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(54) Organic light emitting diode display

Organische lichtemittierende Diodenanzeige

Affichage à diode électroluminescente organique

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(73) Proprietor: **Samsung Display Co., Ltd.
Yongin-City, Gyeonggi-Do, 446-711 (KR)**

(72) Inventors:
• **Kim, Eun-Ah**
Yongin-si, Gyeonggi-do (KR)
• **Jeong, Hee-Seong**
Yongin-si, Gyeonggi-do (KR)
• **Jeong, Chul-Woo**
Yongin-si, Gyeonggi-do (KR)

- **Lee, Joo-Hwa**
ongin-si, Gyeonggi-do (KR)
- **Jeon, Hee-Chul**
Yongin-si, Gyeonggi-do (KR)
- **Jung, Woo-Suk**
Yongin-si, Gyeonggi-do (KR)
- **Kwak, Noh-Min**
Yongin-si, Gyeonggi-do (KR)
- **Park, Soon-Ryong**
Yongin-si, Gyeonggi-do (KR)

(74) Representative: **Walaski, Jan Filip**
Venner Shipley LLP
200 Aldersgate
London
EC1A 4HD (GB)

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Description

[0001] The present invention relates to an organic light emitting diode (OLED) display. More particularly, the present invention relates to an OLED display having enhanced visibility.

[0002] A typical OLED display includes OLEDs each of which has a hole-injection electrode, an organic emission layer, and an electron-injection electrode. The organic emission layer emits light using energy generated when excitons are dropped from an excited state to a ground state after the excitons are generated by the combination of electrons and holes. The OLED display forms images using light emitted from the organic emission layer. The OLED display has a self emissive characteristic and does not need an additional light source unlike the liquid crystal display (LCD). Therefore, the thickness and weight of a display can be reduced. Also, since the OLED display has high definition characteristics such as low power consumption, high luminance, and high reaction speed, the OLED display has been receiving attention as a next generation display device. Typically, electrodes and metal wires in the OLED display reflect light entering from the outside. The reflection of external light deteriorates the display and contrast of a black colour, thereby deteriorating the overall display characteristics of the OLED display.

[0003] EP1557891, US2007/238218 and US2006/152151 disclose OLED displays.

[0004] In accordance with the present invention an OLED display is provided having improved visibility by suppressing reflection of external light. That is, the OLED display has improved display characteristics, also referred to as viewability.

[0005] According to an aspect of the invention, there is provided an organic light emitting diode display according to claim 1.

[0006] An exemplary embodiment of the present invention provides an OLED display that includes a substrate, a thin film transistor (TFT), a planarization layer, a pixel electrode, and a pixel defining layer. The TFT is formed on the substrate and includes a gate electrode, a source electrode, and a drain electrode. The planarization layer is formed on the TFT and has a contact hole that exposes a predetermined part of the drain electrode. The pixel electrode is formed on the planarization layer and connected to a drain electrode of the TFT through the contact hole. The pixel defining layer is formed on the planarization layer and has an opening that exposes the pixel electrode. The pixel defining layer and the planarization layer have different colours.

[0007] The brightness of a mixed colour of the pixel defining layer and the planarization layer may be lower than each colour of the pixel defining layer and the planarization layer.

[0008] The colour of the pixel defining layer and the colour of the planarization layer are in a complementary colour relationship.

[0009] One of the planarization layer and the pixel defining layer may have a substantially red colour, and the other may have a substantially green colour.

[0010] The one of the planarization layer and the pixel defining layer having a substantially red colour may include an acryl type resin.

[0011] The OLED display may further include a conductive layer made of a material substantially the same as at least one of the gate electrode, the source electrode, and the drain electrode, and formed at a layer substantially the same as at least one of the gate electrode, the source electrode, and the drain electrode. At least part of the conductive layer is disposed under the pixel defining layer.

[0012] Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a layout view of an OLED display in accordance with an exemplary embodiment of the present invention.

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

[0013] In the drawings, the size and thickness of each element is approximately shown for better understanding and ease of description. The thickness of layers, films, panels, regions, etc., are exaggerated for clarity.

[0014] The same or similar constituent elements are designated by the same reference numerals throughout the specification. 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 contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

[0015] Although the accompanying drawings illustrate an active matrix (AM) type of OLED display having a 2T1Cap structure in which two TFTs and one capacitor are disposed in a pixel, the present invention is not limited thereto. Therefore, the OLED display may have various structures. For example, the OLED display may include more than three TFTs and more than two capacitors at one pixel and further include additional wires.

[0016] Here, the pixel is a minimum unit for displaying an image, and the OLED display displays an image through a plurality of pixels.

[0017] Referring now to FIG. 1 and FIG. 2, an OLED display 100 includes a switching TFT 10, a driving TFT 20, a capacitor 80, and an OLED 70 in one pixel. The OLED display 100 further includes a gate line 151 disposed along one direction, a data line 171 crossing and insulated from the gate line 151, and a common power line 172. Here, one pixel is defined by the gate line 151, the data line 171, and the common power line 172 as boundaries.

[0018] The organic light emitting element 70 includes

a pixel electrode 710, an organic emission layer 720 on the pixel electrode 710, and a common electrode 730 on the organic emission layer 720. Here, the pixel electrode 710 is a hole injection electrode which is an anode (+), and the common electrode 730 is an electron injection electrode which is a cathode (-). However, the present invention is not limited thereto. The pixel electrode 710 may be a cathode and the common electrode 730 may be an anode according to a driving method of the OLED display 100. Holes and electrons are injected into the organic emission layer 720 from the pixel electrode 710 and the common electrode 730, respectively. Light is emitted when excitons generated by the combination of the injected holes and electrons are dropped from an excited state to a ground state.

[0019] The switching TFT 10 includes a switching semiconductor layer 131, a switching gate electrode 152, a switching source electrode 173, and a switching drain electrode 174. The driving TFT 20 includes a driving semiconductor layer 132, a driving gate electrode 155, a driving source electrode 176, and a driving drain electrode 177.

[0020] The capacitor 80 includes a first sustain electrode 158, a second sustain electrode 178, and an inter-layer insulating layer 160 interposed therebetween.

[0021] The switching TFT 10 is used as a switch to select a pixel to emit light. The switching gate electrode 152 is connected to the gate line 151. The switching source electrode 173 is connected to the data line 171. The switching drain electrode 174 is separated from the switching source electrode 173 and is connected to the first sustain electrode 158.

[0022] The driving TFT 20 applies a driving power to drive an organic emission layer 720 of an organic light emitting element 70 in the selected pixel for emitting light. The driving gate electrode 155 is connected to the first sustain electrode 158. The driving source electrode 176 and the second sustain electrode 178 are connected to the common power line 172. The driving drain electrode 177 is connected to the pixel electrode 710 of the organic light emitting element 70 through a contact hole 182.

[0023] According to the described structure, the switching TFT 10 is driven by a gate voltage applied to the gate line 151 and transfers a data voltage applied to the data line 171 to the driving TFT 20. The capacitor 80 stores a voltage corresponding to a voltage difference between the common voltage applied to the driving TFT 20 from the common power line 172 and the data voltage transferred from the switching TFT 10, and current corresponding to the voltage stored in the capacitor flows to the organic light emitting element 70 through the driving TFT, thereby emitting light.

[0024] Also, the OLED display 100 further includes a planarization layer 180 and a pixel defining layer 190. The pixel defining layer 190 includes an opening that exposes the pixel electrode 710, and the organic emission layer 720 is substantially disposed in the opening of the pixel defining layer 190. That is, in a pixel, an area

where the pixel defining layer 190 is formed is substantially equivalent to a remaining area left when the organic emission layer 720 is formed. Therefore, the pixel defining layer overlaps with at least one of a conductive layer made of a material substantially the same as one or more of the gate electrodes 152, 155, the source electrodes 173, 176, and the drain electrodes 174, 177, and formed at the same layer of the gate electrodes 152, 155, the source electrodes 173, 176, and the drain electrodes 174, 177. The conductive layer includes the gate line 151, the data line 171, the common power line 172, the first sustain electrode 158, and the second sustain electrode 178. That is, at least one of and at least part of the gate line 151, the data line 171, the common power line 172, the first sustain electrode 158, and the second sustain electrode 178 is disposed under the pixel defining layer 190 and the planarization layer 180.

[0025] The planarization layer 180 and the pixel defining layer 190 have different colours. Particularly, the pixel defining layer 190 has a colour having brightness becoming lower if the colour of the pixel defining layer 190 is mixed with a colour of the planarization layer 180. That is, if the colour of the planarization layer 180 and the colour of the pixel defining layer 190 are mixed together, the mixed colour has brightness lower than that of each colour.

[0026] In the invention, the pixel defining layer 190 has a complementary colour to the colour of the planarization layer 180 in view of subtractive mixture.

[0027] That is, in an exemplary embodiment the planarization layer 180 has a colour in a complementary colour relationship with the colour of the pixel defining layer 190.

[0028] According to the above described structure, the OLED display 100 can have improved viewability by suppressing reflection of external light.

[0029] In more detail, the brightness of the external light becomes lower by the colours of the pixel defining layer 190 and the planarization layer 180 when the reflected external light from the conductive layer disposed under the pixel defining layer passes through the pixel defining layer 190 and the planarization layer 180. Particularly, if the pixel defining layer 190 and the planarization layer 180 have colours in a complementary colour relationship, the mixed colour thereof becomes close to a black colour. Therefore, reflection of external light can be further suppressed because the external light cannot pass through the pixel defining layer 190 and the planarization layer 180.

[0030] If the planarization layer 180 has a substantially red colour and the pixel defining layer 190 has a substantially green colour as in an exemplary embodiment of the present invention, the pixel defining layer 190 passes a green light only because the pixel defining layer 190 operates as a green colour filter. Since it is very difficult that green light passes through the planarization layer 180 having the substantially red colour, it is possible to suppress the reflection of the external light from the con-

ductive layer disposed under the pixel defining layer 190 and the planarization layer 180.

[0031] However, the present invention is not limited thereto. Therefore, the planarization layer 180 and the pixel defining layer 190 may have various colours that can be subtractively mixed with each other, instead of the planarization layer 180 having the substantially green colour and the pixel defining layer 190 having the substantially red colour. As another example, the planarization layer 180 may have a substantially blue colour and the pixel defining layer 190 may have a substantially yellow colour.

[0032] Referring now to FIG. 2 specifically, a structure of an OLED display 100 according to an exemplary embodiment of the present invention will be described in more detail. FIG. 2 illustrates the OLED display 100 based on the driving TFT 20, the organic light emitting element 70, and the capacitor 80.

[0033] Hereinafter, a structure of a TFT having the driving TFT 20 will be described. Also, the switching TFT 10 will be described based on differences from the driving TFT 20.

[0034] The substrate 110 is formed of a dielectric substrate made of glass, quartz, ceramic, or plastic. However, the present invention is not limited thereto. Therefore, the substrate 110 may be formed of a metallic substrate made of stainless steel.

[0035] A buffer layer 120 is formed on the substrate 110. The buffer layer 120 may be made of various materials that can prevent impurity penetration and have a planar surface. For example, one of a silicon nitride layer (SiNx), a silicon oxide layer (SiO₂), and a silicon oxynitride layer (SiOxNy) is used as the buffer layer 120. However, since the buffer layer 120 is not an essential element, the buffer layer 120 may be omitted according to a type of the substrate 110 and a fabrication process condition.

[0036] The driving semiconductor layer 132 is formed on the buffer layer 120. The driving semiconductor layer 132 is formed as a polysilicon layer. Also, the driving semiconductor layer 132 includes a channel area 135, a source area 136, and a drain area 137. The source area 136 and the drain area 137 are disposed at both sides of the channel area 135. The channel area is not doped with an impurity, and the source area 136 and the drain area 137 are doped with a P-type impurity (p⁺). Here, a doped ion material is a P-type impurity such as boron (B). Generally, B₂H₆ is used. Here, such an impurity may vary according to a type of a TFT.

[0037] Although a TFT having a PMOS structure using a P-type impurity is used as the driving TFT 20 in an exemplary embodiment of the present invention, the present invention is not limited thereto. Therefore, both of a TFT having a NMOS structure and a TFT having a PMOS structure can be used as the driving TFT 20.

[0038] Although the driving TFT 20 shown in FIG. 2 is a polycrystal TFT having a polysilicon layer, a switching TFT 10 not shown in FIG. 2 may be a polycrystal TFT or

an amorphous TFT having an amorphous silicon layer.

[0039] A gate insulating layer 140 made of a silicon nitride (SiNx) or a silicon oxide SiO₂ is formed on the driving semiconductor layer 132. A gate wire having the driving gate electrode 155 is formed on the gate insulating layer 140. The gate wire further includes a gate line 151 shown in FIG. 1, the first sustain electrode 158, and other wires. The driving gate electrode 155 overlaps with at least a part of the driving semiconductor layer 132 and, particularly, overlaps with the channel area 135.

[0040] An interlayer insulating layer 160 is formed on the gate insulating layer 140, and the interlayer insulating layer 160 covers the driving gate electrode 155. The gate insulating layer 140 and the interlayer insulating layer 160 commonly include through-holes to expose the source area 136 and the drain area 137 of the driving semiconductor layer 132. The interlayer insulating layer 160 is made of a silicon nitride (SiNx) or a silicon oxide (SiO₂) like the gate insulating layer 140.

[0041] A data wire is formed on the interlayer insulating layer 160. The data wire includes the driving source electrode 176 and the driving drain electrode 177. The data wire further includes the data line 171 shown in FIG. 1, the common power line 172, the second sustain electrode 178, and other wires. The driving source electrode 176 and the driving drain electrode 177 are respectively connected to the source area 136 and the drain area 137 of the driving semiconductor layer 132 through through-holes.

[0042] As described above, the driving thin transistor 20 including the driving semiconductor layer 132, the driving gate electrode 155, the driving source electrode 176, and the driving drain electrode 177 is formed.

[0043] However, the structure of the driving TFT 20 according to the present invention is not limited thereto. The structure of the driving TFT 20 may be modified into various well-known structures that can be conveniently realized by those skilled in the art.

[0044] On the interlayer insulating layer 160, the planarization layer 180 is formed to cover data wires 172, 176, 177, 178. The planarization layer 180 removes and planes steps to improve luminous efficiency of the organic light emitting element 70. Also, the planarization layer 180 has a contact hole 182 to expose a part of the drain electrode 177.

[0045] The planarization layer 180 is coloured. For example, the planarization layer 180 may be made of polyacrylates resin having a substantially red colour. However, the present invention is not limited thereto. Therefore, the planarization layer 180 may be made of at least one of epoxy resin, phenolic resin, polyamides resin, polyimides resin, unsaturated polyesters resin, polyphenylenethers resin, polyphenylenesulfides resin, and benzocyclobutene (BCB) with dye having a predetermined colour. In addition, the planarization layer 180 may be formed to have a predetermined colour through well-known various methods.

[0046] The pixel electrode 710 of the organic light emit-

ting element 70 is formed on the planarization layer 180. The pixel electrode 710 is connected to the drain electrode 177 through the contact hole 182 of the planarization layer 180.

[0047] Also, the pixel defining layer 190 is formed on the planarization layer 180. The pixel defining layer 190 has an opening that exposes the pixel electrode 710. That is, the pixel electrode 710 is disposed corresponding to the opening of the pixel defining layer 190.

[0048] The pixel defining layer 190 has a colour having brightness that becomes lower overall if the colour of the pixel defining layer 190 is mixed with a colour of the planarization layer 180. The pixel defining layer 190 has a colour in a complementary colour relationship with the colour of the planarization layer 180 in relation to subtractive mixing. For example, the planarization layer 180 is formed to have a substantially red colour and the pixel defining layer 190 is formed to have a substantially green colour. The pixel defining layer 190 may be made of resin such as acryl-based polyacrylates or polyimides and silica type mineral with dye having a predetermined colour. In addition, the pixel defining layer 190 may be formed to have a predetermined colour through well-known methods.

[0049] The organic emission layer 720 is formed on the pixel electrode 710 in the opening of the pixel defining layer 190, and the common electrode 730 is formed on the pixel defining layer 190 and the organic emission layer 720.

[0050] As described above, the organic light emitting element 70 having the pixel electrode 710, the organic emission layer 720, and the common electrode 730 is formed.

[0051] One of the pixel electrode 710 and the common electrode 730 may be made of a transparent conductive material, and the other may be made of a translucent or reflective conductive material. The type of material used to form the pixel electrode 710 and the common electrode 730 determines the type of the OLED display 100, such as, a top emission type, a bottom emission type, or a dual emission type. The OLED display 100 according to an exemplary embodiment of the present invention is formed as a top emission type.

[0052] Indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), and indium oxide (In₂O₃) may be used for the transparent conductive material. Lithium (Li), calcium (Ca), lithium/calcium fluoride (LiF/Ca), lithium/aluminum fluoride (LiF/Al), aluminum (Al), silver (Ag), magnesium (Mg), or gold (Au) may be used for the reflective material.

[0053] The organic emission layer 720 is made of a low molecule organic material or a high molecule organic material. The organic emission layer 720 is formed as a multilayer including a hole injection layer (HIL), a hole transport layer (HTL), an emission layer, an electron transport layer (ETL), and an electron injection layer (EIL). That is, the hole injection layer (HIL) is disposed at the pixel electrode 710, which is an anode, and the

hole transport layer (HTL), the emission layer, the electron transport layer (ETL), and the electron injection layer (EIL) are sequentially stacked thereon.

[0054] A sealant seals the TFTs 10, 20 and the organic light emitting element 70 formed on the substrate 110, protecting them from the outside.

[0055] According to the described configuration, the OLED display 100 has improved visibility by suppressing reflection of an external light.

Claims

1. An organic light emitting diode display (100), comprising:

a substrate (110);
a thin film transistor (20) on the substrate and including a gate electrode (155), a source electrode (176), and a drain electrode (177);
a planarization layer (180) formed on the thin film transistor and having a contact hole (182) exposing a part of the drain electrode (177);
a pixel electrode (710) on the planarization layer and connected to the drain electrode (177) of the thin film transistor through the contact hole (182); and
a pixel defining layer (190) on the planarization layer and having an opening exposing the pixel electrode (710),
wherein the pixel defining layer (190) and the planarization layer (180) have different colours, **characterized in that**
a colour of the pixel defining layer (190) and a colour of the planarization layer (180) are in a complementary colour relationship in view of subtractive mixture.

2. The organic light emitting diode display of claim 1, wherein one of the planarization layer (180) and the pixel defining layer (190) has a red colour, and the other of the planarization layer and the pixel defining layer has a green colour, or wherein one of the planarization layer (180) and the pixel defining layer (190) has a blue colour, and the other of the planarization layer and the pixel defining layer has a yellow colour.

3. The organic light emitting diode display of claim 2, wherein the one of the planarization layer and the pixel defining layer having a red colour includes an acryl type resin.

4. The organic light emitting diode display of claim 1, further comprising a conductive layer (151, 171, 172, 158, 178) made of a material the same as at least one of the gate electrode, the source electrode, and the drain electrode at a layer the same as at least

one of the gate electrode, the source electrode, and the drain electrode, and at least part of the conductive layer is under the pixel defining layer (190).

Patentansprüche

1. Organische lichtemittierende Diodenanzeige (100), umfassend:

ein Substrat (110),
einen Dünnschichttransistor (20) auf dem Substrat, der eine Gate-Elektrode (155), eine Source-Elektrode (176) und eine Drain-Elektrode (177) einschließt,
eine Planarisierungsschicht (180), die auf dem Dünnschichttransistor ausgebildet ist und ein Kontaktloch (182) hat, das einen Teil der Drain-Elektrode (177) freilegt,
eine sich auf der Planarisierungsschicht befindende Pixelelektrode (710), die durch das Kontaktloch (182) mit der Drain-Elektrode (177) des Dünnschichttransistors verbunden ist, und
eine sich auf der Planarisierungsschicht befindende Pixeldefinierschicht (190), die eine Öffnung hat, die die Pixelelektrode (710) freilegt, wobei die Pixeldefinierschicht (190) und die Planarisierungsschicht (180) unterschiedliche Farben haben, **dadurch gekennzeichnet, dass** eine Farbe der Pixeldefinierschicht (190) und eine Farbe der Planarisierungsschicht (180) in Bezug auf die subtraktive Mischung in einem Komplementärfarbenverhältnis zueinander stehen.

2. Organische lichtemittierende Diodenanzeige nach Anspruch 1, wobei entweder die Planarisierungsschicht (180) oder die Pixeldefinierschicht (190) rot ist und die jeweils andere dieser beiden Schichten grün ist, oder wobei entweder die Planarisierungsschicht (180) oder die Pixeldefinierschicht (190) blau ist und die jeweils andere dieser beiden Schichten gelb ist.
3. Organische lichtemittierende Diodenanzeige nach Anspruch 2, wobei entweder die rote Planarisierungsschicht oder die rote Pixeldefinierschicht ein Acrylharz einschließt.
4. Organische lichtemittierende Diodenanzeige nach Anspruch 1, ferner umfassend eine leitfähige Schicht (151, 171, 172, 158, 178) aus einem Material, aus dem auch die Gate-Elektrode und/oder die Source-Elektrode und/oder die Drain-Elektrode hergestellt ist/sind, an einer Schicht, die die gleiche ist wie die der Gate-Elektrode und/oder der Source-Elektrode und/oder der Drain-Elektrode, und sich wenigstens ein Teil der leitfähigen Schicht unter der

Pixeldefinierschicht (190) befindet.

Revendications

1. Afficheur à diodes électroluminescentes organiques (100), comprenant :

un substrat (110) ;
un transistor à couches minces (20) sur le substrat et comprenant une électrode de grille (155), une électrode de source (176) et une électrode de drain (177) ;
une couche de planarisation (180) formée sur le transistor à couches minces et comportant un trou de contact (182) exposant une partie de l'électrode de drain (177) ;
une électrode de pixel (710) sur la couche de planarisation et connectée à l'électrode de drain (177) du transistor à couches minces à travers le trou de contact (182) ; et
une couche de définition de pixels (190) sur la couche de planarisation et comportant une ouverture exposant l'électrode de pixel (710), dans lequel la couche de définition de pixels (190) et la couche de planarisation (180) ont différentes couleurs, **caractérisé en ce que** une couleur de la couche de définition de pixels (190) et une couleur de la couche de planarisation (180) sont dans une relation de couleurs complémentaires compte tenu d'un mélange soustractif.

2. Afficheur à diodes électroluminescentes organiques selon la revendication 1, dans lequel l'une de la couche de planarisation (180) et de la couche de définition de pixels (190) présente une couleur rouge, et l'autre de la couche de planarisation et de la couche de définition de pixels présente une couleur verte, ou dans lequel l'une de la couche de planarisation (180) et de la couche de définition de pixels (190) présente une couleur bleue, et l'autre de la couche de planarisation et de la couche de définition de pixels présente une couleur jaune.
3. Afficheur à diodes électroluminescentes organiques selon la revendication 2, dans lequel ladite une de la couche de planarisation et de la couche de définition de pixels présentant une couleur rouge comprend une résine de type acrylique.
4. Afficheur à diodes électroluminescentes organiques selon la revendication 1, comprenant en outre une couche conductrice (151, 171, 172, 158, 178) constituée d'un matériau identique à celui d'au moins l'une de l'électrode de grille, de l'électrode de source et de l'électrode de drain au niveau d'une couche la même qu'au moins l'une de l'électrode de grille, de

l'électrode de source et de l'électrode de drain, et au moins une partie de la couche conductrice se trouve sous la couche de définition de pixels (190).

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FIG. 1

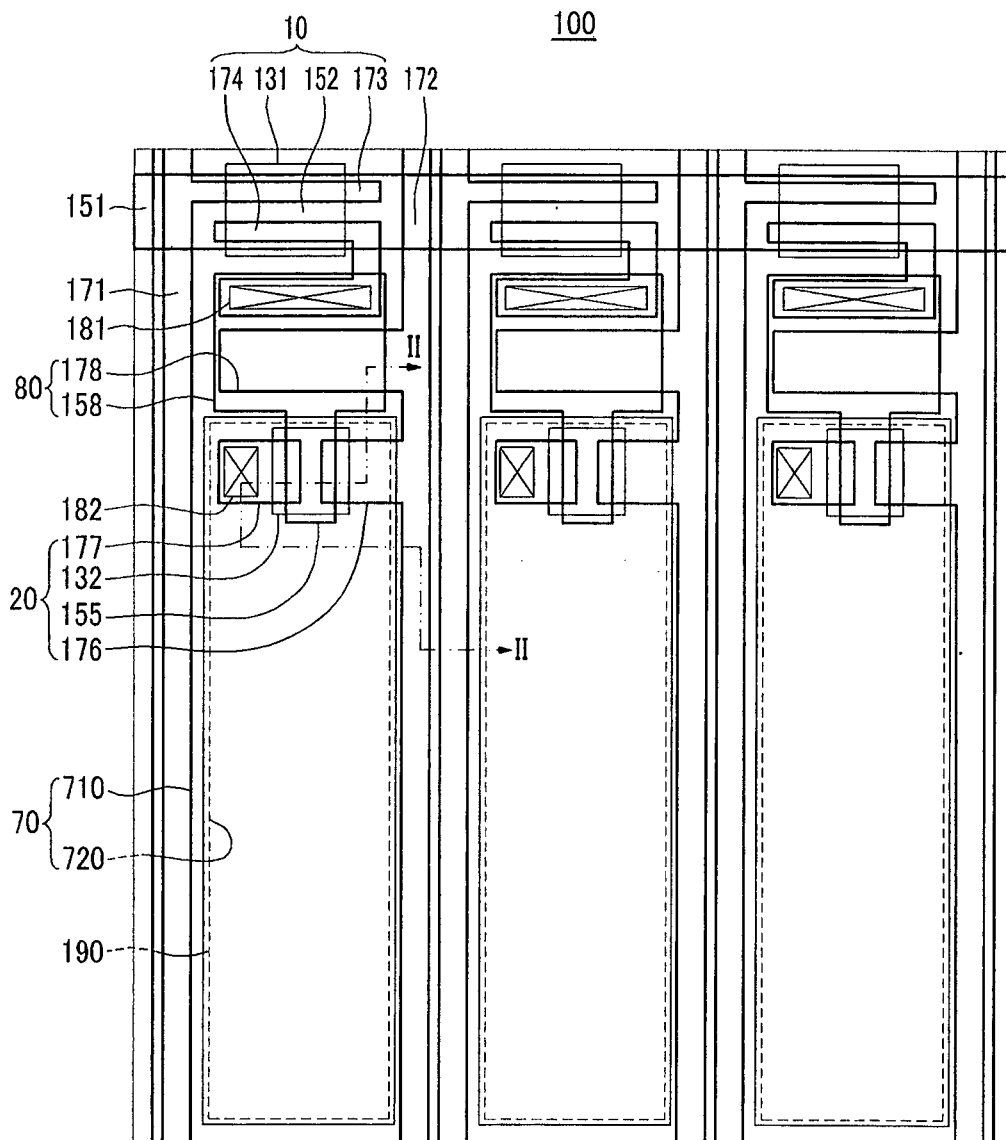
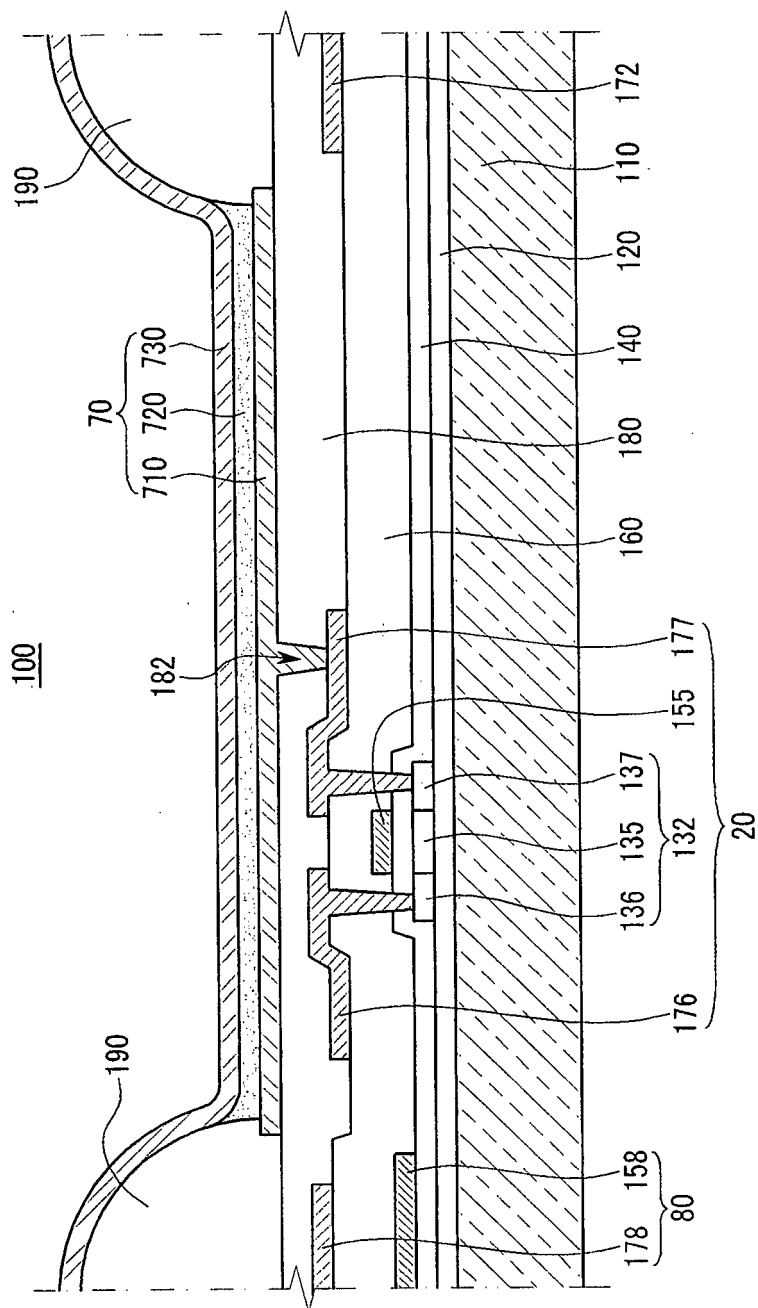


FIG. 2



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 2007238218 A [0003]
- US 2006152151 A [0003]

专利名称(译)	有机发光二极管显示器		
公开(公告)号	EP2149925B1	公开(公告)日	2014-04-30
申请号	EP2009166961	申请日	2009-07-31
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星移动显示器有限公司.		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
[标]发明人	KIM EUN AH JEONG HEE SEONG JEONG CHUL WOO LEE JOO HWA JEON HEE CHUL JUNG WOO SUK KWAK NOH MIN PARK SOON RYONG		
发明人	KIM, EUN-AH JEONG, HEE-SEONG JEONG, CHUL-WOO LEE, JOO-HWA JEON, HEE-CHUL JUNG, WOO-SUK KWAK, NOH-MIN PARK, SOON-RYONG		
IPC分类号	H01L51/52 H01L27/32		
CPC分类号	H01L51/5281 H01L27/3246 H01L27/3258		
优先权	1020080075483 2008-08-01 KR		
其他公开文献	EP2149925A3 EP2149925A2		
外部链接	Espacenet		

摘要(译)

有机发光二极管显示器包括基板，薄膜晶体管，平坦化层，像素电极和像素限定层。薄膜晶体管形成在基板上，并包括栅电极，源电极和漏电极。平坦化层形成在薄膜晶体管上并具有暴露漏电极的预定部分的接触孔。像素电极形成在平坦化层上并通过接触孔连接到薄膜晶体管的漏电极。像素限定层形成在平坦化层上并具有暴露像素电极的开口。像素限定层和平坦化层具有不同的颜色。

FIG. 1

