



US009343514B2

(12) **United States Patent**
Kim et al.

(10) **Patent No.:** **US 9,343,514 B2**
(45) **Date of Patent:** **May 17, 2016**

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

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/056,371**

(22) Filed: **Oct. 17, 2013**

(65) **Prior Publication Data**
US 2014/0319477 A1 Oct. 30, 2014

(30) **Foreign Application Priority Data**
Apr. 26, 2013 (KR) 10-2013-0046778

(51) **Int. Cl.**
H01L 27/32 (2006.01)
(52) **U.S. Cl.**
CPC **H01L 27/3246** (2013.01)
(58) **Field of Classification Search**
CPC H01L 51/52; H01L 33/08; H01L 27/32;
H01L 27/3262; H01J 1/62; H01J 9/00
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

7,294,962 B2 11/2007 Kim et al.
7,507,998 B2 3/2009 Tseng
7,790,526 B2 9/2010 Tseng

7,791,267 B2 9/2010 Baek et al.
8,125,141 B2 2/2012 Park et al.
8,143,782 B2 3/2012 Kim
8,183,769 B2 5/2012 Chang et al.
8,232,575 B2 7/2012 Lee et al.
8,241,933 B2 8/2012 Lee et al.
8,258,523 B2 9/2012 Lee et al.
8,292,684 B2 10/2012 Kim et al.
2006/0108587 A1* 5/2006 Lee G02F 1/13439
257/72
2008/0224599 A1* 9/2008 Kim H01L 27/3276
313/504
2008/0315756 A1* 12/2008 Jeon H01L 27/3246
313/504
2010/0200861 A1 8/2010 Lee et al.
2013/0001564 A1 1/2013 Choi et al.

FOREIGN PATENT DOCUMENTS

KR 10-2007-0035857 A 4/2007
KR 10-2007-0096082 A 10/2007
KR 10-2011-0040244 A 4/2011

* cited by examiner

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(57) **ABSTRACT**

An organic light-emitting diode (OLED) display according to an exemplary embodiment of the present invention includes a substrate, a thin film transistor formed on the substrate, a pixel electrode formed on the thin film transistor and electrically connected to the thin film transistor, a pixel definition layer formed on the pixel electrode so as to define a pixel region, an emission layer formed on the pixel electrode and contacting the pixel electrode in the pixel region, and an interlayer formed on the pixel definition layer and contacting part of the emission layer. One side of the interlayer has an uneven shape so that a surface area of the interlayer is increased.

16 Claims, 7 Drawing Sheets

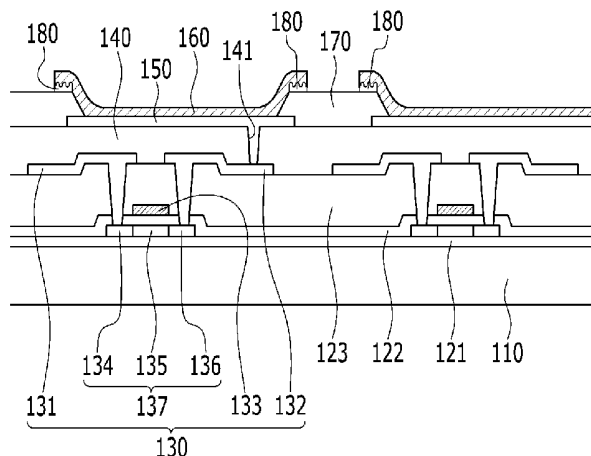


FIG. 1

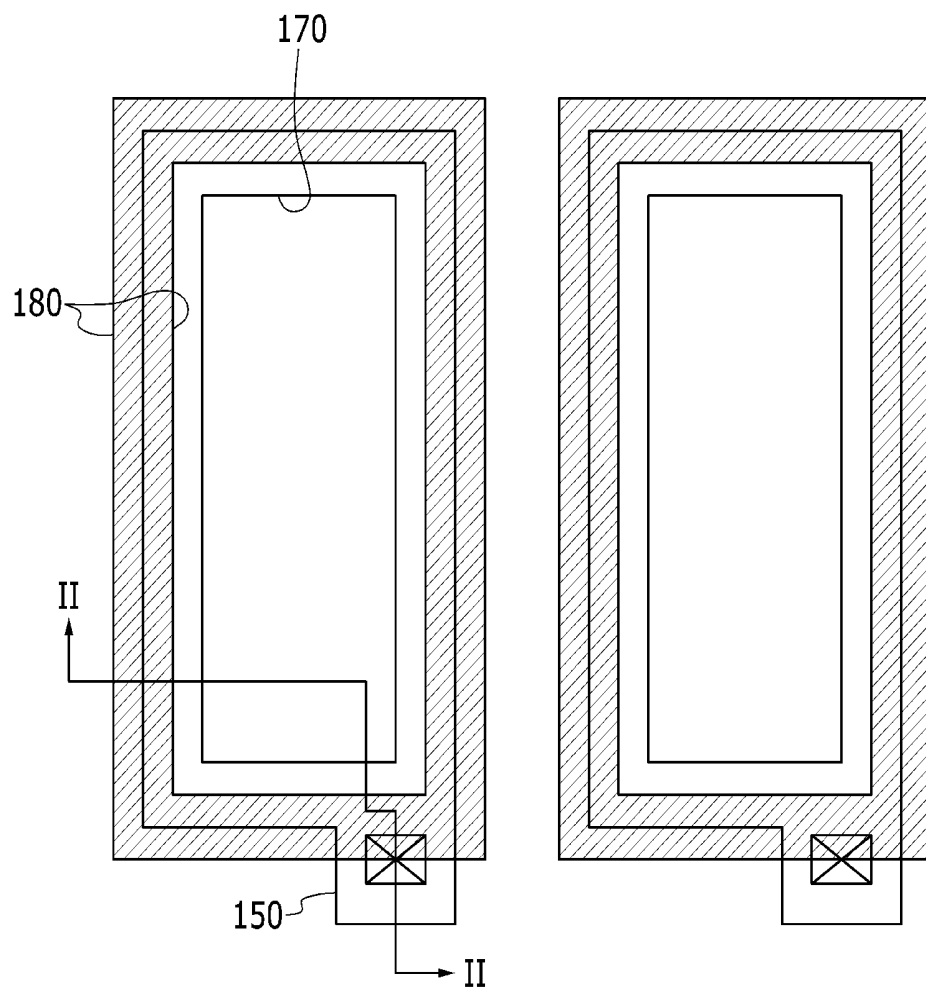


FIG. 2

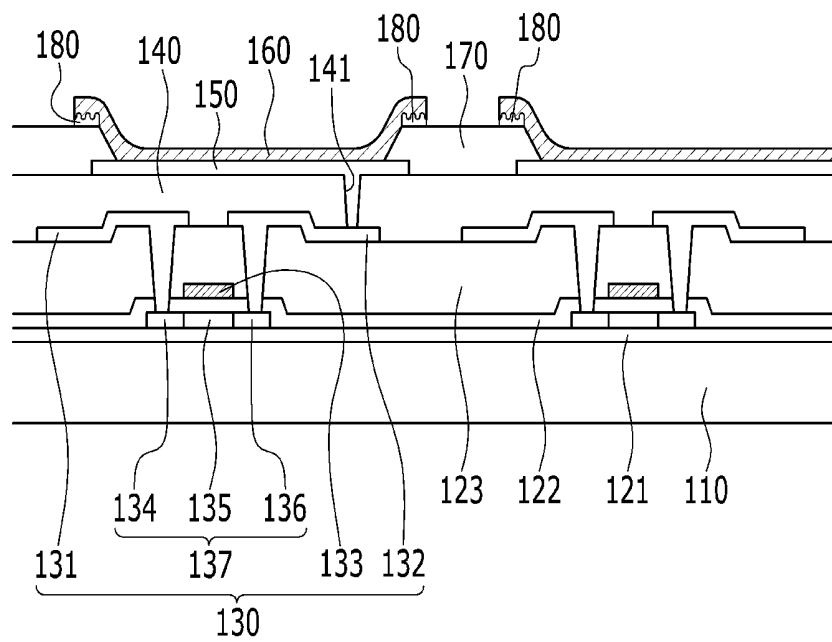


FIG. 3

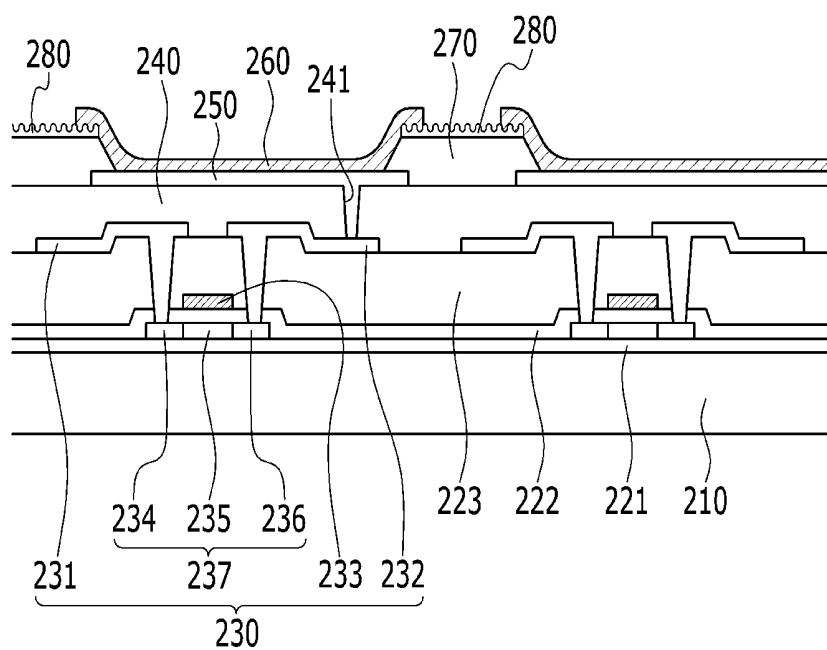


FIG. 4

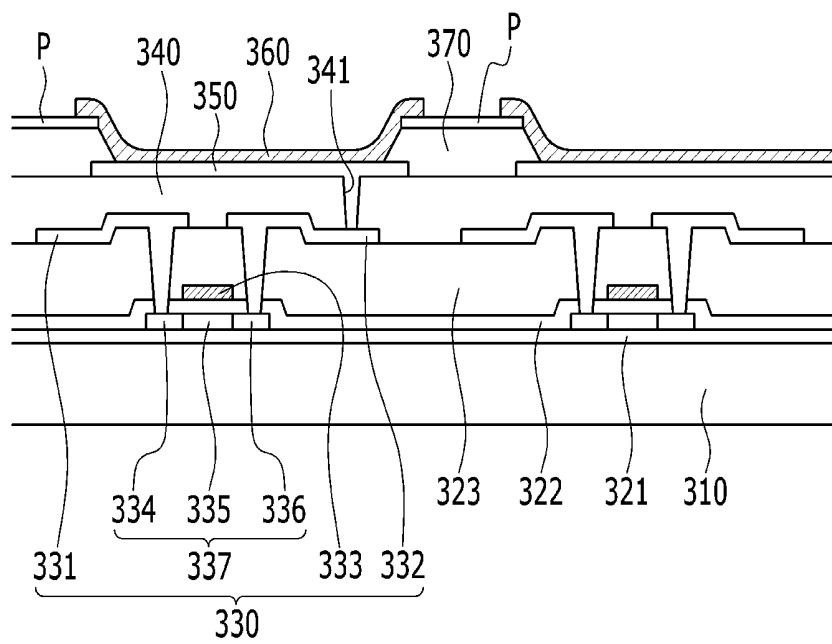
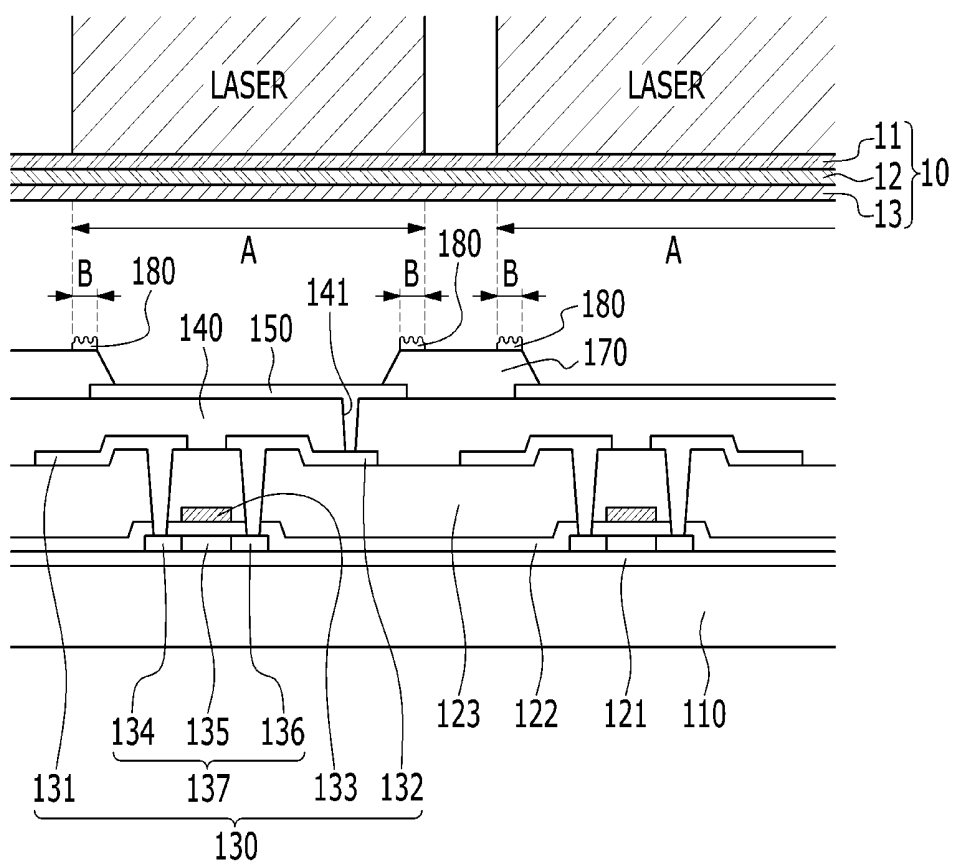


FIG. 5



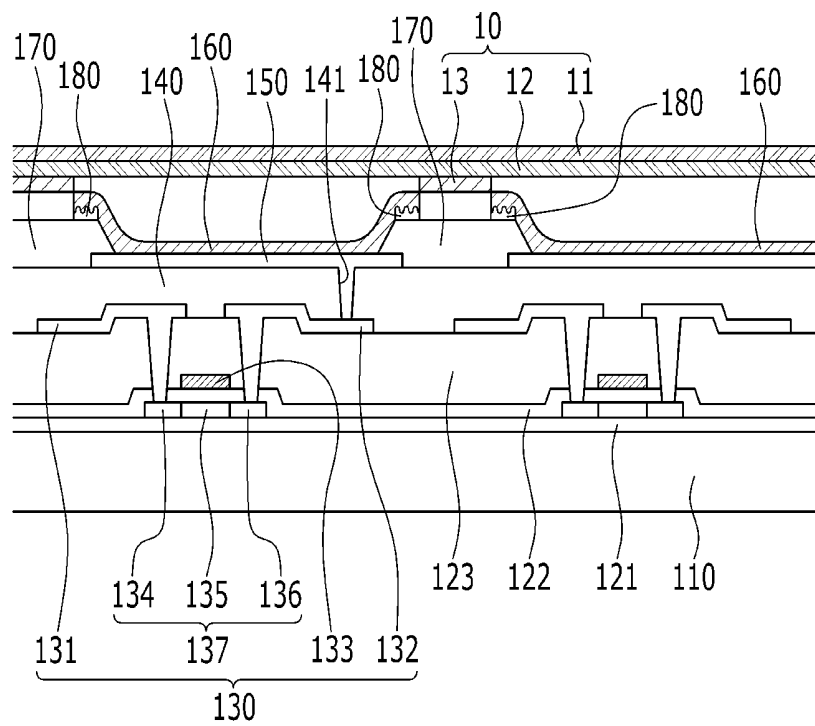
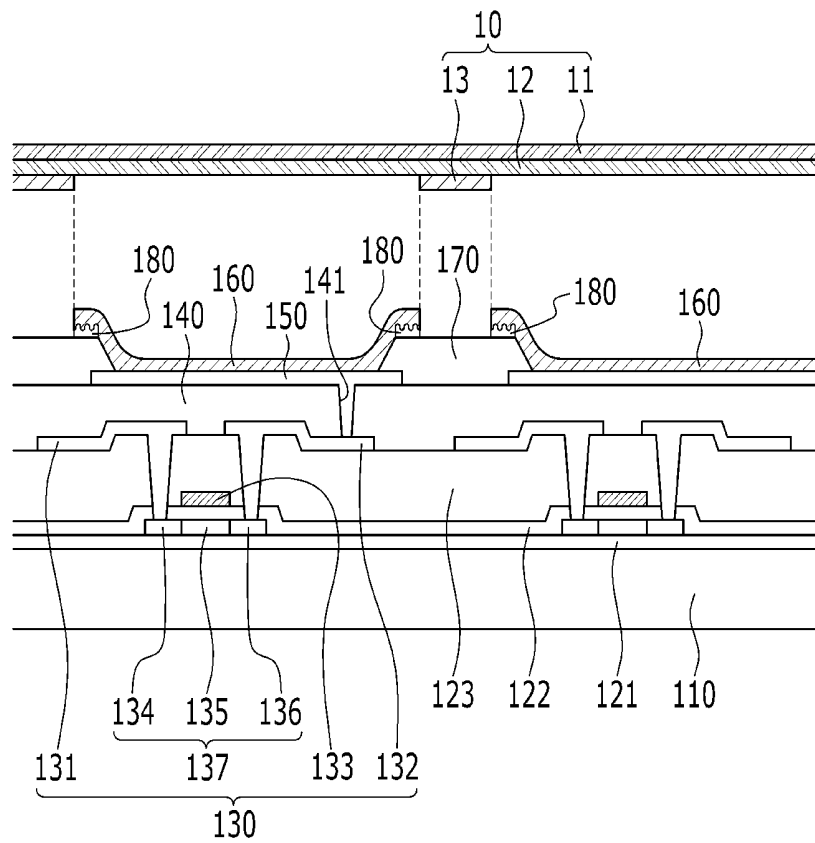


FIG. 7



ORGANIC LIGHT EMITTING DIODE DISPLAY AND METHOD OF MANUFACTURING THE SAME

CLAIM OF PRIORITY

This application makes reference to, incorporates into this specification the entire contents of, and claims all benefits accruing under 35 U.S.C. §119 from an application earlier filed in the Korean Intellectual Property Office on Apr. 26, 2013 and there duly assigned Serial No. 10-2013-0046778.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an organic light emitting diode (OLED) display and a method of manufacturing the same.

2. Description of the Related Art

An OLED used in a flat panel display includes an anode, a cathode and organic layers interposed between the anode and the cathode. The organic layers include a hole injection layer (HIL), a hole transport layer (HTL), an electron transport layer (ETL) and an electron injection layer (EIL) in addition to an emission layer. OLEDs are categorized into a polymer OLED and a low molecular weight OLED according to the composition of an organic layer, particularly, an emission layer.

To implement full colors, the organic layer needs to be patterned on a substrate. A shadow mask is used to pattern an organic layer of a low molecular weight OLED. An organic layer of a polymer OLED is patterned using inkjet printing or laser induced thermal imaging (LITI).

Unlike inkjet printing that is a wet process, LITI is a dry process which can finely pattern the organic layer.

A method of forming a polymer organic layer pattern using LITI requires at least a light source, an acceptor substrate and a donor substrate. The acceptor substrate is a display substrate on which an organic layer is formed and the donor substrate includes a transfer layer composed of a base film, a photo-thermal conversion layer and an organic layer.

Patterning of an organic layer on the acceptor substrate is performed in such a manner that the photothermal conversion layer absorbs a laser emitted from the light source and converts the laser into thermal energy, and the organic layer forming the transfer layer is transferred onto the acceptor substrate according to the thermal energy.

However, part of the organic layer that needs to be transferred to the display substrate using the laser may remain in the transfer layer during a transfer process.

The above information disclosed in this Background section is only for enhancement of an understanding of the background of the invention, and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF THE INVENTION

The present invention has been developed in an effort to provide an OLED display and a method of manufacturing the same having the advantage of completely separating a transfer layer of a transfer region of a donor substrate from a transfer layer disposed around the transfer area so that the separated transfer layer can be transferred onto a pixel region during a process of forming an organic emission layer through thermal transfer.

An exemplary embodiment provides an organic light-emitting diode (OLED) display, including: a substrate; a thin film transistor formed on the substrate; a pixel electrode formed on the thin film transistor and electrically connected to the thin film transistor; a pixel definition layer formed on the pixel electrode so as to define a pixel region; an emission layer formed on the pixel electrode and contacting the pixel electrode in the pixel region; and an interlayer formed on the pixel definition layer and contacting part of the emission layer. One side of the interlayer has an uneven shape so that the surface area of the interlayer increases.

The uneven shape is irregular.

An upper side of the interlayer may have an uneven shape.

A part of the upper side of the interlayer may have protrusions and depressions.

The interlayer may be formed along the edge of the emission layer.

The interlayer may be formed in a round shape so that the pixel electrode disposed in the pixel region is exposed. Another exemplary embodiment of the present invention provides an OLED display substrate, including: a substrate; a thin film transistor formed on the substrate; a pixel electrode formed on the thin film transistor and electrically connected to the thin film transistor; a pixel definition layer formed on the pixel electrode so as to define a pixel region; and an emission layer formed on the pixel electrode and contacting the pixel electrode in the pixel region, wherein one side of the pixel definition layer is hydrophilic, and the emission layer covers the pixel electrode and the one side of the pixel definition layer.

An upper side of the pixel definition layer may be hydrophilic.

The one side of the pixel definition layer may be treated with plasma using one of oxygen, nitrogen and argon.

Another exemplary embodiment of the present invention provides a method of manufacturing an OLED display, including: forming a thin film transistor on a substrate; forming a pixel electrode on the thin film transistor, the pixel electrode being electrically connected to the thin film transistor; forming a pixel definition layer for defining a pixel region on the pixel electrode; forming an interlayer by processing one side of the pixel definition layer into an uneven surface so that the surface area of the pixel definition layer increases; and forming an emission layer contacting the pixel electrode in the pixel region; wherein the emission layer covers the pixel electrode and the one side of the interlayer.

The forming of the interlayer may include processing an upper side of the interlayer into an uneven shape.

The forming of the emission layer may include: disposing a donor substrate on which a transfer layer forming the emission layer is formed above the pixel region; and transferring the transfer layer onto the pixel region.

The transfer layer may cover the pixel electrode and the upper side of the interlayer.

Another exemplary embodiment of the present invention provides a method of manufacturing an OLED display, including: forming a thin film transistor on a substrate; forming a pixel electrode electrically connected to the thin film transistor on the thin film transistor; forming a pixel definition layer for defining a pixel region on the pixel electrode; treating one side of the pixel definition layer with plasma; and forming an emission layer to cover the pixel electrode disposed in the pixel region and the one side of the pixel definition layer.

The plasma treatment may be performed using one of oxygen, nitrogen and argon.

The plasma treatment may be performed on the upper side of the pixel definition layer.

The forming of the emission layer may include: disposing a donor substrate on which a transfer layer forming the emission layer is formed above the pixel region; and transferring the transfer layer onto the pixel region.

The transfer layer may cover the pixel electrode and the upper side of the pixel definition layer.

In an OLED display according to an exemplary embodiment of the present invention, a transfer layer of a donor substrate, irradiated by laser, can be completely separated from the donor substrate to form an organic emission layer.

A method of manufacturing an OLED display according to an exemplary embodiment of the present invention can prevent part of a transfer layer of a transfer region irradiated by laser from being left on the donor substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a top plan view of an OLED display according to a first exemplary embodiment of the invention.

FIG. 2 is a cross-sectional view taken along line II-II of FIG. 1.

FIG. 3 is a cross-sectional view of an OLED display according to a second exemplary embodiment of the invention.

FIG. 4 is a cross-sectional view of an OLED display according to a third exemplary embodiment of the invention.

FIGS. 5 to 7 are cross-sectional views illustrating a method of manufacturing the OLED display according to the first exemplary embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. As those skilled in the art will realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. The drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

In the drawings, dimensions and thicknesses of components are exaggerated, omitted or schematically illustrated for clarity and convenience of description. In addition, dimensions of constituent elements do not entirely reflect actual dimensions thereof.

In the drawings, the thickness of layers, films, panels, regions, etc. are exaggerated for clarity. In addition, thicknesses of some layers and areas are exaggerated for better understanding and ease of description. It will be understood that, when an element such as a layer, film, region, or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present.

In addition, unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising" will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

Furthermore, the expression "on" or "under" may be used herein to represent the relationship of one element to another element as illustrated in the figures. It will be understood that this expression is intended to encompass different orientations of the elements in addition to the orientation depicted in the figures, namely, to encompass both "on" and "under".

FIG. 1 is a top plan view of an OLED display according to a first exemplary embodiment of the invention, and FIG. 2 is a cross-sectional view taken along line II-II of FIG. 1.

Referring to FIGS. 1 and 2, in an OLED display according to the first exemplary embodiment, a transfer layer of a donor substrate, irradiated by laser, may be perfectly separated from the donor substrate to form an organic emission layer.

The OLED display according to the first exemplary embodiment may include a substrate 110, a thin film transistor 130, a pixel electrode 150, a pixel definition layer 170, an emission layer 160 and an interlayer 180.

The structure of the OLED display according to the first exemplary embodiment will now be described in detail in the order of lamination of layers with reference to FIGS. 1 and 2. The OLED display includes a driving thin film transistor (TFT) and the emission layer that emits light according to the driving TFT.

The substrate 110 is an insulating substrate formed of glass, quartz, ceramics, plastics, etc. However, the present invention is not limited thereto and the substrate 110 may be a metal substrate made of stainless steel.

A buffer layer 121 is formed on the substrate 110. The buffer layer 121 prevents impurities from infiltrating into the substrate 110 and planarizes the surface of the substrate 110.

The buffer layer 121 may be formed of materials capable of achieving the above-described functions. For example, the buffer layer 121 can be formed of one of SiNx, SiO₂ and SiOxNy. However, the buffer layer 121 may be omitted according to the type of substrate 110 and process conditions.

A driving semiconductor layer 137 is formed on the buffer layer 121. The driving semiconductor layer 137 is formed from polysilicon. The driving semiconductor layer 137 includes an undoped channel region 135, and a source region 134 and a drain region 136 which are doped with an impurity ion and formed on respective sides of the channel region 135. A p-type impurity such as B may be used as the impurity ion and B₂H₆ can be doped, for example. The impurity doped into the source and drain regions depends on the thin film transistor type.

A gate insulating layer 122 is formed of SiNx or SiO₂ on the driving semiconductor layer 137. A gate line including a driving gate electrode 133 is formed on the gate insulating layer 122. The driving gate electrode 133 is formed on at least part of the driving semiconductor layer 137, particularly, the channel region 135.

An interlayer insulating layer 123 is formed on the gate insulating layer 122 so as to cover the driving gate electrode 133. Through-holes exposing the source region 134 and the drain region 136 of the driving semiconductor 137 are formed in the gate insulating layer 122 and the interlayer insulating layer 123. Like the gate insulating layer 122, the interlayer insulating layer 123 may be formed of a ceramic material such as SiNx or SiO₂.

A data line, including a driving source electrode 131 and a driving drain electrode 132, is formed on the interlayer insulating layer 123. The driving source electrode 131 and the driving drain electrode 132 are respectively connected to the source region 134 and the drain region 136, respectively, of the driving semiconductor layer 137 through the through-holes formed in the interlayer insulating layer 123 and the gate insulating layer 122.

The driving semiconductor layer **137**, the driving gate electrode **133**, the driving source electrode **131** and the driving drain electrode **132** form the driving TFT **130**. The configuration of the driving TFT **130** is not limited thereto and may be changed in various ways to a known configuration.

A planarization layer **140** is formed on the interlayer insulating layer **123** so as to cover the data line. The planarization layer **140** planarizes the uneven surface of the substrate **110** so as to improve luminous efficacy of an OLED formed thereon. In addition, the planarization layer **140** has an electrode contact hole **141** exposing part of the drain electrode **132**.

The planarization layer **140** may be formed of at least one of acryl-based resin, epoxy resin, phenolic resin, polyamide resin, polyimide resin, unsaturated polyester resin, polyphenylene resin, polyphenylenesulfide resin and benzocyclobutene, BCB.

An exemplary embodiment is not limited to the above-described structure, and the planarization layer **140** or the interlayer insulating layer **123** may be omitted as necessary.

The pixel electrode **150** of the OLED is formed on the planarization layer **140**. That is, the OLED includes plural pixel electrodes **150**, each of which is disposed at a respective pixel. The plural pixel electrodes **150** are disposed at intervals. The pixel electrode **150** is connected to the drain electrode **132** through the electrode contact hole **141** of the planarization layer **140**.

The pixel definition layer **170** having an opening for exposing the pixel electrode **150** is formed on the planarization layer **140**. That is, the pixel definition layer **170** includes plural openings, each of which is formed for a respective pixel. The emission layer **160** may be formed in each opening formed by the pixel definition layer **170**. Accordingly, a pixel region in which each emission layer is formed may be defined by the pixel definition layer **170**.

The pixel electrode **150** is disposed in correspondence to the opening of the pixel definition layer **170**. However, the position of the pixel electrode **150** is not limited to the opening of the pixel definition layer **170**, and the pixel electrode **150** may be disposed under the pixel definition layer **170** so that the pixel definition layer **170** is superimposed on part of the pixel electrode **150**.

The pixel definition layer **170** may be formed of a resin such as polyacrylate resin, polyimide, etc. or a silica inorganic material.

The organic emission layer **160** is formed on the pixel electrode **150**. A common electrode (not shown) may be formed on the organic emission layer **160**. In this manner, the OLED including the pixel electrode **150**, the organic emission layer **160** and the common electrode is formed.

The organic emission layer **160** is formed of a low molecular weight organic material or a polymer organic material. The organic emission layer **160** may be formed of multiple layers including at least one of a hole injection layer (HIL), a hole transport layer (HTL), an electron transport layer (ETL) and an electron injection layer (EIL). When the organic emission layer **160** includes all of the layers, the hole injection layer (HIL) is disposed on the pixel electrode **150** corresponding to an anode and the hole transport layer (HTL), emission layer, electron transport layer (ETL) and electron injection layer (EIL) are sequentially laminated thereon.

The pixel electrode **150** and the common electrode may be formed of a transparent conductive material or a transmissive or reflective conductive material. The OLED display may be a top emission, bottom emission or dual type OLED display according to materials of the pixel electrode **150** and the common electrode.

An encapsulation substrate (not shown) may be disposed on the common electrode. The encapsulation substrate may be formed of a transparent material such as glass or plastics in the case of a top emission or dual type OLED display, and may be formed of an opaque material such as a metal in the case of a bottom emission OLED display.

Further referring to FIGS. **1** and **2**, in the OLED display according to the first exemplary embodiment, the interlayer **180** is formed on the pixel definition layer **170**. The interlayer **180** comes into contact with part of the organic emission layer **160** formed on the pixel electrode **150**.

More specifically, the edge of the organic emission layer **160** is disposed on the interlayer **180**, as shown in FIG. **2**. Here, the edge of the organic emission layer **160** is disposed so as to cover the entirety of the interlayer **180** or a part of the interlayer **180**. Accordingly, the organic emission layer **160** covers the pixel electrode **150** exposed by the pixel definition layer **170** and the interlayer **180**.

Further referring to FIG. **1**, the interlayer **180** may be formed in a ring shape along the edge of the emission layer **160** so that the pixel electrode disposed in the pixel region is exposed.

The interlayer **180** may be formed so as to cover part of the pixel definition layer **170**. As shown in FIG. **2**, the interlayer **180** may be formed so that the interlayer **180** is superimposed on part of the pixel definition layer **170**. However, FIG. **3** is a cross-sectional view of an OLED display according to a second exemplary embodiment of the invention, and in the second exemplary embodiment, an interlayer **280** may be formed so as to cover the overall surface of a pixel definition layer **270**.

According to the first exemplary embodiment, a transfer layer of a transfer region irradiated by laser is completely separated from a transfer layer disposed around the transfer region according to the interlayer **180**. This will be described in detail in a method of manufacturing an OLED display according to another exemplary embodiment.

The interlayer **180** may be formed of a polymer material including acrylate or polyimide. However, the interlayer **180** is not limited thereto and may be formed of any of known polymer materials.

According to the first exemplary embodiment, one side of the interlayer **180**, specifically, the surface of the interlayer **180**, is processed into an uneven shape so that a surface area of the interlayer **180** increases. The contact area between the surface of the interlayer **180** and the transfer layer of the donor substrate is increased by processing the surface of the interlayer **180** into an uneven shape. Accordingly, contact force of the transfer layer and the interlayer **180** increases, and thus the transfer layer can be completely separated from the transfer region disposed around the transfer layer.

The uneven shape of the interlayer **180** may be formed through an etching or deposition process. A known etching or deposition process can be used and, as such, a detailed description thereof is omitted.

According to the first exemplary embodiment, the surface of the interlayer **180** may have uneven protrusions and depressions. Otherwise, the interlayer **180** may have even protrusions and depressions.

The protrusions and depressions may be formed only on part of the surface of the interlayer **180**. That is, the protrusions and depressions are selectively formed on an upper side of the interlayer **180** rather than being formed on the overall surface of the interlayer **180**.

FIG. **4** is a cross-sectional view of an OLED display according to a third exemplary embodiment of the invention.

Referring to FIG. 4, in an OLED display according to the third exemplary embodiment, one side of a pixel definition layer 370, specifically, the surface of the pixel definition layer 370, is treated with plasma P. When one side of the pixel definition layer 370 is treated with plasma, the treated side of the pixel definition layer 370 becomes hydrophilic.

In the OLED display according to the third exemplary embodiment, the surface of the pixel definition layer 370, instead of the interlayers 180 and 280 of the OLED displays according to the first and second exemplary embodiments, respectively, are treated with plasma. That is, the surface of the pixel definition layer 370 is hydrophilic.

Plasma treatment forms protrusions and depressions on the surface of the pixel definition layer 370 by electrically impacting the surface of the pixel definition layer 370 or modifying the surface of the pixel definition layer 370 so as to increase attraction between the surface of the pixel definition layer 370 and the transfer layer of the donor substrate.

Here, plasma treatment collides plasma, including active species which include electrons, ions, free radicals, excitons, etc., with the surface of the pixel definition layer 370, or generates a recombination reaction.

The active species colliding with the surface of the pixel definition layer 370 activates the surface to form free radicals, causing modification and structural deformation of the surface of the pixel definition layer 370. In addition, the colliding active species can remove impurities adhering to the surface of the pixel definition layer 370.

The surface energy of the pixel definition layer 370 increases according to plasma treatment, and thus the pixel definition layer 370 can function as an efficient adhesive.

In the OLED display according to the third exemplary embodiment, plasma treatment may be performed using oxygen, nitrogen or argon.

According to the third exemplary embodiment, the edge of an organic emission layer 360 of the OLED display covers the surface of the pixel definition layer 370. More specifically, the edge of the organic emission layer 360 covers the plasma-treated surface of the pixel definition layer 370.

The edge of the transfer layer disposed in the transfer region of the donor substrate comes into contact with the plasma-treated surface of the pixel definition layer 370 during a transfer process, and thus the transfer layer can be completely separated from the transfer layer disposed around the transfer region. Here, the transfer layer separated from the donor substrate forms the organic emission layer 360 of the OLED display.

FIGS. 5 to 7 are cross-sectional views illustrating a method of manufacturing the OLED display according to the first exemplary embodiment. The method of manufacturing the OLED display will now be described with reference to FIGS. 5, 6 and 7.

Referring to FIG. 5, the method of manufacturing the OLED display according to the first exemplary embodiment completely separates a transfer layer 13 of a transfer region A, irradiated by a laser, from a transfer layer 13 disposed around the transfer region A so as to transfer the transfer layer 13 corresponding to the transfer region A onto the pixel region of the display substrate. That is, the method of manufacturing the OLED display according to the first exemplary embodiment can prevent the transfer layer corresponding to the transfer region of the donor substrate from remaining on the donor substrate.

Further referring to FIG. 5, TFTs are formed on the substrate 110. The TFTs may include the driving TFT 130 and a switching TFT (not shown). The TFTs are formed on the

substrate 110 using a known TFT formation process and thus detailed description thereof is omitted.

The pixel electrode 150 is formed on the TFT 130. More specifically, the pixel electrode 150 is formed so that it is electrically connected to the drain electrode 132 of the TFT 130 through the electrode contact hole 141 of the planarization layer 140, as shown in FIG. 5.

Subsequently, the pixel definition layer 170 is formed on the pixel electrode 150. The pixel definition layer 170 defines the pixel region in which an OLED is disposed. An opening is formed in the pixel definition layer 170 to expose the pixel electrode 150.

The interlayer 180 is formed on the pixel definition layer 170. The interlayer 180 may be formed on the pixel definition layer 170 using a mask. The mask may be an exposure mask or a fine metal mask (FMM). The mask needs to have a hole formed therein in order to form the interlayer 180.

One side of the interlayer 180, specifically, the upper side of the interlayer 180, is processed into an uneven shape so as to increase the surface area of the interlayer 180. Accordingly, the contact area of the surface of the interlayer 180 and the transfer layer of the donor substrate increases.

The uneven shape of the interlayer 180 may be obtained through an etching or deposition process. In this case, a known etching or deposition process can be used, and thus detailed description thereof is omitted.

As shown in FIG. 5, the interlayer 180 may be formed so as to cover part of the pixel definition layer 170. That is, the interlayer 180 may be superimposed on part of the pixel definition layer 170. However, referring to FIG. 3, the interlayer 280 may be formed to cover the entire surface of the pixel definition layer 270, as shown in FIG. 3.

Subsequently, referring to FIG. 6, the organic emission layer 160 is formed so as to cover the pixel electrode 150 and the interlayer 180 in the pixel region. As shown in FIG. 6, the organic emission layer 160 is formed on the pixel electrode 150 exposed through the opening of the pixel definition layer 170 and the interlayer 180.

The process of forming the organic emission layer 160 will now be described with reference to FIGS. 5, 6 and 7. The process of forming the organic emission layer 160 includes a step of disposing a donor substrate 10 (FIG. 5) above the pixel region, and a step of transferring a transfer material of the transfer layer 13 onto the pixel region from the donor substrate 10.

Further referring to FIG. 5, the donor substrate 10 is disposed above the pixel region. More specifically, the donor substrate 10 is disposed so that the edge B of the transfer region A of the donor substrate 10 is superimposed on the interlayer 180. The transfer region A is irradiated by laser so as to be transferred to the pixel region.

The edge B of the transfer region A may be superimposed on the entire surface of the interlayer 180 or a part of the surface of the interlayer 180. Referring to FIGS. 5 and 6, the edge B of the transfer layer 13 is superimposed on the uneven surface of the interlayer 180. The edge B of the transfer layer 13 comes into contact with the interlayer 180 having an increased surface area during a transfer process, and thus contact force between the edge B of the transfer layer 13 and the interlayer 180 increases. Accordingly, the transfer layer of the transfer region A can be completely separated from the transfer layer disposed around the transfer region A.

The transfer layer 13 of the donor substrate 10 and the interlayer 180 may be spaced part from each other by a predetermined distance. The transfer layer 13 is spaced apart from the interlayer 180 so that the transfer layer 13 can be

bent downward, and thus the edge B thereof can come into contact with the interlayer **180**.

The transfer region A of the donor substrate **10** is irradiated by laser. Then, a photothermal conversion layer **12** of the donor substrate **10** is expanded. Accordingly, the transfer layer **13** disposed under the photothermal conversion layer **12** is bent downward due to the expanded photothermal conversion layer **12**.

The edge B of the transfer region A comes into contact with the interlayer **180**. Upon contact of the edge B of the transfer region A with the interlayer **180**, the transfer layer **13** of the transfer region A is perfectly separated from the donor substrate **10** according to the contact force between the edge of the transfer layer **13** and the uneven surface of the interlayer **180**.

More specifically, the transfer layer **13** is not completely separated from the donor substrate **10** at the boundary of the transfer region A according to cohesion of the transfer layer **13**. However, when the edge B of the transfer region A comes into contact with the interlayer **180** with the increased surface area, the contact force of the edge B of the transfer layer **13** and the interlayer **180** increases, and thus the transfer layer **13** of the transfer region A is perfectly separated from the transfer layer **13** disposed around the transfer area A. Accordingly, it is possible to prevent the transfer layer **13** from remaining at the edge B thereof.

The transfer layer **13** transferred onto the pixel region forms the organic emission layer **160** of the OLED display. The transfer layer **13** is formed of a transfer material and this transfer material is deposited on the pixel region to form the organic emission layer **160**. The transfer material of the transfer layer **13** may be an organic material.

Upon completion of transfer, the organic emission layer **160** covers the pixel electrode **150** and the interlayer **180**, as shown in FIG. 7. Here, the organic emission layer **160** may cover only part of the interlayer **180**.

A method of manufacturing the OLED display according to the third exemplary embodiment includes a step of treating the surface of the pixel definition layer **370** (FIG. 4) with plasma instead of the step of forming the interlayer in the method of manufacturing the OLED display according to the first exemplary embodiment.

In the method of manufacturing the OLED display according to the third exemplary embodiment, the TFT **330**, pixel electrode **350** and pixel definition layer **370** are sequentially formed in the same manner as in the method of manufacturing the OLED display according to the first exemplary embodiment.

Subsequently, one side of the pixel definition layer **370**, more specifically, the surface of the pixel definition layer **370**, is treated with plasma. As described above, plasma treatment forms protrusions and depressions on the surface of the pixel definition layer **370** by applying electric impact to the surface or modifies the surface of the pixel definition layer **370** to increase attraction between the surface of the pixel definition layer **370** and the transfer layer of the donor substrate.

The surface energy of the pixel definition layer **370** increases according to plasma treatment, and thus the pixel definition layer **370** can function as an efficient adhesive.

In the method of manufacturing the OLED display according to the third exemplary embodiment, plasma treatment can be performed using oxygen, nitrogen or argon.

The organic emission layer **360** is formed to cover the pixel electrode **350** and the surface of the pixel definition layer **370** disposed in the pixel region. As shown in FIG. 4, the organic emission layer **360** is superimposed on the pixel electrode **350**

exposed through the opening of the pixel definition layer **370** and the surface of the pixel definition layer **370**.

The process of forming the organic emission layer **360** includes a step of disposing the donor substrate (FIGS. 5 thru 7) above the pixel region, and a step of transferring the transfer material of the transfer layer **13** onto the pixel region from the donor substrate **10** in the same manner as in the method of manufacturing the OLED display according to the first exemplary embodiment. The step of transferring the transfer material using the donor substrate **10** is identical to that of the method of manufacturing the OLED display according to the first exemplary embodiment, and thus detailed description thereof is omitted.

In an OLED display and a method of manufacturing the same according to an exemplary embodiment, the transfer layer of the transfer region of the donor substrate, irradiated by laser, is completely separated from the donor substrate, and thus the transfer layer is prevented from partially remaining on the donor substrate.

While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the 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 diode (OLED) display device, comprising:

a substrate;

a thin film transistor formed on the substrate;

a pixel electrode formed on the thin film transistor and electrically connected to the thin film transistor;

a pixel definition layer formed on the pixel electrode so as to define a pixel region;

an emission layer formed on the pixel electrode and contacting the pixel electrode in the pixel region; and

an interlayer formed on the pixel definition layer and contacting part of the emission layer;

wherein one side of the interlayer has an uneven shape so that a surface area of the interlayer increases; and

wherein an upper side of the interlayer has an uneven shape and a part of the upper side of the interlayer has protrusions and depressions.

2. The OLED display device of claim 1, wherein the uneven shape is irregular.

3. The OLED display device of claim 1, wherein the interlayer is formed along an edge of the emission layer.

4. The OLED display device of claim 3, wherein the interlayer is formed in a round shape so that the pixel electrode disposed in the pixel region is exposed.

5. An OLED display device, comprising:

a substrate;

a thin film transistor formed on the substrate;

a pixel electrode formed on the thin film transistor and electrically connected to the thin film transistor;

a pixel definition layer formed on the pixel electrode so as to define a pixel region; and

an emission layer formed on the pixel electrode and contacting the pixel electrode in the pixel region;

wherein one side of the pixel definition layer is hydrophilic, and wherein the emission layer covers the pixel electrode and the one side of the pixel definition layer; and

wherein an upper side of the pixel definition layer is hydrophilic.

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6. The OLED display device of claim 5, wherein the one side of the pixel definition layer is treated with plasma using one of oxygen, nitrogen and argon.

7. The OLED display device of claim 5, further comprising an interlayer formed on the pixel definition layer and contacting part of the emission layer.

8. The OLED display device of claim 7, wherein one side of the interlayer has an uneven shape so that a surface area of the interlayer increases.

9. The OLED display device of claim 8, wherein the uneven shape is irregular.

10. The OLED display device of claim 8, wherein an upper side of the interlayer has an uneven shape.

11. The OLED display device of claim 10, wherein a part of the upper side of the interlayer has protrusions and depressions.

12. The OLED display device of claim 7, wherein the interlayer is formed along the edge of the emission layer.

13. The OLED display device of claim 7, wherein the interlayer is formed in a round shape so that the pixel electrode disposed in the pixel region is exposed.

14. An organic light emitting diode (OLED) display device, comprising:

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a substrate;

a thin film transistor formed on the substrate;

a pixel electrode formed on the thin film transistor and electrically connected to the thin film transistor;

a pixel definition layer formed on the pixel electrode so as to define a pixel region;

an emission layer formed on the pixel electrode and contacting the pixel electrode in the pixel region; and

an interlayer formed on the pixel definition layer and contacting part of the emission layer;

wherein one side of the interlayer has an uneven shape so that a surface area of the interlayer increases; and

wherein one side of the pixel definition layer is hydrophilic, and the emission layer covers the pixel electrode and the one side of the pixel definition layer.

15. The OLED display device of claim 14, wherein an upper side of the pixel definition layer is hydrophilic.

16. The OLED display device of claim 14, wherein the one side of the pixel definition layer is treated with plasma using one of oxygen, nitrogen and argon.

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专利名称(译)	有机发光二极管显示器及其制造方法		
公开(公告)号	US9343514	公开(公告)日	2016-05-17
申请号	US14/056371	申请日	2013-10-17
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
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发明人	KIM, NAM-JIN PARK, CHUL-HWAN		
IPC分类号	H01L27/32		
CPC分类号	H01L27/3246		
优先权	1020130046778 2013-04-26 KR		
其他公开文献	US20140319477A1		
外部链接	Espacenet USPTO		

摘要(译)

根据本发明示例性实施例的有机发光二极管 (OLED) 显示器包括基板，形成在基板上的薄膜晶体管，形成在薄膜晶体管上并且电连接到薄膜晶体管的像素电极，形成在像素电极上的像素限定层，以限定像素区域，形成在像素电极上并与像素区域中的像素电极接触的发光层，以及形成在像素限定层上并接触部分发光的中间层层。中间层的一侧具有不均匀的形状，使得中间层的表面积增加。

