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Display device

Abstract

A light-emitting element display device includes: a display area which has an organic insulating layer that is made of an organic insulating material; a peripheral circuit area which is disposed around the display area and which has the organic insulating layer; and a blocking area that is formed between the display area and the peripheral circuit area. The blocking area includes: a first blocking area configured by only one or a plurality of inorganic material layers between an insulating base substrate and an electrode layer which covers the display area and is formed continuously from the display area, and which configures one of two electrodes for allowing the light emitting area to emit the light; and a second blocking area including a plurality of layers configuring the first blocking area, and a light emitting organic layer.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 17/894,257 filed on Aug. 24, 2022, which, in turn, is a continuation of U.S. application Ser. No. 17/151,263 (now U.S. Pat. No. 11,462,716) filed on Jan. 18, 2021, which, in turn, is a continuation of U.S. Application Ser. No. 16/861,305 (now U.S. Pat. No. 10,923,679) filed on Apr. 29, 2020, which, in turn, is a continuation of U.S. Application Ser. No. 16/157,569 (now U.S. Pat. No. 10,673,019) filed on Oct. 11, 2018, which, in turn, is a continuation of U.S. Application Ser. No. 15/950,511 (now U.S. Pat. No. 10,135,027) filed on Apr. 11, 2018, which, in turn, is a continuation of U.S. Application Ser. No. 15/699,113 (now U.S. Pat. No. 9,972,806) filed on Sep. 8, 2017, which, in turn, is a continuation of U.S. Application Ser. No. 15/281,213 (now U.S. Pat. No. 9,793,513) filed on Sep. 30, 2016, which, in turn, is a continuation of U.S. Application Ser. No. 14/318,863 (now U.S. Pat. No. 9,484,550) filed on Jun. 30, 2014. Further, this application claims priority from Japanese application JP2013-139743 filed on Jul. 3, 2013, the entire contents of which are hereby incorporated by reference into this application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

(1) The present invention relates to a light-emitting element display device, and more particularly to a light-emitting element display device that allows light-emitting elements which are self-luminous bodies arranged in respective pixels to emit a light for displaying.

2. Description of the Related Art

(2) In recent years, an image display device using self-luminous bodies called “organic light emitting diode (OLED)” has been put into practical use, hereinafter the image display device is called “organic EL (electro-luminescent) display device”. As compared with a related-art liquid crystal display device, the organic EL display device is not only excellent in visibility and response speed because the self-luminous bodies are used, but also can be further thinned because no auxiliary illuminating device such as a backlight is required.

(3) The organic EL display device thus configured is deteriorated with the absorption of moisture. For that reason, an organic EL panel includes a countermeasure that a sealing glass substrate is stuck onto a TFT (thin film transistor) substrate on which a light emitting layer is formed with a resin for sealing.

(4) JP 2004-335267 A and JP 2008-047515 A disclose a structure in which an organic film is divided between a display area and an area around an outside of the display area in view of an entry route in which the moisture arrives at the display area from the area around the outside of the display area through the organic film.

SUMMARY OF THE INVENTION

(5) A sealing film is formed on a surface of a TFT substrate so as to cover an overall surface of the display area and a peripheral circuit area. However, if a foreign matter adheres to any portion in a process before the sealing film is formed, the portion cannot be sufficiently covered with the sealing film, as a result of which the portion may configure the entry route of the moisture from the external. In particular, in a deposition process before the sealing film is formed, the foreign matter that has adhered to a vapor deposition mask may be transferred to the TFT substrate side during the deposition process. In this case, it is conceivable that sealing using the sealing film is insufficient.

(6) The present invention has been made in view of the above-mentioned circumstance, and therefore an object of the present invention is to provide an organic EL display device that can suppress a display failure attributable to the moisture entry, and maintain a long-term quality.

(7) According to the present invention, there is provided a light-emitting element display device including: a display area area that in which pixels each having a light emitting spontaneously emits a light are arranged in a matrix and which has an organic insulating layer that is made of an organic insulating material; a peripheral circuit area which is disposed around the display area, in which a metal wiring **370** or a circuit using a thin film transistor is arranged and which has the organic

insulating layer; and a blocking area that is formed between the display area and the peripheral circuit area, in which the blocking area includes: a first blocking area configured by only one or a plurality of layers made of inorganic material between an insulating substrate made of a base material and an electrode layer which covers the display area and is formed continuously from the display area, and which configures one of two electrodes for allowing the light emitting area to emit the light; and a second blocking area including a plurality of layers configuring the first blocking area, and a light emitting organic layer.

(8) In this example, the light emitting organic layer means at least one of layers formed between the two electrodes, and specifically includes a hole injection layer, a hole transport layer, an electron injection layer, and an electron transport layer in addition to a light emitting layer that emits a light.

(9) Also, in the light-emitting element display device according to the present invention, the light emitting organic layer may include a light emitting layer that covers the display area made of an organic light emitting material.

(10) Also, in the light-emitting element display device according to the present invention, the light emitting organic layer includes any one of a hole injection layer, a hole transport layer, an electron injection layer, and an electron transport layer.

(11) According to the present invention, there is provided a method of manufacturing a light-emitting element display device, including the steps of: forming a circuit including a TFT (thin film transistor) in a display area and a peripheral circuit area around the display area on an insulating substrate; forming an electrode electrically connected to the circuit in each of pixels within the display area, and an organic insulating film formed around the electrode; depositing a light emitting organic layer with the use of an evaporation mask having a mask area that covers the peripheral circuit area, and comes in contact with only the peripheral circuit area; and forming a sealing film that covers at least the light emitting organic layer for sealing an overall surface of the insulating substrate.

(12) Also, in the method of manufacturing a light-emitting element display device according to the present invention, in the step of forming the light emitting organic layer, an inner end of the evaporation mask is arranged within a blocking area that is formed between the display area and the peripheral circuit area.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a diagram schematically illustrating an organic EL display device according to an embodiment of the present invention;

(2) FIG. 2 is a plan view illustrating a configuration of a TFT substrate in the organic EL display device;

(3) FIG. 3 is a cross-sectional view taken along a line III-III of FIG. 2;

(4) FIG. 4 is a flowchart illustrating a process of manufacturing the organic EL display device according to the embodiment of the present invention;

(5) FIG. 5 is a flowchart illustrating the detail of a TFT substrate manufacturing process in FIG. 4;

(6) FIG. 6 is a diagram illustrating an light emitting organic layer forming process and a cathode/sealing film forming process in FIG. 5 in detail;

(7) FIG. 7 is a diagram illustrating a light emitting organic layer forming process and a cathode/sealing film forming process of a TFT substrate according to a comparative example 1; and

(8) FIG. 8 is a diagram illustrating a light emitting organic layer forming process and a cathode/sealing film forming process of a TFT substrate according to a comparative example 2.

DETAILED DESCRIPTION OF THE INVENTION

(9) Hereinafter, embodiments of the present invention will be described with reference to the

accompanying drawings. In the drawings, the same or equivalent elements are denoted by identical symbols, and a repetitive description thereof will be omitted.

(10) FIG. 1 is a diagram schematically illustrating an organic EL display device **100** according to an embodiment of the present invention. As illustrated in the figure, the organic EL display device **100** is configured by an organic EL panel **200** fixedly sandwiched between an upper frame **110** and a lower frame **120**. The organic EL panel **200** is configured by a TFT substrate **300** which will be described later, and a sealing substrate not shown which is adhered to the TFT substrate **300** with a transparent resin.

(11) FIG. 2 is a plan view illustrating a configuration of the TFT substrate **300**. As illustrated in the figure, the TFT substrate **300** includes a display area **320** in which pixels **310** each having an anode electrode **359** (to be described later) arranged therein, and emitting a light on the basis of a gradation value are arranged in a matrix, a peripheral circuit area **340** that is arranged around the display area **320** in which various signal generator circuits for driving pixel circuits, and a circuit that applies a potential to a cathode electrode **357** (to be described later) are formed, and a blocking area **330** that is formed between the display area **320** and the peripheral circuit area **340**. Also, a driving IC (integrated circuit) **350** that conducts a control for allowing the respective pixels **310** in the display area **320** to emit the light in correspondence with the gradation value is arranged on the TFT substrate **300**.

(12) FIG. 3 is a cross-sectional view taken along a line III-III of FIG. 2. As illustrated in FIG. 3, the TFT substrate **300** includes a pixel circuit **361** and a peripheral circuit **362** made of, for example, an LTPS (low-temperature polysilicon) within inorganic insulating films **352** and **353**, and an organic flattening film **355** which is an organic insulating film for flattening an area in which the pixel circuit **361** and the peripheral circuit **362** are mainly formed, over a glass substrate **351** which is an insulating substrate. The TFT substrate **300** also includes an organic bank **356** which is an organic insulating film formed to cover an end of a conductive film such as an anode electrode **359** formed in a through-hole of the organic flattening film **355**, and a reflection film **360** that is arranged on the glass substrate **351** side of the anode electrode **359** for reflecting a received light. The TFT substrate **300** further includes a light emitting organic layer **358** formed of a light emitting layer that emits the light, and/or hole injection/transport layers and electron injection/transport layers, the cathode electrode **357** which is an electrode facing the anode electrode **359**, and a sealing film **354** formed to cover the overall surface of the TFT substrate **300**. Reference numbers **390** and **391** are examples of a contact area and a wiring respectively.

(13) In this example, the blocking area **330** is configured to block passing of moisture between the display area **320** and the peripheral circuit area **340**. The blocking area **330** includes a first blocking area **331** spread between the cathode electrode **357** and the glass substrate **351**, and made of only an inorganic material, and a second blocking area **332** including the respective films of the first blocking area **331**, and also having the light emitting organic layer **358**. Because moisture entering from the external is advanced through an organic film, for example, the moisture that has entered the peripheral circuit area **340** can be prevented from entering the display area **320** with the provision of an area made of only an inorganic material. A pixel area **321** is provided in the display area **320**.

(14) Hereinafter, a method of manufacturing the configuration according to this embodiment will be described together with advantages of the configuration according to this embodiment. FIG. 4 is a flowchart illustrating a process of manufacturing the organic EL display device **100** according to the embodiment of the present invention. As illustrated in the flowchart, in the process of manufacturing the organic EL display device **100**, the TFT substrate **300** is first manufactured in a TFT substrate manufacturing process **S100**, and a sealing substrate is sequentially manufactured in a sealing substrate manufacturing process **S200**. Then, in a TFT substrate/sealing substrate adhering process **S300**, the TFT substrate **300** and the sealing substrate thus manufactured are adhered to each other with a transparent resin, and in an upper and lower frame fitting process

S400, external members (not shown) such as a COG and an FPC are implemented, and the upper frame **110** and the lower frame **120** are fitted to those components. With the above processes, the organic EL display device **100** is completed.

(15) FIG. 5 is a flowchart illustrating the detail of the TFT substrate manufacturing process **S100** in FIG. 4. As illustrated in this flowchart, in the TFT substrate manufacturing process **S100**, a transistor circuit made of, for example, an LTPS is first formed in a TFT circuit forming process **S110**. The anode electrode **359** and the organic bank **356** are then formed in an anode/organic bank forming process **S120**. Sequentially, the light emitting organic layer **358** is formed by vapor deposition in a light emitting organic layer forming process **S130**. Finally, in a cathode/sealing film forming process **S140**, after the cathode electrode **357** that covers the display area **320**, and extends to the peripheral circuit area **340** has been formed, the sealing film **354** that covers the overall surface of the substrate is formed to complete the TFT substrate **300**.

(16) FIG. 6 is a diagram illustrating the detail of the light emitting organic layer forming process **S130** and the cathode/sealing film forming process **S140**. As described above, the light emitting organic layer **358** is formed by so-called “vapor deposition”. The vapor deposition is conducted in such a manner that a portion of the TFT substrate **300** where no film is formed is covered with an evaporation mask **410**, and a film forming material is attached onto a portion of the TFT substrate **300** which is not covered with the evaporation mask **410**. In this embodiment, the evaporation mask **410** that comes in contact with the peripheral circuit area **340**, but comes out of contact with the display area **320** is used. Referring to FIG. 6, in order to describe the advantages of this embodiment, a case in which a foreign matter **411** is present in a portion corresponding to the peripheral circuit area **340** that comes in contact with the evaporation mask **410** will be described. First, in a mask loading process **S131**, the evaporation mask **410** is loaded on the TFT substrate **300**. In this example, the inner end of the evaporation mask **410** is arranged in the blocking area **330** so that the light emitting organic layer **358** is formed within the blocking area **330**, taking adhesion caused by go-around of the light emitting organic layer **358** in the deposition process into account. Then, in a deposition process **S132**, the light emitting organic layer **358** is deposited. In this process, it is assumed that the foreign matter **411** is transferred to the peripheral circuit area **340** from the evaporation mask **410**. Finally, in the cathode/sealing film forming process **S140**, the cathode electrode **357** and the sealing film **354** are formed. However, because the sealing film **354** is not appropriately formed in a portion to which the foreign matter **411** adheres, the portion may configure an entry route of the moisture.

(17) However, in the TFT substrate **300** according to this embodiment, because the cathode electrode **357** to the glass substrate **351** in the first blocking area **331** are made of only the inorganic material, moisture that has entered the peripheral circuit area **340** is blocked in the first blocking area **331** so that the moisture can be prevented from entering the display area **320**, as indicated by an arrow in the figure. Therefore, there can be provided the organic EL display device that can suppress the display failure and maintain the quality for a long period.

(18) Although the above-mentioned light emitting organic layer **358** may be formed by any number of layers, the light emitting organic layer **358** is generally configured by a plurality of layers. In this case, the deposition process using the above-mentioned evaporation mask **410** is repeated a plurality of times. Also, the plurality of layers may be configured by light emitting layers that emit light, or may be configured by a hole injection layer, a hole transport layer, an electron injection layer, or an electron transport layer. In particular, in the organic EL display device in which the overall surface of the display area **320** emit light with a single color such as white, the light emitting layer can be configured by the light emitting organic layer **358**. In the organic EL display device in which the light emitting layers of RGB are formed for each of the pixels, separately, a common layer formed commonly to the respective pixels among the hole injection layer, the hole transport layer, the electron injection layer, and the electron transport layer may be formed by the light emitting organic layer **358**.

(19) FIG. 7 is a diagram illustrating a light emitting organic layer forming process and a cathode/sealing film forming process of a TFT substrate according to a comparative example 1. The light emitting organic layer forming process and the cathode/sealing film forming process of the comparative example 1 are identical with those in FIG. 6 in that a mask loading process S231, a deposition process S232, and a cathode/sealing film forming process S240 are provided, but different therefrom in that an evaporation mask 510 is used. A mask portion of the evaporation mask 510 spreads from the peripheral circuit area 340 to a portion entering the display area 320. For that reason, the light emitting organic layer 358 formed in the deposition process S232 is formed to fall within the display area 320. Also, because it is conceivable that the mask portion of the evaporation mask 510 comes in contact with the display area 320 together with the peripheral circuit area 340, there is a need to consider a foreign matter 511 transferred in the display area 320 in addition to the foreign matter 411 transferred in the peripheral circuit area 340. Taking the foreign matter 511 into account, in the cathode/sealing film forming process S240, the foreign matter 511 is also transferred in the display area 320 in addition to the peripheral circuit area 340, as a result of which a portion where the sealing film 354 is not appropriately formed appears. Therefore, that portion may form an entry route of moisture. As described with reference to FIG. 6, the moisture entry route from the peripheral circuit area 340 can prevent the moisture from entering the display area 320 due to the existence of the blocking area 330. However, the entry route of the moisture in the display area 320 leads to the deterioration of the light emitting organic layer 358 as it is, and causes the display failure.

(20) FIG. 8 is a diagram illustrating a light emitting organic layer forming process and a cathode/sealing film forming process of a TFT substrate according to a comparative example 2. The light emitting organic layer forming process and the cathode/sealing film forming process of the comparative example 2 are identical with those in FIG. 6 in that a mask loading process S331, a deposition process S332, and a cathode/sealing film forming process S340 are provided, but different therefrom in that an evaporation mask 610 is used. A mask portion of the evaporation mask 610 used in the comparative example 2 has a width fixed in the peripheral circuit area 340. For that reason, the light emitting organic layer 358 formed in the deposition process S332 is formed to spread to the peripheral circuit area 340 beyond the blocking area 330. Because it is conceivable that the mask portion of the evaporation mask 610 comes in contact with only the peripheral circuit area 340 as in FIG. 6, only the foreign matter 411 is considered as in FIG. 6. When the foreign matter 411 adheres to the peripheral circuit area 340, the sealing film 354 is not appropriately formed in the peripheral circuit area 340 in the cathode/sealing film forming process S340, and this portion may form the entry route of the moisture. In this example, because the light emitting organic layer 358 is formed beyond the blocking area 330, if the moisture enters from the moisture entry route of the peripheral circuit area 340, the moisture is not blocked in the blocking area 330, and deteriorates the light emitting organic layer 358 of the display area 320 through the light emitting organic layer 358, thus causing the display failure.

(21) As has been described above, in the above-mentioned embodiment, the blocking area 330 of the TFT substrate 300 has the first blocking area 331 and the second blocking area 332. As a result, even if the moisture entry route is generated in the peripheral circuit area 340, the moisture can be prevented from entering the display area 320. Also, in the light emitting organic layer forming process causing the moisture entry route, the foreign matter can be prevented from being transferred from the evaporation mask to the display area 320. For that reason, the sealing film 354 of the display area 320 can be appropriately formed, and the moisture can be prevented from entering the display area 320. Therefore, the organic EL display device according to this embodiment can suppress the display failure due to the moisture entry of the display area from the outside periphery, and maintain the quality for a long period.

(22) The above-mentioned embodiment can be applied to a light-emitting element display device using the organic light emitting material.

(23) While there have been described what are at present considered to be certain embodiments of the invention, it will be understood that various modifications may be made thereto, and it is intended that the appended claim cover all such modifications as fall within the true spirit and scope of the invention.

Claims

1. A display device comprising: a substrate; a display area on the substrate; a peripheral area surrounding the display area on the substrate; an organic flattening layer on the substrate; a plurality of first electrodes on the organic flattening layer in the display area; an organic insulating layer covering edges of the plurality of first electrodes; an organic layer including a light emitting layer and covering the plurality of first electrodes; a second electrode covering the organic layer; a sealing layer covering the second electrode, the sealing layer extending from the display area to the peripheral area; an inorganic insulating layer including a first portion and a second portion in the peripheral area, wherein the first portion being between the substrate and the organic flattening layer; and the second portion being between the substrate and the organic flattening layer and being closer to the display area compared to the first portion, wherein the peripheral area includes a first exposing area and a second exposing area, the first portion is exposed from the organic flattening layer and the organic insulating layer in the first exposing area, the second portion is exposed from the organic flattening layer and the organic insulating layer in the second exposing area, and the organic insulating layer is in direct contact with the sealing layer between the first exposing area and the second exposing area.
2. The display device according to claim 1, further comprising: a peripheral circuit between the organic flattening layer and the substrate in the peripheral area; and a wiring between the organic flattening layer and the organic insulating layer in the peripheral area, wherein the organic flattening layer includes a first contact hole, the peripheral circuit is in electrical contact with the wiring at the first contact hole, the organic insulating layer includes a second contact hole, and the wiring is in direct contact with the second electrode at the second contact hole.
3. The display device according to claim 2, wherein the second electrode is in direct contact with the sealing layer at the second contact hole.
4. The display device according to claim 2, wherein the first contact hole is covered with the organic insulating layer.
5. The display device according to claim 2, wherein the second contact hole includes a contact area in which the wiring is in direct contact with the second electrode, and the contact area does not overlap with the first contact hole.
6. The display device according to claim 1, wherein the organic layer overlaps with the second exposing area.
7. The display device according to claim 1, wherein the second electrode is in direct contact with the second portion in the second exposing area.
8. The display device according to claim 1, further comprising: a pixel area overlapping one of the plurality of first electrodes; and a bank area between two of the plurality of first electrodes, the bank area overlapping none of the plurality of first electrodes, wherein the substrate includes a first surface and a second surface opposing the first surface, the first surface of the substrate is closer to the sealing layer compared to the second surface of the substrate, the sealing layer includes a third surface and a fourth surface opposing the third surface, the third surface of the sealing layer is closer to the first surface of the substrate compared to the fourth surface of the sealing layer, and a first distance between the first surface of the substrate and the third surface of the sealing layer at the pixel area is different from a second distance between the first surface of the substrate and the third surface of the sealing layer at the bank area.
9. A display device comprising: a substrate; a display area on the substrate; a peripheral area

surrounding the display area on the substrate; an organic flattening layer on the substrate; a plurality of first electrodes on the organic flattening layer in the display area; an organic insulating layer covering edges of the plurality of first electrodes; an organic layer including a light emitting layer and covering the plurality of first electrodes; a second electrode covering the organic layer; a sealing layer covering the second electrode, the sealing layer extending from the display area to the peripheral area; an inorganic insulating layer including a first portion and a second portion in the peripheral area, wherein the first portion being between the substrate and the organic flattening layer and the second portion being between the substrate and the organic flattening layer and being closer to the display area compared to the first portion, wherein the peripheral area includes a first exposing area and a second exposing area, the first portion is exposed from the organic flattening layer and the organic insulating layer in the first exposing area, the second portion is exposed from the organic flattening layer and the organic insulating layer in the second exposing area, and the second electrode is in direct contact with the second portion in the second exposing area.

10. The display device according to claim 9, further comprising: a peripheral circuit between the organic flattening layer and the substrate in the peripheral area; and a wiring between the organic flattening layer and the organic insulating layer in the peripheral area, wherein the organic flattening layer includes a first contact hole, the peripheral circuit is in electrical contact with the wiring at the first contact hole, the organic insulating layer includes a second contact hole, and the wiring is in direct contact with the second electrode at the second contact hole.

11. The display device according to claim 10, wherein the second electrode is in direct contact with the sealing layer at the second contact hole.

12. The display device according to claim 10, wherein the first contact hole is covered with the organic insulating layer.

13. The display device according to claim 10, wherein the second contact hole includes a contact area in which the wiring is in direct contact with the second electrode, and the contact area does not overlap with the first contact hole.

14. The display device according to claim 10, wherein the organic insulating layer is in direct contact with the sealing layer between the first exposing area and the first contact hole.

15. The display device according to claim 9, wherein the organic layer overlaps with the second exposing area.

16. The display device according to claim 9, further comprising: a pixel area overlapping one of the plurality of first electrodes; and a bank area between two of the plurality of first electrodes, the bank area overlapping none of the plurality of first electrodes, wherein the substrate includes a first surface and a second surface opposing the first surface, the first surface of the substrate is closer to the sealing layer compared to the second surface of the substrate, the sealing layer includes a third surface and a fourth surface opposing the third surface, the third surface of the sealing layer is closer to the first surface of the substrate compared to the fourth surface of the sealing layer, and a first distance between the first surface of the substrate and the third surface of the sealing layer at the pixel area is different from a second distance between the first surface of the substrate and the third surface of the sealing layer at the bank area.

17. A display device comprising: a substrate; a display area on the substrate; a peripheral area surrounding the display area on the substrate; an organic flattening layer on the substrate; a plurality of first electrodes on the organic flattening layer in the display area; a second an organic insulating layer covering edges of the plurality of first electrodes; an organic layer including a light emitting layer and covering the plurality of first electrodes; a second electrode covering the organic layer; a sealing layer covering the second electrode, the sealing layer extending from the display area to the peripheral area; an inorganic insulating layer including a first portion and a second portion in the peripheral area, wherein the first portion being between the substrate and the organic flattening layer and the second portion being between the substrate and the organic flattening layer and being closer to the display area compared to the first portion, wherein the peripheral area

includes a first exposing area and a second exposing area, the first portion is exposed from the organic flattening layer and the organic insulating layer in the first exposing area, the second portion is exposed from the organic flattening layer and the organic insulating layer in the second exposing area, and the organic layer overlaps with the second exposing area.

18. The display device according to claim 17, further comprising: a peripheral circuit between the organic flattening layer and the substrate in the peripheral area; and a wiring between the organic flattening layer and the organic insulating layer in the peripheral area, wherein the organic flattening layer includes a first contact hole, the peripheral circuit is in electrical contact with the wiring at the first contact hole, the organic insulating layer includes a second contact hole, and the wiring is in direct contact with the second electrode at the second contact hole.

19. The display device according to claim 18, wherein the second electrode is in direct contact with the sealing layer at the second contact hole.

20. The display device according to claim 18, wherein the first contact hole is covered with the organic insulating layer.
