



US 20100244057A1

(19) **United States**

(12) **Patent Application Publication**  
Ryu et al.

(10) **Pub. No.: US 2010/0244057 A1**  
(43) **Pub. Date: Sep. 30, 2010**

(54) **ORGANIC LIGHT EMITTING DISPLAY DEVICE**

(76) Inventors: **Ji-Hun Ryu**, Yongin-city (KR); **Seung-Yong Song**, Yongin-city (KR); **Young-Seo Choi**, Yongin-city (KR); **Oh-June Kwon**, Yongin-city (KR)

Correspondence Address:  
**CHRISTIE, PARKER & HALE, LLP**  
**PO BOX 7068**  
**PASADENA, CA 91109-7068 (US)**

(21) Appl. No.: **12/603,552**

(22) Filed: **Oct. 21, 2009**

(30) **Foreign Application Priority Data**

Mar. 24, 2009 (KR) ..... 10-2009-0024984

**Publication Classification**

(51) **Int. Cl.**  
**H01L 51/52** (2006.01)

(52) **U.S. Cl.** ..... **257/88**; 257/40; 257/E51.018

(57) **ABSTRACT**

An organic light emitting display device, including: a first substrate on which a plurality of light emitting elements are formed; a second substrate that is disposed to be opposed to the first substrate; a primary dam member that is provided between the first substrate and the second substrate in order to surround the plurality of light emitting elements; a filler that is filled between the first substrate and the second substrate and in a first region defined by the primary dam member, an auxiliary dam member that is between the first substrate and the second substrate and in a second region outside the first region, and is made of porous material; and an inorganic sealant that is provided between the first substrate and the second substrate and in a third region outside the first region and the second region, and is jointed to the first substrate and the second substrate.

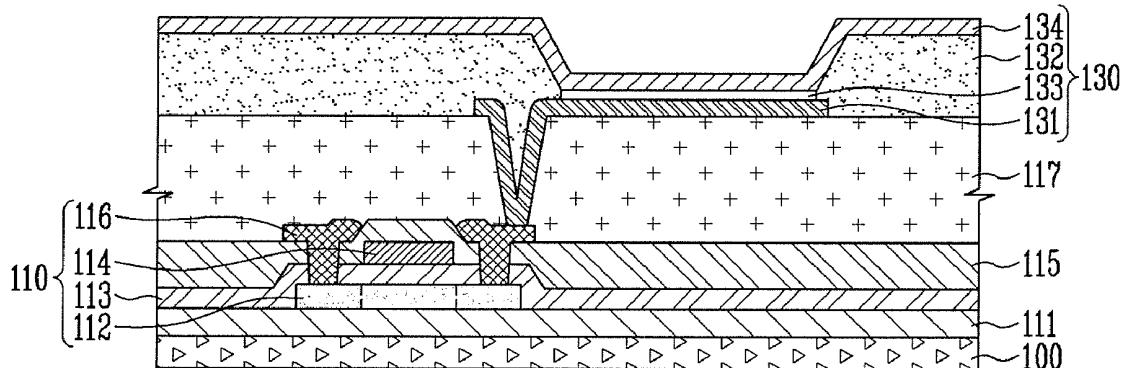


FIG. 1

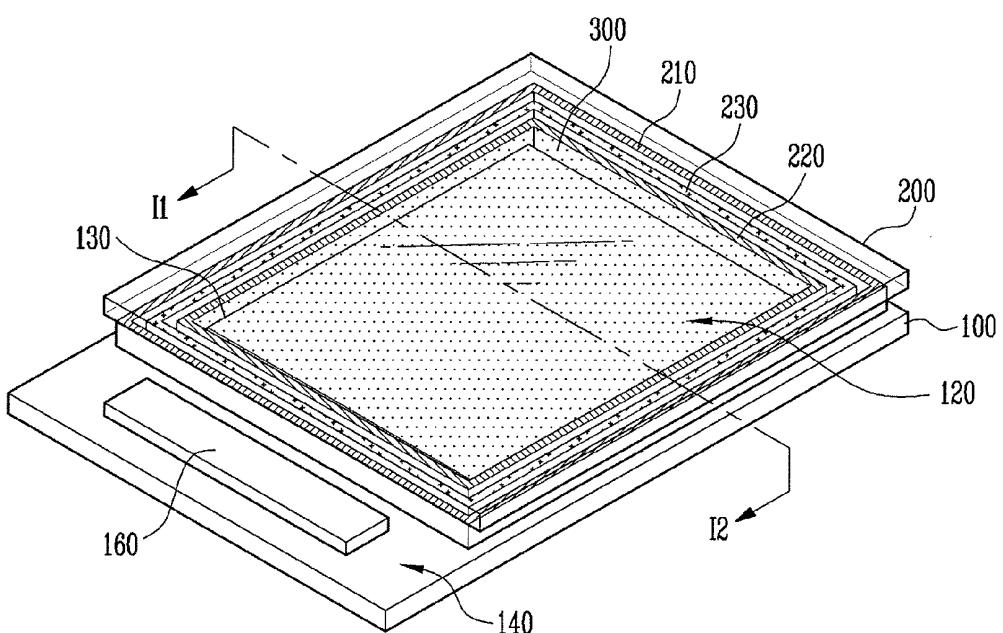


FIG. 2

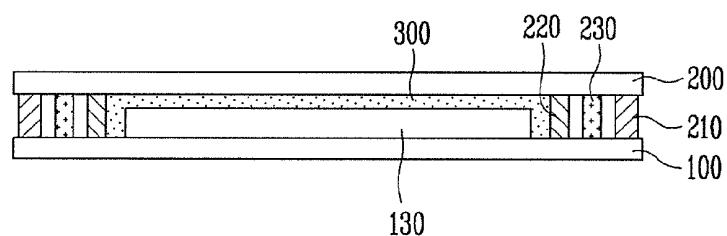


FIG. 3

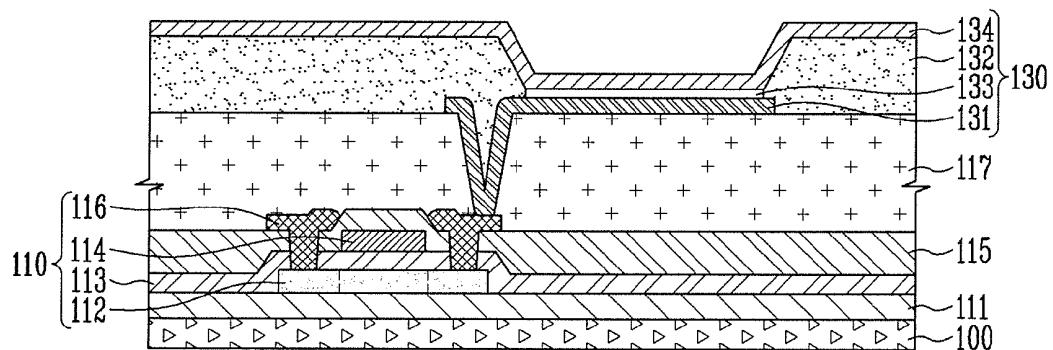


FIG. 4A

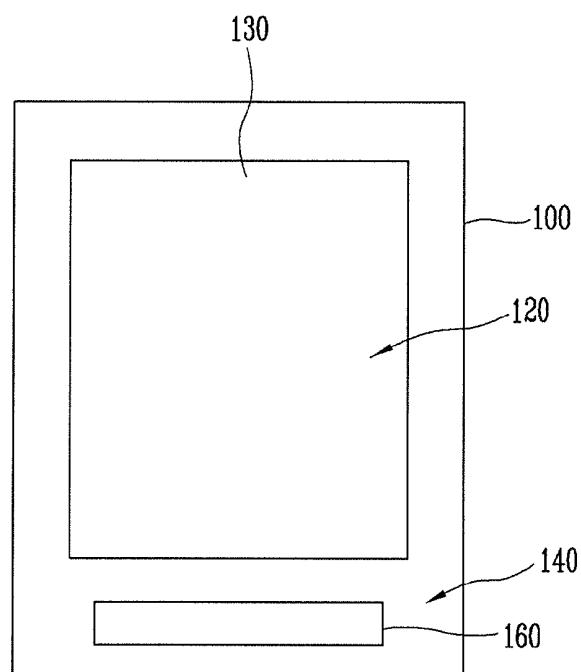


FIG. 4B

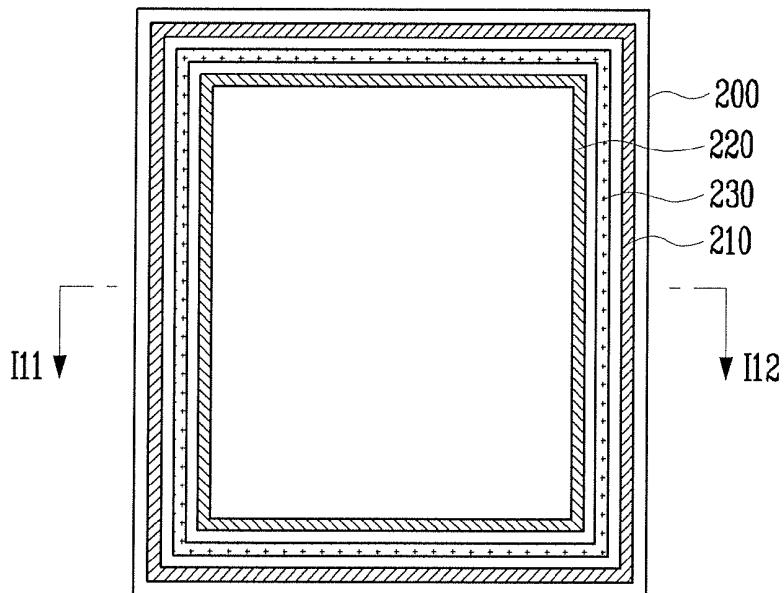


FIG. 5A

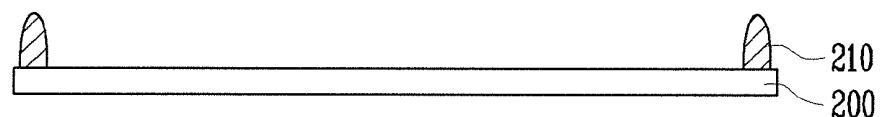


FIG. 5B

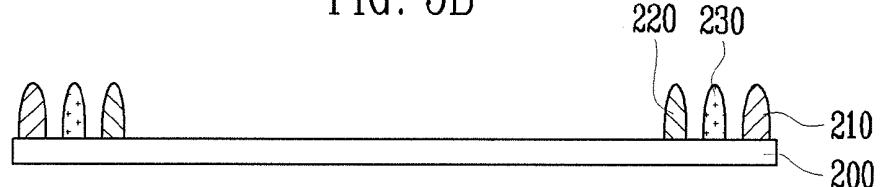


FIG. 5C

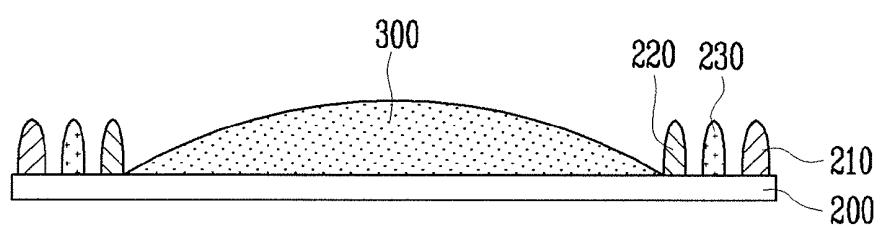


FIG. 5D

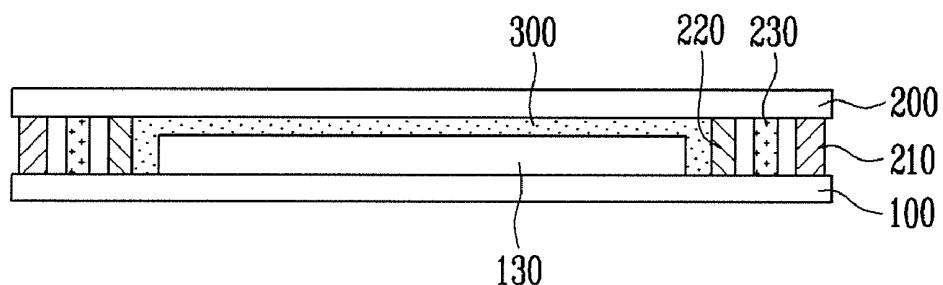


FIG. 5E

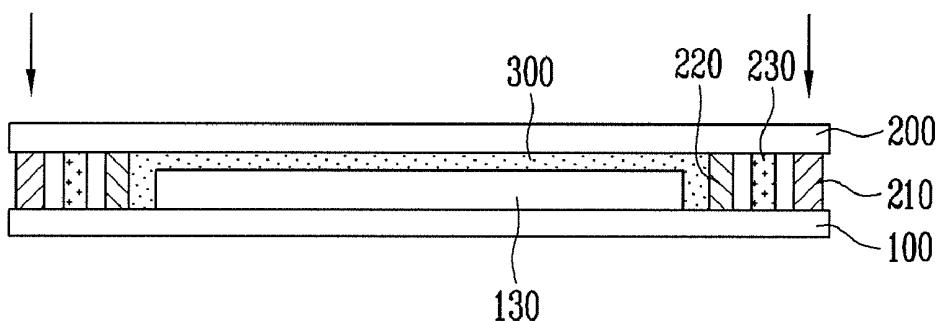
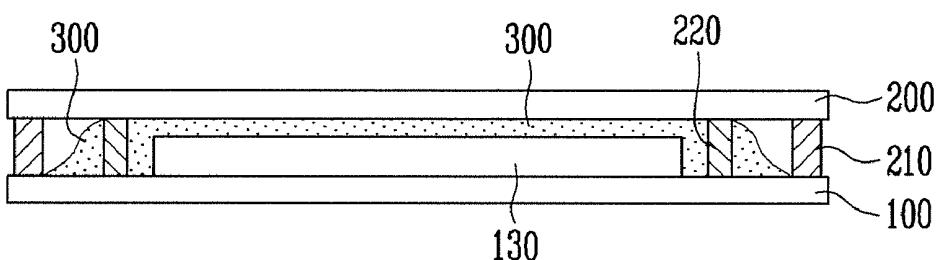


FIG. 6



## ORGANIC LIGHT EMITTING DISPLAY DEVICE

### CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2009-0024984, filed on Mar. 24, 2009, in the Korean Intellectual Property Office, the entire content of which is incorporated herein by reference.

### BACKGROUND

[0002] 1. Field of the Invention

[0003] The following description relates to an organic light emitting display device.

[0004] 2. Discussion of Related Art

[0005] An organic light emitting display device has a relatively high viewing angle, high contrast, high response speed, low power consumption, etc., so that its field of applications has been expanded from a personal portable equipment such as an MP3 player and a cellular phone to a television (TV). In addition, the thickness of the organic light emitting display device has been gradually reduced due to user demand.

[0006] However, if the thickness of the organic light emitting display device is reduced too much, it may cause a difficulty in securing mechanical reliability of the organic light emitting display device if the device is dropped and/or distorted. That is, if the mechanical reliability of the organic light emitting display device is not secured, its sealing can be easily broken even by a small impact so that life span characteristics thereof are deteriorated.

[0007] In particular, since organic light emitting elements that constitute a pixel include organic material that is relatively weak against attack from moisture and/or oxygen, material of an accompanying sealant has a great influence on the mechanical reliability of the organic light emitting display device and in protecting the organic light emitting elements from moisture and/or oxygen using the sealant.

### SUMMARY OF THE INVENTION

[0008] An aspect of an embodiment of the present invention is directed toward an organic light emitting display device that can effectively block infiltration of moisture or oxygen and improve mechanical reliability.

[0009] An aspect of an embodiment of the present invention is directed toward an organic light emitting display device that can prevent or protect an inorganic sealant from being contaminated by a sealant.

[0010] An aspect of an embodiment of the present invention is directed toward an organic light emitting display device in which a space between a substrate on which a light emitting device is formed and a sealing substrate is filled with a sealant.

[0011] An embodiment of the present invention provides an organic light emitting display device. The organic light emitting display device includes: a first substrate; a plurality of light emitting elements on the first substrate; a second substrate facing the first substrate; a primary dam member between the first substrate and the second substrate and surrounding the plurality of light emitting elements; a filler filled between the first substrate and the second substrate and in a first region defined by the primary dam member; an auxiliary dam member between the first substrate and the second substrate and in a second region outside the first region, the

auxiliary dam member being composed of porous material; and an inorganic sealant between the first substrate and the second substrate and in a third region outside the first region and the second region, the inorganic sealant being jointed to the first substrate and the second substrate.

[0012] Here, the organic light emitting display device can effectively block infiltration of moisture and/or oxygen by using the inorganic sealant and/or improve pressure-resistance characteristics, making it possible to have high life span characteristics and mechanical reliability. Also, since the filler overflowing the dam member (or the primary dam member) is absorbed by the porous auxiliary dam member while the substrate on which the light emitting elements are formed is jointed to the sealing substrate, the contamination of the inorganic sealant by the filler is blocked or prevented, making it possible to reduce or minimize the sealing defect.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, together with the specification illustrate exemplary embodiments of the present invention, and, together with the description, serve to explain the principles of the present invention.

[0014] FIG. 1 is a perspective schematic view of an organic light emitting display device according to an embodiment of the present invention;

[0015] FIG. 2 is a cross-sectional schematic view of the organic light emitting display device taken along line I1-I2 of FIG. 1;

[0016] FIG. 3 is a cross-sectional schematic view of the organic light emitting elements of FIG. 1;

[0017] FIGS. 4A and 4B are plan schematic views showing a method for manufacturing an organic light emitting display device according to an embodiment of the present invention;

[0018] FIGS. 5A, 5B, 5C, 5D, and 5E are cross-sectional schematic views showing a method for manufacturing an organic light emitting display device according to an embodiment of the present invention; and

[0019] FIG. 6 is a cross-sectional schematic view of an organic light emitting display device explaining an embodiment of the present invention.

### DETAILED DESCRIPTION

[0020] In the following detailed description, only certain exemplary embodiments of the present invention have been shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. In addition, when an element is referred to as being "on" another element, it can be directly on the another element or be indirectly on the another element with one or more intervening elements interposed therebetween. Also, when an element is referred to as being "connected to" another element, it can be directly connected to the another element or be indirectly connected to the another element with one or more intervening elements interposed therebetween. Hereinafter, like reference numerals refer to like elements.

[0021] Hereinafter, exemplary embodiments according to the present invention will be described with reference to the accompanying drawings.

[0022] A use of inorganic sealant that effectively blocks infiltration of moisture and/or oxygen may be considered as being effective in order to improve life span characteristics of an organic light emitting display device. However, the inorganic material is easily released by impact or distortion, thereby deteriorating mechanical reliability.

[0023] An embodiment of the present invention provides an organic light emitting display device having improved life span characteristics by improving the use of the inorganic sealant that effectively blocks infiltration of moisture and/or oxygen.

[0024] FIG. 1 is a perspective schematic view explaining an organic light emitting display device according to an embodiment of the present invention, and FIG. 2 is a cross-sectional schematic view of the organic light emitting display device taken along line I1-I2 of FIG. 1.

[0025] Referring to FIGS. 1 and 2, the organic light emitting display device includes: a substrate 100 on which a plurality of light emitting elements 130 are formed; a sealing substrate 200 facing (or opposed to) the substrate 100; a dam member (or primary dam member) 220 provided between the substrate 100 and the sealing substrate 200 and surrounding the plurality of light emitting elements 130; a filler 300 filled between the substrate 100 and the sealing substrate 200 and in a first region defined by the dam member 220 (or defined by an inner side of the dam member 220); an auxiliary dam member 230 provided between the substrate 100 and the sealing substrate 200 and in a second region outside the first region (or defined by an outer side of the dam member 220); and an inorganic sealant 210 provided between the substrate 100 and the sealing substrate 200, in the third region outside of the first and second regions (or defined by an outer side of the auxiliary dam member 230), and jointed to the substrate 100 and the sealing substrate 200.

[0026] The substrate 100 is defined with a display region 120 and a non-display region 140 that is a peripheral region of the display region 120. The plurality of light emitting elements 130 are formed in the display region 120, and a driving circuit 160 that drives the plurality of light emitting elements 130 is disposed in the non-display region 140.

[0027] Referring to FIG. 3, the light emitting element 130, which is an organic light emitting element, includes an anode element 131, a cathode electrode 134, and an organic light emitting layer 133 between the anode electrode 131 and the cathode electrode 134. The organic light emitting layer 133 is formed on a light emitting region (a region where the anode electrode 131 is exposed) defined by a pixel definition layer 132. The organic light emitting layer 133 may include a hole injection layer, a hole transport layer, an electron transport layer, and an electron injection layer.

[0028] Also, a thin film transistor 110 that controls an operation and a capacitor that maintains a signal can be connected to the light emitting element 130. The thin film transistor 110 includes a semiconductor layer 112 that provides source and drain regions and a channel region, a gate electrode 114 that is insulated from the semiconductor layer 112 by a gate insulating layer 113, and source and drain electrodes 116 that are connected to the semiconductor layer 112 on the source and drain regions through a contact hole formed on an insulating layer 115 and the gate insulating layer 113. In addition, a buffer layer 111 and a planarization insulating layer 117 are provided and shown in FIG. 3.

[0029] The sealing substrate 200 is disposed to overlap with portions of the display region 120 and the non-display region.

In the case of a top emission structure, the sealing substrate 200 may be made of a transparent material such as glass, and in the case of a bottom emission structure, the sealing substrate 200 may be made of an opaque material.

[0030] The inorganic sealant 210 is made of frit that is melted by laser or infrared rays to be jointed to the substrate 100 and the sealing substrate 200, etc. Such an inorganic sealant 210 is provided between the substrate 100 and the sealing substrate 200 in order to surround the light emitting elements 130, thereby preventing or blocking external moisture and/or oxygen from infiltrating the light emitting elements 130.

[0031] The filler 300 is filled in the first region between the substrate 100 and the sealing substrate 200 and defined by the dam member 220. The filler 300 is colorless (transparent) liquid-phase material having transmittance of 90% or more in a visible light region such as a glass substrate. The filler 300 may use inert liquid, liquid-phase silicon, silicon oils, epoxy-based, acryl-based, photosensitive resin, etc.

[0032] The inert liquid may be selected from the group consisting of perfluorocarbon and fluorinert that have a high stability, i.e., a reacting material that does not react or is inert to constituents of the light emitting element 130. Also, the liquid-phase silicon and the silicon oils exemplarily have no phase-change in a temperature range from -40°C. to 100°C. and have volume variation within 5%. The silicon oils may be, for example, selected from the group consisting of hexamethyldisiloxane, octamethyltrisiloxane, decamethyltetrasiloxane, dodecamethylpentasiloxane, and polydimethylsiloxanes.

[0033] The dam member 220 maintains the shape of the filler 300 by blocking or preventing the flow of the filler 300. The dam member 220 may be made of inorganic material and/or organic material. The inorganic material may use frit, and the organic material may use epoxy, epoxy acrylate, silicones, etc. In the embodiment, the organic material is composed of bisphenol-A type epoxy, cycloaliphatics epoxy resin, phenyl silicon resin, and acrylic epoxy resin, etc.

[0034] When the filler 300 overflows the dam member 220, the auxiliary dam member 230 absorbs the overflowed filler 300 to block or prevent the filler 300 from being contacted with the inorganic sealant 210. The auxiliary dam member 230 is made of suitable porous inorganic and/or organic material that effectively absorbs liquid having a low viscosity and does not generate noxious gas. For example, the porous inorganic material may use frit, silica gel, etc., and the porous organic material may use carbon, foaming resin (Styrofoam), etc. Also, the auxiliary dam member 230 is exemplarily formed having a width between 50 and 100 μm in order to reduce or minimize a dead space and to thereby increase or maximize an absorption effect.

[0035] The present invention will be described in more detail through a method for manufacturing an organic light emitting display device according to an embodiment of the present invention.

[0036] FIGS. 4A and 4B are plan schematic views showing a method for manufacturing an organic light emitting display device according to an embodiment of the present invention, and FIGS. 5A to 5E are cross-sectional schematic views showing a method for manufacturing an organic light emitting display device according to an embodiment of the present invention, wherein FIGS. 5A to 5E show a cross-section of parts of the organic light emitting display device taken along line I11-I12 of FIG. 4B.

[0037] Referring to FIG. 4A, the substrate **100** on which the plurality of light emitting elements **130** are formed is initially prepared. The substrate **100** is defined with the display region **120** and the non-display region **140** that is the peripheral region of the display region **120**. The plurality of light emitting elements **130** may be formed on the substrate **100** and in the display region **120**, and a driving circuit **160** that drives the light emitting elements **130** may be disposed on the substrate **100** and in the non-display region **140**.

[0038] Referring to FIG. 3, the light emitting element **130** may be formed of the organic light emitting element that includes the anode electrode **131**, the organic light emitting layer **133**, and the cathode electrode, and may further include the thin film transistor **110** that controls an operation of the organic light emitting element and a capacitor that maintains a signal. A manufacturing process of the organic light emitting element may be appreciated by referring to Korean Laid-Open Patent Publication Nos. 2002-0047889 (laid-open publication date: Jun. 22, 2002) and 2003-0092873 (laid-open publication date: Dec. 6, 2003), the entire content of which is incorporated herein by reference.

[0039] Referring to FIGS. 4B and 5A, the sealing substrate **200** that seals the light emitting element **130** on the display region **120** is prepared. The sealing substrate **200** may have a size that is overlapped with portions of the display region **120** and the non-display region **140**. The sealing substrate **200** may use a transparent substrate such as glass in the case of a top emission structure, and may use an opaque substrate in the case of a bottom emission structure.

[0040] An inorganic sealant **210** is formed along an outer region of the sealing substrate **200**. The inorganic sealant **210** may use frit, wherein it is coated through a dispenser and/or screen printing process. Frit generally refers to glass raw material in a powder shape. However, in embodiments of the present invention, the frit refers to a paste with an infrared ray absorber, an organic binder, and a filler for reducing thermal expansion coefficient, etc. that are included in a main material, such as SiO<sub>2</sub>, etc. If the frit in the paste state is subject to a dry and/or burning process, the organic binder and moisture are removed so that the frit is hardened. The laser and/or infrared absorber may include a transition metal compound, exemplarily, a vanadium compound.

[0041] Referring to FIGS. 4B and 5B, the dam member **220** is formed on the sealing substrate **200** in a region defined by the inorganic sealant **210** (or defined by the inner side of the inorganic sealant **210**) in order to surround the display region **120**, and the auxiliary dam member **230** is formed on the sealing substrate **200** between the dam member **220** and the inorganic sealant **210** in order to surround the dam member **220**.

[0042] The dam member **220** may be made of organic material and/or inorganic material, and the auxiliary dam member **230** may be made of porous inorganic material and/or organic material that can absorb a filler **300**. The dam member **220** and the auxiliary dam member **230** may be coated through a dispenser and/or a screen printing process. Here, the coated amount is determined by considering the distance from the light emitting element **130** positioned at the outer-most portion of the display region **120** to the inorganic sealant **210** and the height of the dam member **220** and the auxiliary dam member **230**. If the height of the dam member **220** and the auxiliary dam member **230** is higher than that of the inorganic sealant **210**, it is difficult to join the inorganic sealant **210** to the substrate **100**. Therefore, it is exemplar that the height of

the dam member **220** and the auxiliary dam member **230** is equal to or lower than that of the inorganic sealant **210**.

[0043] Also, the dam member **220** and the auxiliary dam member **230** made of material having low viscosity is easily collapsed so that if they in the coated state are temporarily-hardened, they are structurally hardened, making it possible to reinforce a dam function. The temporary-hardening may use heat, electron beam and/or ultraviolet rays according to the material characteristics of the material utilized.

[0044] In one embodiment, the dam member **220** and the auxiliary dam member **230** are formed after the inorganic sealant **210** is formed, however, the formation order may be changed according to the design and process conditions.

[0045] Referring to FIG. 5C, the liquid-phase filler **300** is provided to the sealing substrate **200** in the first region defined by the dam member **220** (or defined by the inner side of the dam member **220**). The filler **300** may be provided through an inkjet, a dispenser, a screen printing or a one drop filling (ODF), etc. For example, the filler **300** having viscosity between 1 and 2000 cPs may be loaded onto the sealing substrate **200** in the first region defined by the inner side of the dam member **220** using the ODF equipment. In this case, the appropriate amount to volume of the theoretical inner space may be easily controlled.

[0046] Referring to FIG. 5D, the substrate **100** and the sealing substrate **200** are then disposed to be opposed to each other. For example, the substrate **100** is mounted on an upper chuck of the junction device, the sealing substrate **200** is mounted on a lower chuck thereof, and then the substrate **100** is jointed to the sealing substrate **200**. As the substrate **100** is jointed to the sealing substrate **200**, the filler **300** is filled in the first region defined by the inner side of the dam member **220**, and the flow of the filler **300** is prevented by the dam member **220** so that the shape of the filler **300** is maintained. Here, the substrate **100** and the sealing substrate **200** can be pressurized so that the space between the light emitting elements **130** and the sealing substrate **200** is completely filled with the filler **300**.

[0047] Referring to FIG. 5E, laser and/or infrared rays are emitted along the inorganic material **210** in the state where the substrate **100** is joined to the sealing substrate **200**. As laser and/or infrared rays are absorbed to generate heat, the inorganic sealant **210** is melted to be jointed to the substrate **100** and the sealing substrate **200**, such that the light emitting elements **130** are thereby sealed.

[0048] When emitting laser and/or infrared rays along the inorganic sealant **210**, laser and/or infrared rays can be emitted only to a desired region using a mask and/or a protective film (not shown), and the filler **300** can be hardened using heat, electron beam and/or ultraviolet rays (UV) in the state where the elements **130** are sealed as described above.

[0049] In a structure where the auxiliary dam member **230** is not provided as shown in FIG. 6, the filler **300** may contact the inorganic sealant **210** by overflowing the dam member **220** while the substrate **100** is jointed to the sealing substrate **200** as shown in FIG. 5. In this case, the inorganic sealant **210** is contaminated by the filler **300** so that when the inorganic sealant **210** is jointed to the substrate **100** by emitting laser and/or infrared rays, the inorganic sealant **210** is not completely jointed to the substrate **100** so that the sealed state is deteriorated. However, in an embodiment of the present invention having a structure where the auxiliary dam member **230** is provided, the filler **300** overflowing the dam member **220** is absorbed by the porous auxiliary dam member **230**,

making it possible to effectively block or prevent the inorganic sealant 210 from being contacted with the filler 300.

[0050] An embodiment of the present invention describes the case where the display region 210 is sealed by the inorganic sealant 210, however, the present invention is not limited thereto, and a driving circuit 160 may also be sealed by the inorganic sealant 210. Also, an embodiment of the present invention describes the case where the inorganic sealant 210 and the auxiliary dam member 230 are formed on the sealing substrate 200, having a single structure, however, the present invention is not limited thereto, and they may be formed on the substrate 100 and/or may be formed to have a double structure or a multiple structure (e.g., a double or multiple layers). For example, the inorganic sealant 210 may be formed to have a double structure or a multiple structure in order to enhance a sealing effect, or the auxiliary dam member 220 may be formed having a double structure or a multiple structure in order to effectively block or prevent the defect due to the overflow of the filler 300.

[0051] While the present invention has been described in connection with certain exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, and equivalents thereof.

What is claimed is:

1. An organic light emitting display device, comprising:
  - a first substrate;
  - a plurality of light emitting elements on the first substrate;
  - a second substrate facing the first substrate;
  - a primary dam member between the first substrate and the second substrate and surrounding the plurality of light emitting elements;
  - a filler filled between the first substrate and the second substrate and in a first region defined by the primary dam member;
  - an auxiliary dam member between the first substrate and the second substrate and in a second region outside the first region, the auxiliary dam member being composed of porous material; and
  - an inorganic sealant between the first substrate and the second substrate and in a third region outside the first region and the second region, the inorganic sealant being jointed to the first substrate and the second substrate.
2. The organic light emitting display device as claimed in claim 1, wherein the filler is composed of a material selected from the group consisting of inert liquids, liquid-phase silicon, silicon oils, epoxy-based resins, acryl-based resins, photosensitive resins, and combinations thereof.
3. The organic light emitting display device as claimed in claim 1, wherein the primary dam member is composed of frit.
4. The organic light emitting display device as claimed in claim 1, wherein the primary dam member comprises a material selected from the group consisting of epoxies, epoxy acrylates, bisphenol-A type epoxies, cycloaliphatics epoxy resins, phenyl silicon resins, acrylic epoxy resins, and combinations thereof.
5. The organic light emitting display device as claimed in claim 1, wherein the porous material comprises a material selected from the group consisting of frits, carbons, silica gels, foaming resins, and combinations thereof.
6. The organic light emitting display device as claimed in claim 1, wherein the auxiliary dam member has a width between about 50 and about 100  $\mu\text{m}$ .
7. The organic light emitting display device as claimed in claim 1, wherein the inorganic sealant is composed of frit.
8. The organic light emitting display device as claimed in claim 7, wherein the frit is a laser or infrared ray melted frit.
9. The organic light emitting display device as claimed in claim 1, wherein the second region is between the primary dam member and the inorganic sealant.
10. An organic light emitting display device, comprising:
  - a first substrate;
  - a second substrate facing the first substrate;
  - a plurality of light emitting elements between the first substrate and the second substrate;
  - a primary dam member between the first substrate and the second substrate and surrounding the plurality of light emitting elements;
  - a filler filled between the first substrate and the second substrate and in a first region defined by the primary dam member;
  - an auxiliary dam member between the first substrate and the second substrate and in a second region outside the first region, the auxiliary dam member being composed of porous material; and
  - an inorganic sealant between the first substrate and the second substrate and in a third region outside the first region and the second region, the inorganic sealant being jointed to the first substrate and the second substrate.
11. An organic light emitting display device, comprising:
  - a first substrate;
  - a second substrate facing the first substrate;
  - a plurality of light emitting elements between the first substrate and the second substrate;
  - a primary dam member between the first substrate and the second substrate and surrounding the plurality of light emitting elements;
  - a filler filled between the first substrate and the second substrate and in a first region defined by an inner side of the primary dam member;
  - an auxiliary dam member between the first substrate and the second substrate and in a second region defined by an outer side of the primary dam member, the auxiliary dam member being composed of porous material; and
  - an inorganic sealant between the first substrate and the second substrate and in a third region defined by an outer side of the auxiliary dam member, the inorganic sealant being jointed to the first substrate and the second substrate.
12. The organic light emitting display device as claimed in claim 11, wherein the second region is further defined by an inner side of the inorganic sealant facing the outer side of the primary dam member.

\* \* \* \* \*

专利名称(译)	有机发光显示装置		
公开(公告)号	<a href="#">US20100244057A1</a>	公开(公告)日	2010-09-30
申请号	US12/603552	申请日	2009-10-21
[标]申请(专利权)人(译)	RYU JI HUN 宋承宪YONG 崔英SEO KWON OH JUNE		
申请(专利权)人(译)	RYU JI-HUN 宋承宪勇 崔英SEO KWON OH-JUNE		
当前申请(专利权)人(译)	RYU JI-HUN 宋承宪勇 崔英SEO KWON OH-JUNE		
[标]发明人	RYU JI HUN SONG SEUNG YONG CHOI YOUNG SEO KWON OH JUNE		
发明人	RYU, JI-HUN SONG, SEUNG-YONG CHOI, YOUNG-SEO KWON, OH-JUNE		
IPC分类号	H01L51/52		
CPC分类号	H01L27/3244 H01L51/56 H01L51/525 H01L51/5246		
优先权	1020090024984 2009-03-24 KR		
其他公开文献	US8357929		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

**摘要(译)**

一种有机发光显示装置，包括：第一基板，在所述第一基板上形成有多个发光元件；第二基板，设置为与第一基板相对；主坝构件，其设置在第一基板和第二基板之间，以包围多个发光元件；填充物填充在第一基板和第二基板之间以及由主坝构件限定的第一区域中，辅助挡板构件位于第一基板和第二基板之间以及第一区域外的第二区域中，由多孔材料制成；和无机密封剂，其设置在第一基板和第二基板之间以及第一区域和第二区域外部的第三区域中，并且连接到第一基板和第二基板。

