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(54) **ORGANIC EL DISPLAY DEVICE AND METHOD OF ENCAPSULATING THE SAME**

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(57) **ABSTRACT**

An organic electroluminescent (EL) display device includes an organic EL element formed on a substrate. The organic EL element includes a lower electrode, an organic EL layer and an upper electrode that are sequentially stacked on the substrate. A flat panel is attached to the substrate to encapsulate the organic EL element. At least one through hole is formed in the organic EL display device so as to allow gas inside the organic EL display device to flow out during an encapsulation process. A cap is provided to shut the one or more through holes.

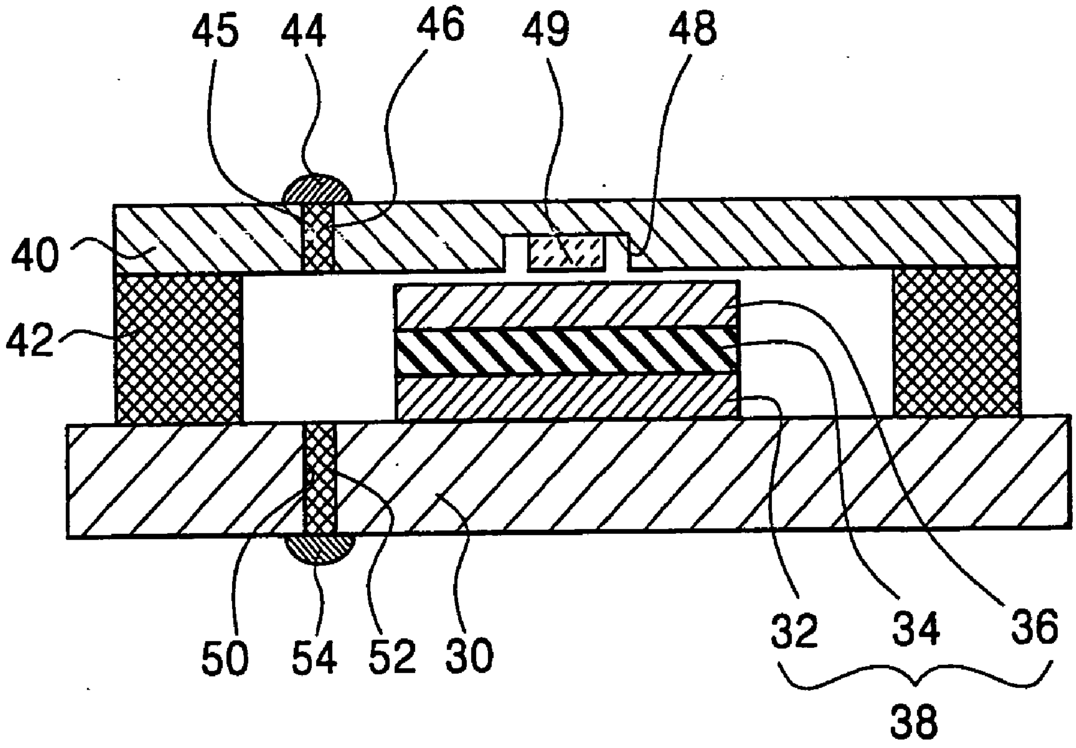

FIG. 1
(PRIOR ART)

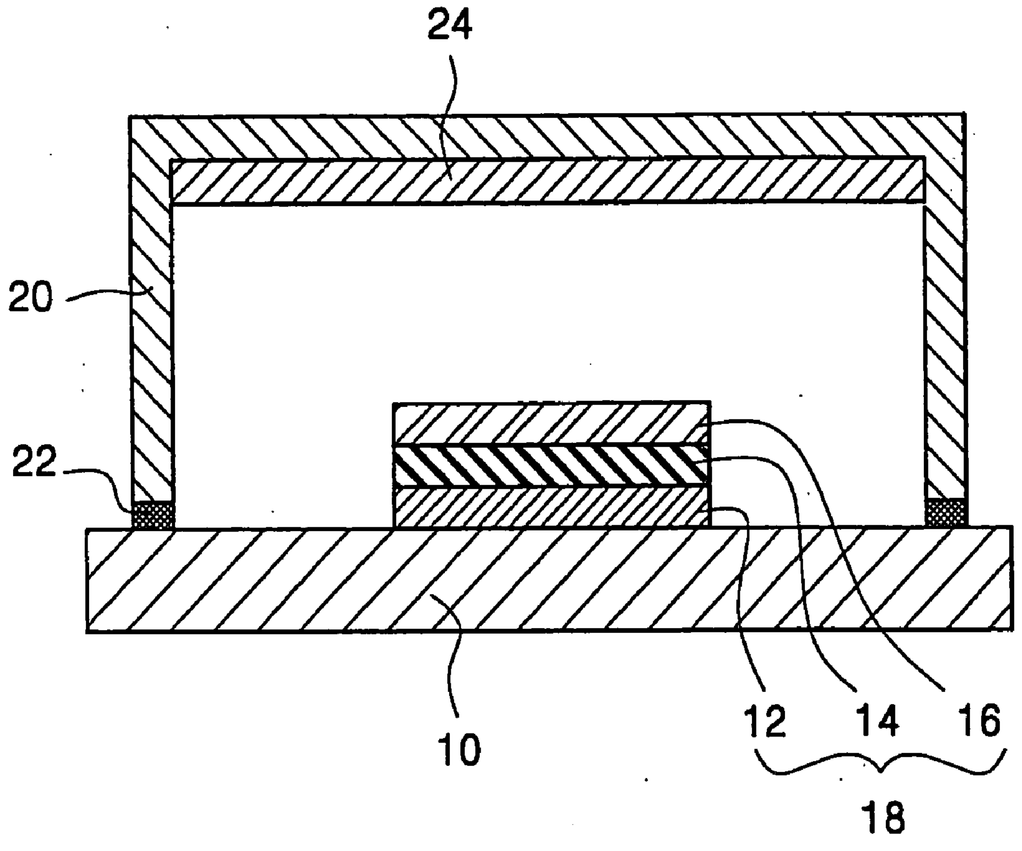

FIG. 2
(PRIOR ART)

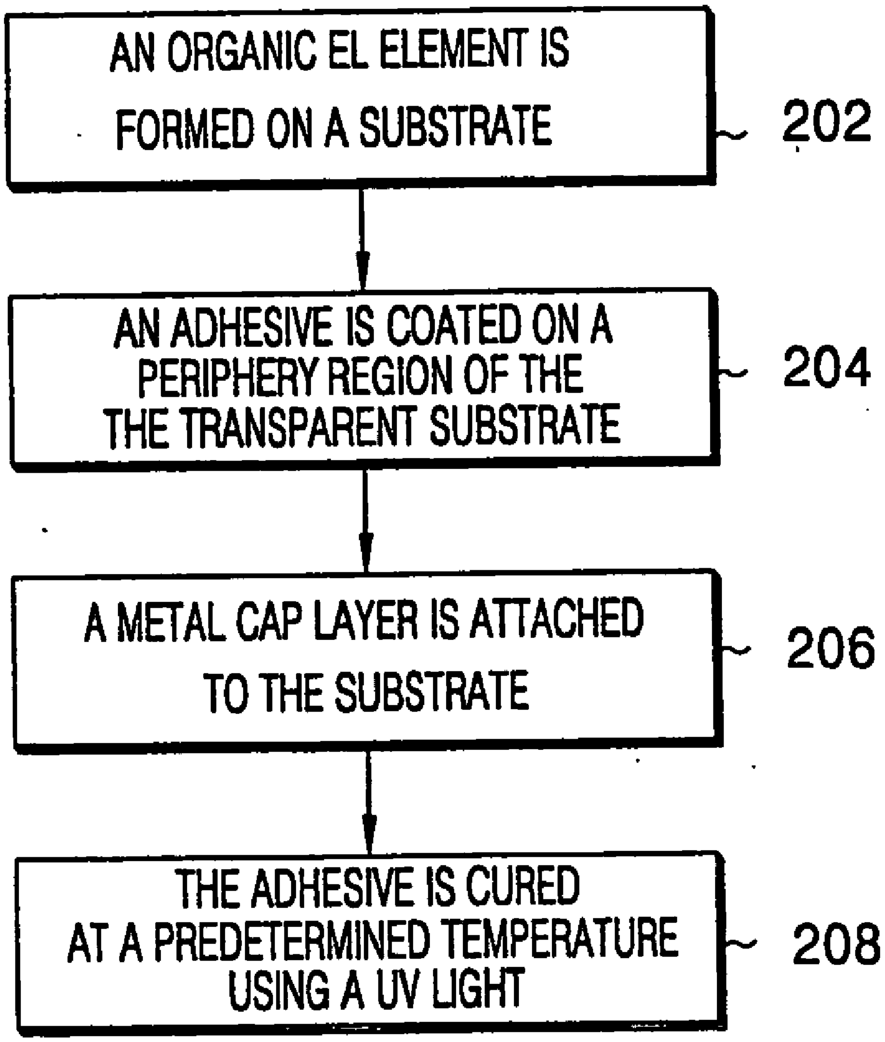

FIG. 3

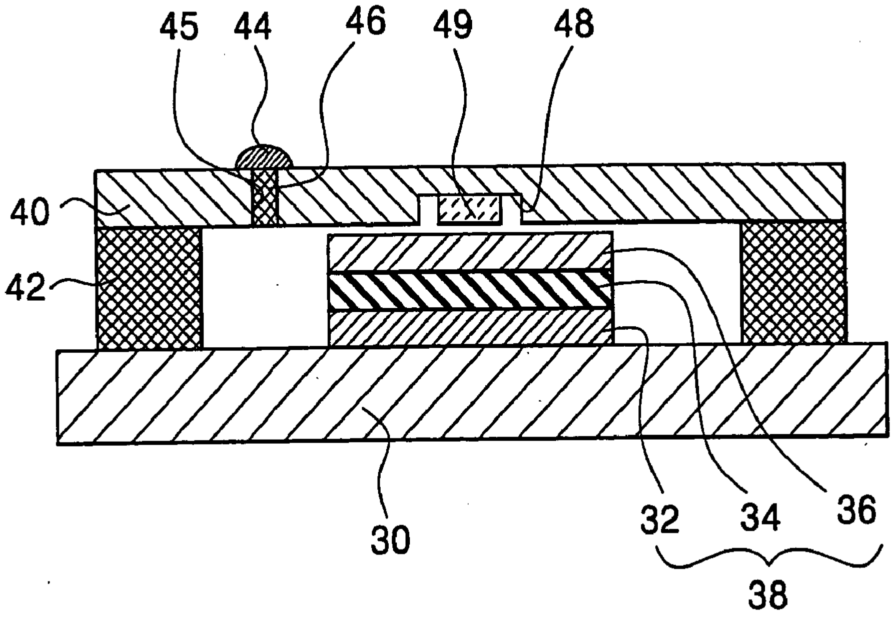
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FIG. 4

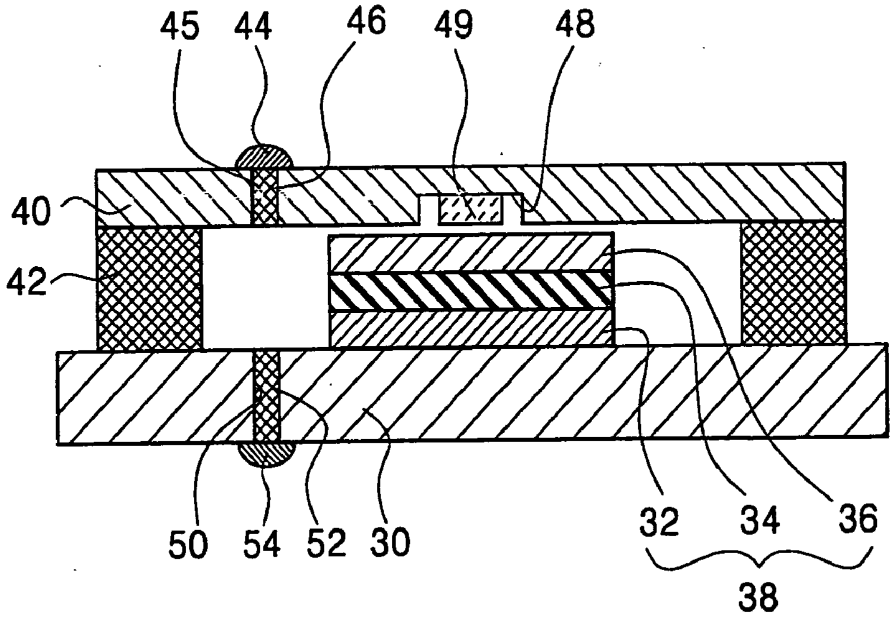
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FIG. 5

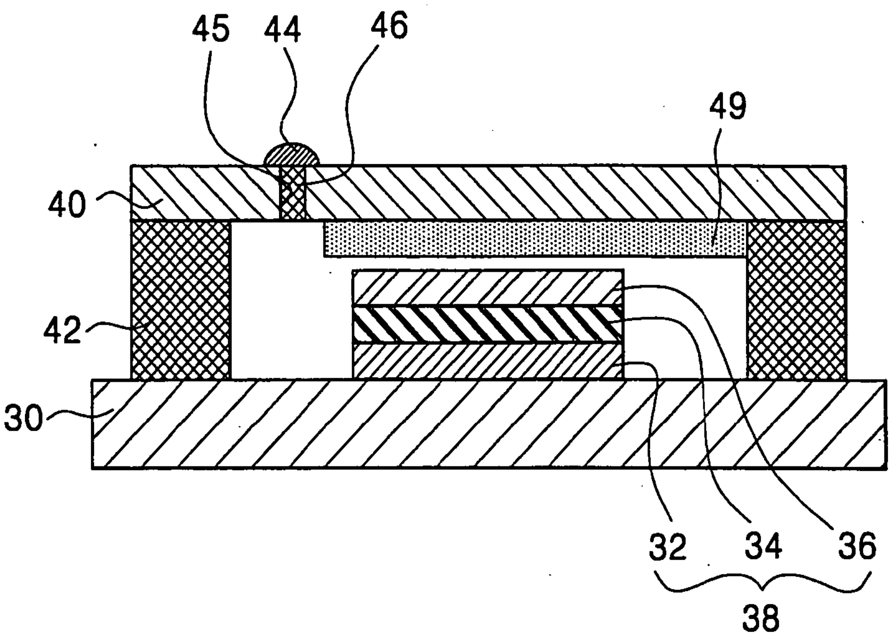
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FIG. 6

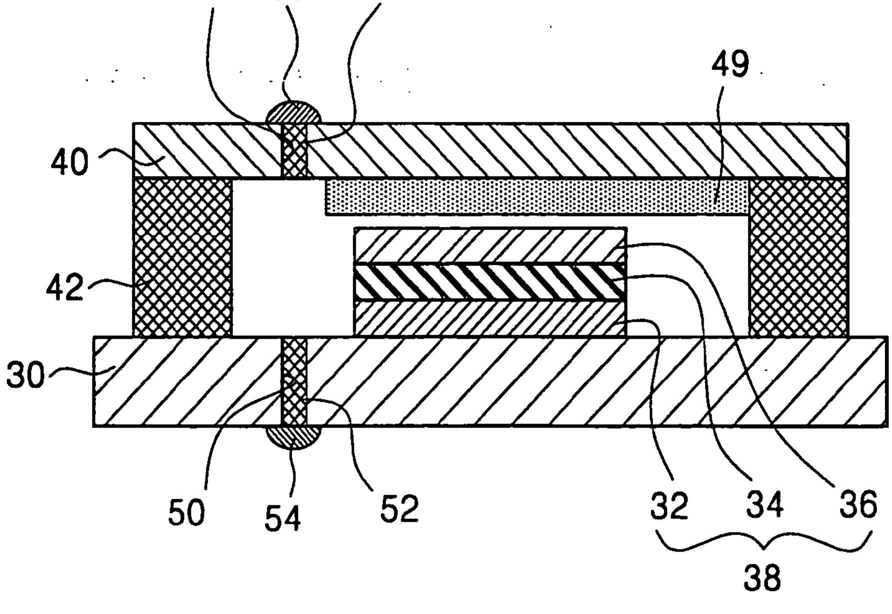
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FIG. 7

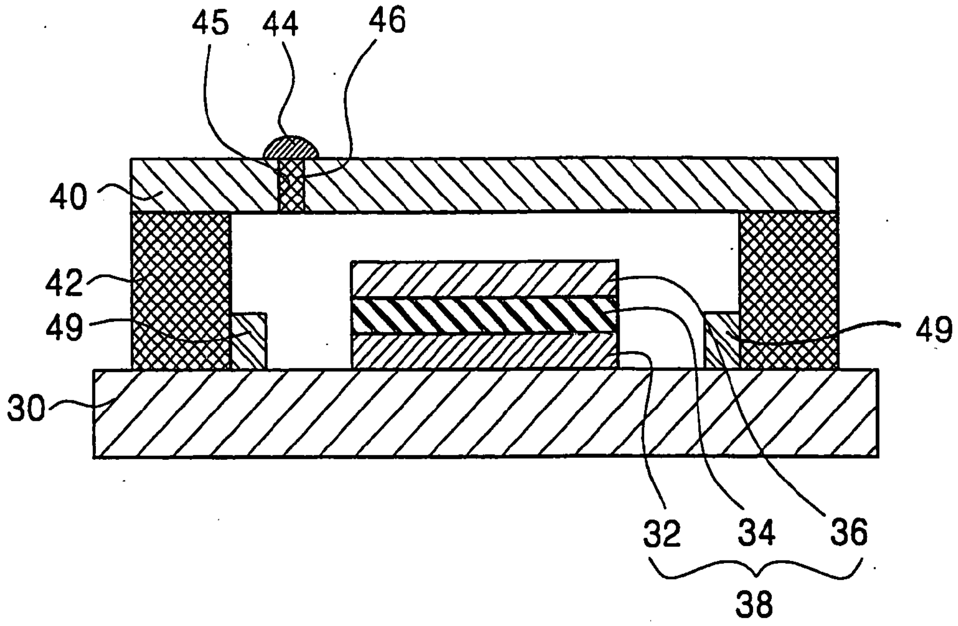
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FIG. 8

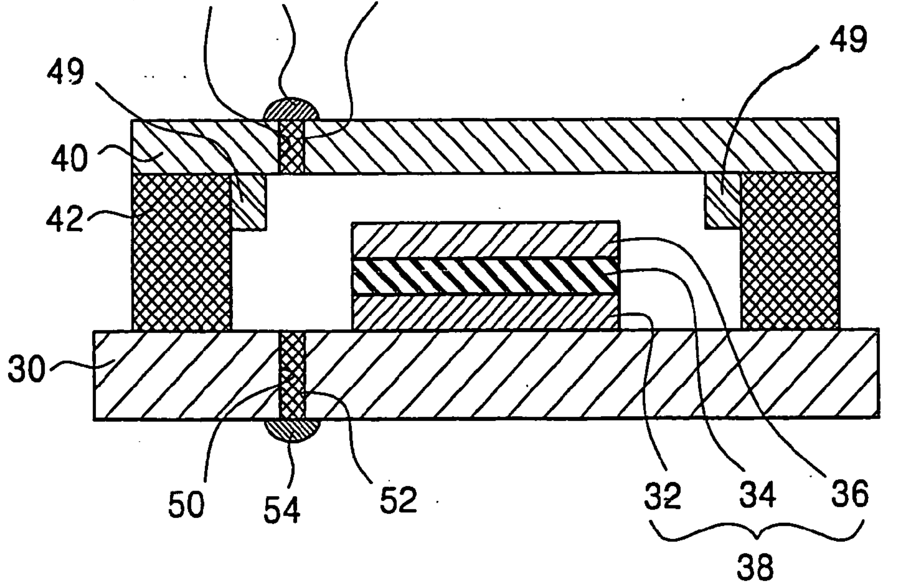
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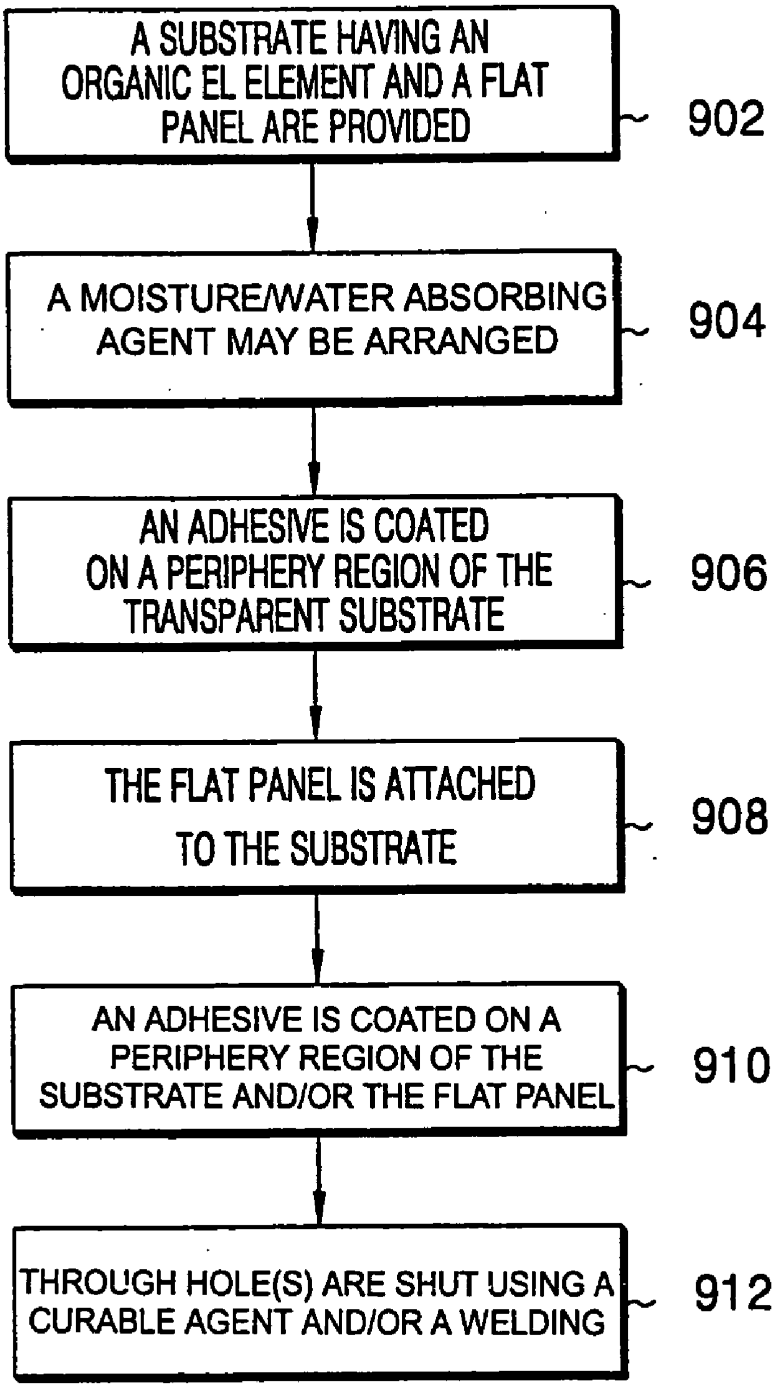
FIG. 9


A SUBSTRATE HAVING AN ORGANIC EL ELEMENT AND A FLAT PANEL ARE PROVIDED
902
A MOISTURE/WATER ABSORBING AGENT MAY BE ARRANGED
904
AN ADHESIVE IS COATED ON A PERIPHERY REGION OF THE TRANSPARENT SUBSTRATE
906
THE FLAT PANEL IS ATTACHED TO THE SUBSTRATE
908
AN ADHESIVE IS COATED ON A PERIPHERY REGION OF THE SUBSTRATE AND/OR THE FLAT PANEL
910
THROUGH HOLE(S) ARE SHUT USING A CURABLE AGENT AND/OR A WELDING
912

ORGANIC EL DISPLAY DEVICE AND METHOD OF ENCAPSULATING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of application Ser. No. 10/067,818, filed Feb. 8, 2002. This application is based upon and claims the priority of Korean Application No. 2001-46018, filed on Jul. 30, 2001, the contents being incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a flat panel display device, and more particularly, to an organic electroluminescent (EL) display device and a method of encapsulating the same.

[0004] 2. Description of Related Art

[0005] Examples of a flat panel display device include a liquid crystal display (LCD) device, an organic EL display (OELD) device, a field emitter display (FED) device, and a plasma display panel (PDP). Of these, the organic EL display device attracts attention due to a wide viewing angle, a clearer moving picture, a high durability, and a high temperature resistance.

[0006] **FIG. 1** is a cross-sectional view illustrating a conventional organic EL display device. The organic EL display device includes a lower electrode **12**, an organic EL layer **14**, and an upper electrode **16** which are sequentially stacked on a transparent insulating substrate ("insulating substrate") **10**.

[0007] A structure that emits light from the organic EL layer **14** toward the insulating substrate **10** is referred to as a back surface light emitting structure, and a structure that emits light from the organic EL layer **14** toward a direction opposite to the insulating substrate **10** is referred to as a front surface light emitting structure.

[0008] In case of the back surface light emitting structure, the lower electrode **12** is made of a transparent conductive material, and the upper electrode **16** is made of an opaque conductive material. On the other hands, in case of the front surface light emitting structure, the lower electrode **12** is made of an opaque conductive material, and the upper electrode **16** is made of a transparent conductive material.

[0009] Hereinafter, the organic EL display device is described focusing on the back surface light emitting structure.

[0010] The lower electrode **12** is made of a transparent conductive material including one of indium tin oxide (ITO) and indium zinc oxide (IZO), and the upper electrode **16** is made of an opaque conductive material including one of magnesium, aluminum, indium, and silver-magnesium.

[0011] A passivation layer (not shown) can be formed over the entire surface of the insulating substrate **10** to cover an organic EL element **18**.

[0012] A metal cap **20** is attached to the insulating substrate **10** using an adhesive **22** to encapsulate the organic EL element **18** so as to protect the organic EL display from oxygen or moisture. The metal cap **20** is made of an aluminum alloy. A moisture/water absorbing layer **24** is arranged on an inner surface of the metal cap **20** to prevent element characteristics (e.g., a light-emitting efficiency) from being deteriorated due to the moisture or water.

[0013] **FIG. 2** shows a flow chart illustrating a process of encapsulating the organic EL display device of **FIG. 1**. The lower electrode **12**, the organic EL layer **14**, and the upper electrode **16** are sequentially formed on the insulating substrate **10** (operation **202**). The adhesive **22** is coated on a periphery region of the insulating substrate **10** to a thickness of about 150 μm (operation **204**). The metal cap **20** is rested on the adhesive **22** and pressurized to attach the metal cap **20** to the insulating substrate **10** (operation **206**). The adhesive **20** is cured at a predetermined temperature using a UV light (operation **208**). Accordingly, encapsulation of the organic EL element **18** is completed.

[0014] However, the conventional encapsulating method has at least the following problems. As the adhesive **22** is pressurized by the metal cap **20**, the thickness of the adhesive **22** is reduced to ~50 μm. Therefore, an inner pressure of a space formed by the insulating substrate **10** and the metal cap **20** is increased. Also, as the adhesive **22** is cured using a UV light, a gas volume of the space causes a thermal expansion. As a result, the adhesive **22** can be separated from the insulating substrate **10** and can have a non-uniform width. Accordingly, moisture can leak into the space, thereby deteriorating element characteristics of the organic EL display device.

[0015] In addition, the conventional organic EL display having the structure described above cannot satisfy a current trend toward a compact display device.

SUMMARY OF THE INVENTION

[0016] Accordingly, it is an object of the present invention provide an organic EL display device having improved element characteristics.

[0017] It is another object of the present invention to provide an organic EL display device having a compact structure.

[0018] Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0019] To achieve the above and other objects of the present invention, there is provided an organic electroluminescent (EL) display device, comprising a substrate, an organic EL element having a lower electrode, an organic EL layer and an upper electrode sequentially stacked on the substrate, a flat panel which encapsulates the organic EL element and is attached to the substrate, at least one through hole formed in the substrate and/or the flat panel, and a through hole shutting cap which shuts the through hole.

[0020] To achieve the above and other objects of the present invention, there is also provided a method of encapsulating an organic EL display device, comprising providing at least one through hole in a substrate and/or a flat panel, forming an organic EL element including a lower electrode, an organic EL layer and an upper electrode that are sequentially stacked on the substrate, coating an adhesive on the substrate and/or the flat panel, attaching the substrate and the flat panel to each other, curing the adhesive at a predetermined temperature, and shutting the through hole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] These and other objects and advantages of the invention will become apparent and more appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

[0022] **FIG. 1** is a cross-sectional view illustrating a conventional organic EL display device;

[0023] **FIG. 2** is a flow chart illustrating a process of encapsulating the organic EL display device of **FIG. 1**;

[0024] **FIG. 3** is a cross-sectional view illustrating an organic EL display device according to an embodiment of the present invention;

[0025] **FIGS. 4 through 8** are cross-sectional views illustrating devices according to various aspects of the present invention; and

[0026] **FIG. 9** is a flow chart illustrating a process of encapsulating the organic EL display devices of **FIGS. 3 through 8**.

DETAILED DESCRIPTION OF PREFFERED EMBODIMENTS

[0027] Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refers to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0028] The organic EL display device according to the present invention can be applied to both a back surface light emitting structure and a front surface light emitting structure. Also, the present invention can be applied to both an active matrix (AM) organic EL display and a passive matrix (PM) organic EL display. However, for the sake of continuity, the present invention will be described in relation to a PM organic EL display device having a back surface light emitting structure.

[0029] **FIG. 3** shows an organic EL display device according to an embodiment of the present invention.

[0030] An organic EL element **38** is formed on a transparent insulating substrate ("insulating substrate") **30**. The insulating substrate **30** comprises a transparent insulating material such as a glass. The organic EL element **38** includes a lower electrode **32**, an organic EL layer **34** and an upper electrode **36** which are sequentially stacked on the insulating substrate **30**. The lower electrode **32** comprises one of indium tin oxide (ITO) and indium zinc oxide (IZO). The upper electrode **36** comprises one of magnesium, aluminum, indium, and silver-magnesium.

[0031] A passivation layer (not shown) can be formed to cover the organic EL element **38**.

[0032] A flat panel **40** is attached to the insulating substrate **30** using an adhesive **42** to encapsulate the organic EL element **38**. Encapsulation protects the organic EL element **38** from being deteriorated by moisture or water. The adhesive **42** can include spacers.

[0033] The flat panel **40** comprises one of an opaque material and a transparent material. To attach the flat panel **40** to the insulating substrate **30**, the adhesive **42** is coated on the insulating substrate **30** and/or the flat panel **42**. Then, the insulating substrate **30** and the flat panel **42** are aligned to each other, pressurized and cured using a UV light.

[0034] The flat panel **40** includes at least one through hole **45**. As the insulating substrate **30** and the flat panel **40** are pressurized, gas in a space formed by the insulating substrate **30** and the flat panel **40** flows out through the through hole **45**, so as to keep an inner pressure of the space constant. In addition, as the adhesive **42** is cured by the UV light, gas in the space also flows out through the through hole **45**, so as to prevent separation of the adhesive **42** from the insulating substrate **30** and a non-uniform width of the adhesive **42**.

[0035] The through hole **45** is filled with a curable agent **46**. In addition, an upper surface of the curable agent **46** may be shut tightly by a welding **44** using one of indium (In) and lead (Pb).

[0036] The flat panel **40** may further include a moisture/water absorbing agent reception groove **48** on a bottom surface thereof. The moisture/water absorbing agent reception groove **48** receives a moisture/water absorbing agent **49** which removes moisture or water from the space formed by the insulating substrate **30** and the flat panel **40**. The moisture/water absorbing agent reception groove **48** also allows the distance between the insulating substrate **30** and the flat panel **40** to be reduced by a distance corresponding to the thickness of the moisture/water absorbing agent **49**. The moisture/water absorbing agent reception groove **48** is arranged at a location that does not shield light emitted from the organic EL element **38**. For example, in case of the front surface light emitting structure, since light emitted from the organic EL element **38** is directed toward the flat panel **40**, the moisture/water absorbing agent reception groove **48** can be arranged on the insulating substrate **30** and/or a portion of the flat panel **40** that does not correspond to the organic EL element **38**. In **FIG. 3**, in case of the back surface light emitting structure, the moisture/water absorbing agent reception groove **48** may be situated on the bottom surface of the flat panel **40**.

[0037] The organic EL display device of **FIG. 3** can have various modifications. According to an aspect of the present invention, **FIG. 4** shows an organic EL display device having a second through hole **50** that is formed in the substrate **30** in addition to the through hole **45** formed in the flat panel **40**. The second through hole **50** is also filled with a curable agent **52**, and an upper surface of the curable agent **52** may be shut tightly by a welding **54** using one of indium (In) and lead (Pb).

[0038] According to another aspect of the present invention, **FIG. 5** shows an organic EL display device having the through hole **45** and a moisture/water absorbing agent **49** that is attached directly to a bottom surface of the flat panel **40** using an adhesive (not shown), and without the moisture/water absorbing agent groove **48** of **FIG. 3**.

[0039] According to yet another aspect of the present invention, **FIG. 6** shows an organic EL display device having both the through hole **45** in the flat panel **40** and the second through hole **50** formed in the substrate **30**, and a moisture/water absorbing agent **49** that is attached directly to a bottom surface of the flat panel **40**. The second through hole **50** is also filled with a curable agent **52**, and an upper surface of the curable agent **52** may be shut tightly by a welding **54** using one of indium (In) and lead (Pb).

[**0040**] According to still another aspect of the present invention, **FIG. 7** shows an organic EL display device having the through hole **45** and a moisture/water absorbing agent **49** that are arranged along a periphery region of the insulating substrate **30** or the flat panel **40** without the moisture/water absorbing agent reception groove **48** of **FIG. 3**.

[**0041**] According to an additional aspect of the present invention, **FIG. 8** shows an organic EL display device having a second through hole **50** that is formed in the insulating substrate **30** in addition to the through hole **45** formed in the flat panel **40** and moisture/water absorbing agents **49** that are arranged along a periphery region of the flat panel **40** or the insulating substrate **30**. The second through hole **50** is also filled with a curable agent **52**, and an upper surface of the curable agent **52** may be shut tightly by a welding **54** using one of indium (In) and lead (Pb).

[**0042**] In **FIGS. 7 and 8**, the moisture/water absorbing agent **49** can be arranged on a portion of the insulating substrate **30** and/or a portion of the flat panel **40** that does not shield light emitted from the organic EL element. In addition, it is understood that while one through hole has been shown to be formed in the insulating substrate **30** and/or the flat panel **40**, additional through holes can be formed in the insulating substrate **30** and the flat panel **40** as needed.

[**0043**] **FIG. 9** shows a flow chart illustrating a process of encapsulating the organic EL display device according to the present invention.

[**0044**] The lower electrode **32**, the organic EL layer **34** and the upper electrode **36** are sequentially formed on the insulating substrate **30** (operation **902**). The moisture/water absorbing agent(s) **49** may be arranged at a predetermined location (operation **904**). The adhesive **42** is coated on a periphery region of the insulating substrate **30** and/or the flat panel **40** (operation **906**). The substrate **30** and the flat panel **40** are aligned to each other and pressurized to attach to each other (operation **908**). Even though a thickness of the adhesive **42** is reduced, gas in the space formed by the insulating substrate **30** and the flat panel **40** flows out through the one or more through holes **45** and **50**. Therefore, an inner pressure of the space is not increased. Accordingly, separation of the adhesive **42** from the insulating substrate **30** and a non-uniform width of the adhesive **42** can be prevented.

[**0045**] The adhesive **42** is cured at a predetermined temperature using a UV light (operation **910**). During the curing process, a gas volume of the space causes a thermal expansion. However, since the gas in the space can flow out through the one or more through holes **45** and **50**, the adhesive **42** is not separated from the insulating substrate **30** and does not have a non-uniform width. Encapsulation of the organic EL display device is completed as the one or more through holes **45** and **50** are shut tightly by the curable agents **46** and **52** and/or the weldings **44** and **54** (operation **912**).

[**0046**] As described herein before, the organic EL display device according to the present invention has at least the following advantages.

[**0047**] Although a thickness of the adhesive **42** is reduced during a pressurization process, an inner pressure of the space is not increased because gas in the space, which is formed by the insulating substrate **30** and the flat panel **40**, is allowed to flow out through the one or more through holes **45** and **50**. Accordingly, separation of the adhesive **42** from the insulating substrate **30** and a non-uniform width of the adhesive **42** can be prevented. Also, even though a gas volume of the space causes a thermal expansion as the adhesive **22** is cured, the gas in the space flows out through the one or more through holes **45** and **50**. Again, the adhesive **22** is not separated from the insulating substrate **30** and does not have a non-uniform width. As a result, moisture or water cannot leak into the space, thereby improving element characteristics of the organic EL display device.

[**0048**] In addition, encapsulating the organic EL display device with the flat panel **40** produces a compact organic EL display device. The flat panel **40** can be attached closer to the insulating substrate **30** because the one or more through holes **45** and **50** regulates the pressure inside the space prior to the completion of the encapsulation process. That is, as the flat panel **40** is attached closer to the substrate **30**, the one or more through holes **45** and **50** can also relieve the pressure that might otherwise increase as the unit area of the space is reduced.

[**0049**] Although a few preferred embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A method of encapsulating an organic EL display device comprising:

forming an organic EL element comprising a lower electrode, an organic EL layer and an upper electrode that are sequentially stacked on a substrate;

coating an adhesive on the substrate and/or the flat panel, wherein the substrate and/or the flat panel comprises a through hole;

attaching the substrate and the flat panel to each other;

curing the adhesive at a predetermined temperature; and

shutting the through hole.

2. The method of claim **10**, wherein said shutting of the through holes comprises filling the through hole with a curable agent.

3. The method of claim **11**, wherein said shutting of the through hole further comprises welding the through hole filled with the curable agent with a welding material.

4. The method of claim **12**, wherein the welding material includes one of indium (In) and lead (Pb).

5. The method of claim **10**, wherein said curing of the adhesive comprises curing the adhesive using a UV light.

6. The method of claim **10**, further comprising arranging a moisture/water absorbing agent at a location inside a space formed by the substrate and the flat panel so as to not shield light emitted from the organic EL element, wherein said moisture/water absorbing agent removes moisture/water from the space.

7. The method of claim **15**, wherein the flat panel includes a moisture/water absorbing agent reception groove receiving the moisture/water absorbing agent.

8. The method of claim **15**, wherein the location is a periphery region of the substrate so as to not shield the light emitted from the organic EL element.

9. The method of claim **15**, wherein the location is a periphery region of the flat panel so as to not shield the light emitted from the organic EL element.

* * * * *

patsnap

专利名称(译)	有机EL显示装置及其封装方法		
公开(公告)号	US20040259454A1	公开(公告)日	2004-12-23
申请号	US10/893917	申请日	2004-07-20
申请(专利权)人(译)	三星SDI CO.，LTD		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	PARK JIN WOO SONG SEUNG YONG KIM HUN		
发明人	PARK, JIN-WOO SONG, SEUNG-YONG KIM, HUN		
IPC分类号	H05B33/04 H01L51/52 H05B33/10		
CPC分类号	H01L51/5237 H01L51/5259 H01L51/5246 H01L51/525 Y10S428/917		
优先权	1020010046018 2001-07-30 KR		
其他公开文献	US7348725		
外部链接	Espacenet USPTO		

摘要(译)

有机电致发光（EL）显示装置包括形成在基板上的有机EL元件。有机EL元件包括顺序堆叠在基板上的下电极，有机EL层和上电极。平板附接到基板以封装有机EL元件。在有机EL显示装置中形成至少一个通孔，以允许有机EL显示装置内的气体在封装过程中流出。提供盖子以关闭一个或多个通孔。