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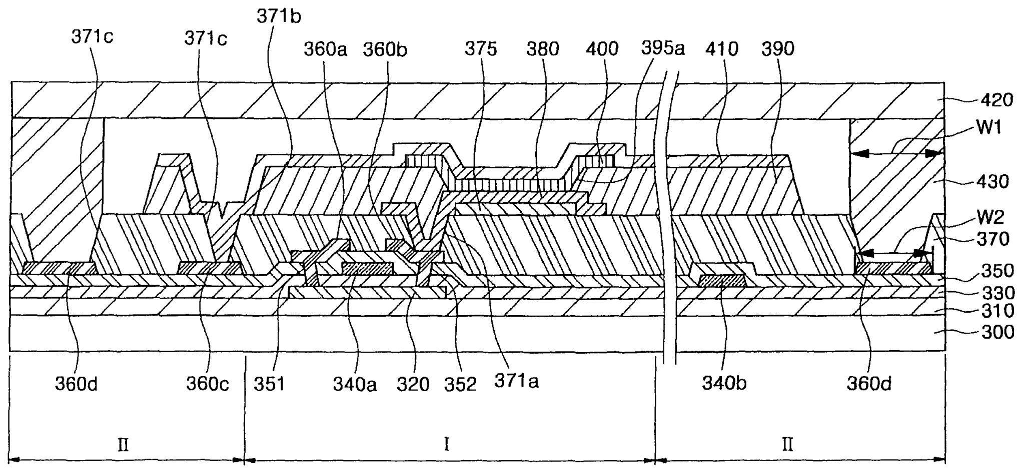
(54) **Organic light emitting display and method of fabricating the same**

(57) Provided are an organic light emitting display and a method of fabricating the same that are capable of preventing an element from being damaged due to a large amount of heat generated when the laser irradiates a glass frit for sealing a substrate. The organic light emitting display includes: a first substrate (300) comprising a pixel region (I) and a non-pixel region (II); an array of organic light emitting pixels formed over the pixel region; a conductive line (360d) formed over the non-pixel region; a second substrate (420) placed over the first substrate such that the array and the conductive line are interposed between the first and second substrates; and a frit seal interposed between the first and second substrates and surrounding the array, the frit seal (430) interconnecting the first and second substrates, the frit seal comprising a portion overlapping the conductive line, wherein when viewed from the second substrate, the portion of the frit seal substantially eclipses the conductive line.

FIG. 5



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an organic light emitting display and a method of fabricating the same, and more particularly, to packaging of an organic light emitting display.

Description of the Related Technology

[0002] With the goal of improving upon the shortcomings of conventional displays such as cathode ray tubes, attention has recently been focused on flat panel displays such as a liquid crystal display (LCD), an organic light emitting display (OLED), and a plasma display panel (PDP).

[0003] Since a liquid crystal display is a passive device rather than an emissive device, it is difficult to make it have high brightness and contrast, a wide viewing angle, and a large-sized screen. On the other hand, a PDP is an emissive device which is self-luminescent. However, a PDP is heavy, consumes a large amount of power, and requires a complex manufacturing process when compared to other displays.

[0004] An organic light emitting display (OLED) is an emissive device. An OLED has a wide viewing angle, and high contrast. In addition, since it does not require a backlight, it can be made lightweight, compact, and power efficient. Further, an OLED can be driven at a low DC voltage, has a rapid response speed, and is formed entirely of a solid material. As a result, the OLED has the ability to withstand external impact and a wide range of temperatures, and can be fabricated at a low cost.

SUMMARY OF CERTAIN INVENTIVE ASPECTS

[0005] According to a first aspect of the invention, there is provided an organic light emitting display (OLED) device as set out in Claim 1. Preferred features of this aspect are set out in Claims 2 to 12.

[0006] According to a second aspect of the invention, there is provided an method of making an organic light emitting display (OLED) device as set out in Claim 13. Preferred features of this aspect are set out in Claims 14 to 20.

[0007] Embodiments of the invention provide an organic light emitting display and a method of fabricating the same that are capable of preventing an element from being damaged due to a large amount of heat generated when the laser irradiates a glass frit for sealing a substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The above and other features of the invention will be described in reference to certain embodiments thereof with reference to the attached drawings in which:

[0009] FIG. 1 is a cross-sectional view of a conventional organic light emitting display; and

[0010] FIGS. 2 to 5 are cross-sectional views of an organic light emitting display in accordance with embodiments of the invention.

[0011] FIG. 6A is a schematic exploded view of a passive matrix type organic light emitting display device in accordance with one embodiment of the invention.

[0012] FIG. 6B is a schematic exploded view of an active matrix type organic light emitting display device in accordance with one embodiment of the invention.

[0013] FIG. 6C is a schematic top plan view of an organic light emitting display in accordance with one embodiment of the invention.

[0014] FIG. 6D is a cross-sectional view of the organic light emitting display of FIG. 6C, taken along the line d-d.

[0015] FIG. 6E is a schematic perspective view illustrating mass production of organic light emitting devices in accordance with one embodiment of the invention.

DETAILED DESCRIPTION OF CERTAIN INVENTIVE EMBODIMENTS

[0016] Certain embodiments of the invention will now be described more fully hereinafter with reference to the accompanying drawings. The invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. In the drawings, the thickness of layers and regions may be exaggerated for clarity. Like reference numerals indicate identical or functionally similar elements.

[0017] An organic light emitting display (OLED) is a display device comprising an array of organic light emitting diodes. Organic light emitting diodes are solid state devices which include an organic material and are adapted to generate and emit light when appropriate electrical potentials are applied.

[0018] OLEDs can be generally grouped into two basic types dependent on the arrangement with which the stimulating electrical current is provided. Fig. 6A schematically illustrates an exploded view of a simplified structure of a passive matrix type OLED 1000. Fig. 6B schematically illustrates a simplified structure of an active matrix type OLED 1001. In both configurations, the OLED 1000, 1001 includes OLED pixels built over a substrate 1002, and the OLED pixels include an anode 1004, a cathode 1006 and an organic layer 1010. When an appropriate electrical current is applied to the anode 1004, electric current flows through the pixels and visible light is emitted from the organic layer.

[0019] Referring to Fig. 6A, the passive matrix OLED (PMOLED) design includes elongate strips of anode 1004 arranged generally perpendicular to elongate strips of cathode 1006 with organic layers interposed therebetween. The intersections of the strips of cathode 1006 and anode 1004 define individual OLED pixels where light is generated and emitted upon appropriate excitation of the corresponding strips of anode 1004 and cathode 1006. PMOLEDs provide the advantage of relatively simple fabrication.

[0020] Referring to Fig. 6B, the active matrix OLED (AMOLED) includes driving circuits 1012 arranged between the substrate 1002 and an array of OLED pixels. An individual pixel of AMOLEDs is defined between the common cathode 1006 and an anode 1004, which is electrically isolated from other anodes. Each driving circuit 1012 is coupled with an anode 1004 of the OLED pixels and further coupled with a data line 1016 and a scan line 1018. In embodiments, the scan lines 1018 supply scan signals that select rows of the driving circuits, and the data lines 1016 supply data signals for particular driving circuits. The data signals and scan signals stimulate the local driving circuits 1012, which excite the anodes 1004 so as to emit light from their corresponding pixels.

[0021] In the illustrated AMOLED, the local driving circuits 1012, the data lines 1016 and scan lines 1018 are buried in a planarization layer 1014, which is interposed between the pixel array and the substrate 1002. The planarization layer 1014 provides a planar top surface on which the organic light emitting pixel array is formed. The planarization layer 1014 may be formed of organic or inorganic materials, and formed of two or more layers although shown as a single layer. The local driving circuits 1012 are typically formed with thin film transistors (TFT) and arranged in a grid or array under the OLED pixel array. The local driving circuits 1012 may be at least partly made of organic materials, including organic TFT. AMOLEDs have the advantage of fast response time improving their desirability for use in displaying data signals. Also, AMOLEDs have the advantages of consuming less power than passive matrix OLEDs.

[0022] Referring to common features of the PMOLED and AMOLED designs, the substrate 1002 provides structural support for the OLED pixels and circuits. In various embodiments of the invention, the substrate 1002 can comprise rigid or flexible materials as well as opaque or transparent materials, such as plastic, glass, and/or foil. As noted above, each OLED pixel or diode is formed with the anode 1004, cathode 1006 and organic layer 1010 interposed therebetween. When an appropriate electrical current is applied to the anode 1004, the cathode 1006 injects electrons and the anode 1004 injects holes. In certain embodiments of the invention, the anode 1004 and cathode 1006 are inverted; i.e., the cathode is formed on the substrate 1002 and the anode is opposingly arranged.

[0023] Interposed between the cathode 1006 and anode 1004 are one or more organic layers. More specifically, at least one emissive or light emitting layer is interposed between the cathode 1006 and anode 1004. The light emitting layer may comprise one or more light emitting organic compounds. Typically, the light emitting layer is configured to emit visible light in a single color such as blue, green, red or white. In the illustrated embodiment, one organic layer 1010 is formed between the cathode 1006 and anode 1004 and acts as a light emitting layer. Additional layers, which can be formed between the anode 1004 and cathode 1006, can include a hole transporting layer, a hole injection layer, an electron transporting layer and an electron injection layer.

[0024] Hole transporting and/or injection layers can be interposed between the light emitting layer 1010 and the anode 1004. Electron transporting and/or injecting layers can be interposed between the cathode 1006 and the light emitting layer 1010. The electron injection layer facilitates injection of electrons from the cathode 1006 toward the light emitting layer 1010 by reducing the work function for injecting electrons from the cathode 1006. Similarly, the hole injection layer facilitates injection of holes from the anode 1004 toward the light emitting layer 1010. The hole and electron transporting layers facilitate movement of the carriers injected from the respective electrodes toward the light emitting layer.

[0025] In some embodiments, a single layer may serve both electron injection and transportation functions or both hole injection and transportation functions. In some embodiments, one or more of these layers are lacking. In some embodiments, one or more organic layers are doped with one or more materials that help injection and/or transportation of the carriers. In embodiments where only one organic layer is formed between the cathode and anode, the organic layer may include not only an organic light emitting compound but also certain functional materials that help injection or transportation of carriers within that layer.

[0026] There are numerous organic materials that have been developed for use in these layers including the light emitting layer. Also, numerous other organic materials for use in these layers are being developed. In some embodiments, these organic materials may be macromolecules including oligomers and polymers. In some embodiments, the organic materials for these layers may be relatively small molecules. The skilled artisan will be able to select appropriate materials for each of these layers in view of the desired functions of the individual layers and the materials for the neighboring layers in particular designs.

[0027] In operation, an electrical circuit provides appropriate potential between the cathode 1006 and anode 1004. This results in an electrical current flowing from the anode 1004 to the cathode 1006 via the interposed organic layer(s). In one embodiment, the cathode 1006 provides electrons to the adjacent organic layer 1010. The anode 1004 injects holes to the organic layer 1010. The holes and electrons recombine in the organic layer 1010 and generate energy particles called "excitons." The excitons transfer their energy to the organic light emitting material in the organic layer 1010, and the energy is used to emit visible light from the organic light emitting material. The spectral characteristics of light generated and emitted by the OLED 1000, 1001 depend on the nature and composition of organic molecules in the organic layer(s). The composition of the one or more organic layers can be selected to suit the needs of a particular application by one of ordinary skill in the art.

[0028] OLED devices can also be categorized based on the direction of the light emission. In one type referred to as "top emission" type, OLED devices emit light and display images through the cathode or top electrode 1006. In these embodiments, the cathode 1006 is made of a material transparent or at least partially transparent with respect to visible light. In certain embodiments, to avoid losing any light that can pass through the anode or bottom electrode 1004, the anode may be made of a material substantially reflective of the visible light. A second type of OLED devices emits light through the anode or bottom electrode 1004 and is called "bottom emission" type. In the bottom emission type OLED devices, the anode 1004 is made of a material which is at least partially transparent with respect to visible light. Often, in bottom emission type OLED devices, the cathode 1006 is made of a material substantially reflective of the visible light. A third type of OLED devices emits light in two directions, e.g. through both anode 1004 and cathode 1006. Depending upon the direction(s) of the light emission, the substrate may be formed of a material which is transparent, opaque or reflective of visible light.

[0029] In many embodiments, an OLED pixel array 1021 comprising a plurality of organic light emitting pixels is arranged over a substrate 1002 as shown in Fig. 6C. The pixels in the array 1021 are controlled to be turned on and off by a driving circuit (not shown), and the plurality of the pixels as a whole displays information or image on the array 1021. In certain embodiments, the OLED pixel array 1021 is arranged with respect to other components, such as drive and control electronics to define a display region and a non-display region. In these embodiments, the display region refers to the area of the substrate 1002 where OLED pixel array 1021 is formed. The non-display region refers to the remaining areas of the substrate 1002. The non-display region can contain logic and/or power supply circuitry. It will be understood that there will be at least portions of control/drive circuit elements arranged within the display region. For example, in PMOLEDs, conductive components will extend into the display region to provide appropriate potential to the anode and cathodes. In AMOLEDs, local driving circuits and data/scan lines coupled with the driving circuits will extend into the display region to drive and control the individual pixels of the AMOLEDs.

[0030] One design and fabrication consideration in OLED devices is that certain organic material layers of OLED devices can suffer damage or accelerated deterioration from exposure to water, oxygen or other harmful gases. Accordingly, it is generally understood that OLED devices be sealed or encapsulated to inhibit exposure to moisture and oxygen or other harmful gases found in a manufacturing or operational environment. Fig. 6D schematically illustrates a cross-section of an encapsulated OLED device 1011 having a layout of Fig. 6C and taken along the line d-d of Fig. 6C. In this embodiment, a generally planar top plate or substrate 1061 engages with a seal 1071 which further engages with a bottom plate or substrate 1002 to enclose or encapsulate the OLED pixel array 1021. In other embodiments, one or more layers are formed on the top plate 1061 or bottom plate 1002, and the seal 1071 is coupled with the bottom or top substrate 1002, 1061 via such a layer. In the illustrated embodiment, the seal 1071 extends along the periphery of the OLED pixel array 1021 or the bottom or top plate 1002, 1061.

[0031] The seal 1071 is made of a frit material as will be further discussed below. In various embodiments, the top and bottom plates 1061, 1002 comprise materials such as plastics, glass and/or metal foils which can provide a barrier to passage of oxygen and/or water to thereby protect the OLED pixel array 1021 from exposure to these substances. At least one of the top plate 1061 and the bottom plate 1002 is formed of a substantially transparent material.

[0032] To lengthen the life time of OLED devices 1011, it is generally desired that seal 1071 and the top and bottom plates 1061, 1002 provide a substantially non-permeable seal to oxygen and water vapor and provide a substantially hermetically enclosed space 1081. In certain applications, it is indicated that the seal 1071 of a frit material in combination with the top and bottom plates 1061, 1002 provide a barrier to oxygen of less than approximately 10^{-3} cc/m^2-day and to water of less than 10^{-6} g/m^2-day. Given that some oxygen and moisture can permeate into the enclosed space 1081, in some embodiments, a material that can take up oxygen and/or moisture is formed within the enclosed space 1081.

[0033] The seal 1071 has a width W, which is its thickness in a direction parallel to a surface of the top or bottom substrate 1061, 1002 as shown in Fig. 6D. The width varies among embodiments and ranges from about 300 μm to about 3000 μm, optionally from about 500 μm to about 1500 μm. Also, the width may vary at different positions of the seal 1071. In some embodiments, the width of the seal 1071 may be the largest where the seal 1071 contacts one of the bottom and top substrate 1002, 1061 or a layer formed thereon. The width may be the smallest where the seal 1071 contacts the other. The width variation in a single cross-section of the seal 1071 relates to the cross-sectional shape of the seal 1071 and other design parameters.

[0034] The seal 1071 has a height H, which is its thickness in a direction perpendicular to a surface of the top or bottom substrate 1061, 1002 as shown in Fig. 6D. The height varies among embodiments and ranges from about 2 μm to about 30 μm, optionally from about 10 μm to about 15 μm. Generally, the height does not significantly vary at different positions of the seal 1071. However, in certain embodiments, the height of the seal 1071 may vary at different positions thereof.

[0035] In the illustrated embodiment, the seal 1071 has a generally rectangular cross-section. In other embodiments, however, the seal 1071 can have other various cross-sectional shapes such as a generally square cross-section, a generally trapezoidal cross-section, a cross-section with one or more rounded edges, or other configuration as indicated by the needs of a given application. To improve hermeticity, it is generally desired to increase the interfacial area where the seal 1071 directly contacts the bottom or top substrate 1002, 1061 or a layer formed thereon. In some embodiments, the shape of the seal can be designed such that the interfacial area can be increased.

[0036] The seal 1071 can be arranged immediately adjacent the OLED array 1021, and in other embodiments, the seal 1071 is spaced some distance from the OLED array 1021. In certain embodiment, the seal 1071 comprises generally linear segments that are connected together to surround the OLED array 1021. Such linear segments of the seal 1071 can extend, in certain embodiments, generally parallel to respective boundaries of the OLED array 1021. In other embodiment, one or more of the linear segments of the seal 1071 are arranged in a non-parallel relationship with respective boundaries of the OLED array 1021. In yet other embodiments, at least part of the seal 1071 extends between the top plate 1061 and bottom plate 1002 in a curvilinear manner.

[0037] As noted above, in certain embodiments, the seal 1071 is formed using a frit material or simply "frit" or "glass frit" which includes fine glass particles. The frit particles includes one or more of magnesium oxide (MgO), calcium oxide (CaO), barium oxide (BaO), lithium oxide (Li_2O), sodium oxide (Na_2O), potassium oxide (K_2O), boron oxide (B_2O_3), vanadium oxide (V_2O_5), zinc oxide (ZnO), tellurium oxide (TeO_2), aluminum oxide (Al_2O_3), silicon dioxide (SiO_2), lead oxide (PbO), tin oxide (SnO), phosphorous oxide (P_2O_5), ruthenium oxide (Ru_2O), rubidium oxide (Rb_2O), rhodium oxide (Rh_2O), ferrite oxide (Fe_2O_3), copper oxide (CuO), titanium oxide (TiO_2), tungsten oxide (WO_3), bismuth oxide (Bi_2O_3), antimony oxide (Sb_2O_3), lead-borate glass, tin-phosphate glass, vanadate glass, and borosilicate, etc. In some embodiments, these particles range in size from about 2 μm to about 30 μm, optionally about 5 μm to about 10 μm, although not limited only thereto. The particles can be as large as about the distance between the top and bottom substrates 1061, 1002 or any layers formed on these substrates where the frit seal 1071 contacts.

[0038] The frit material used to form the seal 1071 can also include one or more filler or additive materials. The filler or additive materials can be provided to adjust an overall thermal expansion characteristic of the seal 1071 and/or to adjust the absorption characteristics of the seal 1071 for selected frequencies of incident radiant energy. The filler or additive material(s) can also include inversion and/or additive fillers to adjust a coefficient of thermal expansion of the frit. For example, the filler or additive materials can include transition metals, such as chromium (Cr), iron (Fe), manganese (Mn), cobalt (Co), copper (Cu), and/or vanadium. Additional materials for the filler or additives include $ZnSiO_4$, $PbTiO_3$, ZrO_2, eucryptite.

[0039] In some embodiments, a frit material as a dry composition contains glass particles from about 20 to 90 about wt%, and the remaining includes fillers and/or additives. In some embodiments, the frit paste contains about 10-30 wt% organic materials and about 70-90% inorganic materials. In some embodiments, the frit paste contains about 20 wt% organic materials and about 80 wt% organic materials. In some embodiments, the organic materials may include about 0-30 wt% binder(s) and about 70-100 wt% solvent(s). In some embodiments, about 10 wt% is binder(s) and about 90 wt% is solvent (s) among the organic materials. In some embodiments, the inorganic materials may include about 0-10 wt% additives, about 20-40 wt% fillers and about 50-80 wt% glass powder. In some embodiments, about 0-5 wt% is additive(s), about 25-30 wt% is filler(s) and about 65-75 wt% is the glass powder among the inorganic materials.

[0040] In forming a frit seal, a liquid material is added to the dry frit material to form a frit paste. Any organic or inorganic solvent with or without additives can be used as the liquid material. In embodiments, the solvent includes one or more organic compounds. For example, applicable organic compounds are ethyl cellulose, nitro cellulose, hydroxyl propyl cellulose, butyl carbitol acetate, terpineol, butyl cellusolve, acrylate compounds. Then, the thus formed frit paste can be applied to form a shape of the seal 1071 on the top and/or bottom plate 1061, 1002.

[0041] In one embodiment, a shape of the seal 1071 is initially formed from the frit paste and interposed between the top plate 1061 and the bottom plate 1002. The seal 1071 can in certain embodiments be pre-cured or pre-sintered to one of the top plate and bottom plate 1061, 1002. Following assembly of the top plate 1061 and the bottom plate 1002 with the seal 1071 interposed therebetween, portions of the seal 1071 are selectively heated such that the frit material forming the seal 1071 at least partially melts. The seal 1071 is then allowed to resolidify to form a secure joint between the top plate 1061 and the bottom plate 1002 to thereby inhibit exposure of the enclosed OLED pixel array 1021 to oxygen or water.

[0042] In some embodiments, the selective heating of the frit seal is carried out by irradiation of light, such as a laser or directed infrared lamp. As previously noted, the frit material forming the seal 1071 can be combined with one or more additives or filler such as species selected for improved absorption of the irradiated light to facilitate heating and melting of the frit material to form the seal 1071.

[0043] In some embodiments, OLED devices 1011 are mass produced. In an embodiment illustrated in Fig. 6E, a plurality of separate OLED arrays 1021 is formed on a common bottom substrate 1101. In the illustrated embodiment, each OLED array 1021 is surrounded by a shaped frit to form the seal 1071. In embodiments, common top substrate (not shown) is placed over the common bottom substrate 1101 and the structures formed thereon such that the OLED arrays 1021 and the shaped frit paste are interposed between the common bottom substrate 1101 and the common top substrate. The OLED arrays 1021 are encapsulated and sealed, such as via the previously described enclosure process for a single OLED display device. The resulting product includes a plurality of OLED devices kept together by the common bottom and top substrates. Then, the resulting product is cut into a plurality of pieces, each of which constitutes an OLED device 1011 of Fig. 6D. In certain embodiments, the individual OLED devices 1011 then further undergo additional packaging operations to further improve the sealing formed by the frit seal 1071 and the top and bottom substrates 1061, 1002.

[0044] FIG. 1 is a cross-sectional view of a conventional organic light emitting display. Referring to FIG. 1, the organic light emitting display includes a substrate 100, a semiconductor layer 110, a gate insulating layer 120, a gate electrode 130a, a scan driver 130b, an interlayer insulating layer 140, and source and drain electrodes 150. The substrate 100 has a pixel region I and a non-pixel region II. In addition, the organic light emitting display further includes a common power supply line 150b which is electrically connected to the source and drain electrodes 150. The organic light emitting display also includes a second electrode power supply line 150a.

[0045] A planarization layer 160 is disposed over the substantially entire surface of the substrate 100. The planarization layer 160 may include an organic material such as acryl-based resin or polyimide-based resin.

[0046] The planarization layer 160 has via-holes for exposing the common power supply line 150b, the second electrode power supply line 150a, and the source and drain electrodes 150. The common power supply line 150b is exposed to enhance adhesive strength when the substrate is sealed using a glass frit.

[0047] A first electrode 171 including a reflective layer 170 is disposed over portions of the planarization layer 160 in the pixel region I. A pixel defining layer 180 is disposed over the substantially entire surface of the substrate 100.

[0048] An organic layer 190 including at least one emission layer is disposed over the first electrode 171. A second electrode 200 is disposed over the organic layer 190. An encapsulation substrate 210 is disposed opposite to the substrate 100. The substrate 100 and the encapsulation substrate 210 are sealed with a glass frit 220.

[0049] The illustrated organic light emitting display includes the common power supply line disposed under the glass frit 220 for sealing the substrate. The common power supply line has a width wider than the glass frit. Therefore, when a laser beam is radiated to the glass frit, the laser beam may be also radiated to a portion of the common power supply line. The common power supply line may transfer a heat generated by the laser to the second power supply line, thereby transferring the heat into an element along the second electrode. This problem may damage the organic layer, degrading the reliability of the organic light emitting display.

[0050] FIGS. 2 to 5 are cross-sectional views of an organic light emitting display in accordance with embodiments of the present invention. Referring to FIG. 2, a substrate 300 includes a pixel region I and a non-pixel region II. The substrate 300 may be an insulating glass substrate, a plastic substrate, or a conductive substrate.

[0051] In the illustrated embodiment, a buffer layer 310 is formed over the substantially entire surface of the substrate 300. The buffer layer 310 may be a silicon oxide layer, a silicon nitride layer, or a composite layer of silicon oxide and silicon nitride. In addition, the buffer layer 310 may functions as a passivation layer for preventing impurities from out-diffusing from the substrate 300.

[0052] Next, a semiconductor layer 320 is formed on a portion of the buffer layer 310 in the pixel region I. The semiconductor layer 320 may include amorphous silicon or polysilicon. Then, a gate insulating layer 330 is formed over the substantially entire surface of the substrate 300. The gate insulating layer 330 may be a silicon oxide layer, a silicon nitride layer, or a composite layer of silicon oxide and silicon nitride.

[0053] Then, a gate electrode 340a is formed over the gate insulating layer 330. The gate electrode 340a overlaps with a portion of the semiconductor layer 320. The gate electrode 340a may be formed of Al, Cu, or Cr.

[0054] Next, an interlayer insulating layer 350 is formed over the substantially entire surface of the substrate 300. The interlayer insulating layer 350 may be a silicon oxide layer, a silicon nitride layer, or a composite layer of silicon oxide and silicon nitride. The interlayer insulating layer 350 and the gate insulating layer 330 in the pixel region I are etched to form contact holes 351 and 352 for exposing portions of the semiconductor layer 320.

[0055] Then, source and drain electrodes 360a and 360b are formed on the interlayer insulating layer 350 in the pixel region I. The source and drain electrodes 360a and 360b may be formed of one selected from the group consisting of Mo, Cr, Al, Ti, Au, Pd and Ag. In addition, the source and drain electrodes 360a and 360b are electrically connected to the semiconductor layer 320 through the contact holes 351 and 352.

[0056] Further, when forming the source and drain electrodes 360a and 360b, a conductive line 360d may be formed in the non-pixel region II. The conductive line 360d may act as a common power supply line. In addition, a second electrode power supply line 360c may also be formed at the same time. Furthermore, when the gate electrode 340a is formed, a scan driver 340b may be formed in the non-pixel region II.

[0057] In one embodiment, the conductive line 360d in the non-pixel region II is narrower than a glass frit 430 (Figure 5) which will be formed over the conductive line 360d. The glass frit 430 may have a portion overlapping the conductive line 360d. When viewed from above (i.e. in a direction perpendicular to the substrate 300), the portion of the glass frit substantially eclipses the conductive line 360d. In one embodiment, the glass frit may have a width W1 between about 0.6mm and about 0.7mm. The width W1 of the glass frit, however, may vary depending on the design of an OLED device. The width W2 of the conductive line 360d may be adapted to that of the glass frit. In one embodiment, the width W2 of the conductive line 360d is about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about 65%, about 70%, about 75%, about 80%, about 85%, about 90%, about 95%, about 96%, about 97%, about 98%, about 99%, or about 100% of the maximum width W1 of the glass frit 430.

[0058] The glass frit serves as a sealant for the OLED device, as will be described later in more detail. The glass frit is attached to at least a portion of the top surface of the conductive line 360d by a laser process. During the laser process, a laser beam is irradiated onto the glass frit from above. In one embodiment, the diameter of the laser beam may be equal to or larger than the width of the glass frit. At least a portion of the laser beam may be irradiated on edge portions of the glass frit. In certain embodiments, the diameter of the laser beam may be smaller than the width of the glass frit. In such embodiments, the laser beam may be irradiated onto the edge portions of the glass frit by moving the laser beam over the edge portions. These configurations facilitate curing edge portions of the glass frit.

[0059] If the conductive line is wider than the glass frit, as in the conventional organic light emitting display of Figure 1, the conductive line may be exposed to the laser beam during the laser process. The conductive line may transfer a heat generated by the laser beam to the second electrode power supply line. The heat may be transferred through the second electrode to another element. This problem causes damages to an organic layer in the pixel region I. The illustrated conductive line 360d has a narrower width than that of the glass frit sealant. In addition, the substantially entire portion of the conductive line 360d is covered by the glass frit. This configuration prevents the conductive line 360d from being exposed to the laser beam during the laser process.

[0060] In the illustrated embodiment, a top-gate thin film transistor is described. In other embodiments, the conductive line structure may apply to a bottom-gate thin film transistor having a gate electrode disposed under a semiconductor layer. In certain embodiments, the conductive line may be formed simultaneously with forming the gate electrode or a first electrode which will be described later.

[0061] Referring to FIG. 3, a planarization layer 370 is formed over the substantially entire surface of the substrate 300. The planarization layer 370 may include an organic layer, an inorganic layer, or a composite layer thereof. The inorganic layer may be formed by spin on glass (SOG). The organic layer may include an acryl-based resin, a polyimide-based resin, or benzocyclobutene (BCB).

[0062] The planarization layer 370 in the pixel region I is etched to form a via-hole 371a for exposing one of the source and drain electrodes. The planarization layer 370 in the non-pixel region II is etched to form openings 371b and 371c for exposing the conductive line 360d and the second electrode power supply line 360c. The conductive line 360d is exposed to increase adhesive strength with the substrate when the substrate is sealed by the glass frit.

[0063] Referring to FIG. 4, a first electrode 380 including a reflective layer 375 is formed on the planarization 370 in the pixel region I. The first electrode 380 is disposed on a bottom surface of the via-hole 371 to be in contact with one of the exposed source and drain electrodes 360a and 360b. The first electrode 380 also extends onto portions of the planarization layer 370. The first electrode 380 may be formed of indium tin oxide (ITO) or indium zinc oxide (IZO).

[0064] Then, a pixel defining layer 390 is formed over the substantially entire surface of the substrate 300. The pixel defining layer 390 also covers the first electrode 380 to a thickness sufficient to fill the via-hole 371a, in which the first electrode 380 is disposed. The pixel defining layer 390 may be formed of an organic layer or an inorganic layer. In one embodiment, the pixel defining layer 390 is formed of one selected from the group consisting of BCB, an acryl-based polymer, and polyimide. The pixel defining layer 390 may have high flowability such that the pixel defining layer can be evenly formed over the substantially entire surface of the substrate.

[0065] The pixel defining layer 390 is etched to form an opening 395a for exposing the first electrode 380 in the pixel region I, and an opening 395b for exposing a portion of the second electrode power supply line 360c in the non-pixel region II. In addition, the pixel defining layer 390 is also etched to expose a portion of the conductive line 360d in the non-pixel region II.

[0066] Then, an organic layer 400 is formed on the first electrode 380 exposed through the opening 395a. The organic layer 400 includes at least an emission layer. The organic layer 400 may further include at least one of a hole injection layer, a hole transport layer, an electron transport layer, and an electron injection layer.

[0067] Next, a second electrode 410 is formed over the substantially entire surface of the substrate 300. The second electrode 410 is a transmissive electrode. The second electrode may be formed of Mg, Ag, Al, Ca, or an alloy of two or more of the foregoing. The second electrode may be formed of a material which is transparent and has a low work function. The second electrode 410 in the non-pixel region II may be etched to expose the conductive line 360d and the planarization layer 370.

[0068] Referring to FIG. 5, an encapsulation substrate 420 is placed opposite to the substrate 300. The encapsulation substrate 420 may be formed of an etched insulating glass or a non-etched insulating glass.

[0069] Then, a glass frit 430 is applied to edges of the encapsulation substrate 420. The glass frit 430 may be formed of one or more materials selected from the group consisting of magnesium oxide (MgO), calcium oxide (CaO), barium oxide (BaO), lithium oxide (Li_2O), sodium oxide (Na_2O), potassium oxide (K_2O), boron oxide (B_2O_3), vanadium oxide (V_2O_5), zinc oxide (ZnO), tellurium oxide (TeO_2), aluminum oxide (Al_2O_3), silicon dioxide (SiO_2), lead oxide (PbO), tin oxide (SnO), phosphorous oxide (P_2O_5), ruthenium oxide (Ru_2O), rubidium oxide (Rb_2O), rhodium oxide (Rh_2O), ferrite oxide (Fe_2O_3), copper oxide (CuO), titanium oxide (TiO_2) tungsten oxide (WO_3), bismuth oxide (Bi_2O_3), antimony oxide (Sb_2O_3), lead-borate glass, tin-phosphate glass, vanadate glass, and borosilicate. The glass frit 430 may be applied by a dispensing method or a screen printing method.

[0070] In the illustrated embodiment, the glass frit 430 is first applied to the encapsulation substrate 420 and then the encapsulation substrate 420 with the glass frit 430 is placed over the substrate 300. In other embodiments, the glass frit 430 may be first applied to the substrate 300, and then the encapsulation substrate 420 is placed over the substrate 300.

[0071] Then, the encapsulation substrate 420 is aligned with the substrate 300. The glass frit 430 is in contact with the conductive line 360d and the planarization layer 370 formed over the substrate 300.

[0072] Next, when the glass frit 430 is irradiated with a laser beam, the glass frit 430 is melted and solidified to adhere to the substrate and the encapsulation substrate, thereby sealing the organic light emitting display.

[0073] As described above, the illustrated conductive line has a width narrower than that of the glass frit, thereby reducing heat transfer to elements in the pixel region during the laser process. Thus, the reliability of the resulting OLED can be improved.

[0074] As can be seen from the foregoing, in an organic light emitting display and a method of fabricating the same in accordance with the embodiments, it is possible to prevent an element from being damaged due to a large amount of heat generated when the laser beam is radiated to a glass frit for sealing a substrate.

[0075] Although the invention has been described with reference to certain embodiments thereof, it will be understood by those skilled in the art that a variety of modifications and variations may be made to the invention without departing from the scope of the invention defined in the appended claims, and their equivalents.

Claims

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

   a first substrate comprising a pixel region and a non-pixel region;
   an array of organic light emitting pixels formed over the pixel region;
   a conductive line formed over the non-pixel region;
   a second substrate placed over the first substrate such that the array and the conductive line are interposed between the first and second substrates; and
   a frit seal interposed between the first and second substrates and surrounding the array, the frit seal interconnecting the first and second substrates, the frit seal comprising a portion overlapping the conductive line in a segment of the device where the frit seal is formed, wherein the portion of the frit seal substantially eclipses the conductive line in the segment when viewed from the second substrate.

2. A device according to Claim 1, wherein the conductive line is electrically connected to the array via another electrical interconnection.

3. A device according to Claim 1 or 2, further comprising a plurality of thin film transistors interposed between the first substrate and the array, wherein the conductive line is connected to the plurality of thin film transistors.

4. A device according to any one of Claims 1 to 3, further comprising a planarization layer formed over at least part of the non-pixel region of the first substrate, wherein the frit seal contacts the planarization layer.

5. A device according to any one of Claims 1 to 4, wherein the frit seal contacts the conductive line.

6. A device according to any one of Claims 1 to 5, wherein the conductive line extends along a peripheral edge of the first substrate, and wherein the portion of the frit seal extends along the peripheral edge of the first substrate.

7. A device according to any one of Claims 1 to 6, wherein the portion extends at least the length of one side of the array.

8. A device according to any one of Claims 1 to 7, wherein the frit seal further comprises a non-eclipsing portion in another segment of the device, wherein the non-eclipsing portion of the frit seal does not eclipse the conductive line when viewed from the second substrate.

9. A device according to any one of Claims 1 to 8, wherein the portion of the frit seal has a width, and the conductive line has a width where the portion of the frit seal overlaps with the conductive line, and wherein the width of the portion of the frit is substantially greater than the width of the conductive line.

10. A device according to any one of Claims 1 to 8, wherein the portion of the frit seal has a width, and

the conductive line has a width where the portion of the frit seal overlaps with the conductive line, and wherein the width of the portion of the frit seal is from about 100% to about 200% of the width of the conductive line.

11. A device according to any preceding Claim, wherein the conductive line is made of metal.

12. A device according to any preceding Claim, wherein the frit seal comprises one or more materials selected from the group consisting of magnesium oxide (MgO), calcium oxide (CaO), barium oxide (BaO), lithium oxide (Li_2O), sodium oxide (Na_2O), potassium oxide (K_2O), boron oxide (B_2O_3), vanadium oxide (V_2O_5), zinc oxide (ZnO), tellurium oxide (TeO_2), aluminum oxide (Al_2O_3), silicon dioxide (SiO_2), lead oxide (PbO), tin oxide (SnO), phosphorous oxide (P_2O_5), ruthenium oxide (Ru_2O), rubidium oxide (Rb_2O), rhodium oxide (Rh_2O), ferrite oxide (Fe_2O_3), copper oxide (CuO), titanium oxide (TiO_2), tungsten oxide (WO_3), bismuth oxide (Bi_2O_3), antimony oxide (Sb_2O_3), lead-borate glass, tin-phosphate glass, vanadate glass, and borosilicate.

13. A method of making an organic light emitting display (OLED) device, the method comprising:

providing an unfinished device comprising a first substrate, an array of organic light emitting pixels formed over the first substrate, and a conductive line formed over the substrate and not overlapping the array;
further providing a second substrate;
interposing a frit between the first and second substrates such that the array is interposed between the first and second substrates, that the frit surrounds the array and that a portion of the frit overlaps the conductive line, whereby the portion of the frit seal substantially eclipses the conductive line when viewed from the second substrate; and
melting and resolidifying at least part of the frit so as to interconnect the unfinished device and the second substrate via the frit, wherein the frit connects to the conductive line with or without a material therebetween, and wherein the frit connects to the second substrate with or without a material therebetween.

14. A method according to Claim 13, wherein melting comprises applying heat to the at least part of the frit.

15. A method according to Claim 13 or 14, wherein melting comprises applying laser or infrared light to the at least part of the frit in a direction from the second substrate to the first substrate, and wherein substantially all the light reaching the conductive line reaches the electrically conductive line after passing through the frit.

16. A method according to any one of Claims 13 to 15, wherein the conductive line is made of metal.

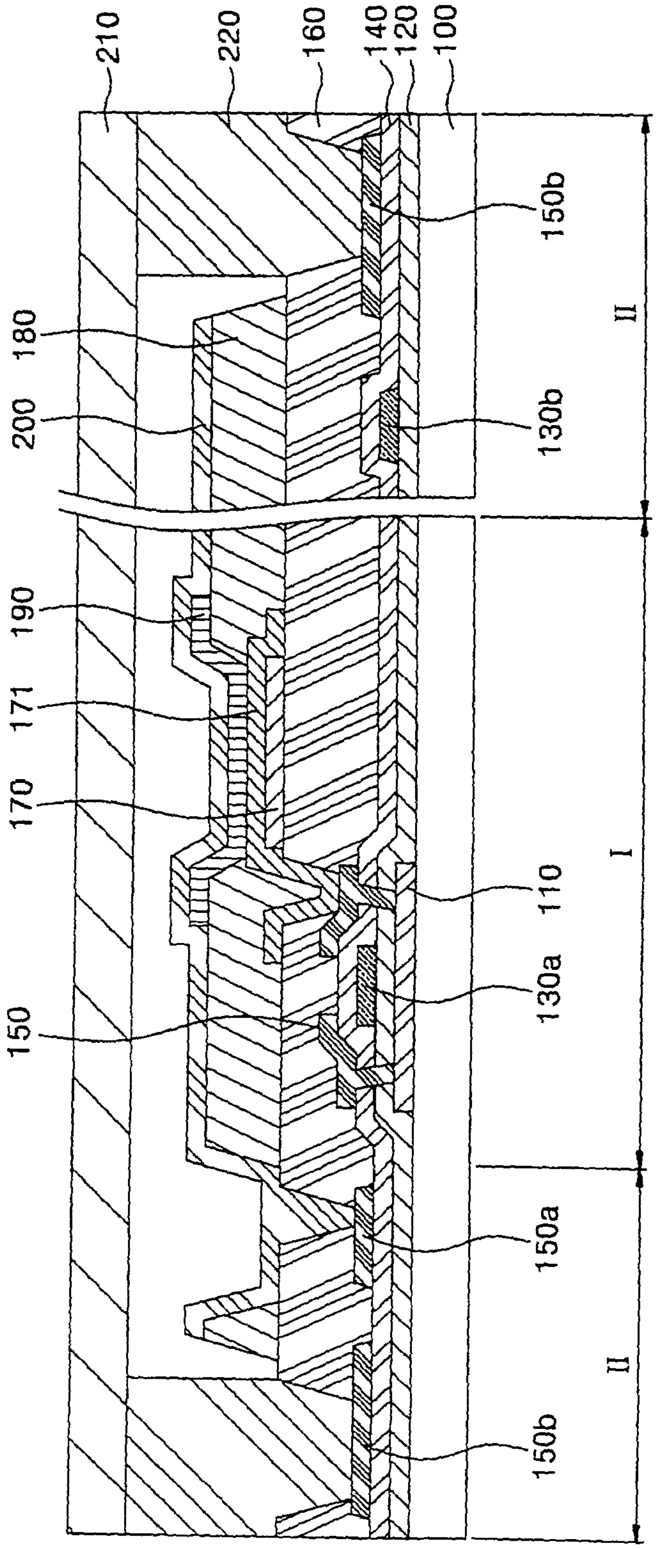
17. A method according to any one of Claims 13 to 16, wherein interposing the frit comprises contacting the frit with the conductive line.

18. A method according to any one of Claims 13 to 17, wherein interposing the frit comprises contacting the frit with the second substrate.

19. A method according to any one of Claims 13 to 18, wherein the unfinished device further comprises a planarization layer generally formed over the conductive line with an opening exposing part of the conductive line, and wherein interposing the frit comprises contacting the frit with the conductive line through the opening.

20. A method according to any one of Claims 13 to 19, wherein the portion of the frit seal has a width, and the conductive line has a width where the portion overlaps, and wherein the width of the portion is from about 100% to about 200% of the width of the conductive line.

FIG. 1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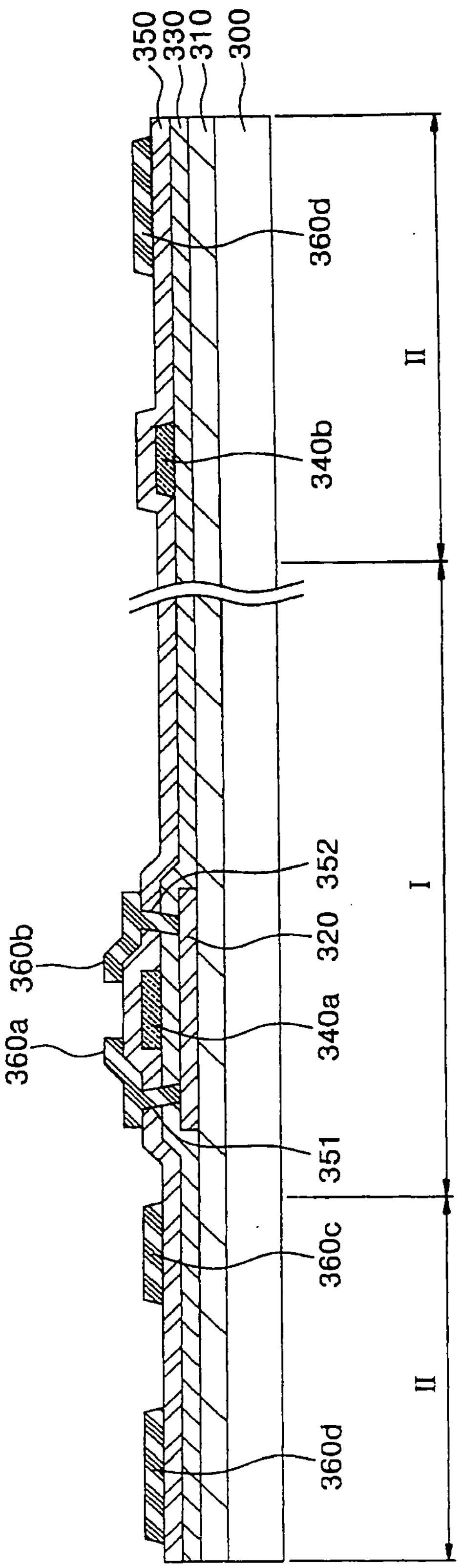
150a
II
150b

FIG. 2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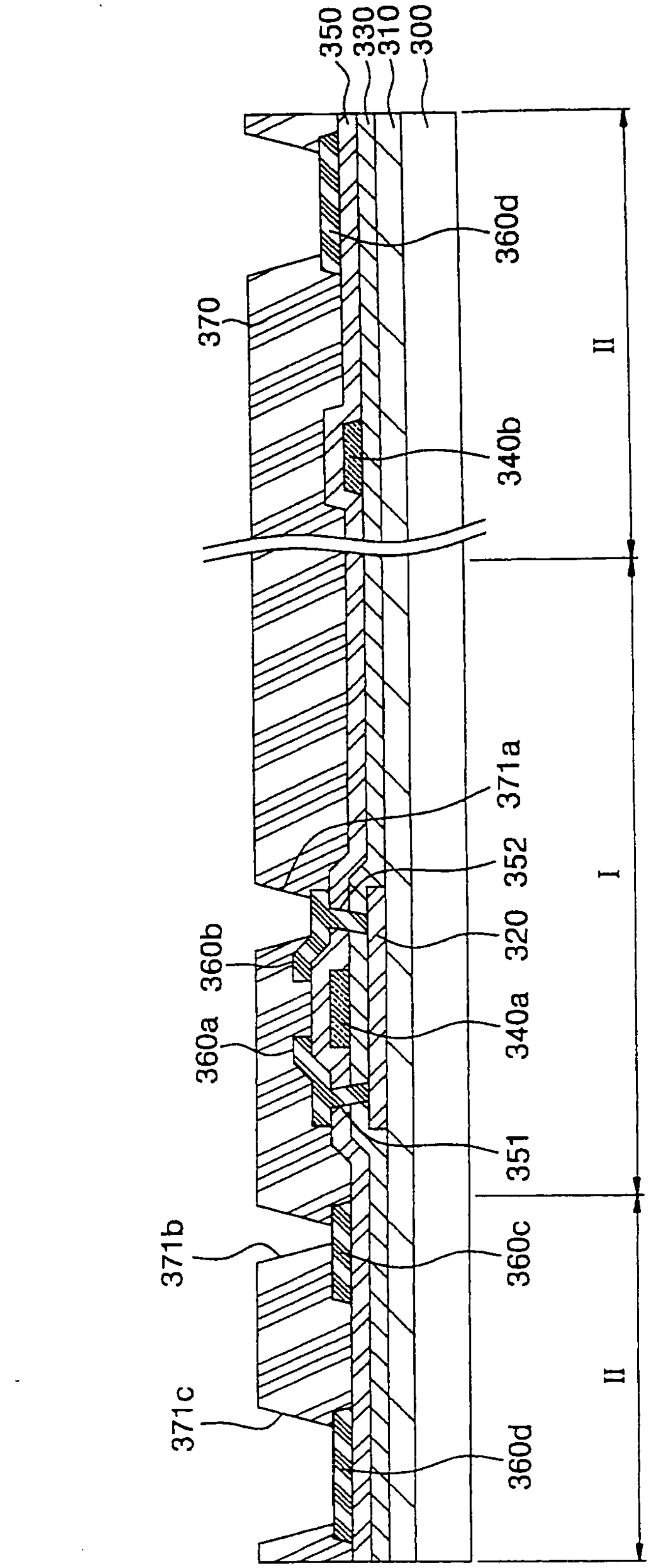
360d

FIG. 3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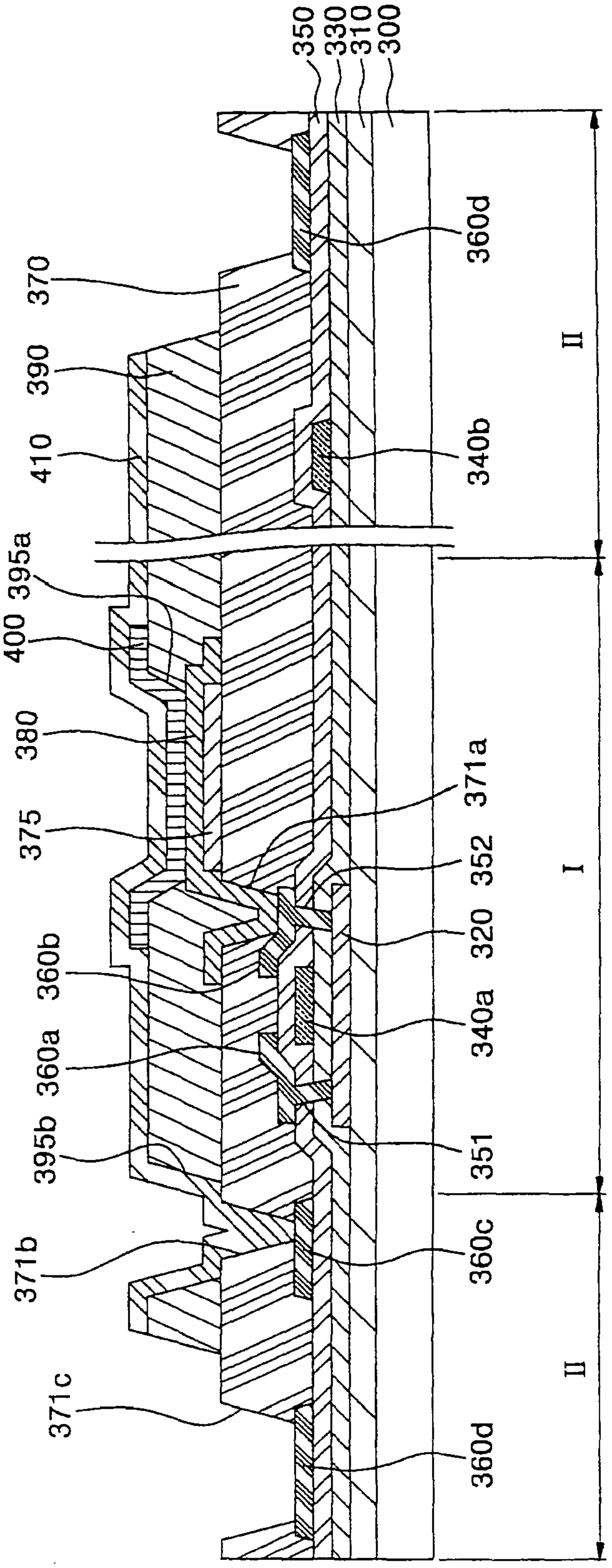
371c
360d
II

FIG. 4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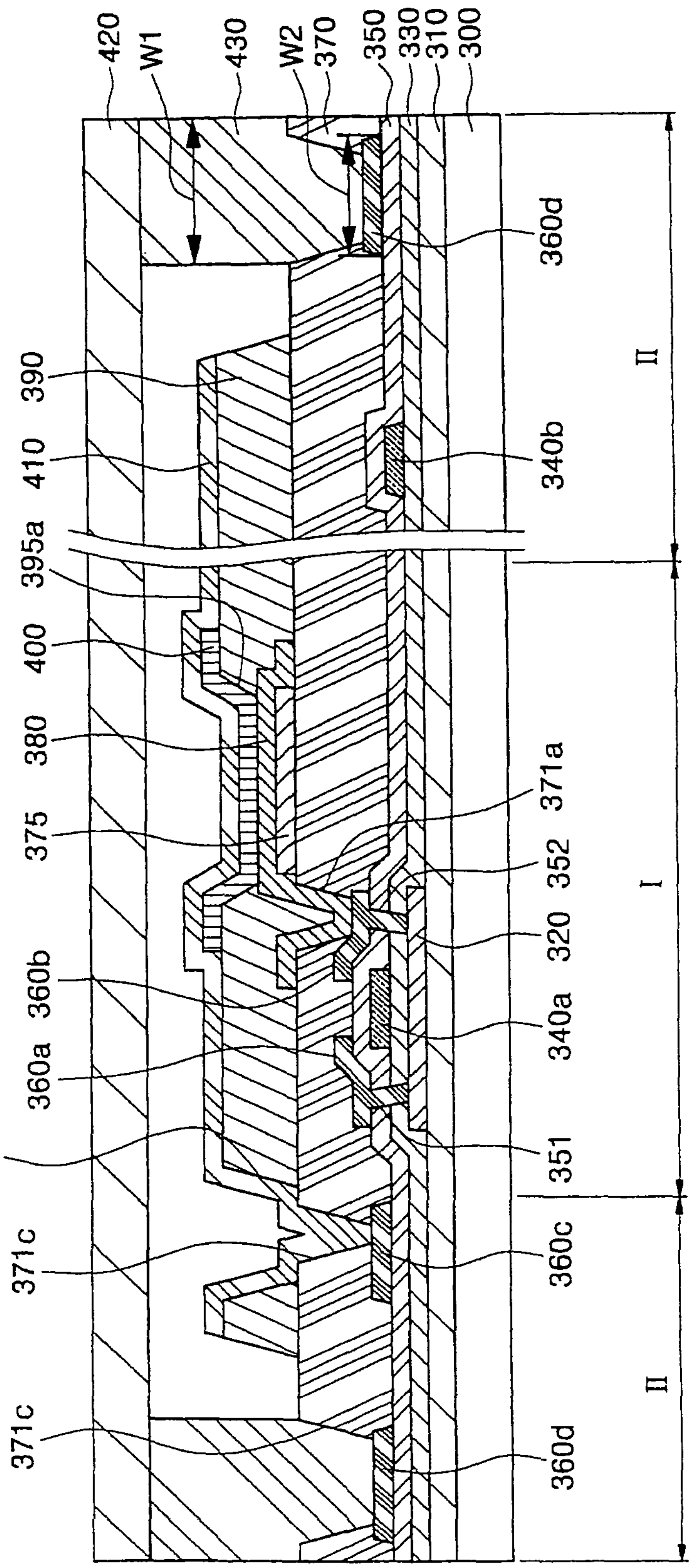
360d
II

FIG. 5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360c
360d
II
I
II

FIG. 6A

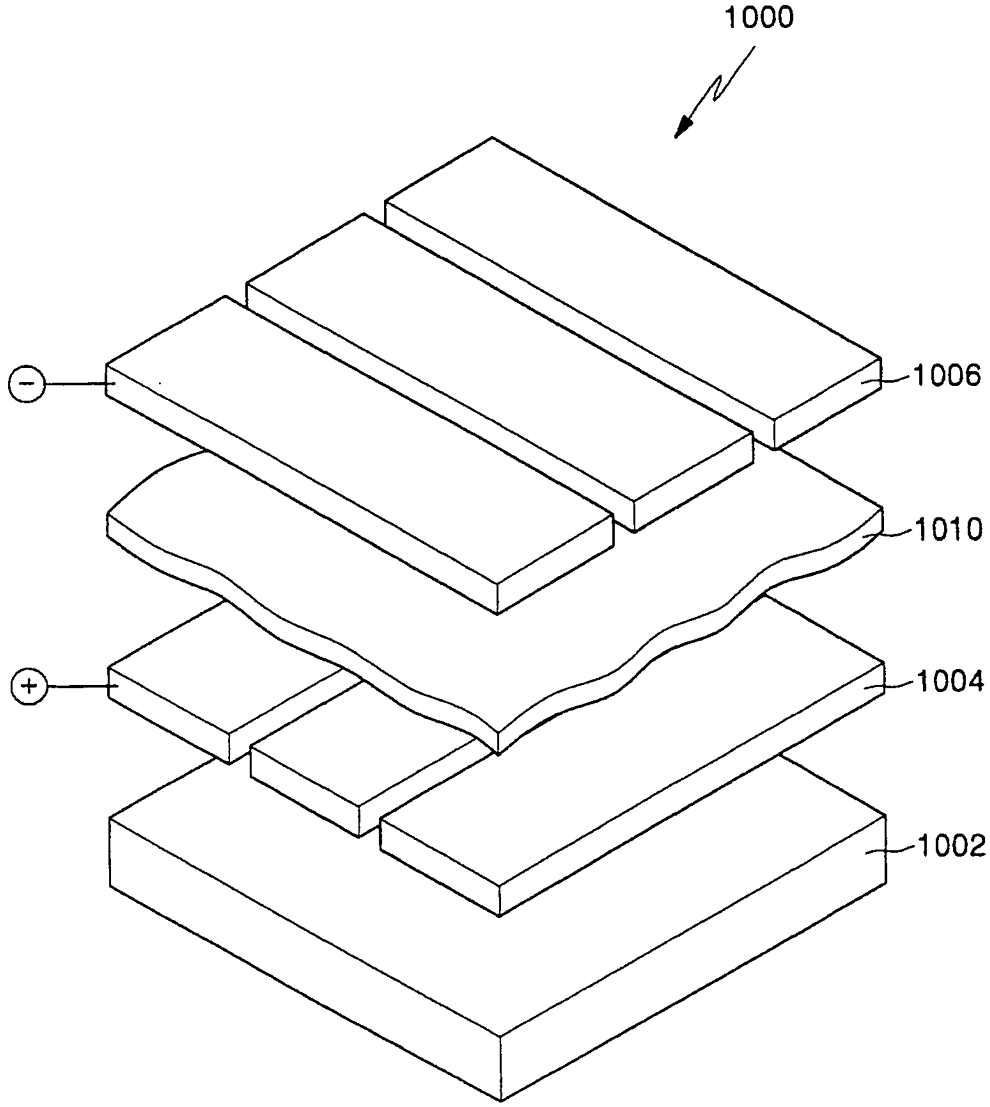


FIG. 6B

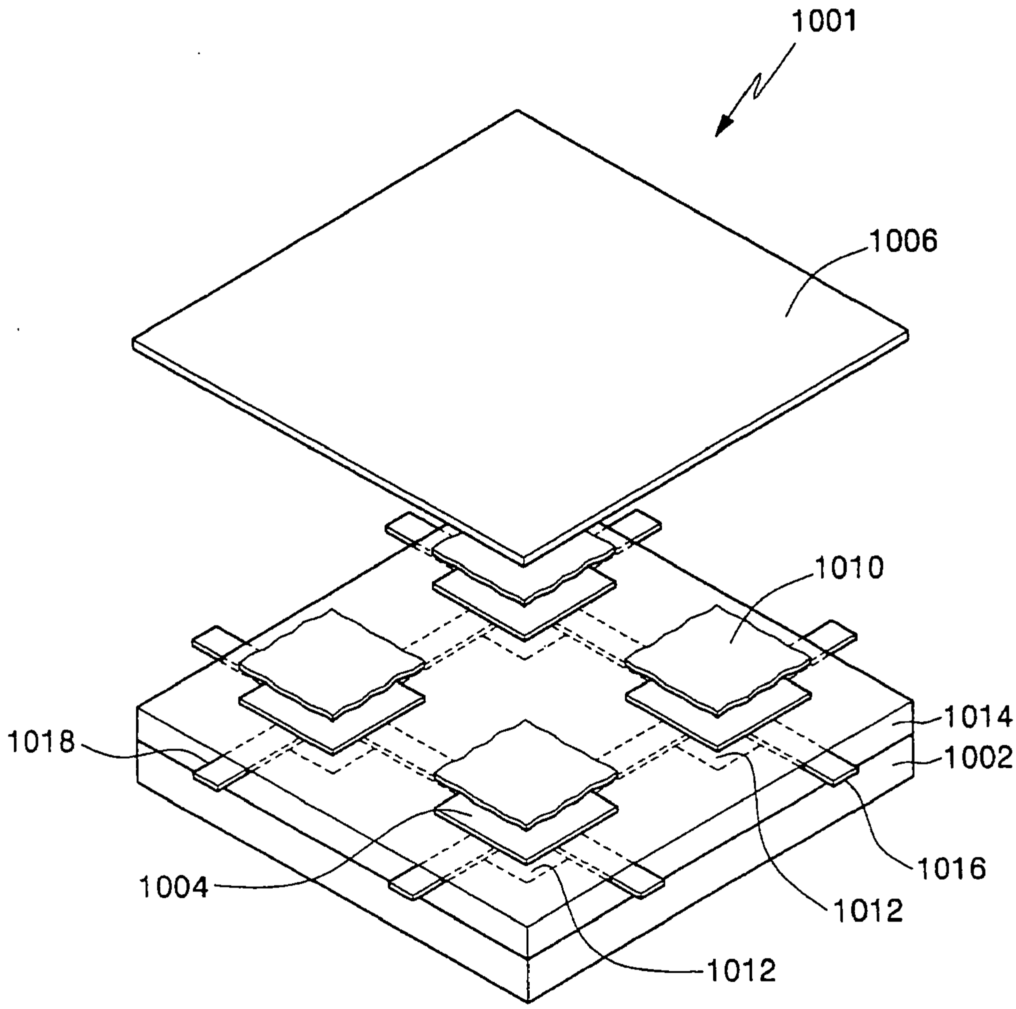


FIG. 6C

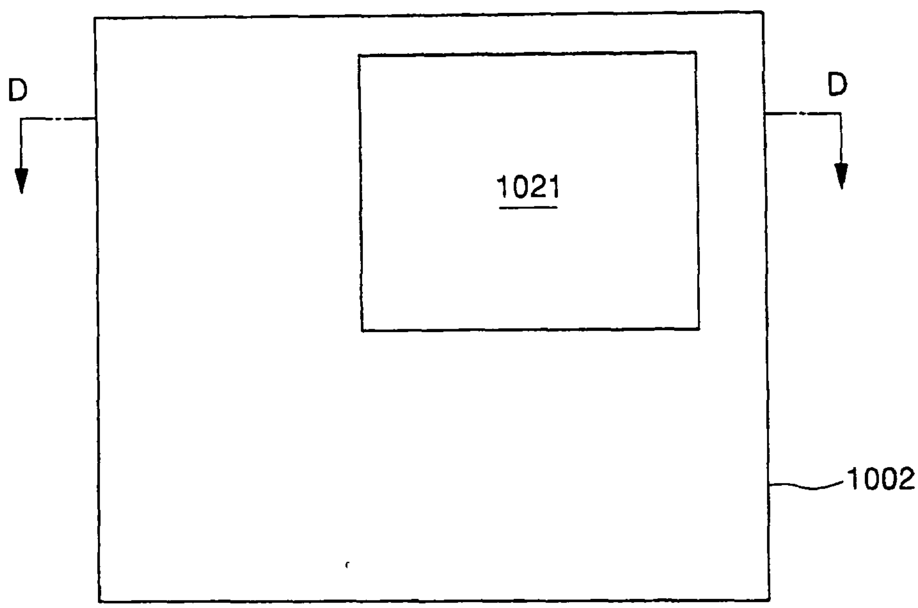


FIG. 6D

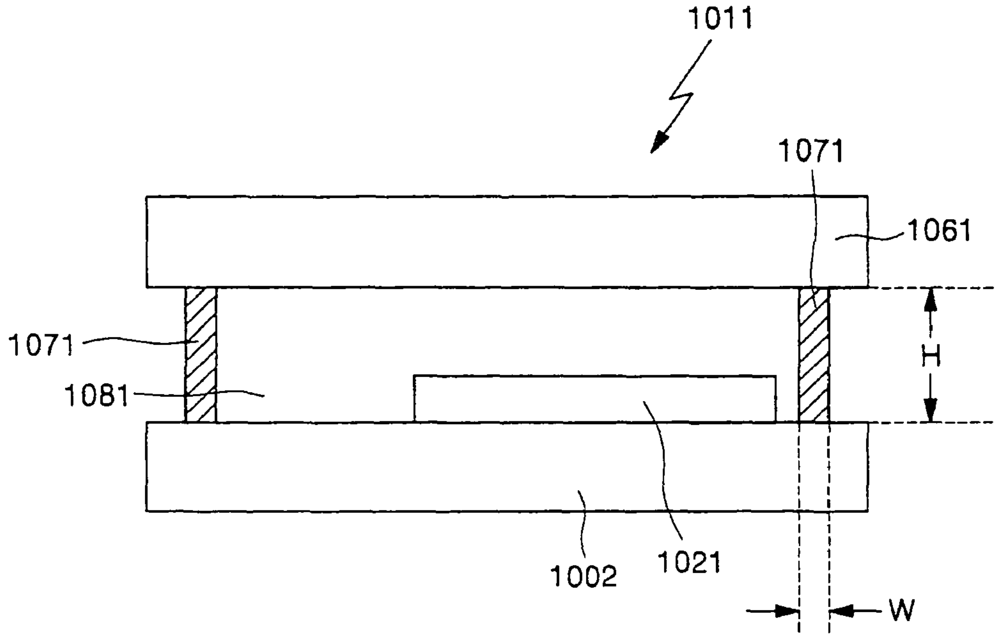
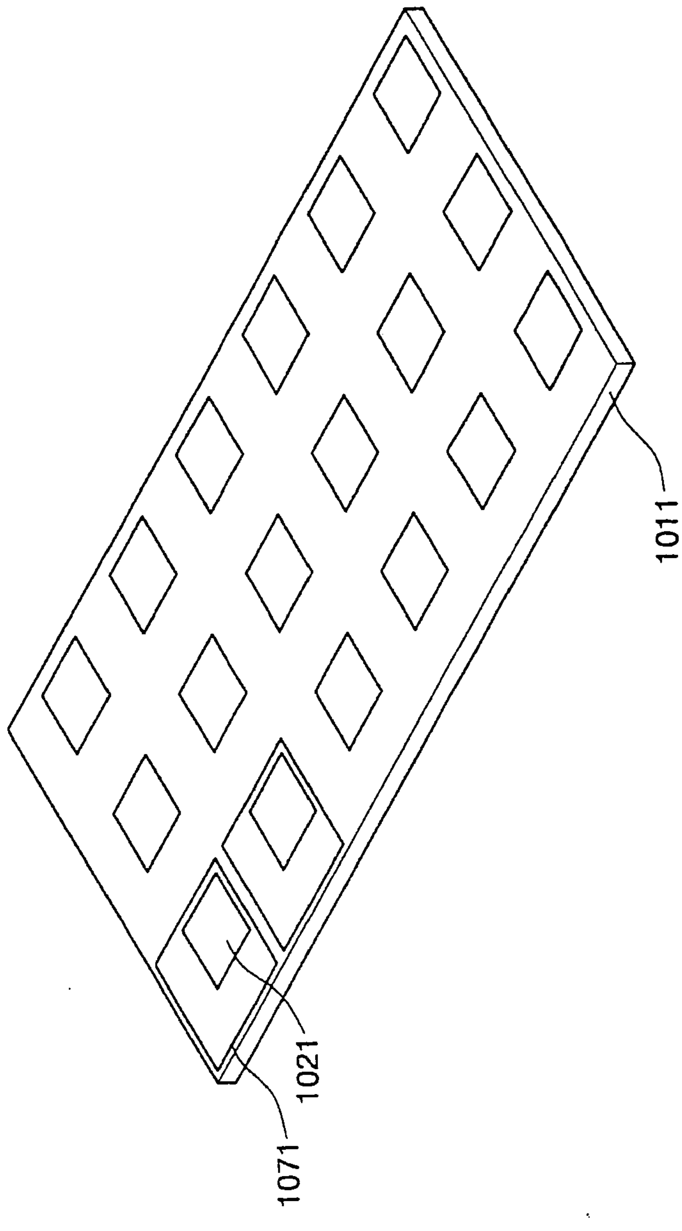


FIG. 6E



专利名称(译)	有机发光显示器及其制造方法		
公开(公告)号	EP1811571A2	公开(公告)日	2007-07-25
申请号	EP2007250270	申请日	2007-01-23
[标]申请(专利权)人(译)	三星斯笛爱股份有限公司		
申请(专利权)人(译)	三星SDI CO.，LTD.		
当前申请(专利权)人(译)	三星SDI CO.，LTD.		
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IPC分类号	H01L27/32 H01L51/52		
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优先权	1020060007025 2006-01-23 KR		
其他公开文献	EP1811571A3 EP1811571B1		
外部链接	Espacenet		

摘要(译)

本发明提供一种有机发光显示器及其制造方法，其能够防止元件在激光照射用于密封基板的玻璃料时产生的大量热量而被损坏。有机发光显示器包括：第一基板（300），包括像素区域（I）和非像素区域（II）;在像素区域上形成的有机发光像素阵列;形成在非像素区域上方的导线（360d）;第二基板（420）放置在第一基板上，使得阵列和导线插入第一和第二基板之间;和玻璃料密封件插入在第一和第二基板之间并围绕阵列，玻璃料密封件（430）互连第一和第二基板，玻璃料密封件包括与导电线重叠的部分，其中当从第二基板观察时，该部分玻璃料密封件的基本上遮盖了导电线。

FIG. 5