;

a passivation layer on the substrate so as to cover the source electrode and the drain electrode, the passivation layer being configured to expose the first electrode;

a bank insulation layer on the passivation layer;

an organic light-emitting layer on the first electrode; and a second electrode on the organic light-emitting layer,

wherein each of the source electrode and the drain electrode includes a lower layer portion, a middle layer portion, which are formed of different transparent conductive materials, and an upper layer portion, which is formed of a metal material,

wherein the first electrode is integrally formed with one of the lower layer portion of the source electrode and the lower layer portion of the drain electrode, and

wherein the passivation layer is formed of a hydrophilic inorganic insulation material, and the bank insulation layer is formed of a hydrophobic organic insulation layer.

2. The device according to claim 1, wherein the passivation layer is provided so as to extend to a bottom of an edge portion of the organic light-emitting layer.

3. The device according to claim 2, wherein the organic light-emitting layer has a greater height in the edge portion thereof than a height in a central portion thereof.

4. The device according to claim 2, wherein:

the middle layer portion of the source electrode or the drain electrode is provided below the passivation layer so as to extend to the bottom of the edge portion of the organic light-emitting layer, and

a side surface end of the middle layer portion of the source electrode or the drain electrode contacts with the organic light-emitting layer.

5. The device according to claim 4, further comprising: a dummy conductive layer provided between an edge of the passivation layer and an edge of the first electrode being below an edge of the organic light-emitting layer, wherein a side surface of the dummy conductive layer contacts the organic light-emitting layer, and the dummy conductive layer is in a same layer as the middle layer portion.

6. The device according to claim 1, wherein the lower layer portion is formed of indium tin oxide (ITO), and the middle layer portion is formed of indium gallium zinc oxide (IGZO) or indium zinc oxide (IZO).

7. The device according to claim 1, wherein the lower layer portion is formed of indium gallium zinc oxide (IGZO) or indium zinc oxide (IZO), and the middle layer portion is formed of indium tin oxide (ITO).

8. The device according to claim 1, wherein the lower layer portion is formed of a first transparent conductive material, the middle layer portion is formed of a second transparent conductive material different to the first transparent conductive material on the lower layer portion, and the upper layer portion is formed on the middle layer portion.

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专利名称(译)	有机发光显示装置及其制造方法		
公开(公告)号	US10361257	公开(公告)日	2019-07-23
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[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	YANG HEE JUNG SHIN WOO SUP		
发明人	YANG, HEE-JUNG SHIN, WOO-SUP		
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外部链接	Espacenet		

摘要(译)

公开了一种有机发光显示装置及其制造方法。有机发光显示装置包括：薄膜晶体管，包括源电极和漏电极；第一电极，通过延伸源电极或漏电极；钝化层；以及堤绝缘层，位于薄膜晶体管上，被配置为暴露第一电极。电极以限定发光区域，设置在第一电极上的有机发光层和配置为覆盖有机发光层的第二电极。源电极或漏电极包括多个层，并且第一电极与源电极或漏电极的任何一个层部分一体形成。

