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(54) ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE

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(57) **ABSTRACT**

An organic light emitting diode (OLED) display device including a substrate having a display region and a non-display region surrounding the display region; an OLED on the substrate in the display region; an encapsulation substrate bonded to the substrate via an adhesive layer such that the encapsulation substrate and the substrate face each other; and a step-difference compensation portion in the non-display region and configured to compensate for a step difference between the display region and the non-display region.

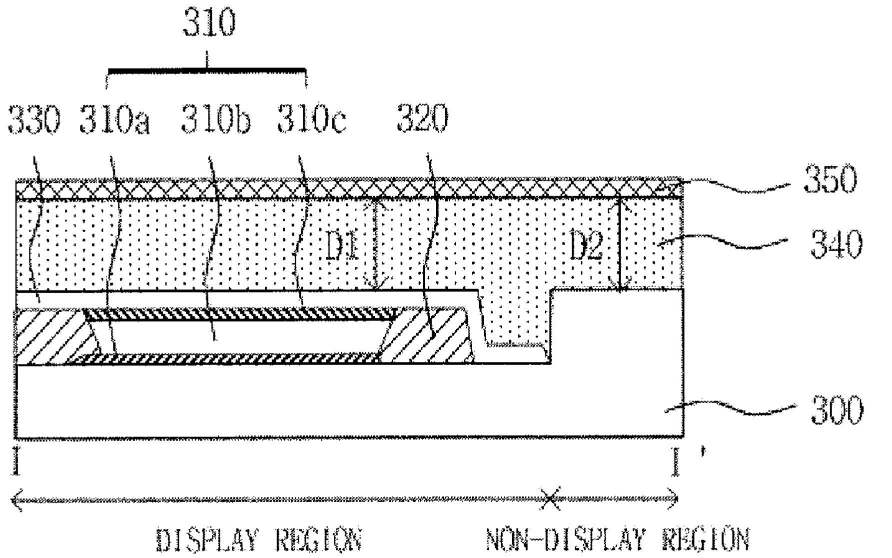


FIG.1

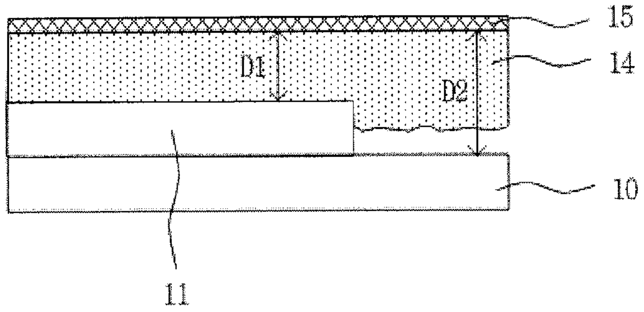


FIG.2A

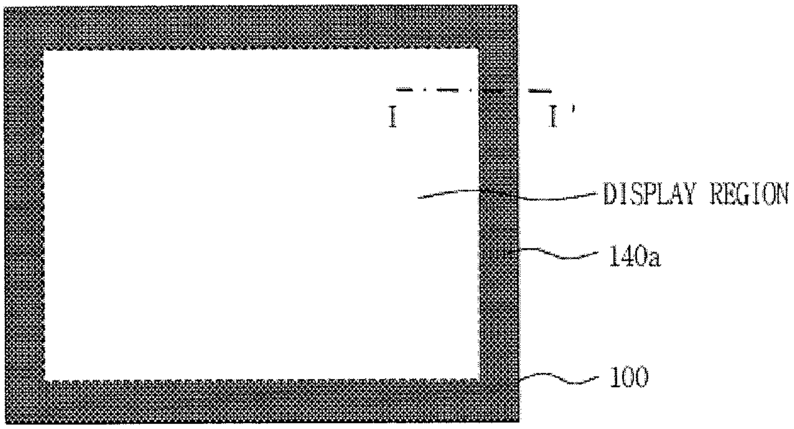


FIG.2B

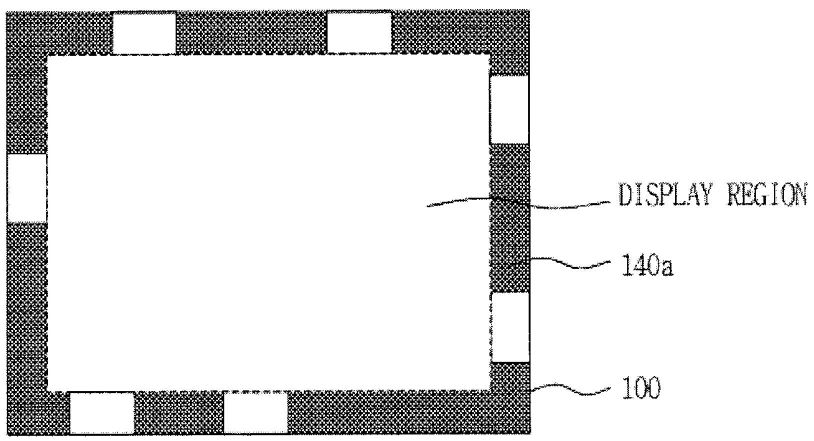

DISPLAY REGION
140a
100

FIG.3A

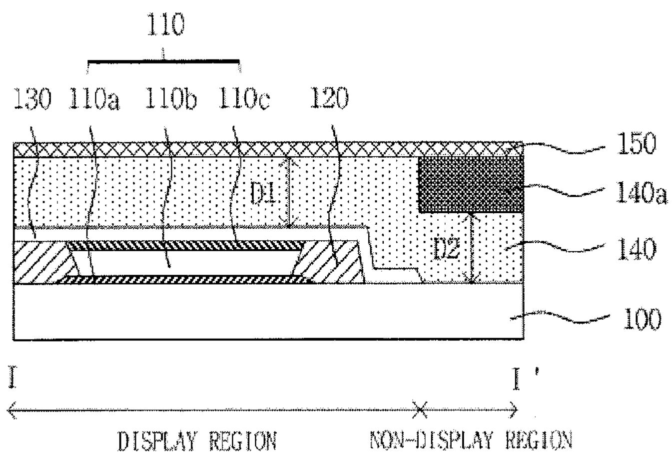

110
130
110a
110b
110c
120
150
140a
140
100
D1
D2
I
I'
DISPLAY REGION
NON-DISPLAY REGION

FIG.4A

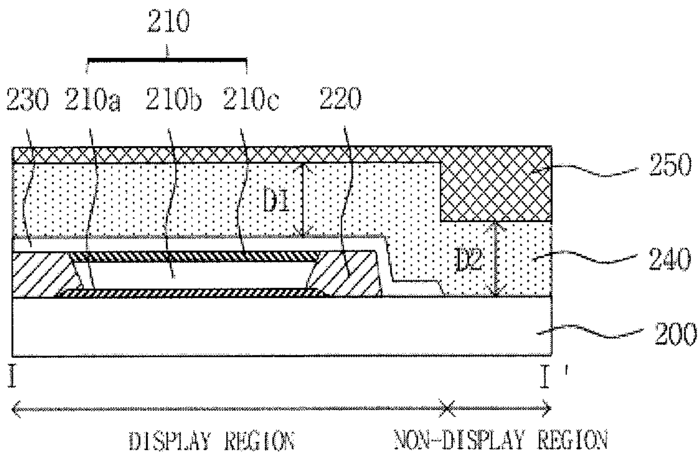

210
230
210a
210b
210c
220
250
240
200
D1
D2
I
I'
DISPLAY REGION
NON-DISPLAY REGION

FIG.4B

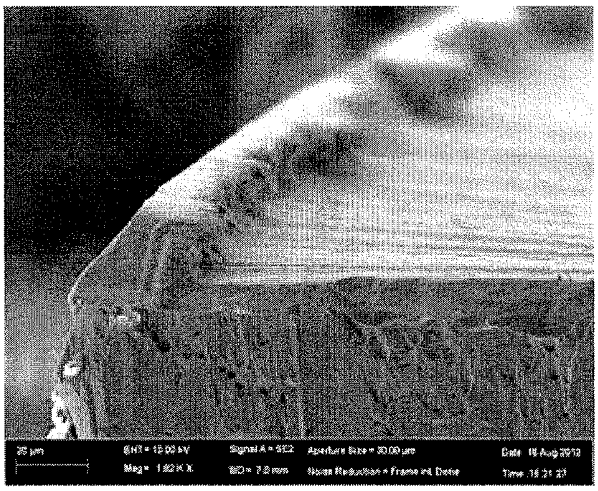


FIG.3B

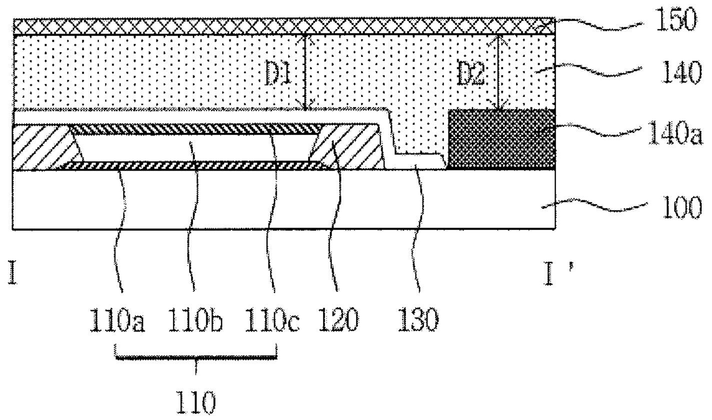

150
140
140a
100
D1
D2
I
I'
110a
110b
110c
120
130
110

FIG.3C

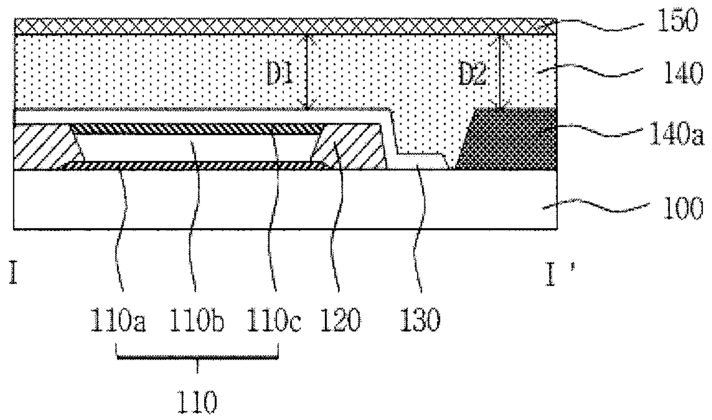

150
140
140a
100
D1
D2
I
I'
110a
110b
110c
120
130
110

FIG.5

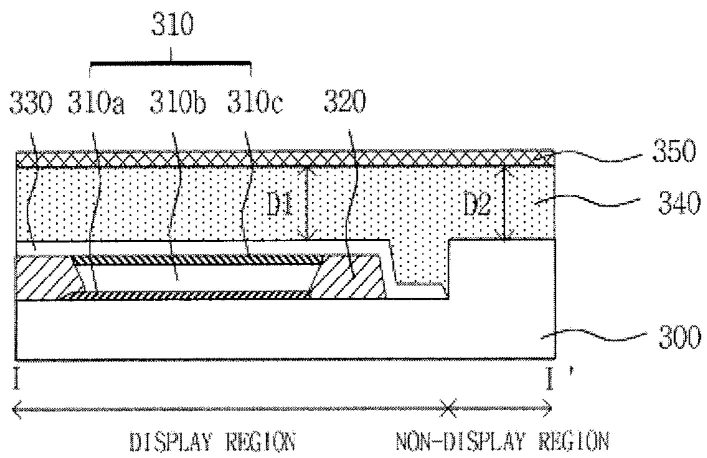

310
330 310a 310b 310c 320
350
340
D1
D2
300
I
I'
DISPLAY REGION
NON-DISPLAY REGION

FIG.6

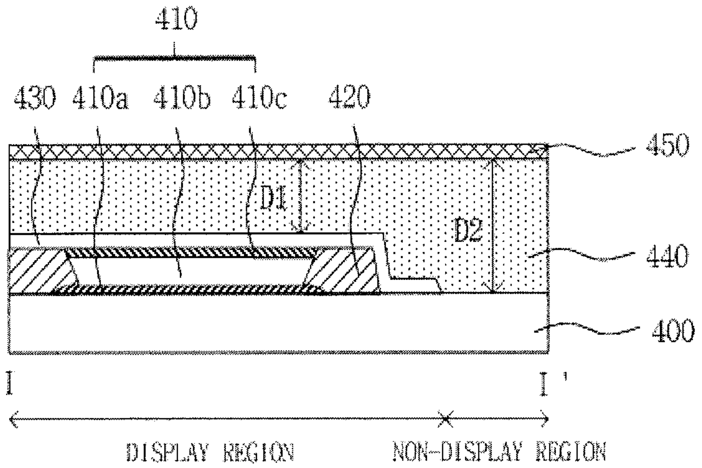

410
430 410a 410b 410c 420
450
440
D1
D2
400
I
I'
DISPLAY REGION
NON-DISPLAY REGION

FIG.7

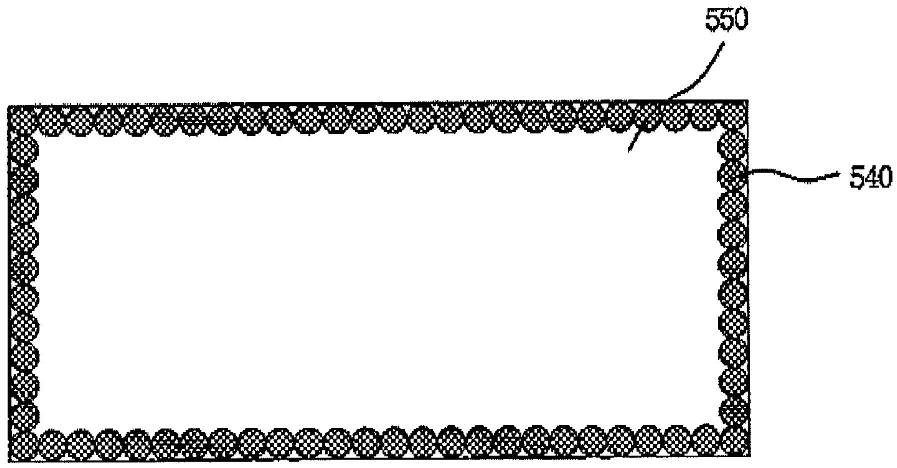
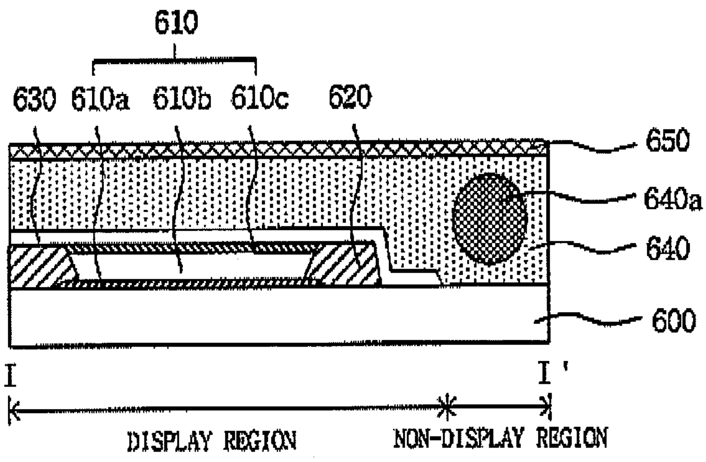

550
540

FIG.8


610
630 610a 610b 610c 620
650
640a
640
600
I
I '
DISPLAY REGION
NON-DISPLAY REGION

ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE

[0001] This application claims the benefit of Korean Patent Application No. 10-2012-0151923, filed on Dec. 24, 2012, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a display device, and more particularly, to an organic light emitting diode (OLED) display device having improved reliability by preventing defective bonding between a substrate and an encapsulation substrate.

[0004] 2. Discussion of the Related Art

[0005] An OLED display device displays an image by adjusting an amount of light emitted from a light emitting layer. The OLED display device also have a reduced weight and volume compared to the larger cathode ray tubes (CRTs).

[0006] Further, the OLED display device is a self-emitting device using a thin light emitting layer disposed between electrodes. In more detail, the OLED includes a first electrode functioning as an anode and being connected to a thin film transistor disposed in each sub-pixel region of a substrate, a light emitting layer (EML), and a second electrode functioning as a cathode.

[0007] When a voltage is applied to the first and second electrodes of the OLED, holes and electrons are recombined in the light emitting layer to create excitons that emit light when falling from an excited state to a ground state.

[0008] However, such OLED easily deteriorates from external factors such as moisture, oxygen, UV radiation, and manufacturing conditions of the display device. In the related art OLED display devices, a substrate including the OLED and an encapsulation substrate are bonded to each other via an adhesive layer.

[0009] In more detail, FIG. **1** is a cross-sectional view illustrating defective bonding of a related art OLED display device. Referring to FIG. **1**, an OLED **11** is formed on a substrate **10**, and the substrate **10** is bonded to an encapsulation substrate **15** via an adhesive layer **14**. For example, the adhesive layer **14** is applied to the encapsulation substrate **15**, and then a cover peeling layer is removed from the adhesive layer **14** (i.e., to expose the adhesive layer **14**). The encapsulation substrate **15** with the attached adhesive layer **14** is pressed or combined with the substrate **10** including the OLED **11**.

[0010] However, during this joining or combining process, a step difference between a display region including OLED **11** and a non-display region not including OLED **11** is formed. That is, as show in in FIG. **1**, a distance D2 between the substrate **10** and the encapsulation substrate **15** in the non-display region is greater than a distance D1 between the substrate **10** and the encapsulation substrate **15** in the display region. Thus, moisture, oxygen, or other particles can enter this region and damage the OLED **11**.

SUMMARY OF THE INVENTION

[0011] Accordingly, one object of the present invention is to provide an OLED display device that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0012] Another object of the present invention is to provide an OLED display device having improved reliability by preventing defective bonding of the substrate provided with an OLED and an encapsulation substrate.

[0013] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, the present invention provides in one aspect an organic light emitting diode (OLED) display device including a substrate having a display region and a non-display region surrounding the display region; an OLED on the substrate in the display region; an encapsulation substrate bonded to the substrate via an adhesive layer such that the encapsulation substrate and the substrate face each other; and a step-difference compensation portion in the non-display region and configured to compensate for a step difference between the display region and the non-display region.

[0014] In another aspect, the present invention provides a method of manufacturing an organic light emitting diode (OLED) display device. The method includes providing a substrate having a display region and a non-display region surrounding the display region; forming an OLED on the substrate in the display region; forming an encapsulation substrate with an integrally-formed step-difference compensation portion in the non-display region for compensating for a step difference between the display region and the non-display region; and bonding to the substrate and the encapsulation substrate via an adhesive layer such that the encapsulation substrate and the substrate face each other.

[0015] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0017] FIG. **1** is a cross-sectional view illustrating defective bonding of a related art OLED display device;

[0018] FIGS. **2**A and **2**B are plan views illustrating an OLED display device according to one embodiment of the present invention;

[0019] FIG. **3**A is a cross-sectional view illustrating a portion of FIG. **2**A taken along line I-I';

[0020] FIG. **3**B is a cross-sectional view illustrating a step difference compensation portion of FIG. **2**A formed on a substrate;

[0021] FIG. **3**C is a cross-sectional view illustrating the step-difference compensation portion of FIG. **3**B having an inclined surface;

[0022] FIG. **4**A is a cross-sectional view illustrating an OLED display device according to another embodiment of the present invention;

[0023] FIG. **4**B is a photograph of an encapsulation substrate of FIG. **4**A;

[0024] FIG. **5** is a cross-sectional view illustrating an OLED display device according to still another embodiment of the present invention;

[0025] FIG. **6** is a cross-sectional view illustrating an OLED display device according to yet another embodiment of the present invention;

[0026] FIG. **7** is a plan view illustrating an OLED display device according to another embodiment of the present invention; and

[0027] FIG. **8** is a cross-sectional view illustrating an OLED display device according to still another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0029] Further, the thickness of the OLED **11** region is very small and thus the step difference is also small. The present inventors have advantageously determined that even though this step difference has been small, the step difference has negatively impacted the OLED **11**, because moisture, etc. reaches the OLED **11** through the step difference.

[0030] An OLED display device according to an embodiment of the present invention will now be described in detail with reference to the accompanying drawings.

[0031] FIGS. **2**A and **2**B are plan views illustrating an OLED display device according to one embodiment of the present invention. In particular, FIG. **2**A illustrates that a step-difference compensation portion is integrally formed with the non-display region to surround a display region, and FIG. **2**B illustrates that a step-difference compensation portion is partially formed. Further, FIG. **3**A is a cross-sectional view illustrating a portion of FIG. **2**A taken along line I-**1'**, and FIG. **3**B is a cross-sectional view illustrating a step difference compensation portion of FIG. **2**A formed on a substrate. In addition, FIG. **3**C is a cross-sectional view illustrating the step-difference compensation portion of FIG. **3**B having an inclined surface.

[0032] Referring to FIGS. **2**A and **3**A, the OLED display device includes a substrate **100** having a display region and a non-display region surrounding the display region, an OLED **110** formed on the substrate **100** in the display region, an encapsulation substrate **150** bonded to the substrate **100** via an adhesive layer **140** such that the encapsulation substrate **150** and the substrate **100** face each other, and a step-difference compensation portion **140***a* formed between the encapsulation substrate **150** and the adhesive layer **140** at a portion corresponding to the non-display region.

[0033] In addition, the step-difference compensation portion **140***a* may be integrally formed with the non-display region as illustrated in FIG. **2**A or partially formed in the non-display region as illustrated in FIG. **2**B. Further, gate lines and data lines are formed in a matrix array in the display region of the substrate **100**, and a plurality of sub-pixel regions are defined by intersections of the gate lines and data lines.

[0034] In addition, thin film transistors are respectively arranged at sub-pixel regions. The OLED **110** connected to the thin film transistor is also formed. In more detail, the OLED **110** includes a first electrode **110***a*, which is connected to the thin film transistor disposed in each sub-pixel region of a substrate, a light emitting layer **110***b*, and a second electrode **110***c*, which are sequentially laminated.

[0035] The first electrode **110***a* that constitutes an anode is formed of a transparent conductive material such as tin oxide (TO), indium tin oxide (ITO), indium zinc oxide (IZO), and indium tin zinc oxide (ITZO). A bank insulating film **120** that exposes a portion of the first electrode **110***a* is also formed over the substrate **100**. In more detail, the bank insulating film **120** partitions a plurality of OLEDs and defines luminescent regions of the display region.

[0036] Then, the organic light emitting layer **110***b* and the second electrode **110***c* are sequentially formed on the first electrode **110***a* exposed by the bank insulating film **120**. The light emitting layer **110***b* may be formed of a material emitting red (R), green (G), blue (B), or white (W) light in each of the sub-pixel regions. Alternatively, the light emitting layer **110***b* may be formed of a material emitting only white (W) light.

[0037] When the light emitting layer **110***b* is formed of a material emitting only white (W) light, each of the sub-pixel regions includes an R, G, or B color filter such that various colors may be realized while the white light emitted from the light emitting layer **110***b* passes through the R, G, or B color filter.

[0038] Further, the second electrode **110***c* disposed on the light emitting layer **110***b* constitutes a cathode and is formed of a reflective metallic material such as aluminum (Al) so as to reflect light emitted from the light emitting layer **110***b* toward the first electrode **110***a*. On the other hand, when the second electrode **110***c* is formed of a transparent conductive material, the first electrode **110***a* is formed of a reflective metal to reflect light emitted from the light emitting layer **110***b* toward the second electrode **110***c*.

[0039] As described above, the OLED **110** including the first electrode **110***a*, the light emitting layer **110***b*, and the second electrode **110***c*, which are sequentially laminated, emits light as holes and electrodes that are recombined in the light emitting layer **110***b* to create excitons in accordance with application of a voltage to the first and second electrodes **110***a* and **110***c*, and the excitons fall from an excited state to a ground state.

[0040] In addition, a hole injection layer and a hole transport layer may further be disposed between the first electrode **110***a* and the light emitting layer **110***b*. In more detail, the hole injection layer and the hole transport layer are used to facilitate hole injection into the light emitting layer **110***b*. Further, an electron injection layer and an electron transport layer may further be disposed between the light emitting layer **110***b* and the second electrode **110***c*. The electron injection layer and the electron transport layer are used to facilitate electron injection into the light emitting layer **110***b*.

[0041] In addition, because the OLED **110** is vulnerable to moisture and oxygen, a passivation film **130** is formed to cover the OLED **110** to block inflow of external moisture and oxygen. In the drawings, the passivation film **130** completely surrounds the OLED **110**. However, the passivation film **130** may be formed only on the OLED **110**.

[0042] Further, the passivation film **130** may be an inorganic film formed of at least one inorganic material selected from the group consisting of SiO_x, SiN_x, SiC, SiON, SiOC, SiONC, and amorphous carbon (a-C) or an organic film formed of at least one organic material selected from the group consisting of acrylates, epoxy polymers, and imide polymers. The passivation film **130** may also have a structure in which the inorganic layer and the organic layer are laminated at least once.

[0043] Then, the encapsulation substrate **150** is bonded to the entire surface of the substrate **100** via the adhesive layer **140**. Here, the encapsulation substrate **150** may be formed of glass, plastic, or metal foil to protect the OLED **110** from external moisture, oxygen, and the like. In addition, the adhesive layer **140** for bonding the encapsulation substrate **150** to the substrate **100** may be formed of an acrylic resin, a silicone resin, or a sealant.

[0044] As discussed previously, in the related art OLED display devices, the distance D2 between the substrate **100** and the encapsulation substrate **150** in the non-display region is greater than the distance D1 between the substrate **100** and the encapsulation substrate **150** in the display region due to a step difference between the display region and the non-display region as described above.

[0045] Thus, the substrate **100** is not sufficiently covered by the adhesive layer **140**. Accordingly, the non-display region of the substrate **100** cannot be sufficiently bonded to the encapsulation substrate **150**, so that external moisture and oxygen can enter the OLED **110**, thereby decreasing reliability.

[0046] Thus, the OLED display device according to an embodiment of the present invention includes a step-difference compensation portion **140*a*** that is interposed between the encapsulation substrate **150** and the adhesive layer **140** to correspond to the non-display region, thereby compensating for the step difference between the display region and the non-display region.

[0047] The step-difference compensation portion **140*a*** may be formed of a metal such as copper (Cu), aluminum (Al), and molybdenum (Mo) or an inorganic insulating material such as silicon oxide (SiO) and silicon nitride (SiN_x). Alternatively, the step-difference compensation portion **140*a*** may be formed of an organic insulating material such as benzocyclobutene and photo acryl or a mixed material of an inorganic insulating material and an organic insulating material. In addition, the step-difference compensation portion **140*a*** may have a thickness of 0.1 μm to 100 μm, preferably, 3 μm to 20 μm.

[0048] The OLED display device includes the step-difference compensation portion **140*a*** formed on the encapsulation substrate **150** corresponding to the non-display region to compensate for the step difference between the display region and the non-display region. Thus, the distance D1 between the substrate **100** and the encapsulation substrate **150** in the display region is substantially equal to the distance D2 between the substrate **100** and the encapsulation substrate **150** in the non-display region.

[0049] Therefore, the entire surface of the substrate **100** is sufficiently bonded to the encapsulation substrate **150** via the adhesive layer **140**. As a result, inflow of external moisture and oxygen into the OLED **110** is prevented, thereby improving the reliability of the display device.

[0050] Further, as shown in FIG. **3**B, the step-difference compensation portion **140*a*** may also be formed between the substrate **100** and the adhesive layer **140**, instead of being disposed between the encapsulation substrate **150** and the adhesive layer **140**. In this instance, the step-difference compensation portion **140*a*** may be formed when forming the OLED **110**. Further, as illustrated in FIG. **3**C, at least one side of the step-difference compensation portion **140*a*** may be inclined.

[0051] Next, FIG. **4**A is a cross-sectional view illustrating an OLED display device according to a second embodiment of the present invention, and FIG. **4**B is a photograph of an encapsulation substrate of FIG. **4**A.

[0052] The OLED display device according to this embodiment of the present invention does not include a step-difference compensation portion. Instead, edge portions of the encapsulation substrate **250** have greater thicknesses than a central portion of the encapsulation substrate **250**, so that the edge portions of the encapsulation substrate **250** function as the step-difference compensation portions.

[0053] In more detail, as illustrated in FIG. **4**A, the OLED display device includes a substrate **200** having a display region and a non-display region, an OLED **210** formed on the substrate **200** in the display region, and an encapsulation substrate **250** bonded to the substrate **200** via an adhesive layer **240**.

[0054] Here, edge portions of the encapsulation substrate **250** have greater thicknesses than a central portion of the encapsulation substrate **250**, which corresponds to the display region. Thus, the edge portions of the encapsulation substrate **250** function as step-difference compensation portions compensating for the step difference between the display region and non-display region.

[0055] In particular, gate lines and data lines are formed in a matrix array in the display region of the substrate **200**, and a plurality of sub-pixel regions are defined by intersections of the gate lines and data lines. In addition, thin film transistors are respectively arranged at sub-pixel regions. The OLED **210** connected to the thin film transistor is also formed, and includes a first electrode **210*a*,** which is connected to the thin film transistor disposed in each sub-pixel region of a substrate, a light emitting layer **210*b***, and a second electrode **210*c*,** which are sequentially laminated.

[0056] Then, a passivation film **230** is formed to cover the OLED **210**. The encapsulation substrate **250** formed of glass or plastic can also be bonded to the entire surface of the substrate **200** via the adhesive layer **240**. The encapsulation substrate **250** is also formed to protect the OLED **210** from external moisture and oxygen. The adhesive layer **240** may be formed of an acrylic resin, a silicone resin, or a sealant.

[0057] In addition, the edge portions of the encapsulation substrate **250** corresponding to the non-display region have greater thicknesses than the central portion of the encapsulation substrate **250** corresponding to the display region. In particular, the edge portions of the encapsulation substrate **250** have greater thicknesses than the central portion thereof by 0.1 μm to 100 μm, preferably, 3 μm to 20 μm.

[0058] Thus, as discussed above, the OLED display device according to the second embodiment of the present invention does not include the step-difference compensation portion at the encapsulation substrate **250** or the substrate **200** in the non-display region. As illustrated in FIG. **4**B, the adhesive layer **240** has a uniform thickness between the encapsulation substrate **250** and the substrate **200** due to the thickness difference of the encapsulation substrate **250**.

[0059] Thus, a distance D1 between an upper surface of the OLED **210** and the encapsulation substrate **250** is equal to a distance D2 between the non-display region of the substrate **100** in which the OLED **210** is not formed and the encapsulation substrate **150**. Accordingly, in the OLED display device, the entire surface of the substrate **200** is sufficiently bonded to the encapsulation substrate **250** via the adhesive layer **240**. As a result, inflow of external moisture and oxygen into the OLED **210** may be prevented, thereby improving reliability of the display device.

[0060] FIG. **4**B also illustrates the edge portion of the encapsulation substrate **250** is integrally formed with the encapsulation substrate. Thus, the encapsulation substrate **250** can be formed in a single process reducing the overall costs of manufacturing the display device.

[0061] Next, FIG. **5** is a cross-sectional view illustrating an OLED display device according to another embodiment of the present invention. In this OLED display device, an edge portion of a substrate, instead of an encapsulation substrate, has a greater thickness than a central portion thereof. Thus, edge portions of the substrate function as step-difference compensation portions.

[0062] Particularly, as illustrated in FIG. **5**, the OLED display device includes a substrate **300** having a display region and a non-display region, an OLED **310** formed on the substrate **300** in the display region, and an encapsulation substrate **350** bonded to the substrate **300** via an adhesive layer **340**. As shown, edge portions of the substrate **300** corresponding to the non-display region have greater thicknesses than a central portion of the substrate **300** corresponding to the display region.

[0063] Thus, the edge portions of the substrate **300** function as step-difference compensation portions that compensate for the step difference between the display region and the non-display region. Particularly, the thicknesses of the edge portions of the substrate **300** may be greater than that of the central portion thereof by 0.1 μm to 100 μm, preferably 3 μm to 20 μm. Further, the substrate **300** can be formed in a single process with the higher edge portions.

[0064] The OLED display device in this embodiment of the present invention does not include a step-difference compensation portion at the non-display region of the substrate **300** or the encapsulation substrate **350**. Further, the adhesive layer **340** has a uniform thickness between the encapsulation substrate **350** and the substrate **300** due to the thickness difference of the substrate **300**.

[0065] Thus, in the OLED display device according to this embodiment of the present invention, the entire surface of the substrate is sufficiently bonded to the encapsulation substrate via the adhesive layer. Therefore, inflow of external moisture and oxygen into the OLED is prevented, thereby improving the reliability of the display device.

[0066] Next, FIG. **6** is a cross-sectional view illustrating an OLED display device according to yet another embodiment of the present invention. In this embodiment, neither the substrate nor the encapsulation substrate is changed, but the adhesive layer has different thicknesses between a display region and a non-display region.

[0067] As illustrated in FIG. **6**, the OLED display device includes a substrate **400** having a display region and a non-display region, an OLED **410** formed on the substrate **400** in the display region, and an encapsulation substrate **450** bonded to the substrate **400** via an adhesive layer **440**. Edge portions of the adhesive layer **440** corresponding to the non-display region have greater thicknesses than a central portion thereof corresponding to the display region.

[0068] Particularly, the thickness of the central portion of the adhesive layer **440** is equal to the distance D**1** between the substrate **400** and the encapsulation substrate **450** in the display region, and the thicknesses of the edge portions of the adhesive layer **440** are equal to the distance D**2** between the substrate **400** and the encapsulation substrate **450** in the non-display region. Further, the edge portions of the adhesive layer **440** have greater thicknesses than the central portion thereof by 0.1 μm to 100 μm, preferably, 3 μm to 20 μm.

[0069] Next, FIG. **7** is an underside view of an encapsulation substrate **550** including a step-difference compensation portion according to another embodiment of the present invention. As shown, the encapsulation substrate **550** includes a step-difference compensation portion **540** formed around the bottom edges of the substrate **550**. The compensation portion **540** can be formed of beads or another type of material and are preferably formed completely around the outer edges of the substrate **550** to prevent moisture or other materials from reaching the OLED.

[0070] Thus, in one example, the substrate **550** can be formed, and then compensation portion **540** can be placed on the substrate **550**. For example, a glue gun can be used to place the compensation portion **540** around the edges. The encapsulation substrate **550** can then be flipped over and placed on the lower substrate including the OLED. Thus, the compensation portion **540** can be squeezed between the substrates and fill in or compensate for any step-difference.

[0071] Further, the compensation portion **540** can be beads or any material discussed above. For example, the material may be formed of a metal such as copper (Cu), aluminum (Al), and molybdenum (Mo) or an inorganic insulating material such as silicon oxide (SiO) and silicon nitride (SiN_x). Alternatively, the step-difference compensation portion **140*a*** may be formed of an organic insulating material such as benzocyclobutene and photo acryl or a mixed material of an inorganic insulating material and an organic insulating material. In addition, the step-difference compensation portion **140*a*** may have a thickness of 0.1 μm to 100 μm, preferably, 3 μm to 20 μm. When beads are used, the overall dimensions of the beads can satisfy this thickness dimension as well.

[0072] Beads also work particularly well, because they tend to expand when pressed against the lower substrate thereby creating a sufficient tension in the beads to further create a tighter seal between the substrates. FIG. **7** illustrates edges of the beads touching each other, but it is also possible to slightly separate each bead, which when pressed against the lower substrate will expand outwards so as to compete the seal between the substrates. The compensation portion **540** may also be integrally formed onto the encapsulation substrate **500** rather than added on in a separate step.

[0073] Next, FIG. **8** is a cross-sectional view illustrating an OLED display device according to yet another embodiment of the present invention. In particular, FIG. **8** is similar to FIG. **6** but includes a compensation portion **640*a***. As illustrated in FIG. **6**, the OLED display device includes a substrate **600** having a display region and a non-display region, an OLED **610** formed on the substrate **600** in the display region, and an encapsulation substrate **650** bonded to the substrate **600** via an adhesive layer **640**. Edge portions of the adhesive layer **640** corresponding to the non-display region also include the compensation portion **640*a***.

[0074] In addition, the components in FIG. **8** are similar to the components shown in FIG. 3A, for example, except use corresponding numbers in the 600 range. Accordingly, detailed descriptions of the additional elements in FIG. **8** are not repeated here. Further, the step-difference compensation portion **640*a*** is interposed within the adhesive layer **640** to correspond to the non-display region, thereby compensating for the step difference between the display region and the non-display region.

[0075] The step-difference compensation portion **640***a* may be formed of a metal such as copper (Cu), aluminum (Al), and molybdenum (Mo) or an inorganic insulating material such as silicon oxide (SiO) and silicon nitride (SiN_x). Alternatively, the step-difference compensation portion **140***a* may be formed of an organic insulating material such as benzocyclobutene and photo acryl or a mixed material of an inorganic insulating material and an organic insulating material.

[0076] The OLED display device in this embodiment includes the step-difference compensation portion **640***a* formed on within the adhesive layer **640** corresponding to the non-display region to compensate for the step difference between the display region and the non-display region. Thus, a strong bond is created between the adhesive layer and the compensation portion **640***a*.

[0077] Therefore, the entire surface of the substrate **600** is sufficiently bonded to the encapsulation substrate **650** via the adhesive layer **640** and compensation portion **640***a*. As a result, inflow of external moisture and oxygen into the OLED **610** can be prevented, thereby improving the reliability of the display device.

[0078] The present invention also related to a method of manufacturing an organic light emitting diode (OLED) display device. For example, the method includes providing a substrate **100**, **200**, **300**, **400**, **600** etc. having a display region and a non-display region surrounding the display region; forming an OLED **110**, **210**, **310**, **410**, **610**, etc. on the substrate in the display region; forming an encapsulation substrate **150**, **250**, **350**, **450**, **650**, etc. with an integrally-formed step-difference compensation portion in the non-display region for compensating for a step difference between the display region and the non-display region; and bonding to the substrate and the encapsulation substrate via an adhesive layer **140**, **240**, **340**, **440**, **640** such that the encapsulation substrate and the substrate face each other. Further, the integrally-formed step-difference compensation portion is preferably formed entirely around edges of the encapsulation substrate as shown in FIG. 4B. Further, the other substrate **100** can be integrally formed with the step-difference compensation portion.

[0079] As is apparent from the above description, according to the OLED display device according to the present invention, the step difference between the display region and the non-display region may be compensated for by forming the step-difference compensation portion between the encapsulation substrate and the adhesive layer or between the substrate and the adhesive layer in the non-display region, or by varying the thickness of the adhesive layer. Accordingly, the entire surface of the substrate is sufficiently bonded to the encapsulation substrate via the adhesive layer, so that inflow of external mixture and oxygen into the OLED may be prevented, thereby improving reliability.

[0080] The present invention encompasses various modifications to each of the examples and embodiments discussed herein. According to the invention, one or more features described above in one embodiment or example can be equally applied to another embodiment or example described above. The features of one or more embodiments or examples described above can be combined into each of the embodiments or examples described above. Any full or partial combination of one or more embodiment or examples of the invention is also part of the invention.

[0081] As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

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

a substrate having a display region and a non-display region surrounding the display region;

an OLED on the substrate in the display region;

an encapsulation substrate bonded to the substrate via an adhesive layer such that the encapsulation substrate and the substrate face each other; and

a step-difference compensation portion in the non-display region and configured to compensate for a step difference between the display region and the non-display region.

2. The OLED display device according to claim **1**, wherein the step-difference compensation portion is integrally formed with the encapsulation substrate.

3. The OLED display device according to claim **2**, wherein the step-difference compensation portion and the encapsulation substrate is a single body.

4. The OLED display device according to claim **2**, wherein a thickness of a portion of the encapsulation substrate corresponding to the non-display region is greater than a thickness of a portion of the encapsulation substrate corresponding to the display region.

5. The OLED display device according to claim **4**, wherein the thickness of the portion of the encapsulation substrate corresponding to the non-display region is greater than the thickness of the portion of the encapsulation substrate corresponding to the display region by 0.1 μm to 100 μm.

6. The OLED display device according to claim **1**, wherein the step-difference compensation portion is integrally formed with the non-display region and completely surrounds the display region.

7. The OLED display device according to claim **1**, wherein the step-difference compensation portion includes a material selected from the group consisting of a metal, an inorganic insulating material, and an organic insulating material or a mixed material of an inorganic insulating material and an organic insulating material.

8. The OLED display device according to claim **1**, wherein the step-difference compensation portion has a thickness of 0.1 μm to 100 μm.

9. The OLED display device according to claim **1**, wherein the step-difference compensation portion is integrally formed with the substrate.

10. The OLED display device according to claim **9**, wherein a thickness of a portion of the substrate corresponding to the non-display region is greater than a thickness of a portion of the substrate corresponding to the display region by 0.1 μm to 100 μm.

11. The OLED display device according to claim **1**, wherein the step-difference compensation portion has at least one inclined surface.

12. The OLED display device according to claim **1**, wherein a thickness of the adhesion layer at the step-difference compensation portion equals a thickness of the adhesion layer at a central portion thereof.

13. The OLED display device according to claim **15**, wherein the step-difference compensation portion has an inclined inner surface inclining towards the OLED.

14. The OLED display device according to claim **1**, wherein the adhesive layer corresponding to the non-display region is void of a gap region.

15. The OLED display device according to claim **14**, wherein a thickness of the portion of the adhesive layer corresponding to the non-display region is greater than a thickness of the portion of the adhesive layer corresponding to the display region by 0.1 μm to 100 μm.

16. The OLED display device according to claim **1**, wherein the step-difference compensation portion is within the adhesive layer.

17. A method of manufacturing an organic light emitting diode (OLED) display device, the method comprising:

providing a substrate having a display region and a non-display region surrounding the display region;

forming an OLED on the substrate in the display region;

forming an encapsulation substrate with an integrally-formed step-difference compensation portion in the non-display region for compensating for a step difference between the display region and the non-display region; and

bonding to the substrate and the encapsulation substrate via an adhesive layer such that the encapsulation substrate and the substrate face each other.

18. The method according to claim **17**, wherein the integrally-formed step-difference compensation portion is formed entirely around edges of the encapsulation substrate.

19. The method according to claim **17**, wherein a height of the integrally-formed step-difference compensation portion is 0.1 μm to 100 μm.

20. The method according to claim **17**, wherein outside edges of the integrally-formed step-difference compensation portion are inclined towards the encapsulation substrate.

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专利名称(译)	有机发光二极管显示装置		
公开(公告)号	[US20140175972A1]()	公开(公告)日	2014-06-26
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[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
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摘要(译)

一种有机发光二极管（OLED）显示装置，包括具有显示区域和围绕显示区域的非显示区域的基板;显示区域中的基板上的OLED;封装基板通过粘合层粘合到基板上，使得封装基板和基板彼此面对;非显示区域中的阶差补偿部分，用于补偿显示区域和非显示区域之间的阶梯差。