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(54) ELECTROLUMINESCENCE DISPLAY

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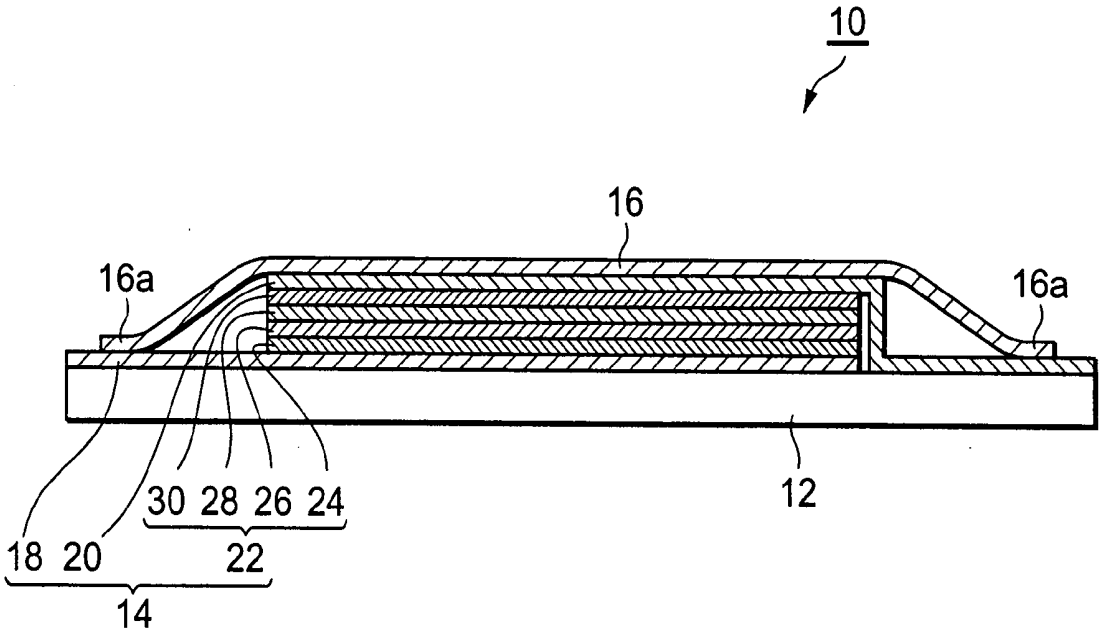
(57) **ABSTRACT**

An EL display device includes a transparent substrate, an electroluminescence element provided on the transparent substrate, and a sealing resin sheet having a function of moisture absorption. The sealing resin sheet is fusion bonded to the transparent substrate by heat to seal the electroluminescence element between the sealing resign sheet and the transparent substrate.



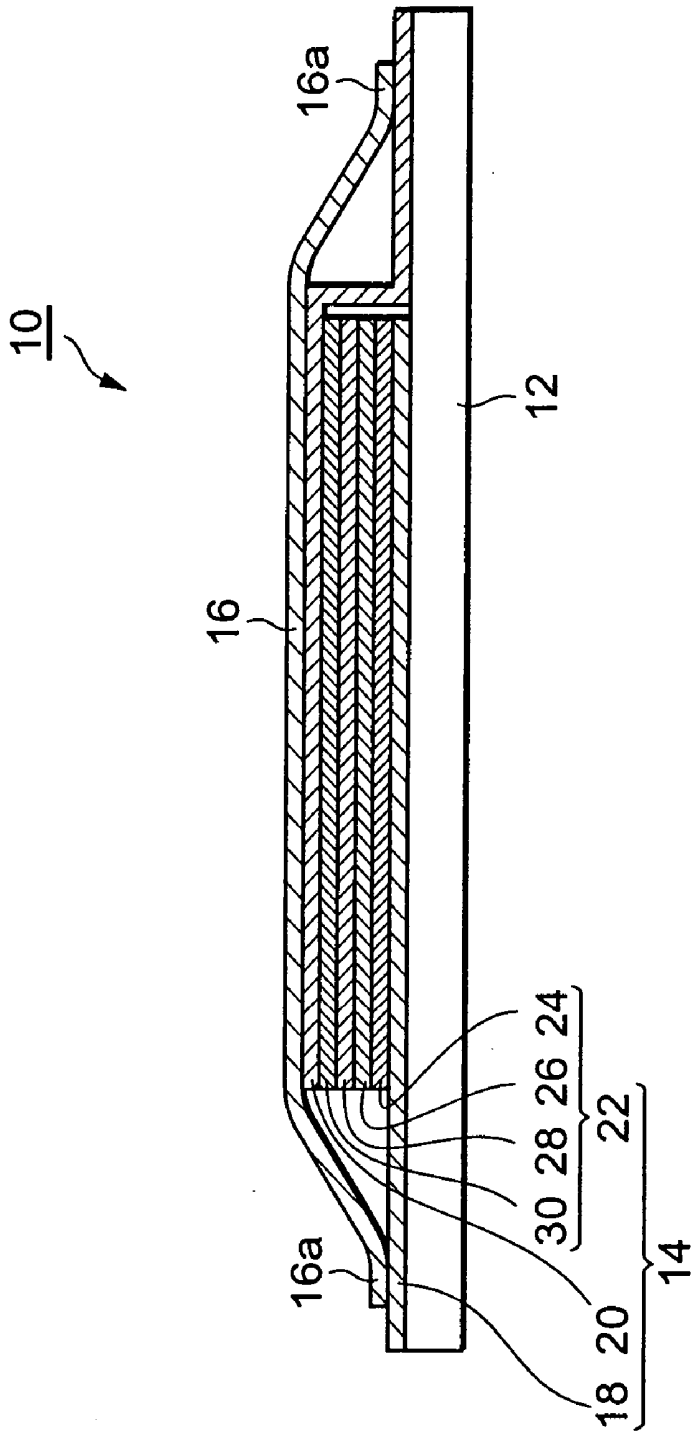


Fig.1

Fig.2

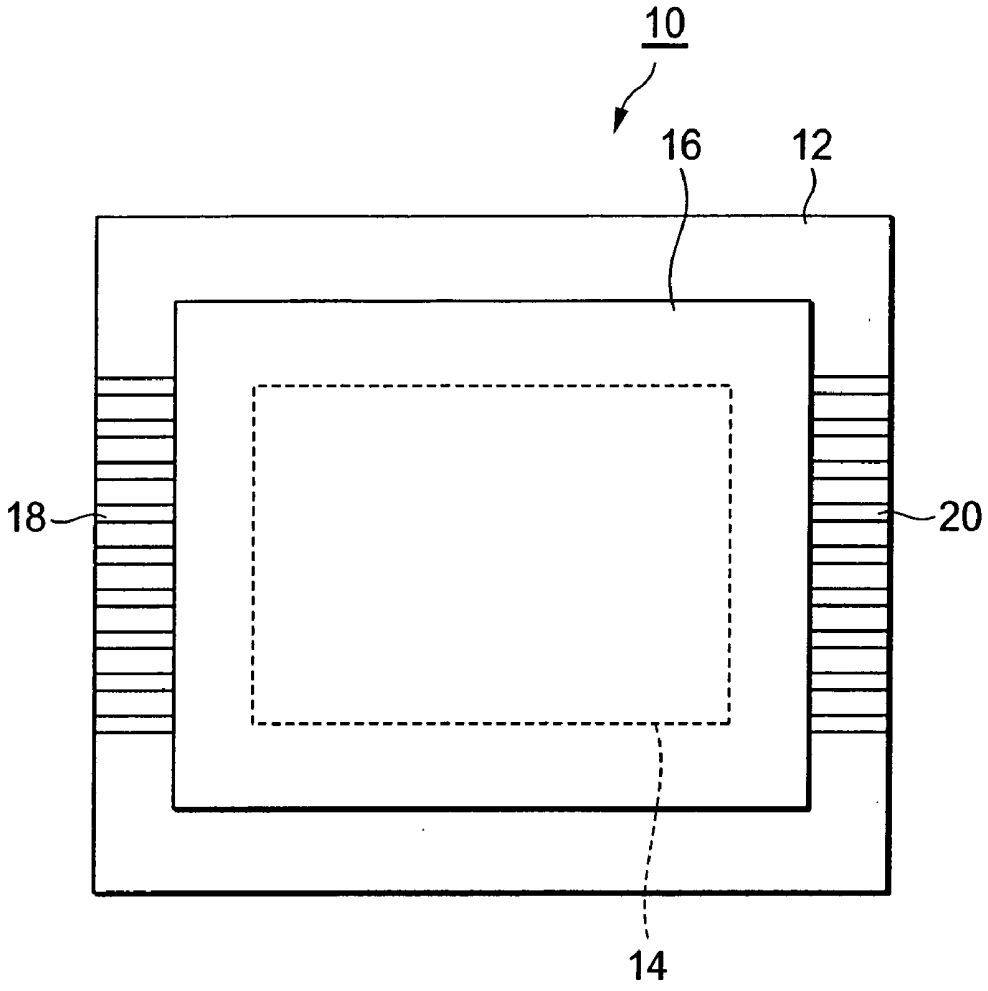


Fig.3

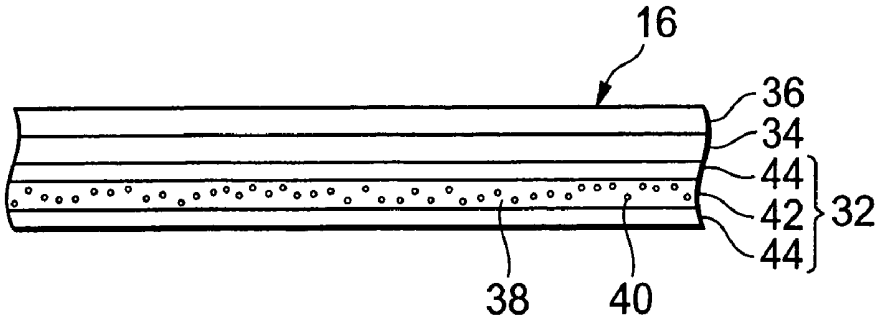
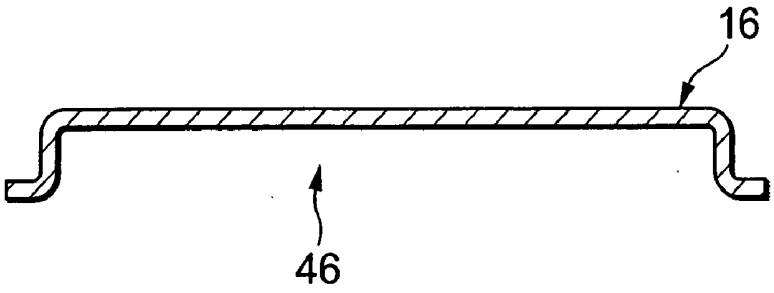


Fig.4



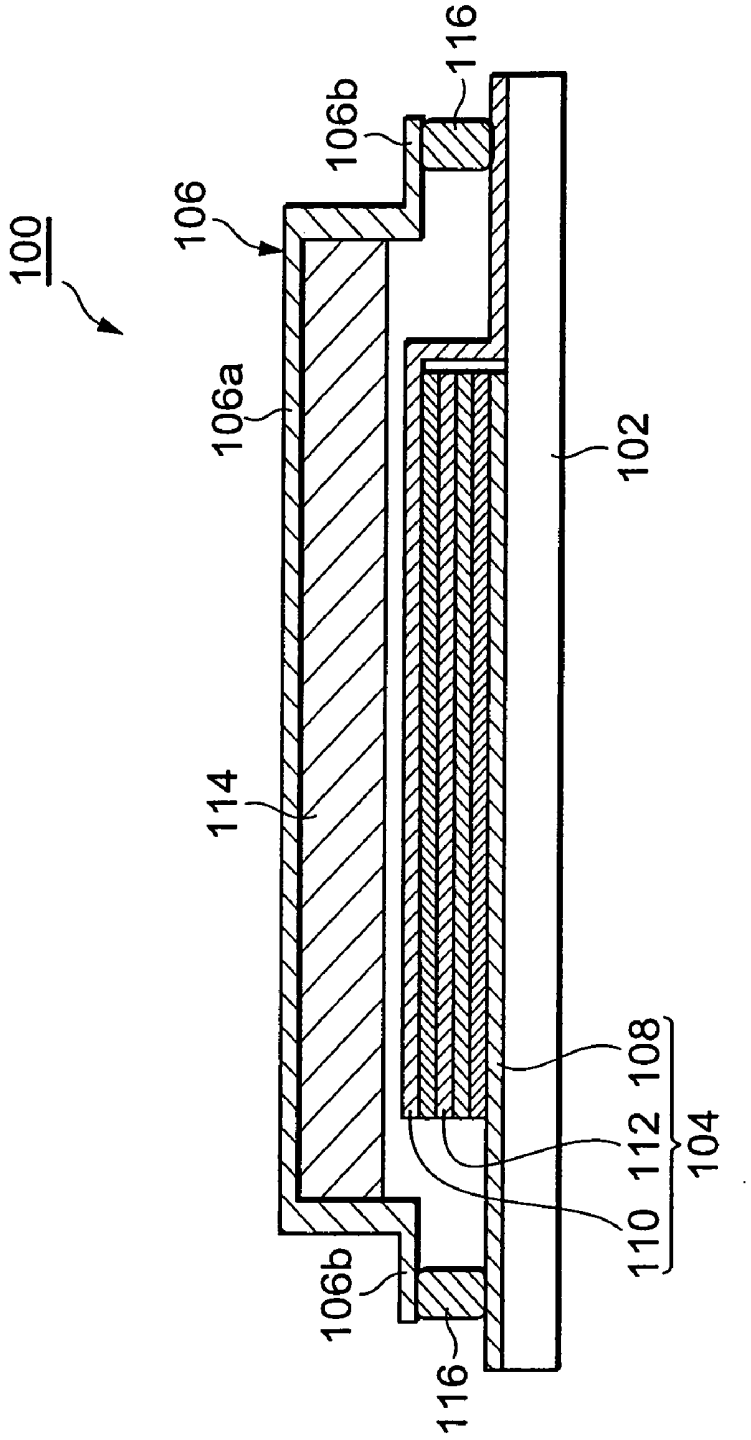


Fig.5

ELECTROLUMINESCENCE DISPLAY

TECHINAL FIELD

[0001] The present invention relates to an electroluminescence display device.

BACKGROUND ART

[0002] In recent years, electroluminescence (hereinafter, simply referred to as "EL" as well) display devices have come to be widely used as information display devices. In general, as shown in **FIG. 5**, such an EL display device **100** includes a transparent substrate **102** as a faceplate, an EL element **104** formed on the transparent substrate **102**, and a sealing body **106** for sealing the EL element **104**.

[0003] The EL element **104** has transparent electrodes **108**, back electrodes **110**, and a light-emitting portion **112** provided between these electrodes. The sealing body **106** is constituted of a molded stainless steel body, and has a housing portion **106***a* for housing the EL element **104** and a flange portion **106***b* used to join the sealing body **106** to the transparent substrate **102**. Moreover, drying agent **114** is housed in the housing portion **106***a*. The sealing body **106** is joined onto the transparent substrate **102** through the flange portion **106***b* by ultraviolet (UV) curing resin **116** in the state of where the EL element **104** is housed in the housing portion **106***a*.

[0004] Accordingly, the EL element **104** is sealed with the sealing body **106** and the moisture within the sealing body **106** is absorbed by the drying agent **114**, where by the EL element **104** is prevented from being wet.

DISCLOSURE OF THE INVENTION

[0005] As a result of investigation into the above-described conventional art, the present inventor has discovered the following problems. Specifically, in the known EL display device described above, since a space has been required within the housing portion of the sealing body for housing the drying agent, the thickness of the sealing body has increased correspondingly, causing the EL display device to be large.

[0006] Moreover, the ultraviolet curing resin used to join the sealing body and the transparent substrate together has high moisture permeability, and moisture enters inside the sealing body even after the EL element is sealed. Therefore, it has been infeasible to sufficiently suppress the EL element from being wet. Thus, the EL element has been deteriorated with time, and it has been difficult to achieve the long lifetime of the EL display device.

[0007] The present invention has been accomplished in light of the above-described circumstances, and an object of the present invention is to provide a small EL display device capable of sufficiently suppressing an EL element from being wet and achieving the long lifetime of the EL display device.

[0008] An EL display device according to the present invention includes (1) a transparent substrate, (2) an electroluminescence element provided on the transparent substrate, and (3) a sealing resin sheet having a function of moisture absorption. The sealing resin sheet is fusion bonded to the transparent substrate by heat to seal the electroluminescence element between the sealing resin sheet and the transparent substrate.

[0009] In this EL display device, the sealing resin sheet having the function of moisture absorption is fusion bonded to the transparent substrate by heat, whereby the EL element is sealed between the transparent substrate and the sealing resin sheet. Therefore, compared to the conventional case where an EL element is sealed with a molded stainless steel body, the EL display device is thinner corresponding to the fact that a space for housing drying agent is no longer needed, and consequently achieving miniaturization of the device. Moreover, the sealing resin sheet is fusion bonded to the transparent substrate by heat without using adhesive with high moisture permeability such as ultraviolet curing resin, and the sealing sheet itself has the function of moisture absorption. Therefore, moisture is prevented from entering from the bonded portion. As a result, the EL element is sufficiently suppressed from being wet, thus enabling the device to have a long lifetime.

[0010] In the EL display device according to the present invention, the sealing resin sheet is preferably fusion bonded to the transparent substrate by heat through a peripheral portion of the sealing resin sheet. This reduces a possibility that the EL element will be damaged by heat when the sealing resin sheet is fusion bonded to the transparent substrate by heat.

[0011] Moreover, in the EL display device according to the present invention, the sealing resin sheet preferably has a moisture trapping layer made of thermoplastic resin to which inorganic filler having a function of moisture absorption is added. This makes it possible to fusion bond the sealing resin sheet to the transparent substrate by heat, because of the thermoplastic resin. Furthermore, the EL element is sufficiently suppressed from being wet by the inorganic filler having the function of moisture absorption.

[0012] In the EL display device according to the present invention, it is also preferable that the thermoplastic resin is either polyolefin or modified polyolefin which is adhesive. With this type of thermoplastic resin, it is possible to perform the preferable fusion bonding of the sealing resin sheet to the transparent substrate by heat.

[0013] Further, in the EL display device according to the present invention, the inorganic filler preferably contains at least any one of magnesium sulfate, calcium oxide, and calcined hydrotalcite. This type of inorganic filler is preferable because it exerts a moisture absorbing function that sufficiently prevents the EL element from being wet.

[0014] Further, in the EL display device according to the present invention, the sealing resin sheet preferably has a metal layer on the outer side of the moisture trapping layer with respect to the electroluminescence element. This reduces a possibility that moisture will enter through the sealing resin sheet into the space sealed with the transparent substrate and the sealing resin sheet.

[0015] Furthermore, in the EL display device according to the present invention, the sealing resin sheet preferably has a protective layer for protecting the metal layer. This prevents the metal layer from being exposed to the outside, and reduces a possibility that the sealing performance of the metal layer will be lowered by an external scratch.

[0016] Also, in the EL display device according to the present invention, the sealing resin sheet is preferably embossed to have a size capable of housing the EL element. This makes it easy to position the sealing resin sheet when the EL element is sealed with the sealing resin sheet. A possibility is also reduced, that undue stress will be placed on the EL element after sealing, thus inhibiting characteristic deterioration of the EL display device.

[0017] In addition, in the EL display device according to the present invention, the electroluminescence element may be an organic electroluminescence element.

[0018] A sealing resin sheet according to the present invention is the sealing resin sheet used in the above-described electroluminescence display device. The sealing resin sheet is fusion bonded to the transparent substrate by heat to be capable of sealing the electroluminescence element between the sealing resin sheet and the transparent substrate. The sealing resin sheet also has a function of moisture absorption.

[0019] The present invention will be more fully understood by reference to the detailed description below and the accompanying drawings. However, these are shown for the purpose of merely exemplifying the present invention and should not be considered to limit the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] **FIG. 1** is a cross-sectional view showing the structure of an EL display device according to the present embodiment.

[0021] **FIG. 2** is a rear elevational view showing the structure of the EL display device according to the present embodiment.

[0022] **FIG. 3** is a cross-sectional view showing the structure of a sealing resin sheet included in the EL display device according to the present embodiment.

[0023] **FIG. 4** is a cross-sectional view showing the structure of an embossed sealing resin sheet.

[0024] **FIG. 5** is a cross-sectional view showing the structure of a conventional EL display device.

BEST MODES FOR CARRYING OUT THE INVENTION

[0025] Hereinafter, an embodiment of the present invention will be described in detail with reference to the accompanying drawings. Note that the same reference numerals are used for the same components throughout descriptions of the drawings, and that duplicate descriptions will be omitted.

[0026] **FIG. 1** is a cross-sectional view showing the structure of an electroluminescence (EL) display device according to the present embodiment, and **FIG. 2** is a rear elevational view showing the structure of the EL display device. As shown in **FIGS. 1 and 2**, the EL display device **10** comprises a transparent substrate **12** as a faceplate, an EL element **14** formed on the transparent substrate **12**, and a sealing resin sheet **16** for sealing the EL element **14**.

[0027] The transparent substrate **12** is translucent to visible light and functions as a faceplate, from which the light emitted from the EL element **14** is obtained. The transparent substrate **12** can be constituted of a glass substrate, a resin substrate, or the like. For glass constituting the glass substrate, inorganic glass or the like, such as alkali glass, non-alkali glass, or silica glass can be used. Among these, the use of non-alkali glass, such as barium borosilicate glass, aluminosilicate glass, or the like is preferred from the viewpoints of improvement of heat resistance and avoidance of characteristic deterioration caused by alkali ions. The thickness of the transparent substrate **12** is not particularly limited, but is preferably 0.3 mm to 1.5 mm.

[0028] The EL element **14** has transparent electrodes **18** as anodes, back electrodes **20** as cathodes, and a light-emitting portion **22** provided between these electrodes.

[0029] The transparent electrodes **18** can be made of indium tinoxide (ITO), indiumantimonyoxide (In—Sb oxide), indium zinc oxide (In—Zn oxide), or the like. Note that the thicknesses of the transparent electrodes **18** are not particularly limited, but preferably 1 μm or smaller.

[0030] The back electrodes **20** can be made from metal, such as aluminum (Al), nickel, copper, or the like. The thickness of the back electrodes **20** is not particularly limited, but preferably 50 μm or smaller.

[0031] The light-emitting portion **22** can be made of a stack including an organic light-emitting layer. For example, the light-emitting portion **22** can be made by stacking a hole injection layer **24**, a hole transport layer **26**, an organic light-emitting layer **28**, and an electron injection layer **30** in this order on the aforementioned transparent electrodes **18**. The materials constituting respective ones of these layers can be appropriately selected from various known materials to be used. For one example for the respective layers, the hole injection layer **24** can be made using copper phthalocyanine (CuPC), the hole transport layer **26** can be made using naphthyl-substituted triphenylamine tetramer (NTPA), the organic light-emitting layer **28** can be made using aluminum **3**-hydroxyquinoline (Alq_3) doped with N, N'-dimethyl-quinacridone (DMqd), and the electron injection layer **30** can be made using lithium fluoride (LiF).

[0032] As shown in **FIG. 3**, the sealing resin sheet **16** has a moisture trapping layer **32** having the function of moisture absorption, a metal layer **34** provided on the moisture trapping layer **32**, and a protective layer **36** provided on the metal layer **34**.

[0033] The moisture trapping layer **32** is formed by mixing inorganic filler **40**, as drying agent having hygroscopicity, into thermoplastic resin **38**. Preferably, the thermoplastic resin **38** is polyolefin or modified polyolefin which is adhesive. Examples thereof are polyethylene, polypropylene, ionomer, ethylene vinylacetate copolymer (EVA), ethylene ethyl acrylate (EEA), ethyl methacrylate (EMA), acid-modified products thereof, and the like.

[0034] For the inorganic filler **40**, it is possible to use calcined hydrotalcites from which water of crystallization is removed by sintering, magnesium sulfate, calcium oxide, or the like. More preferably, the magnesium sulfate is anhydrous magnesium sulfate. The inorganic filler **40** is preferably made from particulate matter having an average grain size of approximately 0.1 μm to 10 μm. These inorganic fillers **40** may be used singly or as a combination of two or more kinds thereof as needed. The mixture ratio of the inorganic filler **40** to the binder resin **38** is preferably 5% to 50% by weight to 100% by weight of the total amount of the binder resin **38**.

[0035] Incidentally, as shown in **FIG. 3**, the moisture trapping layer **32** may have a three-layer structure in which a core layer **42**, made by adding the inorganic filler **40** to the thermoplastic resin **38**, is sandwiched between cover layers **44** formed from the aforementioned thermoplastic resin. The thickness of the moisture trapping layer **32** is preferably 5 μm to 150 μm.

[0036] The metal layer **34** has a function to prevent moisture from entering through the sealing resin sheet **16** from the outside. The metal layer **34** can be made of foil or an evaporated metal film. As the foil, it is possible to use aluminum foil, stainless steel foil, nickel foil, or the like. The evaporated metal film can be formed by evaporating metal such as aluminum. In particular, it is preferable to use iron-aluminum alloy foil as the metal layer **34**. Due to above, the strength of the entire sealing resin sheet **16** is improved, thus reducing a possibility that the sealing resin sheet **16** will tear during embossing which will be described later.

[0037] The protective layer **36** prevents the metal layer **34** from being exposed to the outside and has a function to reduce a possibility that the sealing performance of the metal layer **34** will be lowered due to an external scratch. The protective layer **36** can be made from resin or the like having excellent scratch resistance. For the resin constituting the protective layer **36**, it is possible to use polyethylene terephthalate (PET), polyamide (nylon), or the like. The thickness of the protective layer **36** is preferably 5 μm to 50 μm.

[0038] The above-described protective layer **36** and the metal layer **34** can be adhered to each other by, for example, urethane adhesive or the like. As the urethane adhesive, for example, one obtained by mixing and cross-linking two liquids, polyol and isocyanate, can be used. Moreover, the metal layer **34** and the moisture trapping layer **32** can be joined together by, for example, thermal laminating.

[0039] Here, the sealing resin sheet **16** constituted as described earlier can be embossed to have a size capable of housing the EL element **14**, as shown in **FIG. 4**. This makes it easy to position the sealing resin sheet **16** by positioning the sealing resign sheet based on a concave portion **46** formed by embossing, when the EL element **14** is sealed with the sealing resin sheet **16**. Moreover, a possibility is reduced, that undue stress will be placed on the EL element **14** after sealing, and deterioration in the characteristics of the EL display device **10** is inhibited.

[0040] The EL display device **10** according to the present embodiment is formed as follows: As shown in **FIGS. 1 and 2**, the EL element **14** provided on the transparent substrate **12** is covered over with the sealing resin sheet **16**, and only the peripheral portion **16***a* of the sealing resin sheet **16** is thermocompression bonded to the transparent substrate **12** to seal the EL element **14**. Accordingly, the sealing resin sheet **16** is fusion bonded to the transparent substrate **12** by heat only through the peripheral portion **16***a* thereof, thereby reducing a possibility that the EL element **14** will be damaged by heat when joining the sealing resin sheet **16** to the transparent substrate **12**.

[0041] Next, operations and advantages of the EL display device **10** according to the present embodiment will be described.

[0042] In the EL display device **10** according to the present embodiment, a sealing resin sheet **16** includes a moisture trapping layer **32** obtained by adding a inorganic filler **40** having a function of moisture absorption to a thermoplastic resin **38**. This sealing resin sheet **16** is fusion bonded to a transparent substrate **12** by heat, whereby an EL element **14** is sealed between the transparent substrate **12** and the sealing resin sheet **16**. Accordingly, compared to the conventional case where an EL element is sealed with a molded stainless steel body, the thickness of the EL display device **10** is smaller corresponding to the fact that a space for housing drying agent is no longer necessary, which can in turn realize miniaturization of the device. Moreover, the sealing resin sheet **16** is fusion bonded directly to the transparent substrate **12** by heat without using adhesive such as ultraviolet curing resin with a high moisture permeability, and the sealing resin sheet **16** itself also has the function of moisture absorption. Therefore, moisture is prevented from entering from the bonded portion. As a result, the EL element **14** is sufficiently suppressed from being wet, thus making it possible to attain the long lifetime of the device **10**.

[0043] Moreover, in the EL display device **10** according to the present embodiment, the sealing resin sheet **16** has a metal layer **34** on the outer side of the moisture trapping layer **32** with respect to the EL element **14**. Accordingly, it is possible to reduce a possibility that moisture will enter from the outside through the sealing resin sheet **16** into the space sealed with the transparent substrate **12** and the sealing resin sheet **16**. Thus, further long lifetime of the device **10** can be achieved.

[0044] In addition, in the EL display device **10** according to the present embodiment, the sealing resin sheet **16** has a protective layer **36** for protecting the metal layer **34**. Accordingly, it is possible to prevent the metal layer **34** from being exposed to the outside, and to reduce a possibility that the sealing performance of the metal layer **34** will be lowered by an external scratch. Thus, the lifetime of the device **10** can be yet further lengthened.

[0045] Furthermore, in the EL display device **10** according to the present embodiment, the sealing resin sheet **16** is embossed to have a size capable of housing the EL element **14**. Accordingly, when the EL element **14** is sealed with the sealing resin sheet **16**, easy positioning of the sealing resin sheet **16** is possible. Moreover, a possibility is reduced, that undue stress will be placed on the EL element **14** after sealing, thus making it possible to inhibit deterioration in the characteristics of the EL display device **10**.

[0046] Next, tests conducted to evaluate the waterproof characteristics of the EL display device **10** according to the present embodiment will be described.

[0047] (Test Sample 1)

[0048] In the preparation of test sample 1, first of all, a 500 mm square PET sheet and a 500 mm square aluminum foil were prepared. Then, the PET sheet and the aluminum foil were adhered to each other with urethane adhesive by a dry laminator to make a PET/Al composite sheet. The thickness of the PET sheet was 12 μm, the thickness of the aluminum foil was 9 μm, and the thickness of the urethane adhesive was 2 μm.

[0049] Next, a 500 mm square moisture trapping film having a three-layer structure was made by a three-layer blown film extruder. This moisture trapping film had a

three-layer structure of acid-modified polyethylene/acid-modified polyethylene containing magnesium sulfate/acid-modified polyethylene. The thickness of each of these layers was 20 μm. The layer of acid-modified polyethylene containing magnesium sulfate was made by adding 20% by weight of anhydrous magnesium sulfate to 100% by weight of acid-modified polyethylene.

[0050] This moisture trapping film was adhered to the Al surface of the PET/Al composite sheet by thermal laminating to make a sealing resin sheet having a structure of PET (protective layer)/Al (metal layer)/moisture trapping film (moisture trapping layer). At this point, the sealing resin sheet was made using a heat roll having a roll diameter of 100 mm and a temperature of 150° C. at a speed of 1 m/min. Thereafter, this was cut into a 9 cm square.

[0051] On the other hand, a 10 cm square glass substrate having a thickness of 1 mm was prepared. On this glass substrate, transparent electrodes (ITO), each having a width of 1 mm, were evaporated with a pitch of 2 mm. Then, a 5 cm square PET film having a thickness of 0.1 mm was mounted on the center portion of the glass substrate. These operations were conducted in a dry box.

[0052] Next, also in a dry box, the sealing resin sheet explained earlier that is cut into a 9 cm square was mounted on the glass substrate having the PET film mounted on the center portion thereof, facing the innermost absorbent film to the glass substrate. Then, 2 mm of the edge portions on the four sides of the sealing resin sheet were pressed with a heat bar at a temperature of 150° C. for five seconds to be fusion bonded to the glass substrate, thus making test sample 1. In this test sample 1, the initial moisture content of the PET film sealed with the sealing resin sheet was 100 ppm.

[0053] (Test Sample 2)

[0054] For a test sample 2, a molded stainless steel body was prepared instead of the sealing resin sheet used in the above-described test sample 1. In the molded stainless steel body, a 5 cm-square center portion of a 9 cm square stainless steel plate having a thickness of 0.1 mm was drawn to have a depth of 1 mm. In the depressed portion of the molded stainless steel body, 10 g of calcium oxide was sealed as drying agent, and this portion was covered with PET adhesive tape so that calcium oxide will not spill out.

[0055] Moreover, a glass substrate having a PET film mounted on the center portion thereof was prepared in a similar manner to that of test sample 1. UV curing resin was applied to have a thickness of 20 μm within 2 mm of the peripheral portion of the 9 cm-square center portion of the glass substrate (2 mm inside the 9 cm square portion), and the aforementioned molded stainless steel body was mounted thereon. Then, ultraviolet was irradiated from the glass substrate side to cure the UV curing resin, thus joining the glass substrate and the molded stainless steel body together to make test sample 2. In this test sample 2, the initial moisture content of the PET film sealed with the molded stainless steel body was also 100 ppm.

[0056] (Test Method)

[0057] Test samples 1 and 2 prepared in the above described way were left at a temperature of 60° C. and a relative humidity (RH) of 95% for 30 days. Then, the moisture contents of the internal PET films were measured.

[0058] (Test Result)

[0059] In test sample 2, the moisture content of the internal PET film was increased to 120 ppm. On the other hand, in test sample 1, the moisture content of the inside PET film was still 100 ppm, which revealed that the moisture content did not increase at all from the initial moisture content.

[0060] From this result, it was confirmed that test sample 1 having a sealing structure with the sealing resin sheet had an excellent waterproof performance. Therefore, the EL display device **10** according to the present embodiment, which is constituted by sealing the EL element using the same sealing structure as that of test sample 1, has an extremely low possibility of the characteristic deterioration of the device due to moisture, thus making it possible to achieve the long lifetime of the device.

[0061] Note that the present invention is not limited to the aforementioned embodiment and various modifications are possible.

[0062] For example, in the aforementioned embodiment, an organic EL display device made of a stack, in which the light-emitting portion **22** includes the organic light-emitting layer **28**, was described. However, it is obvious that the EL display device **10** according to the present invention is not limited to an organic EL display device, and that the present invention can also be applied to an inorganic EL display device. In this case, a light-emitting portion can be made of a stack including an inorganic light-emitting layer. For example, the light-emitting portion can be made by stacking an inorganic light-emitting layer and a dielectric layer in this order on the transparent electrodes.

[0063] Moreover, in the aforementioned embodiment, the sealing resin sheet **16** is located so as to cover over the transparent electrodes **18** and the back electrodes **20** for sealing. This makes it possible to extend the electrodes to the outside from the sealed portion, while suitably protecting the internal EL element **14**. However, the present invention is not limited to this type of structure in which the electrodes are covered and sealed, and the electrodes may be arranged in a different configuration.

[0064] From the hitherto-described description of the present invention, it is obvious that the present invention can be modified in various ways. Such modifications can not be recognized if they depart from the spirit and scope of the present invention. It should also be appreciated that improvements obvious to those skilled in the art are included in the following claims.

INDUSTRIAL APPLICABILITY

[0065] According to the present invention, a small EL display device capable of sufficiently suppressing an EL element from being wet to achieve the long lifetime thereof is provided.

1. An electroluminescence display device comprising:

a transparent substrate;

an electroluminescence element provided on the transparent substrate; and

a sealing resin sheet having a function of moisture absorption, the sealing resin sheet being fusion bonded to the

transparent substrate by heat to seal the electroluminescence element between the sealing resin sheet and the transparent substrate.

2. The electroluminescence display device according to claim 1, wherein the sealing resin sheet is fusion bonded to the transparent substrate by heat through a peripheral portion of the sealing resin sheet.

3. The electroluminescence display device according to any one of claims **1** and **2**, wherein the sealing resin sheet has a moisture trapping layer in which inorganic filler having a function of moisture absorption is added to thermoplastic resin.

4. The electroluminescence display device according to claim 3, wherein the thermoplastic resin is any one of polyolefin and modified polyolefin which is adhesive.

5. The electroluminescence display device according to any one of claims **3** and **4**, wherein the inorganic filler contains at least any one of magnesium sulfate, calcium oxide, and calcined hydrotalcite.

6. The electroluminescence display device according to any one of claims 3 to 5, wherein the sealing resin sheet has a metal layer on the outer side of the moisture trapping layer with respect to the electroluminescence element.

7. The electroluminescence display device according to claim 6, wherein the sealing resin sheet has a protective layer for protecting the metal layer.

8. The electroluminescence display device according to any one of claims 1 to 7, wherein the sealing resin sheet is embossed to have a size capable of housing the electroluminescence element.

9. The electroluminescence display device according to any one of claims 1 to 8, wherein the electroluminescence element is an organic electroluminescence element.

10. A sealing resin sheet used in the electroluminescence display device according to claim 1, the sealing resin sheet having a function of moisture absorption and being fusion bonded to the transparent substrate by heat to be capable of sealing the electroluminescence element between the sealing resin sheet and the transparent substrate.

* * * * *

专利名称(译)	电致发光显示器		
公开(公告)号	US20040104673A1	公开(公告)日	2004-06-03
申请号	US10/470420	申请日	2002-11-29
[标]申请(专利权)人(译)	细川武宏 田中圭一		
申请(专利权)人(译)	细川武宏 田中圭一		
当前申请(专利权)人(译)	住友电气工业有限公司		
[标]发明人	HOSOKAWA TAKEHIRO TANAKA KEIICHI		
发明人	HOSOKAWA, TAKEHIRO TANAKA, KEIICHI		
IPC分类号	H01L51/50 H01L51/52 H05B33/04 H05B33/00		
CPC分类号	H01L51/5237 H01L51/5259 H05B33/04 H01L51/524 H01L51/5246		
优先权	2001364823 2001-11-29 JP		
外部链接	Espacenet USPTO		

摘要(译)

EL显示装置包括透明基板，设置在透明基板上的电致发光元件，以及具有吸湿功能的密封树脂片。密封树脂片通过加热熔融粘合到透明基板上，以密封在密封树脂片和透明基板之间的电致发光元件。