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Sasatani et al.

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(54) **ELECTROLUMINESCENT DISPLAY DEVICE WITH DESICCANT LAYER**

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(22) Filed: **Apr. 22, 2003**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**^{7} **H05B 33/00**

(52) **U.S. Cl.** **313/512**; 313/498

(58) **Field of Search** 313/498–512; 428/690

(56) **References Cited**

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(57) **ABSTRACT**

In a sealing structure of an electroluminescent display device, in which a first glass substrate formed with an EL element and a second glass substrate as a cap are attached to each other, breaking of the element device is prevented when external force is applied to the first glass substrate and the second glass substrate. The sealing structure has the first glass substrate provided with the EL element on a surface thereof, the second glass substrate attached to the first glass substrate with a sealing resin, a desiccant layer formed on a surface of the second glass substrate and a stress buffer layer covering a surface of the desiccant layer.

5 Claims, 6 Drawing Sheets

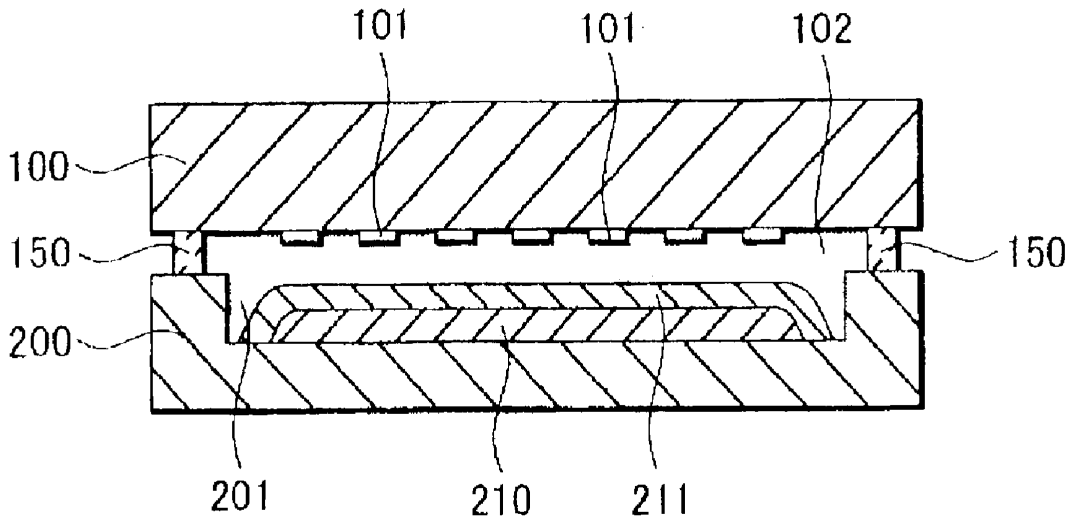


FIG. 1

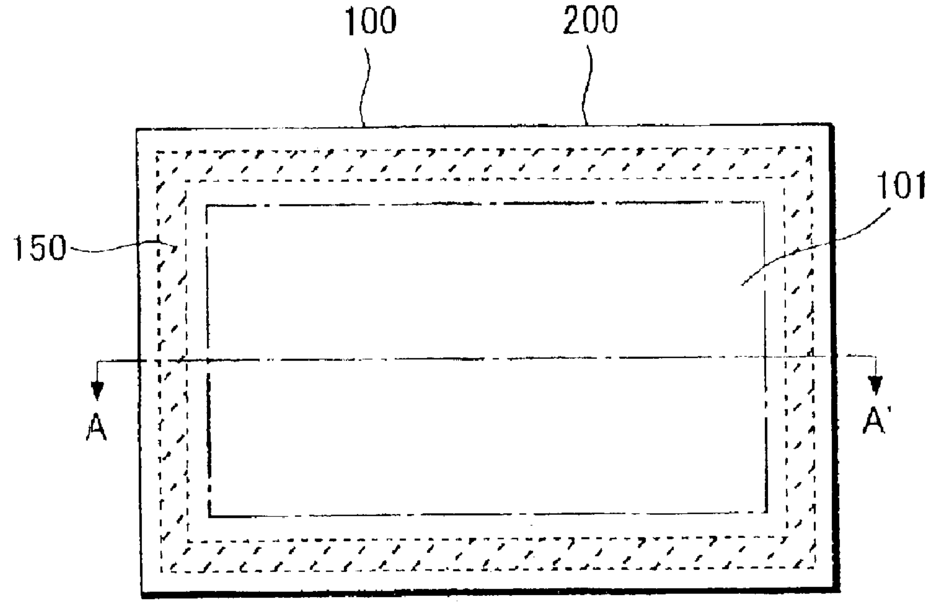


FIG. 2

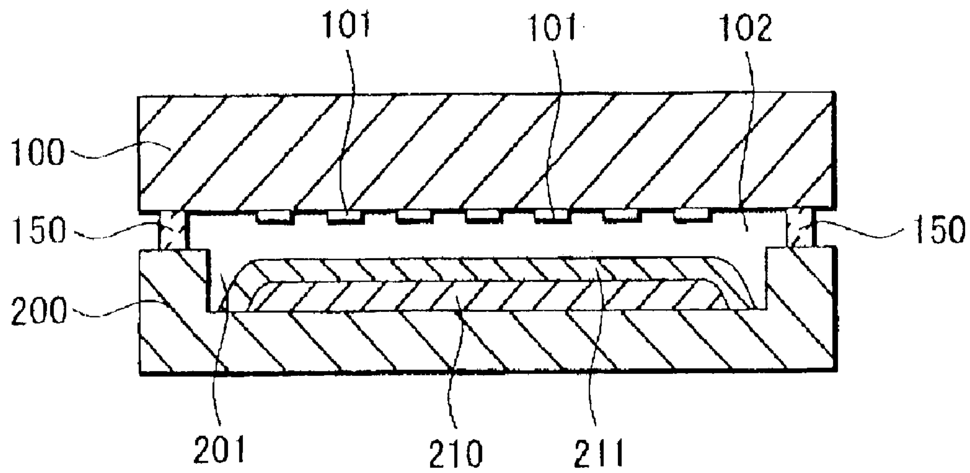


FIG.3

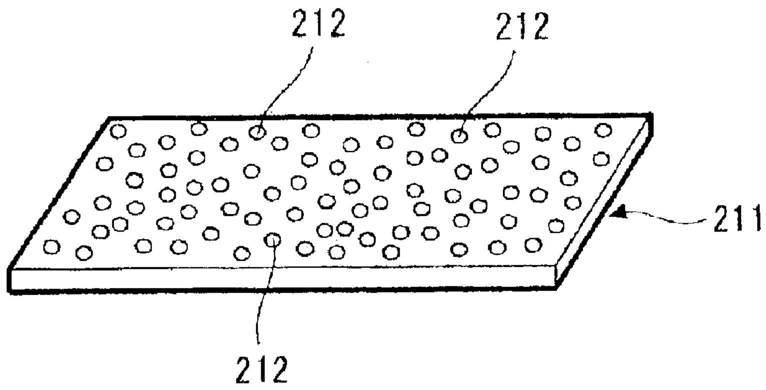


FIG.4

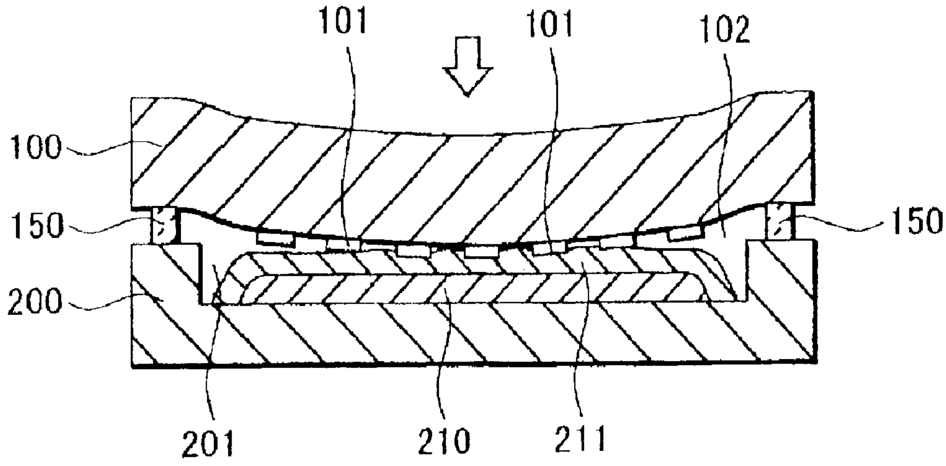


FIG.5

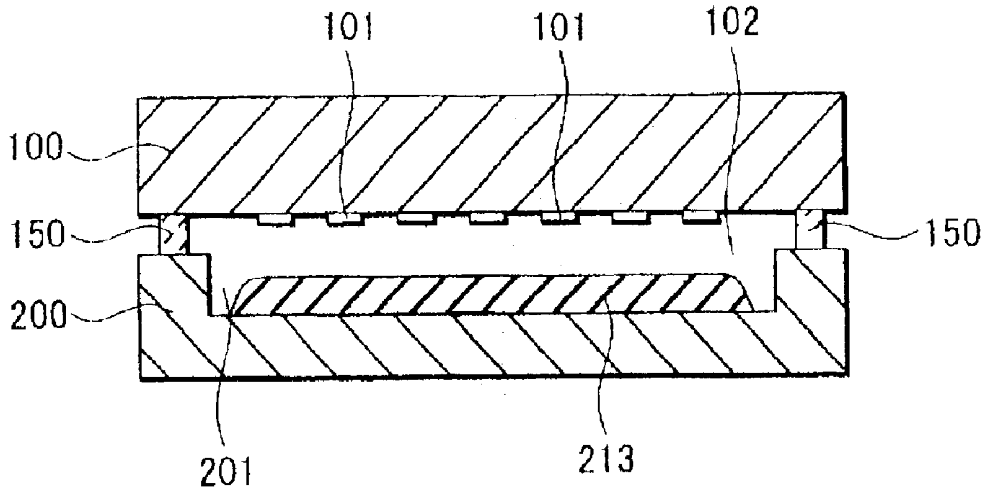
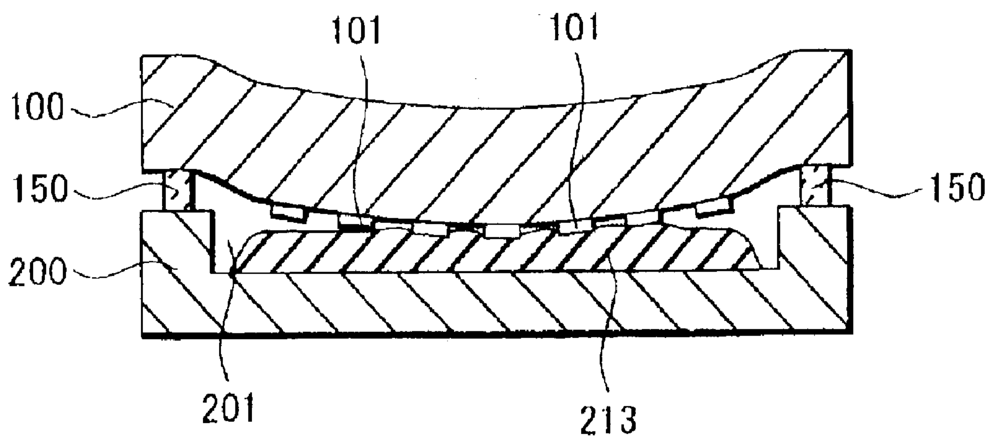

101
101
102
100
150
150
200
201
213

FIG.6


101
101
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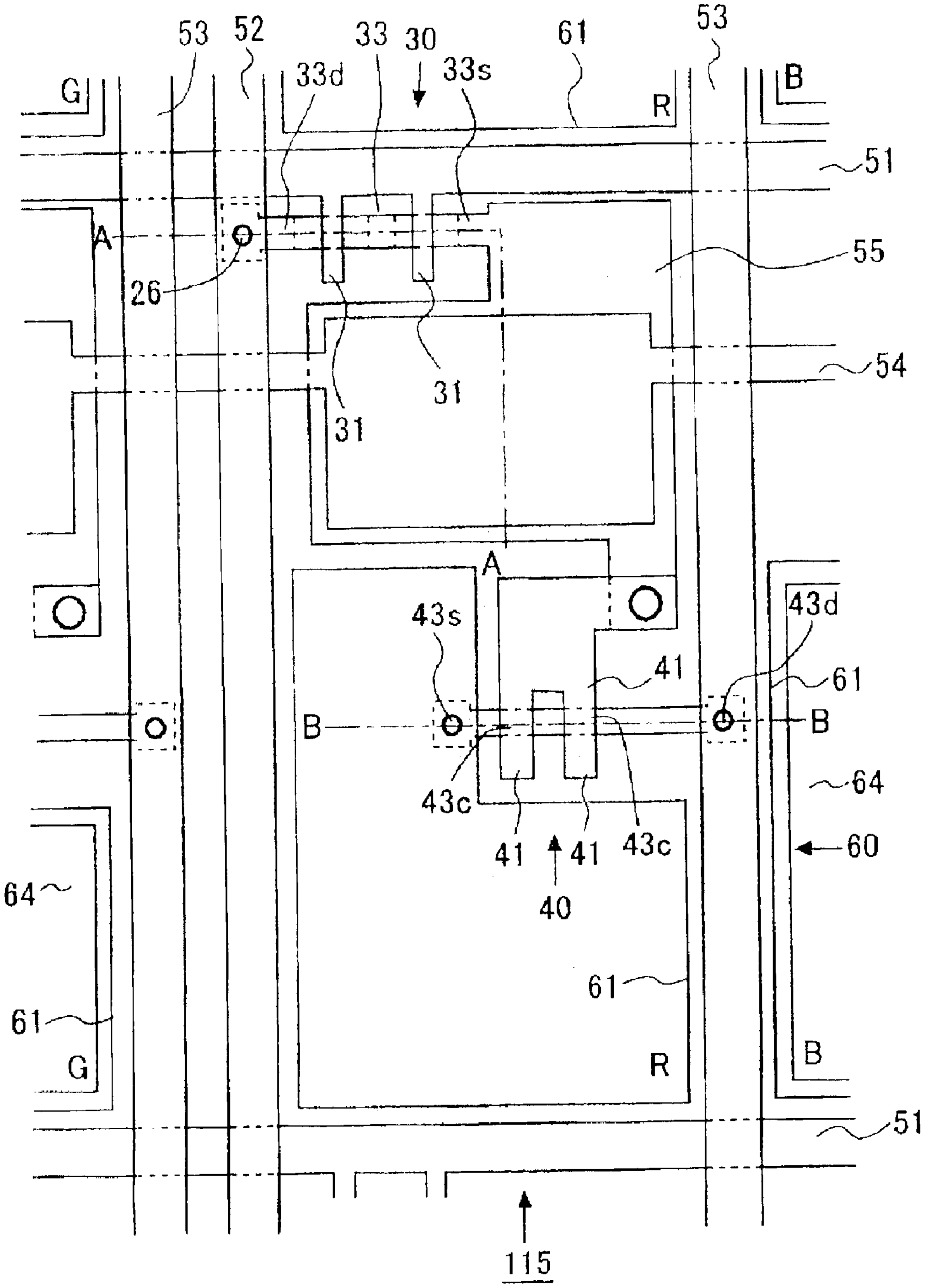
200
201
213

FIG. 7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43s
41
61
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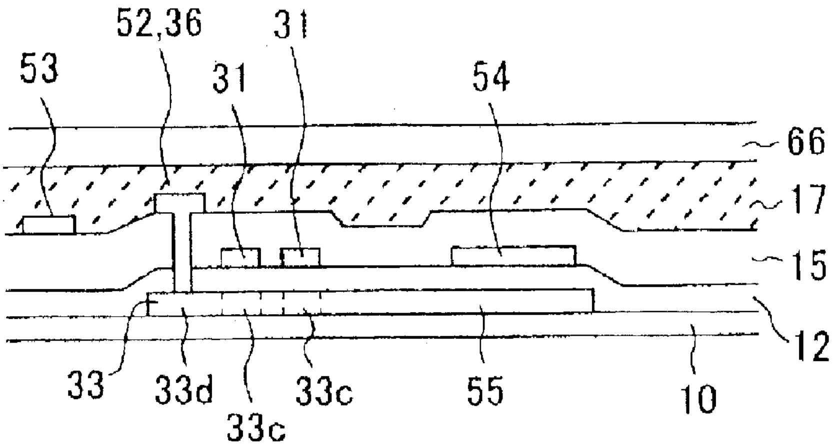
R
B
51
115

FIG.8A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12
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33d
33c
33c
55
10

FIG.8B

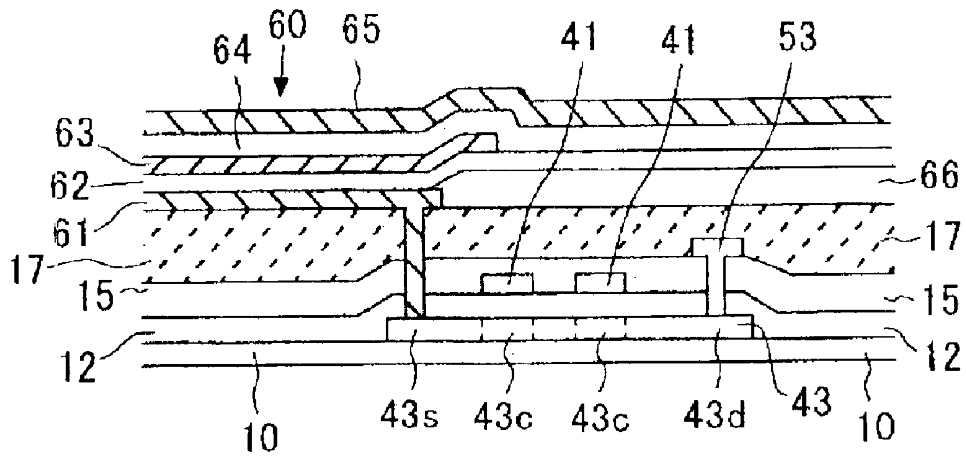

60
64
65
41
41
53
63
62
66
61
17
17
15
15
12
12
10
43s
43c
43c
43d
43
10

FIG.9

PRIOR ART

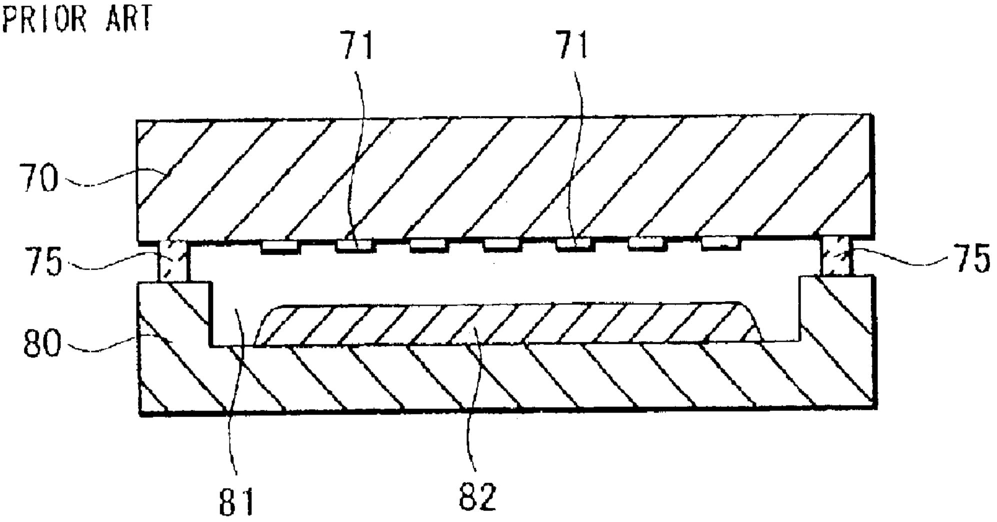
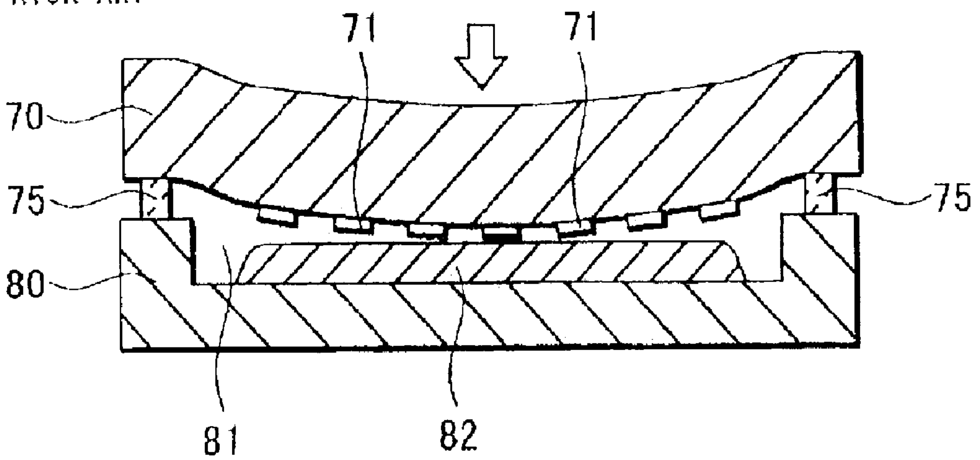


FIG.10

PRIOR ART



ELECTROLUMINESCENT DISPLAY DEVICE WITH DESICCANT LAYER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electroluminescent display device, particularly to a sealing structure of the electroluminescent display device.

2. Description of the Related Art

In recent years, electroluminescent (hereafter, referred to as an EL) display devices with EL elements have been receiving an attention as a display device substituting a CRT and an LCD.

Since the EL element is sensitive to moisture, there has been known an EL display panel structure in which the EL element is covered with a metal cap or a glass cap coated with a desiccant. FIG. **9** is a cross-sectional view showing such a conventional structure of the EL display panel.

A first glass substrate **70** has a display region formed with many EL elements **71** thereon. The first glass substrate **70** is attached to a second glass substrate **80** working as a cap with sealing resin **75** made of an epoxy resin. The second glass substrate **80** has a concave portion **81** (hereafter, referred to as a pocket portion **81**) in a region corresponding to the above display region. The pocket portion **81** is coated with a desiccant layer **82** for absorbing moisture.

Here, the forming of the pocket portion **81** is for securing a space between the desiccant layer **82** and the EL element **71**, thereby preventing the EL element **71** from being contacted by the desiccant layer **82**, which may result in damaging the EL element **71**.

As shown in FIG. **10**, however, an external force can be applied to a surface of the first glass substrate **70**. This can occur even in a manufacturing process of the EL display device (for example, a process of conveying a glass substrate) and also when a panel surface of the EL display device is touched by a user. This external force causes flexure in the first glass substrate **70**, and the desiccant layer **82** and the EL element **71** contact each other. With the application of the further external force, the EL element **71** may be broken by stress from the desiccant layer **82**. Furthermore, the same problems are caused by applying of the external force to a surface of the second glass substrate **80**.

SUMMARY OF THE INVENTION

The invention provides an electroluminescent display device that includes a first substrate having an electroluminescent element thereon, a second substrate attached to the first substrate, a desiccant layer disposed on the second substrate so that the desiccant layer faces the first substrate, and a stress buffer layer covering the desiccant layer.

The invention also provides an electroluminescent display device that includes a first substrate having an electroluminescent element thereon, a second substrate attached to the first substrate, and a desiccant layer disposed on the second substrate so that the desiccant layer faces the first substrate. The desiccant layer has an elastic coefficient low enough to absorb mechanical stresses generated by the electroluminescent element when it contacts the desiccant layer under an application of an external force to the display device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of an electroluminescent display device according to a first embodiment of the invention.

FIG. **2** is a cross-sectional view of the device of FIG. **1** along line A–A' FIG. **1**.

FIG. **3** is a perspective view of a stress buffer layer of the first embodiment of the invention.

FIG. **4** is a cross-sectional view of the electroluminescent display device of FIG. **1** under application of an external force.

FIG. **5** is a cross-sectional view of an electroluminescent display device according to a second embodiment of the invention.

FIG. **6** is a cross-sectional view of the electroluminescent display device of FIG. **5** under application of an external force.

FIG. **7** is a plan view of a pixel of the display devices of the first and second embodiments.

FIGS. **8**A and **8**B are cross-sectional views of the pixel of the organic EL display device of FIG. **7**.

FIG. **9** is a cross-sectional view of a conventional electroluminescent display device.

FIG. **10** is a cross-sectional view of the electroluminescent display device of FIG. **9** a cross-sectional view of the electroluminescent display device of FIG. **1** under application of an external force.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a plan view of an electroluminescent display device according to a first embodiment of the invention. FIG. **2** is a cross-sectional view along line A–A' of FIG. **1**.

A first glass substrate **100** (a display panel) has a display region formed with many EL elements **101** on a surface thereof. The thickness of the first glass substrate **100** is approximately 0.7 mm. In this display region, a plurality of pixels is disposed in a matrix and the EL element **101** is disposed in each of those pixels.

A second glass substrate **200** is a glass substrate for sealing the above mentioned first glass substrate **100** and its thickness is approximately 0.7 mm. This second glass substrate **200** has a concave portion **201** (hereafter, referred to as a pocket portion **201**) in a region corresponding to the display region, which is formed by etching. The depth of the pocket portion **201** is approximately 0.3 mm.

There is coated in the pocket portion **201** a desiccant layer **210** for absorbing moisture. The desiccant layer **210** is formed, for example, by coating a solvent dissolved with powdered calcium oxide or barium oxide and resin as an adhesive on a bottom of the pocket portion **201** and then hardening the solvent by UV irradiation or heating.

The desiccant layer **210** is covered with a stress buffer layer **211**. The stress buffer layer **211** is formed, for example, by coating the desiccant layer **210** with an epoxy resin or by covering the desiccant layer **210** with a sheet having elasticity made of, for example, polyethylene terephthalate (PET) or fluoroplastic.

Furthermore, the stress buffer layer **211** is preferably has many air vents **212** as shown in FIG. **3**. This is for keeping air permeability of the desiccant layer **210** high to prevent it from losing the function as a desiccant.

The first glass substrate **100** and the second glass substrate **200** are attached with sealing resin **150** made of an epoxy resin in a chamber of N_2 gas atmosphere. Thus, N_2 gas fills a space surrounded by the stress buffer layer **211**, the first glass substrate **100** and the sealing resin **150** to form an N_2 gas layer **102**.

According to this embodiment, the electroluminescent display device has a structure in which the stress buffer layer **211** is disposed between the desiccant layer **210** and the EL element **101**. Therefore, as shown in FIG. **4**, when an external force is applied to the first glass substrate **100** to cause flexure therein, and the EL element **101** and the stress buffer layer **211** contact each other, elastic deformation occurs in the stress buffer layer **211** so that the stress applied to the EL element **101** is dispersed and absorbed by this stress buffer layer **211**, thereby preventing the breaking of the EL element **101**.

Second Embodiment

FIG. **5** is a cross-sectional view showing an electroluminescent display device according to a second embodiment of the invention. FIG. **5** corresponds to a cross-sectional view along line A–A' of FIG. **1**. Note that the same numerals are given to the same portions as those of FIG. **2**.

While in the first embodiment the desiccant layer **210** is covered with the stress buffer layer **211**, in this embodiment the elasticity is provided in the desiccant layer **213** itself, thereby relaxing the stress applied to the EL element **101**.

The desiccant layer **213** is formed by coating a solvent dissolved with powdered calcium oxide or barium oxide and a resin as an adhesive on a bottom of the pocket portion **201** and then hardening the solvent by UV irradiation or heating. Here, the amount of the resin in this desiccant layer **213** is increased to 20 or more weight % for increasing the elasticity. Epoxy resin or UV resin is appropriate as the resin.

Consequently, as shown in FIG. **6**, when an external force is applied to the first glass substrate **100** to cause flexure therein, and the EL element **101** and the desiccant layer **213** contact each other, elastic deformation occurs in the desiccant layer **213** itself so that the stress applied to the EL element **101** is dispersed and absorbed by the desiccant layer **213**, thereby preventing the breaking of the EL element **101**.

Next, there is described an example of structures of the pixel of the EL display device applied to the first and second embodiments described above.

FIG. **7** is a plan view showing a pixel of an organic EL display device. FIG. **8**A is a cross-sectional view along line A—A of FIG. **7** and FIG. **8**B is a cross-sectional view along line B—B of FIG. **7**.

As shown in FIG. **7**, a pixel **115** is formed in a region enclosed with a gate signal line **51** and a drain signal line **52**. A plurality of the pixels **115** is disposed in a matrix.

There are disposed in the pixel **115** an organic EL element **60** as a self-emission device, a switching TFT (thin film transistor) **30** for controlling a timing of supplying an electric current to the organic EL element **60**, a driving TFT **40** for supplying an electric current to the organic EL element **60** and a storage capacitor. The organic EL element **60** includes an anode **61**, an emissive made of an emission material and a cathode **65**.

The switching TFT **30** is provided in a periphery of a point of intersection of the both signal lines **51** and **52**. A source **33***s* of the switching TFT **30** serves as a capacitor electrode **55** for forming a capacitor with a storage capacitor electrode line **54** and is connected to a gate electrode **41** of the driving TFT **40**. A source **43***s* of the driving TFT **40** is connected to the anode **61** of the organic EL element **60**, while a drain **43***d* is connected to a driving source line **53** as a current source to be supplied to the organic EL element **60**.

The storage capacitor electrode line **54** is disposed in parallel with the gate signal line **51**. The storage capacitor electrode line **54** is made of Cr (chromium) etc and forms a capacitor by storing an electric charge with the capacitor electrode **55** connected to the source **33***s* of the TFT through a gate insulating film **12**. The storage capacitor **56** is provided for storing voltage applied to the gate electrode **41** of the driving TFT **40**.

As shown in FIGS. **8**A and **8**B, the organic EL display device is formed by laminating the TFTs and the organic EL element sequentially on a substrate **10** such as a substrate made of a glass or a synthetic resin, a conductive substrate, or a semiconductor substrate. When using a conductive substrate or a semiconductor substrate as the substrate **10**, however, an insulating film such as SiO_2 or SiN_x is formed on the substrate **10**, and then the switching TFT **30**, the driving TFT **40** and the organic EL element **60** are formed thereon. Each of the two TFTs has a so-called top gate structure in which a gate electrode is disposed above an active layer with a gate insulating film being interposed therebetween.

There will be described the switching TFT **30** first. As shown in FIG. **8**A, an amorphous silicon film (hereafter, referred to as an a-Si film) is formed on the insulating substrate **10** made of a silica glass or a non-alkali glass by a CVD method. The a-Si film is irradiated by laser beams for melting and recrystalizing to form a poly-silicon film (hereafter, referred to as a p-Si film) as an active layer **33**. On the active layer **33**, a single-layer or a multi-layer of an SiO_2 film and an SiN_x film is formed as the gate insulating film **12**. There are disposed on the gate insulating film **12** the gate signal line **51** made of metal having a high melting point such as Cr or Mo (molybdenum) and also serving as a gate electrode **31**, the drain signal line **52** made of Al (aluminum), and the driving source line **53** made of Al and serving as a driving source of the organic EL element.

An interlayer insulating film **15** laminated with an SiO_2 film, an SiN_x film and an SiO_2 film sequentially is formed on the whole surfaces of the gate insulating film **12** and the active layer **33**. There is provided a drain electrode **36** by filling metal such as Al in a contact hole provided correspondingly to a drain **33***d*. Furthermore, a planarization insulation film **17** for planarizing a surface which is made of organic resin is formed on the whole surface.

Next, there will be described the driving TFT **40** of the organic EL element. As shown in FIG. **8**B, an active layer **43** formed by poly-crystalizing an a-Si film by irradiating laser beams thereto, the gate insulating film **12**, and the gate electrode **41** made of metal having a high melting point such as Cr or Mo are formed sequentially on the insulating substrate **10**. There are provided in the active layer **43** a channel **43***c*, and a source **43***s* and a drain **43***d* on both sides of the channel **43***c*. The interlayer insulating film **15** is formed on the whole surfaces of the gate insulating film **12** and the active layer **43**. There is disposed the driving source line **53** connected to a driving source by filling metal such as Al in a contact hole provided correspondingly to a drain **43***d*. Furthermore, a planarization insulation film **17** for planarizing the surface, which is made of, for example, an organic resin is formed on the whole surface. A contact hole is formed in a position corresponding to a source **43***s* in the planarization insulation film **17**. There is formed on the planarization insulation film **17** a transparent electrode made of ITO (Indium Tin Oxide) and contacting to the source **43***s* through the contact hole, i.e., the anode **61** of the organic EL element. The anode **61** is formed in each of the pixels, being isolated as an island.

The organic EL element **60** has a structure of laminating sequentially the anode **61** made of a transparent electrode such as ITO, a hole transport layer **62** including a first hole transport layer made of MTDATA (4,4-bis(3-methylphenylphenylamino)biphenyl) and a second hole transport layer made of TPD (4,4,4-tris(3-methylphenylphenylamino) triphenylanine), an emissive **63** made of $Bebq_2$ (bis(10-hydroxybenzo[h]quinolinato) beryllium) containing a quinacridone derivative, an electron transport layer **64** made of $Bebq_2$, and a cathode **65** made of magnesium-indium alloy, aluminum or aluminum alloy.

Incidentally, the planarization insulation film **17** is formed with a second planarization insulation film **66** thereon. The second planarization insulation film **66** is removed on the anode **61**.

In the organic EL element **60**, a hole injected from the anode **61** and an electron injected from the cathode **65** are recombined in the emissive and an exciton is formed by exciting an organic module forming the emissive **63**. Light is emitted from the emissive **63** in a process of radiation of the exciton and then released outside after going through the transparent anode **61** to the transparent insulating substrate **10**, thereby to complete light-emission.

According to this embodiment, in the sealing structure of the electroluminescent display device in which the first glass substrate (a display panel) having the EL element and the second glass substrate for sealing the EL element are attached together, the stress buffer layer is disposed between the desiccant layer and the EL element, thereby preventing the breaking of the EL element **101** when external force is applied to the first glass substrate or the second glass substrate. Furthermore, the amount of the resin in the desiccant layer is increased so that the same effect is obtained without using the stress buffer layer.

What is claimed is:

1. An electroluminescent display device comprising:

a first substrate having an electroluminescent element thereon;

a second substrate attached to the first substrate;

a desiccant layer coated on the second substrate so that the desiccant layer faces the first substrate; and

a stress buffer layer covering the desiccant layer so that a peripheral portion of the stress buffer layer is attached directly to the second substrate.

2. The electroluminescent display device of claim **1**, wherein the stress buffer layer is made of a resin.

3. The electroluminescent display device of claim **1**, wherein the stress buffer layer includes a plurality of air vents.

4. The electroluminescent display device of claim **2**, wherein the stress buffer layer includes a plurality of air vents.

5. The electroluminescent display device of claim **1**, wherein the second substrate includes a concave portion and the desiccant layer is disposed in the concave portion.

* * * * *

专利名称(译)	具有干燥剂层的电致发光显示装置		
公开(公告)号	US6930449	公开(公告)日	2005-08-16
申请号	US10/419982	申请日	2003-04-22
[标]申请(专利权)人(译)	三洋电机株式会社		
申请(专利权)人(译)	SANYO ELECTRIC CO. , LTD.		
当前申请(专利权)人(译)	SANYO ELECTRIC CO. , LTD.		
[标]发明人	SASATANI TORU OMURA TETSUJI		
发明人	SASATANI, TORU OMURA, TETSUJI		
IPC分类号	H01L51/52 H01L51/50 H05B33/04 H01L27/32 H05B33/00		
CPC分类号	H01L51/5237 H01L27/3244 H01L51/5259		
代理机构(译)	美富律师事务所		
审查员(译)	WILLIAMS , JOSEPH		
优先权	2002122114 2002-04-24 JP		
其他公开文献	US20040012332A1		
外部链接	Espacenet USPTO		

摘要(译)

在电致发光显示装置的密封结构中，其中形成有EL元件的第一玻璃基板和作为盖的第二玻璃基板彼此附接，当外力施加到第一玻璃基板上时，防止了元件装置的断裂。玻璃基板和第二玻璃基板。密封结构具有在其表面上设置有EL元件的第一玻璃基板，利用密封树脂附接到第一玻璃基板的第二玻璃基板，形成在第二玻璃基板的表面上的干燥剂层和应力缓冲层覆盖干燥剂层的表面。