US 20070090759A1

(19) **United States**

(12) **Patent Application Publication**

Choi et al.

(10) **Pub. No.: US 2007/0090759 A1**

(43) **Pub. Date: Apr. 26, 2007**

(54) ORGANIC LIGHT EMITTING DISPLAY AND METHOD OF FABRICATING THE SAME

(76) Inventors: **Dong-Soo Choi**, Suwon-si (KR); **Jin-Woo Park**, Suwon-si (KR); **Tae-Seung Kim**, Suwon-si (KR)

Correspondence Address:
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614 (US)

(21) Appl. No.: **11/529,948**

(22) Filed: **Sep. 29, 2006**

(30) **Foreign Application Priority Data**

Oct. 21, 2005 (KR) 10-2005-0099838

Publication Classification

(51) **Int. Cl.**
H05B 33/04 (2006.01)
H01L 51/50 (2006.01)

(52) **U.S. Cl.** **313/512**; 445/25; 313/503

(57) ABSTRACT

An organic light emitting display device includes a first substrate, an array of organic light emitting pixels formed on the substrate, a second substrate opposing the first substrate. A frit seal interconnects the first and second substrates and surrounds the array of organic light emitting pixels. A film structure interposed between the second substrate and the array of organic light emitting pixels and contacts both the second substrate and the array.

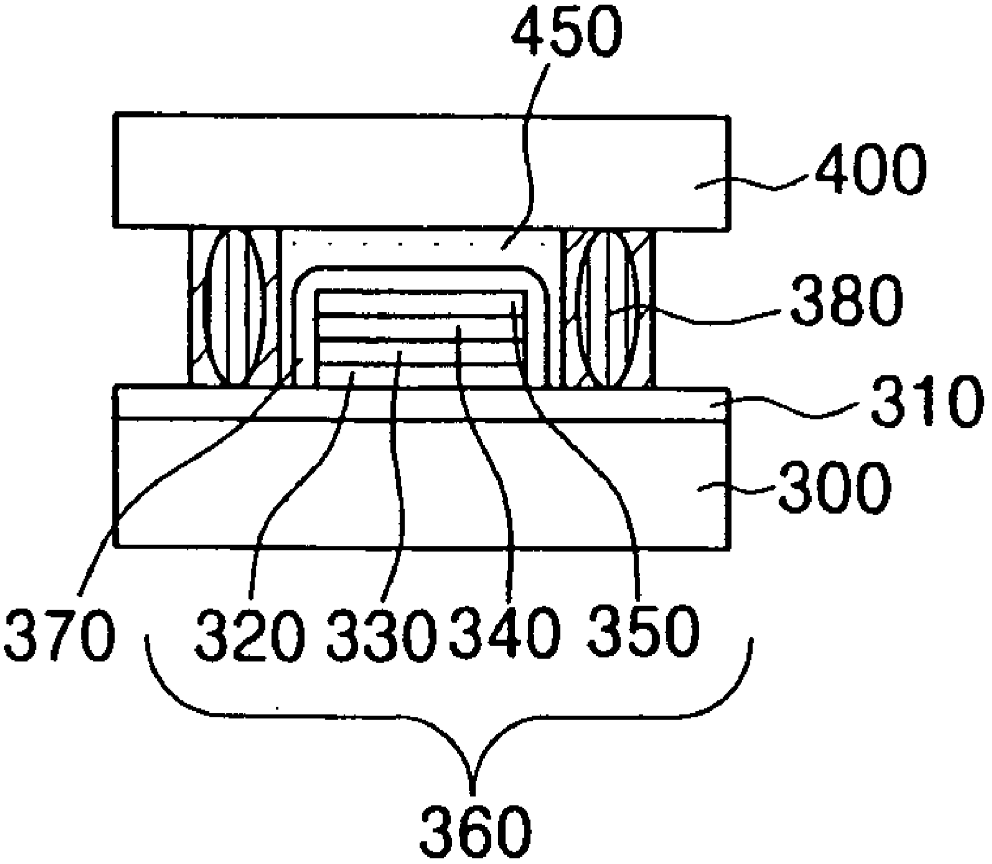


FIG.1

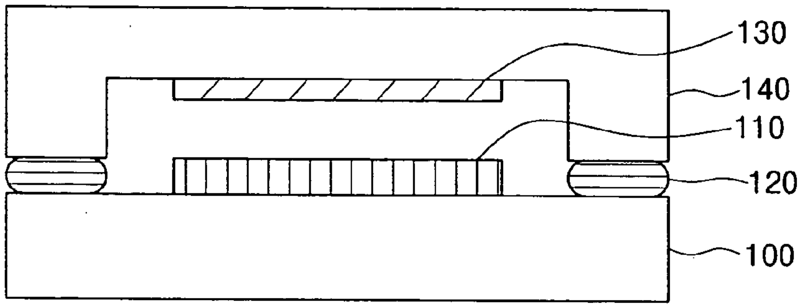


FIG.2

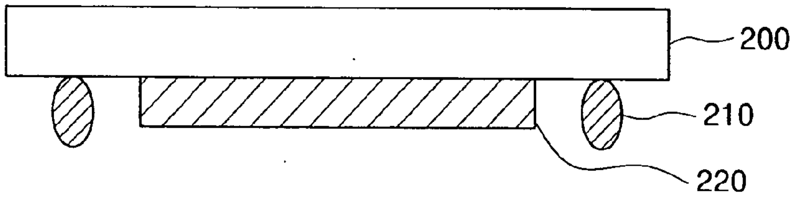


FIG.3

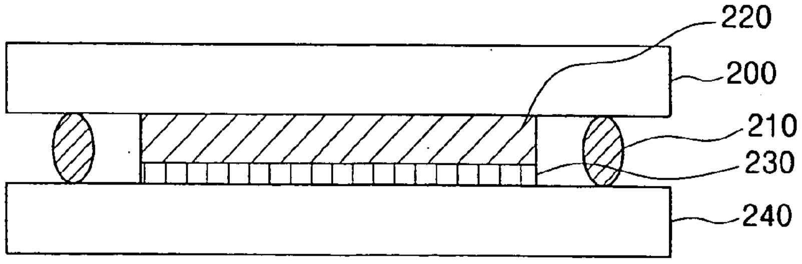


FIG.4

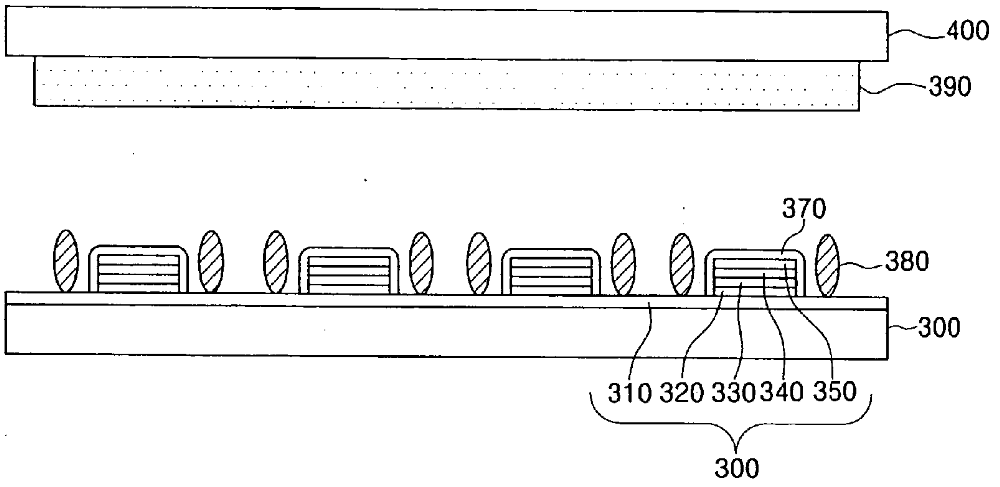

400
390
370
380
300
310 320 330 340 350
300

FIG.5

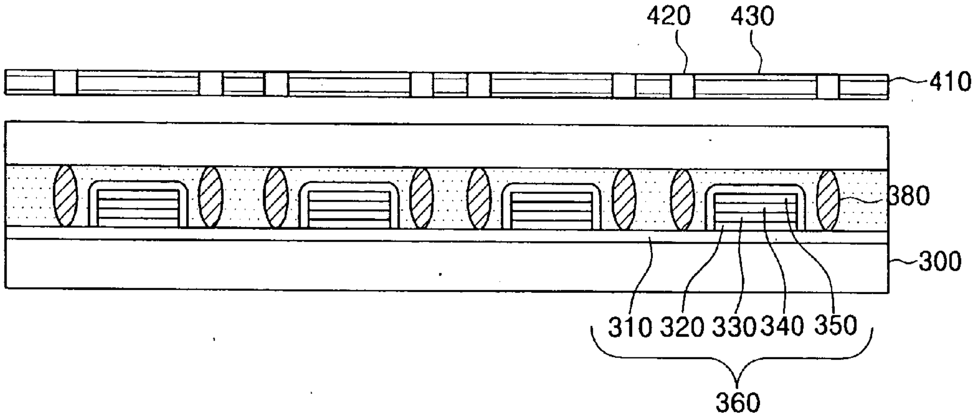

420
430
410
380
300
310 320 330 340 350
360

FIG.6

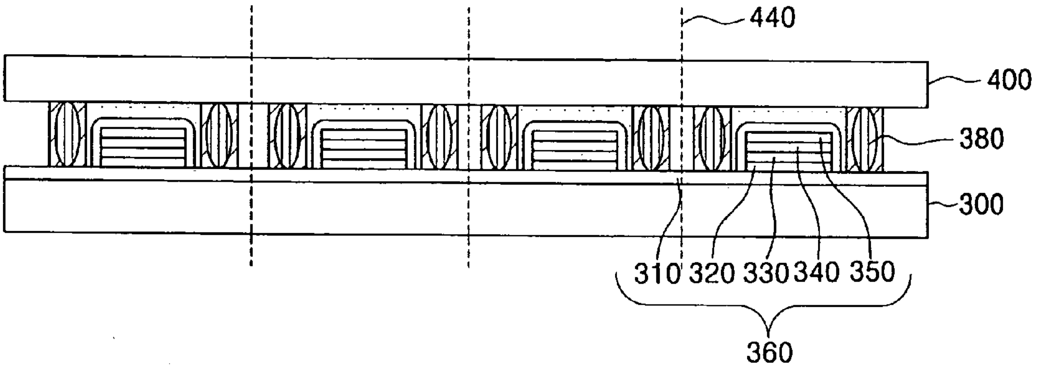

440
400
380
300
310
320
330
340
350
360

FIG.7

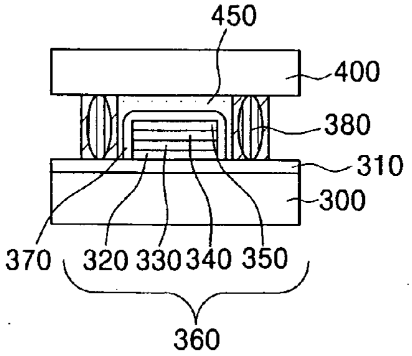

450
400
380
310
300
370
320
330
340
350
360

FIG. 8A

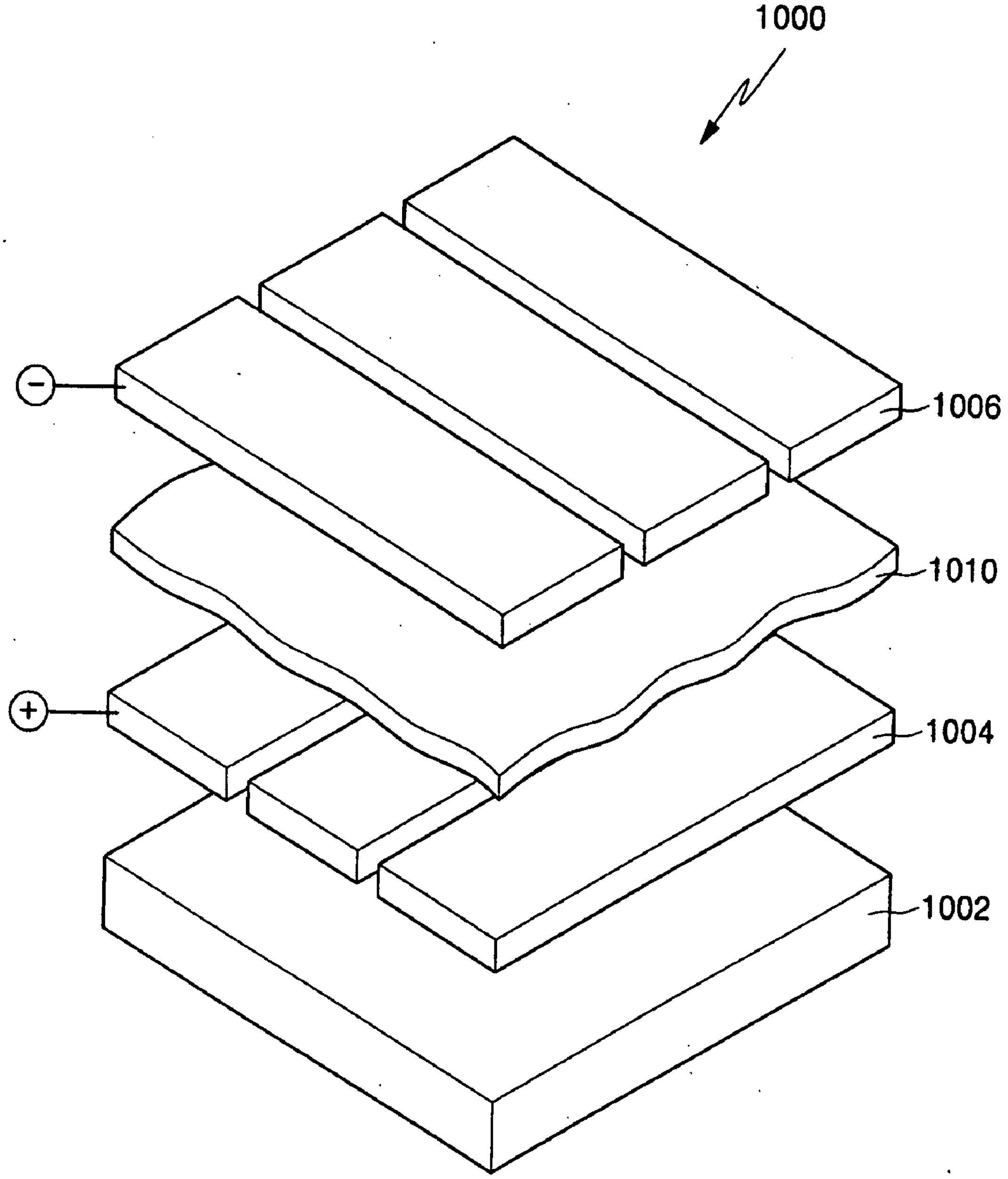


FIG. 8B

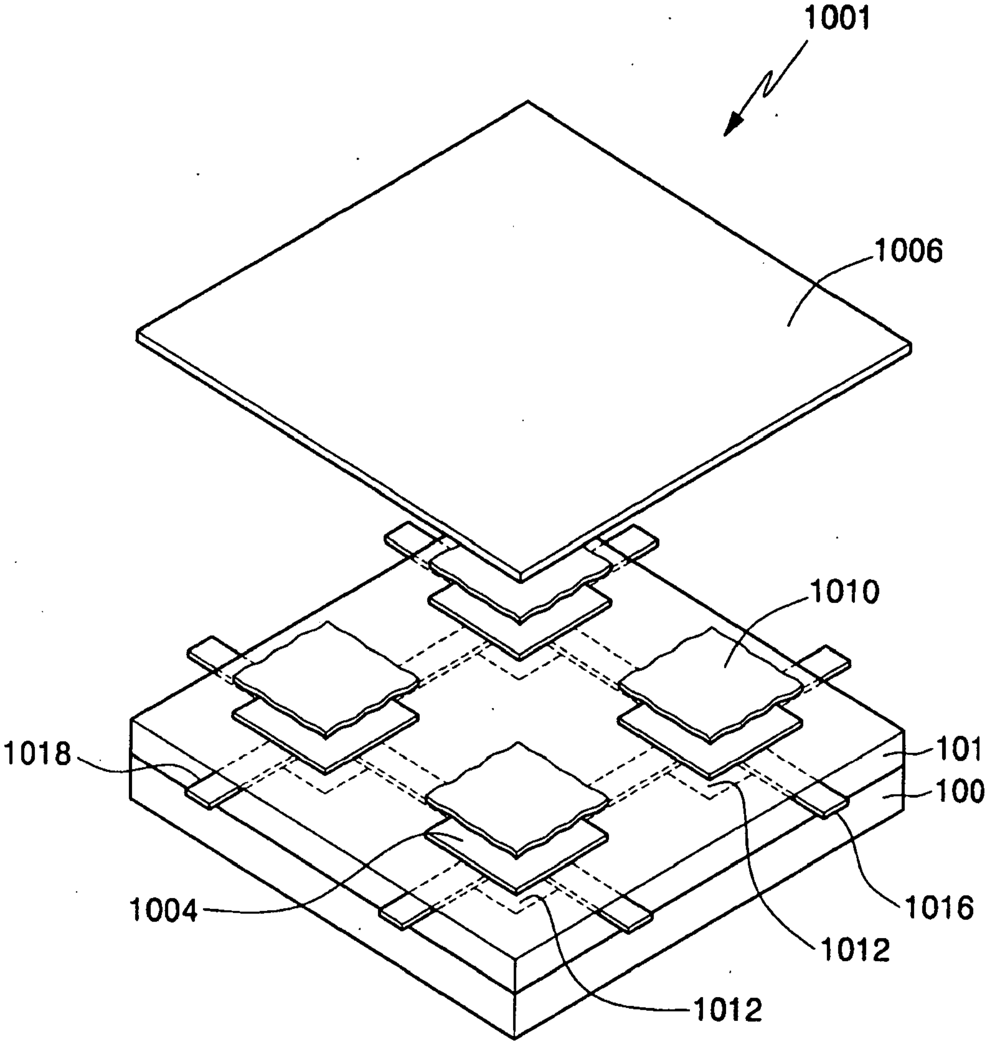


FIG. 8C

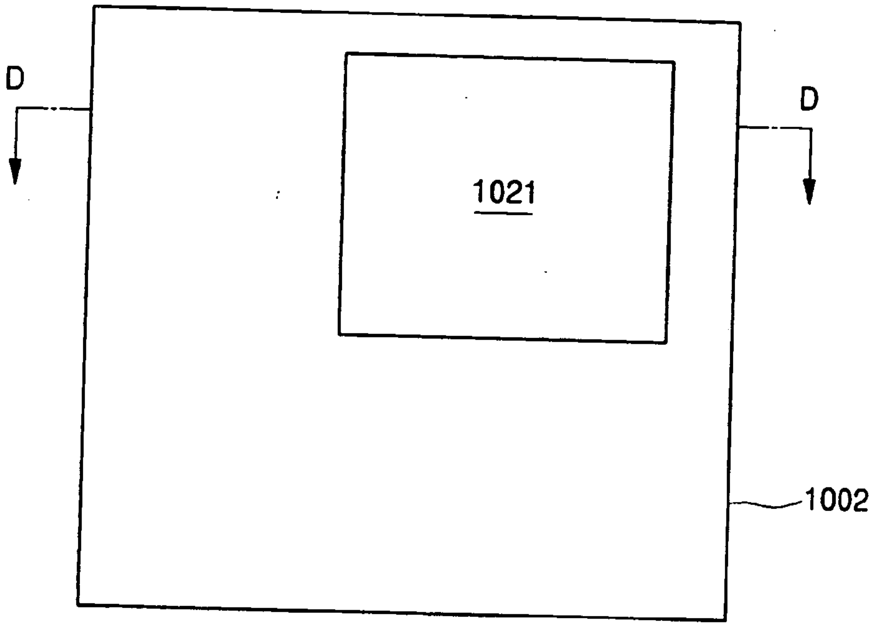


FIG. 8D

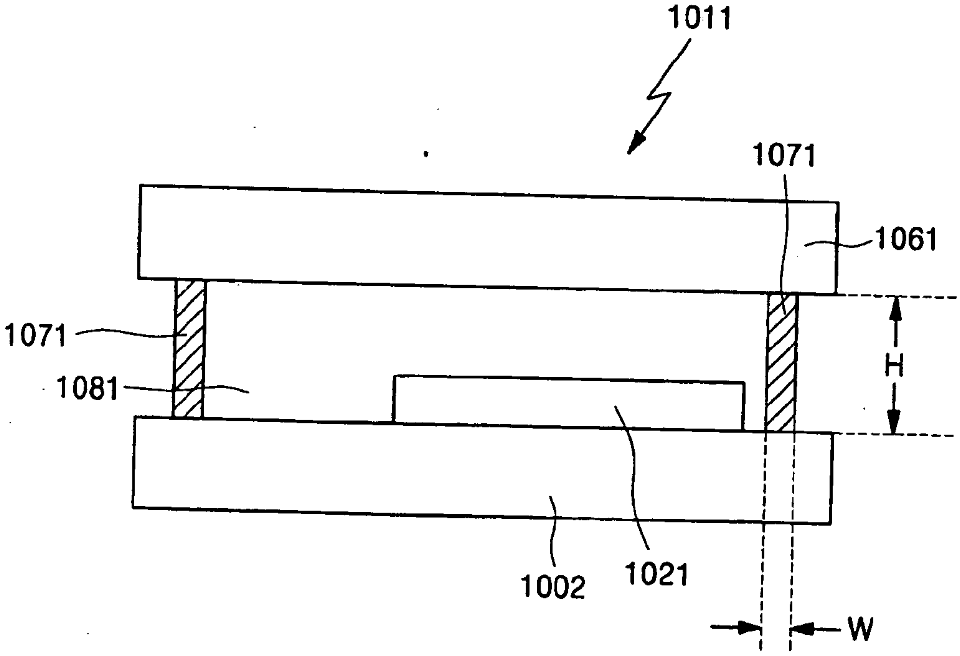
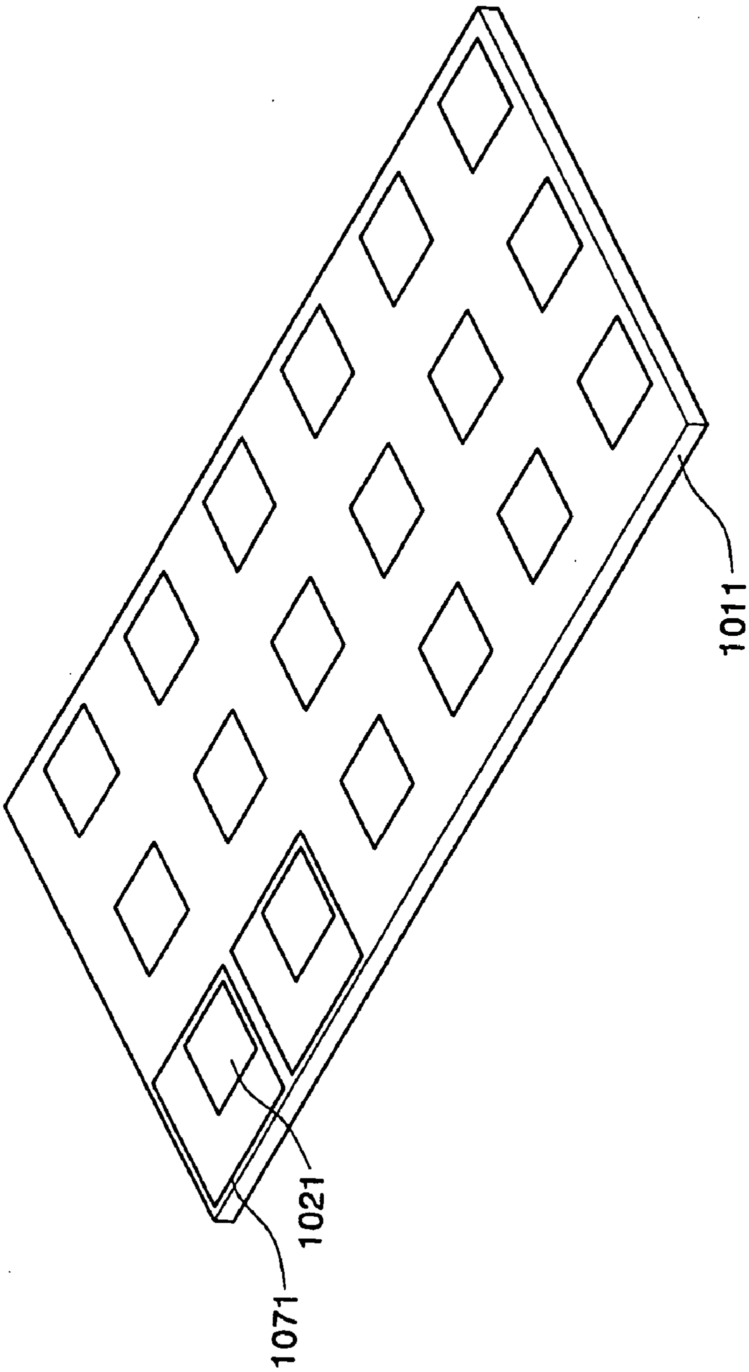


FIG. 8E



ORGANIC LIGHT EMITTING DISPLAY AND METHOD OF FABRICATING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2005-0099838, filed Oct. 21, 2005, which is incorporated herein by reference in its entirety. This application is related to and incorporates herein by reference the entire contents of the following concurrently filed application:

Title	Atty. Docket No.	Filing Date	Application No.
ORGANIC LIGHT EMITTING DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME	SDISW.026AUS		

BACKGROUND

[0002] 1. Field of the Invention

[0003] The present invention relates to an organic light emitting display device, and more particularly, to encapsulating the organic light emitting display device.

[0004] 2. Description of Related Art

[0005] Generally, an organic light emitting display (OLED) includes an anode electrode layer, a hole transport layer, an organic emission layer, and an electron transport layer, which are sequentially formed on the anode electrode layer, and a cathode electrode layer formed on the resultant structure. In such a structure, when a voltage is applied, a hole injected from the anode electrode layer moves to the organic emission layer via the hole transport layer, and an electron injected from the cathode electrode layer moves to the organic emission layer via the electron transport layer, so that carriers of the hole and electron combine in the organic emission layer to create excitons. The organic emission layer emits light by energy generated when the excitons created as described above make the transition from an excited state to a ground state.

[0006] However, organic thin layers formed of an organic compound having low thermal resistivity is likely to be degraded by moisture, and a cathode electrode formed on the organic thin layers can be lowered in performance due to oxidation. Therefore, the organic thin layers should be hermetically sealed to prevent moisture or oxygen from contacting the thin layers. FIG. **1** is a cross-sectional view of an exemplary organic light emitting display. As shown in FIG. **1**, an organic light emitting diode **110** is formed on a substrate **100**. The substrate **100** includes a thin film transistor having a semiconductor layer, a gate electrode, a source electrode, and a drain electrode. Then, after forming a moisture absorption layer **130** on one surface of a sealing substrate **140** facing the organic light emitting diode **110**, the substrate **100** and the sealing substrate **140** are adhered to each other using a sealant **120**, thereby completing an organic light emitting display.

SUMMARY OF CERTAIN INVENTIVE ASPECTS

[0007] An aspect of the invention provides an organic light emitting display device, which may comprises: a first substrate; a second substrate comprising an interior surface opposing the first substrate; an array of organic light emitting pixels formed between the first and second substrates, the array comprising a top surface facing the second substrate; a frit seal interposed between the first and second substrates while surrounding the array; and a film structure comprising one or more layered films, the film % structure comprising a portion interposed between the second substrate and the array, the film structure contacting the interior surface and the top surface.

[0008] In the foregoing device, the film structure may cover substantially the entire portion of the top surface. The film structure may further comprise a portion interposed between the first and second substrates while not interposed between the array and the second substrate. The film structure may contact the frit seal. The film structure may not contact the frit seal. The array may comprise a first electrode, a second electrode and an organic light emitting material interposed between the first and second electrodes, wherein the first electrode may have a first distance from the first substrate, and the second electrode may have a second distance from the first substrate, wherein the second distance may be greater than the first distance, and wherein the top surface may be a surface of the electrode.

[0009] Still in the foregoing device, the film structure may comprise an organic resin layer and a protective layer interposed between the array and the organic resin layer, wherein the protective layer may be configured to substantially inhibit components of the organic resin layer from diffusing into the array. The protective layer may comprise at least one selected from the group consisting of silicon oxide and silicon nitride. The organic resin layer may comprise a urethane acrylic resin. The array may emit visible light through the second substrate.

[0010] Further in the foregoing device, at least part of the film structure may be substantially transparent with respect to visible light. The film structure may have a reflectance for visible light smaller than or substantially equal to that of the second substrate. The film structure may have a refractory index substantially equal to that of material that forms a layer contacting the film structure. The film structure may be substantially nonconductive. The frit seal may comprise 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.

[0011] Another aspect of the invention provides a method of making an organic light-emitting display device, which may comprise: providing an unfinished product comprising a first substrate, a second substrate comprising an interior surface opposing the first substrate, a first array of organic light emitting pixels interposed between the first and second substrates, the first array comprising a first top surface facing the second substrate, a first frit interposed between the first and second substrates while surrounding the first array, a second array of organic light emitting pixels interposed between the first and second substrates, the second array comprising a second top surface facing the second substrate, a second frit interposed between the first and second substrates while surrounding the second array, and a first film structure comprising one or more layered films interposed between the first array and the second substrate, the first film structure contacting the interior surface and the first top surface, and at least one film of the first film structure comprising a curable material, a second film structure comprising one or more layered films interposed between the second array and the second substrate, the second film structure contacting the interior surface and the second top surface, and at least one film of the second film structure comprising a curable material; cutting the unfinished product into a first piece and a second piece, wherein the first piece comprises a cut piece of the first substrate, a cut piece of the second substrate, the first array, the first frit and the first film structure, wherein the second piece comprises a cut piece of the first substrate, a cut piece of the second substrate, the second array, the second frit and the second film structure; and curing the curable material.

[0012] In the forgoing method, providing the unfinished product may comprise providing the first substrate and the first and second arrays formed over the first substrate, providing the second substrate and the curable material formed over the second substrate; arranging the first and second substrates such that the curable material is located between the first and second substrates; and interposing the first and second frits between the first and second substrates. The curable material may contact the first frit, and wherein curing the curable material may comprise first curing a portion of the curable material in the vicinity of the first frit and then curing the remainder of the curable material. Curing the portion in the vicinity of the first frit may comprise irradiating UV light. Curing the remainder may comprise heating the curable material. The first array may comprise a first electrode, a second electrode and an organic light emitting material interposed between the first and second electrodes, wherein the first electrode may have a first distance from the first substrate, and the second electrode may have a second distance from the first substrate, wherein the second distance may be greater than the first distance, and wherein the top surface is a surface of the electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The above and other aspects and features of the present invention will be described in reference to certain exemplary embodiments thereof with reference to the attached drawings in which:

[0014] FIG. **1** is a cross-sectional view of an exemplary organic light emitting display;

[0015] FIGS. **2** and **3** are cross-sectional views of an organic light emitting display in accordance with embodiments of the present invention;

[0016] FIGS. **4** to **7** are cross-sectional views of an organic light emitting display in accordance with embodiments of the present invention;

[0017] FIG. **8**A is a schematic exploded view of a passive matrix type organic light emitting display device in accordance with one embodiment;

[0018] FIG. **8**B is a schematic exploded view of an active matrix type organic light emitting display device in accordance with one embodiment;

[0019] FIG. **8**C is a schematic top plan view of an organic light emitting display in accordance with one embodiment;

[0020] FIG. **8**D is a cross-sectional view of the organic light emitting display of FIG. **8**C, taken along the line d-d; and

[0021] FIG. **8**E is a schematic perspective view illustrating mass production of organic light emitting devices in accordance with one embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] Various embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. In the drawings, the length or thickness of layers and regions may be exaggerated for the sake of illustration.

[0023] 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.

[0024] OLEDs can be generally grouped into two basic types dependent on the arrangement with which the stimulating electrical current is provided. FIG. **8**A schematically illustrates an exploded view of a simplified structure of a passive matrix type OLED **1000**. FIG. **8**B 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.

[0025] Referring to FIG. **8**A, 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.

[0026] Referring to FIG. **8**B, 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.

[0027] 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.

[0028] 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, 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, the anode **1004** and cathode **1006** are inverted; i.e., the cathode is formed on the substrate **1002** and the anode is opposingly arranged.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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. **8**C. In embodiments, 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**. In embodiments, 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.

[0036] 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. **8**D schematically illustrates a cross-section of an encapsulated OLED device **1011** having a layout of FIG. **8**C and taken along the line d-d of FIG. **8**C. 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**.

[0037] In embodiments, 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. In embodiments, at least one of the top plate **1061** and the bottom plate **1002** are formed of a substantially transparent material.

[0038] 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**.

[0039] 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. **8**D. 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.

[0040] 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. **8**D. 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.

[0041] 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.

[0042] 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.

[0043] 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 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.

[**0044**] 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.

[**0045**] In 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 % inorganic 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.

[**0046**] 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, hydroxylpropyl 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**.

[**0047**] In one exemplary 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.

[**0048**] In 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**.

[**0049**] In some embodiments, OLED devices **1011** are mass produced. In an embodiment illustrated in FIG. **8**E, 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 **10111** of FIG. **8**D. 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**.

[**0050**] When an upper (or top) substrate and a lower (or bottom) substrate are formed of glass, the organic light emitting display may show Newton's rings, which are ring-shaped patterns of, such as, an ellipse or a concentric circle that are created due to optical interferences between the light entering from the exterior and certain reflections thereof.

[**0051**] FIGS. **2** and **3** are cross-sectional views of an organic light emitting display in accordance with embodiments of the present invention. Referring to FIG. **2**, frits **210** are formed on one surface of a sealing substrate **200**, which is equivalent to the top plate **1061**. The sealing substrate **200** is formed of an insulating glass substrate, and the frits **210** are formed of a glass frit having strong adhesive force, mechanical strength, and chemical durability. The glass frit is fabricated by melting glass having one 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, and a composite thereof, and pulverizing the glass to form fine powder.

[**0052**] A film **220** is formed between the frits **210**. In certain embodiments, the film **220** is formed of urethane acryl capable of reducing optical interference. In an embodiment, the film **220** has a refractive index substantially equal to that of a material that forms a layer contacting the film **220** in order to substantially reduce the optical interference. In one embodiment, the refractory index of the film **220** is from about 90% to 110% of that of the material that forms a layer contacting the film **220**. For example, the refractory index of the film **220** is from about 90, 92, 94, 95, 96, 97, 97.5, 98, 98.5, 99, 99.5, 100, 100.5, 101, 101.5, 102, 102.5, 103, 104, 105, 106, 108 and 110% of that of the material that forms a layer contacting the film **220**. In an embodiment, the film **220** is adhered to the substrate **200** in a laminated manner.

[**0053**] Next, as shown in FIG. **3**, an array of organic light emitting diodes or pixels **230** is formed on a substrate **240**, which is equivalent to the bottom plate **1002**. In some embodiments, the substrate **240** includes a thin film transistor having a semiconductor layer, a gate electrode, a source electrode, and a drain electrode. The organic light emitting diode or pixel **230** includes at least one of a hole injection layer, a hole transport layer, an organic emission layer, an electron transport layer, and an electron injection layer.

[**0054**] In the illustrated embodiment, the substrate **240** is aligned to the sealing substrate **200** and the frits **210** are thermally cured at a temperature of about 180 to about 350° C. For example, the frits **210** may be irradiated with a laser beam so that the frits **210** are melted and solidified. When the sealing substrate **200** is aligned to the substrate **240**, the film **220** formed on one surface of the sealing substrate **200** is in contact with the entire surface of the organic light emitting diode **230** formed on the substrate **240**. The film **220** is in contact with one surface of the organic light emitting diode **230** through which light is emitted, thereby reducing generation of the interference pattern.

[**0055**] In the illustrated organic light emitting display, since the substrate is hermetically sealed using a glass frit having strong adhesive force, excellent mechanical strength, and chemical durability, it is possible to protect the organic light emitting diode without a moisture absorption material. In an embodiment, an additional film for reducing optical interference may be attached to remove an interference pattern.

[**0056**] FIGS. **4** to **7** are cross-sectional views of an organic light emitting display in accordance with certain embodiments of the present invention. First, as shown in FIG. **4**, a first electrode **310** is formed on a substrate **300**, which is equivalent to the bottom plate **1011**. The substrate **300** includes a thin film transistor having a semiconductor layer, a gate electrode, a source electrode, and a drain electrode, and the first electrode may be formed of transparent ITO or IZO having a high work function. In an embodiment, an organic light emitting diode or pixel **360** is formed over the first substrate **300**. The organic light emitting diode **360** includes the first electrode **310**, a hole transport layer **320**, an organic emission layer **330**, an electron transport layer **340**, and a second electrode **350**. In an embodiment, an inorganic layer **370** for protecting the organic light emitting diode **360** is formed. The inorganic layer **370** for protecting the organic light emitting diode from a sealant is formed of one transparent material selected from silicon oxides or silicon nitrides.

[**0057**] Next, in the illustrated embodiment, frits **380** are formed to surround the organic light emitting diode **360**. Similar to the above described embodiment, the frits **380** are formed of a glass frit having strong adhesive force, mechanical strength, and chemical durability. The glass frit is fabricated by melting glass having one 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, and a composite thereof, and pulverizing the glass to form fine powder.

[**0058**] Then, in an embodiment, a transparent sealant **390** is formed at one surface of a sealing substrate **400** facing the organic light emitting diode **360**. The sealant **390** may be formed of urethane acryl capable of reducing optical interference to remove the interference pattern. The urethane acryl has a refractive index substantially equal to that of a material that forms a layer contacting the film **220** in order to reduce optical interference.

[**0059**] Then, in the illustrated embodiment in FIG. **5**, the substrate **300** and the sealing substrate **400** are aligned to each other. In an embodiment, a UV mask **410** is provided to optically and partially cure the sealant **390**. The mask has an area **420** which allows UV light to pass and another area **430** which inhibits UV light from passing. Next, in an embodiment in FIG. **6**, the sealant formed at the vicinity of the frit **380** is cured by using the UV mask **410**, and the sealant formed at the other regions are not cured. Thus, an unfinished product is obtained. The unfinished product is cut along a cutting line **440**, and then, in an embodiment, the non-cured sealant around the cutting line **440** is removed. Referring to FIG. **7**, the non-cured sealant **450** formed on the organic light emitting diode **360** is thermally cured, thereby completing the organic light emitting display.

[**0060**] In the above organic light emitting display, the substrate is hermetically sealed using a glass frit having strong adhesive force, excellent mechanical strength and chemical durability, thereby providing a better sealing effect. In addition, a sealant for reducing optical interference is used to remove an unwanted interference pattern. Therefore, an organic light emitting display and a method of fabricating the same according to the present invention are capable of providing excellent sealing characteristics, protecting the display from external impact, and removing a glass interference pattern.

[**0061**] Although the present invention has been described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that a variety of modifications and variations may be made to the present invention without departing from the spirit or scope of the present invention defined in the appended claims, and their equivalents.

What is claimed is:

1. An organic light emitting display device comprising:

a first substrate;

a second substrate comprising an interior surface opposing the first substrate;

an array of organic light emitting pixels formed between the first and second substrates, the array comprising a top surface facing the second substrate;

a frit seal interposed between the first and second substrates while surrounding the array; and

a film structure comprising one or more layered films, wherein the film structure comprising a portion interposed between the second substrate and the array, the film structure contacting the interior surface and the top surface.

2. The device of claim 1, wherein the film structure covers substantially the entire portion of the top surface.

3. The device of claim 1, wherein the film structure further comprises a portion interposed between the first and second substrates while not interposed between the array and the second substrate.

4. The device of claim 1, wherein the film structure contacts the frit seal.

5. The device of claim 1, wherein the film structure does not contact the frit seal.

6. The device of claim 1, wherein the array comprises a first electrode, a second electrode and an organic light emitting material interposed between the first and second electrodes, wherein the first electrode has a first distance from the first substrate, and the second electrode has a second distance from the first substrate, wherein the second distance is greater than the first distance, and wherein the top surface is a surface of the electrode.

7. The device of claim 1, wherein the film structure comprises an organic resin layer and a protective layer interposed between the array and the organic resin layer, wherein the protective layer is configured to substantially inhibit components of the organic resin layer from diffusing into the array.

8. The device of claim 7, wherein the protective layer comprises at least one selected from the group consisting of silicon oxide and silicon nitride.

9. The device of claim 7, wherein the organic resin layer comprises a urethane acrylic resin.

10. The device of claim 1, wherein the array emits visible light through the second substrate.

11. The device of claim 1, wherein at least part of the film structure is substantially transparent with respect to visible light.

12. The device of claim 1, wherein the film structure has a reflectance for visible light smaller than or substantially equal to that of the second substrate.

13. The device of claim 1, wherein the film structure has a refractory index substantially equal to that of material that forms a layer contacting the film structure.

14. The device of claim 1, wherein the film structure is substantially nonconductive.

15. The device of claim 1, 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.

16. A method of making an organic light-emitting display device, the method comprising:

providing an unfinished product comprising:

a first substrate;

a second substrate comprising an interior surface opposing the first substrate;

a first array of organic light emitting pixels interposed between the first and second substrates, the first array comprising a first top surface facing the second substrate;

a first frit interposed between the first and second substrates while surrounding the first array;

a second array of organic light emitting pixels interposed between the first and second substrates, the second array comprising a second top surface facing the second substrate;

a second frit interposed between the first and second substrates while surrounding the second array; and

a first film structure comprising one or more layered films interposed between the first array and the second substrate, the first film structure contacting the interior surface and the first top surface, and at least one film of the first film structure comprising a curable material;

a second film structure comprising one or more layered films interposed between the second array and the second substrate, the second film structure contacting the interior surface and the second top surface, and at least one film of the second film structure comprising a curable material;

cutting the unfinished product into a first piece and a second piece, wherein the first piece comprises a cut piece of the first substrate, a cut piece of the second substrate, the first array, the first frit and the first film structure, wherein the second piece comprises a cut piece of the first substrate, a cut piece of the second substrate, the second array, the second frit and the second film structure; and

curing the curable material.

17. The method of claim 16, wherein providing the unfinished product comprises:

providing the first substrate and the first and second arrays formed over the first substrate;

providing the second substrate and the curable material formed over the second substrate;

arranging the first and second substrates such that the curable material is located between the first and second substrates; and

interposing the first and second frits between the first and second substrates.

18. The method of claim 16, wherein the curable material contacts the first frit, and wherein curing the curable material comprises first curing a portion of the curable material in the vicinity of the first frit and then curing the remainder of the curable material.

19. The method of claim 18, wherein curing the portion in the vicinity of the first frit comprises irradiating UV light.

20. The method of claim 18, wherein curing the remainder comprises heating the curable material.

21. The method of claim 16, wherein the first array comprises a first electrode, a second electrode and an organic light emitting material interposed between the first and second electrodes, wherein the first electrode has a first distance from the first substrate, and the second electrode has a second distance from the first substrate, wherein the second distance is greater than the first distance, and wherein the top surface is a surface of the electrode.

* * * * *

专利名称(译)	有机发光显示器及其制造方法		
公开(公告)号	US20070090759A1	公开(公告)日	2007-04-26
申请号	US11/529948	申请日	2006-09-29
[标]申请(专利权)人(译)	崔东SOO 朴镇宇 金泰SEUNG		
申请(专利权)人(译)	崔东SOO 朴镇宇 金泰SEUNG		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	CHOI DONG SOO PARK JIN WOO KIM TAE SEUNG		
发明人	CHOI, DONG-SOO PARK, JIN-WOO KIM, TAE-SEUNG		
IPC分类号	H05B33/04 H01L51/50		
CPC分类号	H01L51/524 H01L2251/566		
优先权	1020050099838 2005-10-21 KR		
其他公开文献	US7545094		
外部链接	Espacenet USPTO		

摘要(译)

有机发光显示装置包括第一基板，形成在基板上的有机发光像素阵列，与第一基板相对的第二基板。玻璃料密封件将第一和第二基板互连并围绕有机发光像素阵列。一种膜结构，插入在第二基板和有机发光像素阵列之间，并接触第二基板和阵列。