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

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H01J 7/24 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
USPC 345/214, 76-83, 204; 313/11-47;
315/169.3
See application file for complete search history.

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(57) **ABSTRACT**

An organic light emitting diode (OLED) display device comprises a display panel including first and second substrates, an OLED disposed between the first and second substrates, and a heating controller, a heater configured to apply heat to the display panel, and a temperature controller. The display panel has a display area and a non-display area on which the second substrate does not overlap the first substrate. The first and second substrates and the OLED are arranged in the display area. The heating controller is arranged in the non-display area. A first side and a second side of the temperature controller are electrically connected to the heater and the heating controller, respectively. The heating controller supplies a voltage to the heater when it is determined that an image is not displayed on the display panel. The temperature controller cuts electrical connection with the heater at a predetermined temperature.

20 Claims, 4 Drawing Sheets

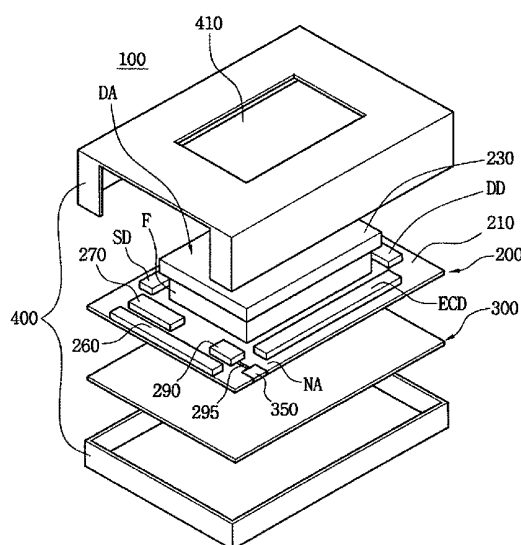


FIG. 2

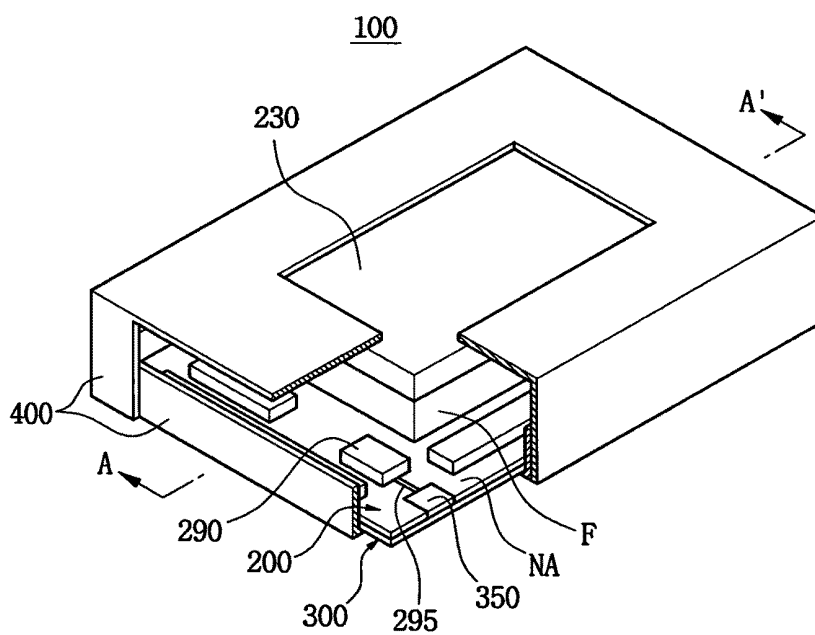


FIG. 5

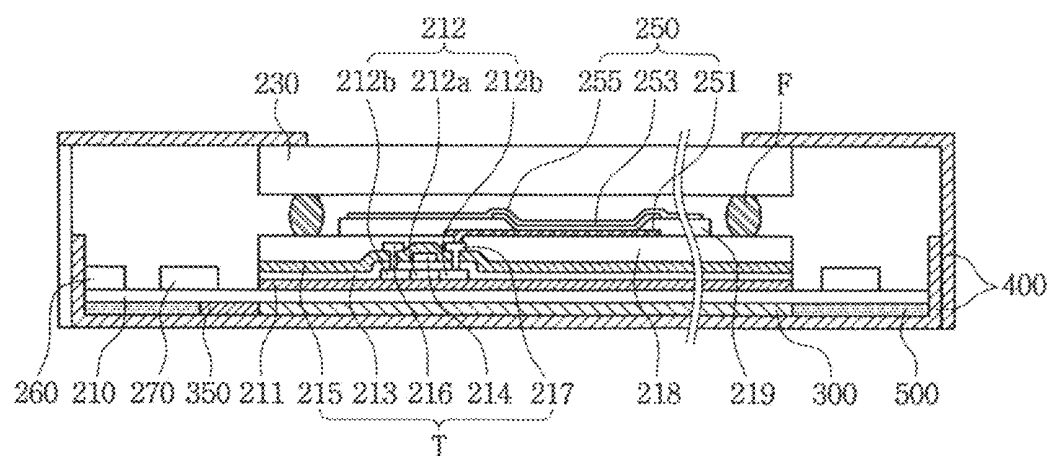
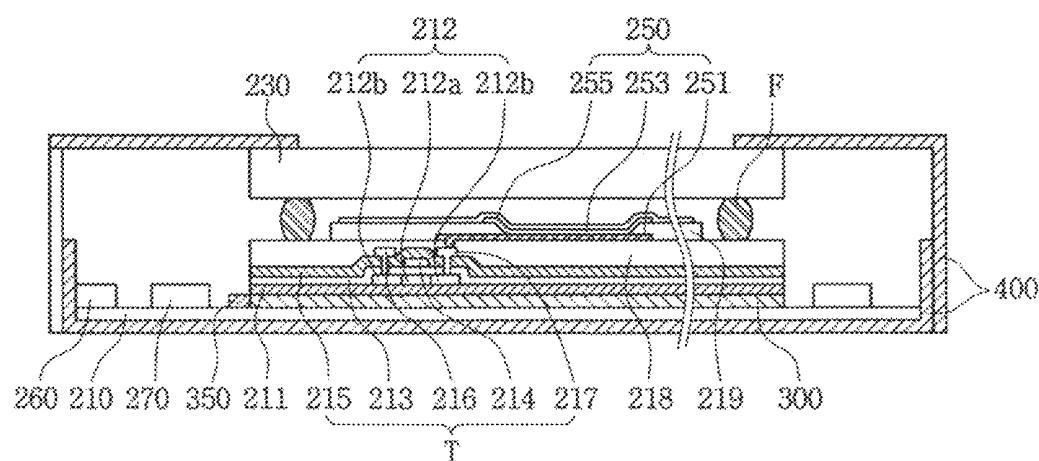


FIG. 6



ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE AND METHOD OF DRIVING THE SAME

BACKGROUND OF THE INVENTION

1. Field

The embodiments relate to an organic light emitting diode (OLED) display device and a method of driving the same, and more particularly, to an OLED display device that is capable of preventing characteristics of an amorphous silicon thin film transistor from being degraded and deteriorated and a method of driving the same.

2. Description of the Related Art

In general, an OLED display device includes a display panel configured to display an image, and a drive circuit configured to drive the display panel. The display panel includes an OLED formed between two substrates, and at least one thin film transistor (TFT) configured to drive the OLED.

The OLED includes an anode electrode, a cathode electrode, and an emission layer disposed between the anode electrode and the cathode electrode.

An electron injected from the cathode electrode is coupled to a hole injected from the anode electrode to form an exciton in the emission layer, and the exciton emits energy to emit light.

The TFTs may include a switching TFT configured to select a pixel, and a drive TFT configured to drive the OLED to emit light having brightness in proportion to a current.

Here, as the TFT, an amorphous silicon TFT or a polysilicon TFT may be selected considering image quality, power consumption, stability, a large-sized screen, costs, etc.

When the conventional amorphous TFT is driven for a long time, characteristics of the amorphous silicon TFT may be deteriorated. Consequently, a threshold voltage V_{th} may increase, and mobility of the amorphous silicon TFT may decrease.

Such a phenomenon occurs because a dangling bond is formed in an amorphous silicon thin film. The dangling bond may cause more defects in the thin film and increase in a trap density at an interface between amorphous silicon and gate oxide, and decrease in mobility of a charge.

In addition, the current required to drive the OLED is varied to generate a difference in screen display characteristics according to a unit pixel in the panel. Therefore, when characteristics of the drive TFT are changed due to degradation or deterioration of the TFT, reliability of products may be decreased.

SUMMARY

Embodiments are therefore directed to an OLED display device that is capable of preventing characteristics of an amorphous silicon thin film transistor from being degraded and deteriorated and a method of driving the same, which substantially overcome one or more of the problems due to the limitations and disadvantages of the related art.

It is therefore a feature of an embodiment to provide an organic light emitting diode display device, comprising: a display panel including a first substrate, a second substrate, an organic light emitting diode disposed between the first and second substrates, and a heating controller, the display panel having a display area and a non-display area, the non-display area being an area on which the second substrate does not overlap the first substrate, the first substrate, the second substrate, and the organic light emitting diode being arranged in

the display area, and the heating controller being arranged in the non-display area; a heater configured to apply heat to the display panel; and a temperature controller, a first side of the temperature controller being electrically connected to the heater and a second side of the temperature controller being electrically connected to the heating controller.

The temperature controller may be bimetallic.

A thin film transistor may be arranged in the display area, disposed between the first and second substrates, and electrically connected to the organic light emitting diode. The thin film transistor may include a semiconductor layer made of amorphous silicon.

The heating controller may include: a determination unit configured to determine whether an image is displayed on the display panel or not, and output a state of the display panel; and a power supply unit configured to receive a signal output from the determination unit, and supply a voltage according to the received signal.

The voltage may be applied to the heater via the temperature controller.

A first side of the temperature controller may be in contact with the heater so as to be electrically connected thereto, and a second side of the temperature controller may be electrically connected to a lead terminal extending from the heating controller.

The temperature controller may be disposed in a hole formed in the first substrate, and may be in contact with the heater.

The first substrate may have an inner surface facing the second substrate and an outer surface opposite to the inner surface. The heater may be disposed on the outer surface of the first substrate, and have a size corresponding to the first substrate.

The first substrate may have an inner surface facing the second substrate and an outer surface opposite to the inner surface. The heater may be disposed on the outer surface of the first substrate, and has a size corresponding to the display area.

An auxiliary layer may be disposed on a first region of the outer surface of the first substrate other than a second region of the first substrate, and the second region is a region on which the heater is disposed.

The temperature controller may be disposed on a side surface of the heater so as to be in contact with the heater.

The first substrate may have an inner surface facing the second substrate and an outer surface opposite to the inner surface. The heater may be disposed on an inner surface of the first substrate, and have a size corresponding to the display area.

The temperature controller may further be configured to bend the first side of the temperature controller in a direction opposite to the heater at a predetermined temperature so as to cut electrical connection between the temperature controller and the heater.

It is therefore another feature of an embodiment to provide a method of driving an organic light emitting diode display device comprising a display panel, a heater, a power supply unit, and a temperature controller, the method comprising: determining whether an image is displayed on the display panel or not; outputting a voltage from the power supply unit when it is determined that the image is not displayed on the display panel; applying the output voltage to the heater via the temperature controller; applying heat to the display panel with the heater; and cutting off the voltage applied to the heater at a predetermined temperature using the temperature controller.

The predetermined temperature may be a temperature of an amorphous silicon thin film included in the display panel. The predetermined temperature may be in a range of 80 to 100° C.

When a first side of the temperature controller is electrically connected to the power supply unit, and a second side of the temperature controller is electrically connected to the heater, the voltage output from the power supply unit may be applied to the heater.

The first side of the temperature controller in contact with the heater may be bent in a direction opposite to the heater at the predetermined temperature, and the voltage applied to the heater may be cut off.

When a first side of the temperature controller is connected to a lead terminal extending from the power supply unit and a second side of the temperature controller is in contact with the heater, the voltage output from the power supply unit may be applied to the heater.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages will become more apparent to those of ordinary skill in the art by describing in detail exemplary embodiments with reference to the attached drawings, in which:

FIG. 1 illustrates a perspective, exploded view of an OLED display device in accordance with an exemplary embodiment;

FIG. 2 illustrates a perspective cutaway view of the assembled OLED display device of FIG. 1;

FIG. 3 illustrates a cross-sectional view of the OLED display device along the line A-A' shown in FIG. 2;

FIG. 4 is a block diagram illustrating schematic configuration of a heating controller in accordance with an exemplary embodiment; and

FIG. 5 illustrates a cross-sectional view of an OLED display device in accordance with another exemplary embodiment.

FIG. 6 illustrates a cross-sectional view of an OLED display device in accordance with another exemplary embodiment.

DETAILED DESCRIPTION

Korean Patent Application No. 10-2009-0086548, filed on Sep. 14, 2009, in the Korean Intellectual Property Office, and entitled: "Organic Light Emitting Diode Display Device and Method of Driving the Same," is incorporated by reference herein in its entirety.

Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. It will also be understood that when a layer or element is referred to as being "on" another layer or substrate, it can be directly on the other layer or substrate, or intervening layers may also be present. In addition, it will also be understood that when a layer is referred to as being "between" two layers, it can be the only layer between the two layers, or one or more intervening layers may also be present. Like reference numerals refer to like elements throughout.

FIG. 1 is a perspective, exploded view of an OLED display device in accordance with an exemplary embodiment. FIG. 2 is a perspective cutaway view of the assembled OLED display

device of FIG. 1. FIG. 3 is a cross-sectional view of the OLED display device along the line A-A' shown in FIG. 2.

Referring to FIGS. 1 to 3, an OLED display device 100 may include a display panel 200 which includes a heating controller 290, a heater 300 configured to supply heat to the display panel 200, and a temperature controller 350. The temperature controller 350 may be configured to selectively connect or block a current flow between the heating controller 290 and the heater 300. The heater 300 may be disposed outside or inside the display panel 200. A first side of the temperature controller 350 may be electrically connected to the heating controller 290. A second side of the temperature controller 350 may be electrically connected to the heater 300. The temperature controller 350 may be bimetallic.

The position of the temperature controller 350 is not specifically limited. Since the temperature controller 350 may be electrically connected to the heating controller 290 and the heater 300, the temperature controller 350 may be disposed in the vicinity of the heating controller 290 and the heater 300.

In addition, the OLED display device 100 may further include a receiving vessel 400 configured to receive the display panel 200, the heater 300, and the temperature controller 350.

The receiving vessel 400 may have a transparent area or an opening 410 configured to expose an image displayed on the display panel 200 to the outside.

The display panel 200 may be provided in a small mobile device such as a mobile phone, a PDP, etc. Also, the display panel 200 may be provided in a large display such as a television, etc.

The display panel 200 may have a display area DA and a non-display area NA. The display area DA may display an image according to an external signal. In the display area DA, a first substrate 210, a second substrate 230, and a single or a plurality of OLEDs 250 disposed between the first substrate 210 and the second substrate 230 may be arranged.

Here, sealing material such as frit F may be applied along a periphery of the first substrate 210 or the second substrate 230. Heat may be applied to the frit to plasticize the frit. Consequently, the first and second substrates 210 and 230 may be adhered so as to seal the single or the plurality of OLEDs 250 and protect the OLEDs 250 from external gas, moisture, air, etc.

In the display area DA, a single or a plurality of TFTs T may be disposed between the first and second substrates 210 and 230. The single or the plurality of TFTs T may be configured to control emission of light from the OLEDs 250. The single or the plurality of TFTs T may be electrically connected to the OLEDs 250, respectively. In FIG. 3, a cross-sectional view of the OLED display device, including the OLEDs 250 and the TFTs T in the display area DA is illustrated. The illustrated cross-sectional view includes formation of the OLEDs 250 and the TFTs T on the first substrate 210.

A buffer layer 211 may be formed on the first substrate 210. A semiconductor layer 212 including an active region 212a and source/drain regions 212b may be patterned and formed on the buffer layer 211.

Here, the semiconductor layer 212 may be formed by applying an amorphous silicon thin film on the buffer layer 211, and then removing a portion of the amorphous silicon thin film in an etching process.

A gate insulating layer 213 may be formed on the semiconductor layer 212 and a part of the buffer layer 211. On the part of the buffer layer 211, the semiconductor layer 212 is not

formed. A gate electrode **214** may be patterned and formed on the gate insulating layer **213** so as to correspond to the active region **212a**.

An interlayer insulating layer **215** may be formed on the gate electrode **214** and a part of the gate insulating layer **213**. On the part of the gate insulating layer **213**, the gate electrode **214** is not formed. The gate insulating layer **213** and the interlayer insulating layer **215** may be partially removed so as to expose portions of the source/drain regions **212b**.

Source and drain electrodes **216** and **217** may be patterned and formed on the interlayer insulating layer **215**, and connected to the exposed portions of the source and drain regions **212b**.

A planarization layer **218** may be formed on the source and drain electrodes **216** and **217** and a part of the interlayer insulating layer **215**. On the part of the interlayer insulating layer **215**, the source and drain electrodes **216** and **217** are not formed. A portion of the planarization layer **218** may be removed so as to expose a portion of one of the source and drain electrodes **216** and **217**.

A first electrode **251** may be patterned and formed on the planarization layer **218**, and connected to the exposed portion of one of the source and drain electrodes **216** and **217**.

A pixel defining layer **219** having an opening (not shown) may be formed on the first electrode **251** and a part of the planarization layer **218** so as to expose a portion of the first electrode **251**. On the part of the planarization layer **218**, the first and second electrodes **251** are not formed.

An organic layer **253** may be formed on the first electrode **251** exposed through the opening (not shown) of the pixel defining layer **219**. A second electrode **255** may be formed on the organic layer **253** and a part of the pixel defining layer **219**. On the part of the pixel defining layer **219**, the organic layer **253** is not formed.

The non-display area **NA** may be an area in which the second substrate **230** does not overlap the first substrate **210**. A pad part **260**, which may be pads (not shown) extending from the display area **DA**, may be disposed in the non-display area **NA**.

In addition, various devices such as a controller **270**, a scan driver **SD**, a data driver **DD**, an emission control driver **ECD**, etc., may be disposed in the non-display area **NA** to control operations required for displaying an image by the OLEDs **250** according to external signals.

Furthermore, the heating controller **290** may be disposed in the non-display area **NA**. The heating controller **290** may be electrically connected to the temperature controller **350**, and supply a voltage to the heater **300** electrically connected to the temperature controller **350**.

FIG. 4 is a block diagram illustrating schematic configuration of a heating controller in accordance with an exemplary embodiment.

Referring to FIG. 4, the heating controller **290** may include a determination unit **291** and a power supply unit **293**. The determination unit **291** is configured to determine whether an image is displayed on the display panel **200** or not, and output a signal indicating a state of the display panel **200**. The power supply unit **293** is configured to receive the signal output from the determination unit **291**, and supply a voltage to the heater **300** via the temperature controller **350**.

Here, the heating controller **290** may supply a voltage to the heater **300** when it is determined that an image is not displayed on the display panel **200**. The heating controller **290** may not supply a voltage to the heater **300** when it is determined that an image is displayed on the display panel **200**.

The heater **300** may be formed of a metal thin film having high thermal conductivity. The heater **300** may be disposed on

one surface (an outer surface) of the first substrate **210** opposite to the other surface (an inner surface). The other surface or the inner surface faces the second substrate. On the other surface, the TFT **T** and the OLED **250** may be formed. The heater **300** may have a size corresponding to the first substrate **210**.

Here, a first side of the temperature controller **350** may be in contact with the heater **300** so as to be electrically connected thereto. A second side of the temperature controller **350** may be electrically connected to the heating controller **290**, more specifically, to a lead terminal **295** extending from the power supply unit **293**.

Of course, while the first side of the temperature controller **350** may be in contact with the heater **300**, the temperature controller **350** may be connected to the heater **300** using a lead terminal, a wire, etc., not limited thereto. Various connection manners may be used according to positions of the heating controller **290**, the heater **300**, and the temperature controller **350**.

Here, the lead terminal **295** may be insulated from the heater **300** to prevent the lead terminal from contacting the heater **300** directly.

The position of the temperature controller **350** is not specifically limited. The temperature controller **350** may be disposed in a hole formed in the first substrate **210** so that the first side of the temperature controller **350** may be in contact with the heater **300**.

When a voltage supplied from the power supply unit **293** is applied to the heater **300** via the temperature controller **350**, heat may be generated from the temperature controller **350**. When the temperature of the temperature controller **350** may increase to a certain temperature or more by the heat, the first side of the temperature controller **350** in contact with the heater **300** may be bent in a direction opposite to the heater **300** so as to cut electrical connection between the temperature controller **350** and the heater **300**.

FIG. 5 illustrates a cross-sectional view of an OLED display device in accordance with another exemplary embodiment.

Referring to FIG. 5, the heater **300** may be disposed at an outer surface of the first substrate **210**. The heater **300** may be formed to have a size corresponding to the display area **DA**.

Here, to compensate the height, an auxiliary layer **500** having the same thickness as the heater **300** may be disposed at a first region of the outer surface of the first substrate **210** other than a second region of the outer surface of the first substrate **210**. The heater **300** is disposed on the second region.

In the case that the heater **300** has a size corresponding to the display area **DA** and the temperature controller **350** is disposed as shown in FIGS. 1 to 3, it may be difficult to bring the temperature controller **350** in contact with the heater **300**.

Therefore, the temperature controller **350** may be disposed at a side surface of the heater **300** so as to be in contact with the heater **300**, while the lead terminal **295** may further extend so as to be connected to the temperature controller **350**.

FIG. 6 illustrates a cross-sectional view of an OLED display device in accordance with another exemplary embodiment.

Referring to FIG. 6, the heater **300** may be disposed on the inner surface of the first substrate **210**. That is, the first substrate **210**, the heater **300**, and the buffer layer **211** may be sequentially formed, while the TFT **T** and the OLED **250** may be formed on the buffer layer **211**. That is, the heater **300** may be disposed between the first substrate **210** and the buffer layer **211**, and have a size corresponding to the display area **DA**.

Here, the temperature controller **350** may be formed on the inner surface of the first substrate **210** so as to be disposed at a side surface of the heater **300** to readily contact the heater **300**.

Here, operation of the OLED display device is briefly described. The determination unit **291** may determine whether an image is displayed on the display panel **200** or not. When it is determined that the image is not displayed on the display panel **200**, the power supply unit **293** may generate and output a voltage. The output voltage may be transmitted to the heater **300** via the temperature controller **350**.

When it is determined that the image is displayed on the display panel **200**, the power supply unit **293** may not output the voltage, and no power may be supplied to the heater **300**.

The temperature of the heater **300** may be increased by the supplied voltage for generating heat to be applied to the panel including the TFT.

The amorphous silicon thin film, which forms the semiconductor layer **212**, has thermal annealing characteristics that may recover from deterioration when heat is applied. Therefore, the TFT's characteristics deteriorated by the image displaying operation may be recovered by the applied heat.

However, excessive heat may change characteristics of the amorphous silicon thin film, and also affect the other elements of the display panel. Therefore, the voltage applied to the heater should be cut off when the amorphous silicon thin film reaches a certain temperature.

The temperature controller **350** may be provided to prevent the temperature from increasing to a predetermined temperature or more. When the temperature is the predetermined temperature or more, the temperature controller **350** may be bent so as to cut off the electrical connection between the heating controller and the heater. Accordingly, no power may be supplied to the heater, and thus no heat may be applied to the panel.

When the temperature of the amorphous silicon thin film is too low, a sufficient amount of heat may not be supplied to recover the deteriorated characteristics. When the temperature is too high, the characteristics may not be changed. Therefore, the temperature of the amorphous silicon thin film may be selected in a range of 80 to 100° C.

As described above, by applying heat to the panel including the TFT formed of an amorphous silicon thin film, degradation and deterioration in characteristics of the amorphous silicon TFT may be prevented.

What is claimed is:

1. An organic light emitting diode display device, comprising:

- a display panel including a first substrate, a second substrate, an organic light emitting diode disposed between the first and second substrates such that the first substrate is under the organic light emitting diode, and a heating controller, the display panel having a display area and a non-display area, the non-display area being an area on which the second substrate does not overlap the first substrate, wherein the first substrate, the second substrate, and the organic light emitting diode are arranged in the display area, and the heating controller is arranged in the non-display area;
- a heater configured to apply heat to the display panel, the heater being under the first substrate and overlapping at least an entirety of the display area; and
- a temperature controller, a first side of the temperature controller being electrically connected to the heater and a second side of the temperature controller being electrically connected to the heating controller.

2. The organic light emitting diode display device as claimed in claim 1, wherein the temperature controller is bimetallic.

3. The organic light emitting diode display device as claimed in claim 1, wherein a thin film transistor is arranged in the display area, is disposed between the first and second substrates, and is electrically connected to the organic light emitting diode, and

the thin film transistor includes a semiconductor layer made of amorphous silicon.

4. The organic light emitting diode display device as claimed in claim 1, wherein the heating controller includes:

a determination unit configured to determine a state of the display panel based on whether an image is displayed on the display panel or not, and to output the state of the display panel; and

a power supply unit configured to receive a signal output from the determination unit based on the state of display panel, and to supply a voltage according to the received signal to the heating controller, the heater being configured to apply the heat to the display panel based on the state of the display panel received from the heating controller.

5. The organic light emitting diode display device as claimed in claim 1, wherein a first side of the temperature controller is in contact with the heater so as to be electrically connected thereto, and a second side of the temperature controller is electrically connected to a lead terminal extending from the heating controller.

6. The organic light emitting diode display device as claimed in claim 5, wherein the temperature controller is disposed in a hole formed in the first substrate, and is in contact with the heater.

7. The organic light emitting diode display device as claimed in claim 1, wherein the first substrate has an inner surface facing the second substrate and an outer surface opposite to the inner surface, and

wherein the heater is disposed on the outer surface of the first substrate, and has a size corresponding to the first substrate.

8. The organic light emitting diode display device as claimed in claim 1, wherein the first substrate has an inner surface facing the second substrate and an outer surface opposite to the inner surface, and

wherein the heater is disposed on the outer surface of the first substrate, and has a size corresponding to the display area.

9. The organic light emitting diode display device as claimed in claim 8, wherein an auxiliary layer is disposed on a first region of the outer surface of the first substrate other than a second region of the first substrate, and the second region is a region on which the heater is disposed.

10. The organic light emitting diode display device as claimed in claim 8, wherein the temperature controller is disposed on a side surface of the heater so as to be in contact with the heater.

11. The organic light emitting diode display device as claimed in claim 1, wherein the first substrate has an inner surface facing the second substrate and an outer surface opposite to the inner surface, and

wherein the heater is disposed on an inner surface of the first substrate, and has a size corresponding to the display area.

12. The organic light emitting diode display device as claimed in claim 11, wherein the temperature controller is disposed on a side surface of the heater so as to be in contact with the heater.

13. The organic light emitting diode display device as claimed in claim 1, wherein the temperature controller is further configured to bend the first side of the temperature controller in a direction opposite to the heater at a predetermined temperature so as to cut electrical connection between the temperature controller and the heater.

14. A method of driving an organic light emitting diode display device comprising a display panel, a heater, a power supply unit, and a temperature controller, the method comprising:

determining whether an image is displayed on the display panel or not;

outputting a voltage from the power supply unit when it is determined that the image is not displayed on the display panel;

applying the output voltage to the heater via the temperature controller;

applying heat to the display panel with the heater; and cutting off the voltage applied to the heater at a predetermined temperature using the temperature controller.

15. The method as claimed in claim 14, wherein the predetermined temperature is a temperature of an amorphous silicon thin film included in the display panel, and in a range of 80 to 100° C.

16. The method as claimed in claim 14, wherein when a first side of the temperature controller is electrically connected to the power supply unit, and a second side of the temperature controller is electrically connected to the heater, the voltage output from the power supply unit is applied to the heater.

17. The method as claimed in claim 16, wherein the first side of the temperature controller in contact with the heater is bent in a direction opposite to the heater at the predetermined temperature, and the voltage applied to the heater is cut off.

18. The method as claimed in claim 14, wherein when a first side of the temperature controller is connected to a lead terminal extending from the power supply unit and a second side of the temperature controller is in contact with the heater, the voltage output from the power supply unit is applied to the heater.

19. The method as claimed in claim 18, wherein the first side of the temperature controller in contact with the heater is bent in a direction opposite to the heater at the predetermined temperature, and the voltage applied to the heater is cut off.

20. The method as claimed in claim 14, wherein: determining whether the image is displayed on the display panel includes having a determination unit of the temperature controller output a signal indicating an on-state or an off-state of image display on the display panel to the power supply unit,

outputting the voltage from the power supply unit occurs only when the signal from the determination unit indicates the off-state of image display on the display panel, and

during the off-state of image display on the display panel, the voltage from the power supply unit is applied to the heater and the heat is applied to the display panel with the heater such that a temperature of the display panel is increased with the heater.

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专利名称(译)	有机发光二极管显示装置及其驱动方法		
公开(公告)号	US8531363	公开(公告)日	2013-09-10
申请号	US12/659138	申请日	2010-02-26
[标]申请(专利权)人(译)	YOO宰豪		
申请(专利权)人(译)	YOO JAE-HO		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD.		
[标]发明人	YOO JAE HO		
发明人	YOO, JAE-HO		
IPC分类号	G09G3/32 H01J7/24		
CPC分类号	H01L27/3244 G09G3/3225 H01L27/3241 G09G2320/041 H01L51/529		
优先权	1020090086548 2009-09-14 KR		
其他公开文献	US20110063282A1		
外部链接	Espacenet USPTO		

摘要(译)

一种有机发光二极管 (OLED) 显示装置, 包括: 显示面板, 包括第一基板和第二基板; OLED, 设置在第一基板和第二基板之间; 加热控制器; 加热器, 被配置为向显示面板施加热量; 以及温度控制器。显示面板具有显示区域和非显示区域, 第二基板不与第一基板重叠。第一基板和第二基板以及OLED布置在显示区域中。加热控制器布置在非显示区域中。温度控制器的第一侧和第二侧分别电连接到加热器和加热控制器。当确定图像未显示在显示面板上时, 加热控制器向加热器提供电压。温度控制器在预定温度下切断与加热器的电连接。

