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(54) **ORGANIC EL DISPLAY DEVICE**

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(57) **ABSTRACT**

The invention prevents moisture infiltration into a pixel region and improves reliability of an organic EL display device. A plurality of pixels is disposed in a matrix on a device substrate to form a pixel region. Each of the pixels in the pixel region is provided with an organic EL element and a driving transistor for driving the organic EL element. Furthermore, organic interlayer insulating films are formed on the driving transistor and under the organic EL element. The device substrate and a sealing substrate are attached with a sealing member disposed on a peripheral region of the pixel region. The organic interlayer insulating films are separated by a separating region provided between the sealing member and the pixel region.

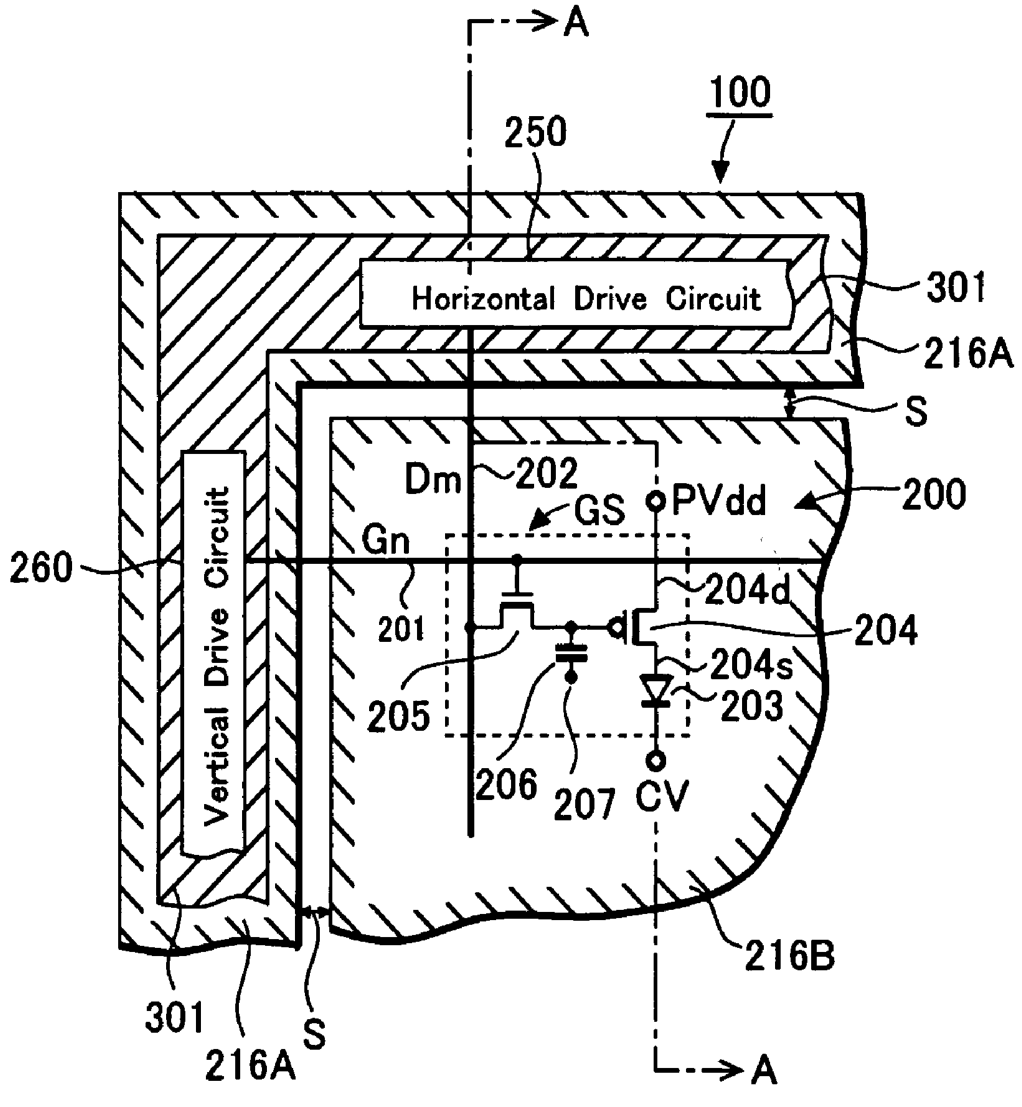


FIG.1

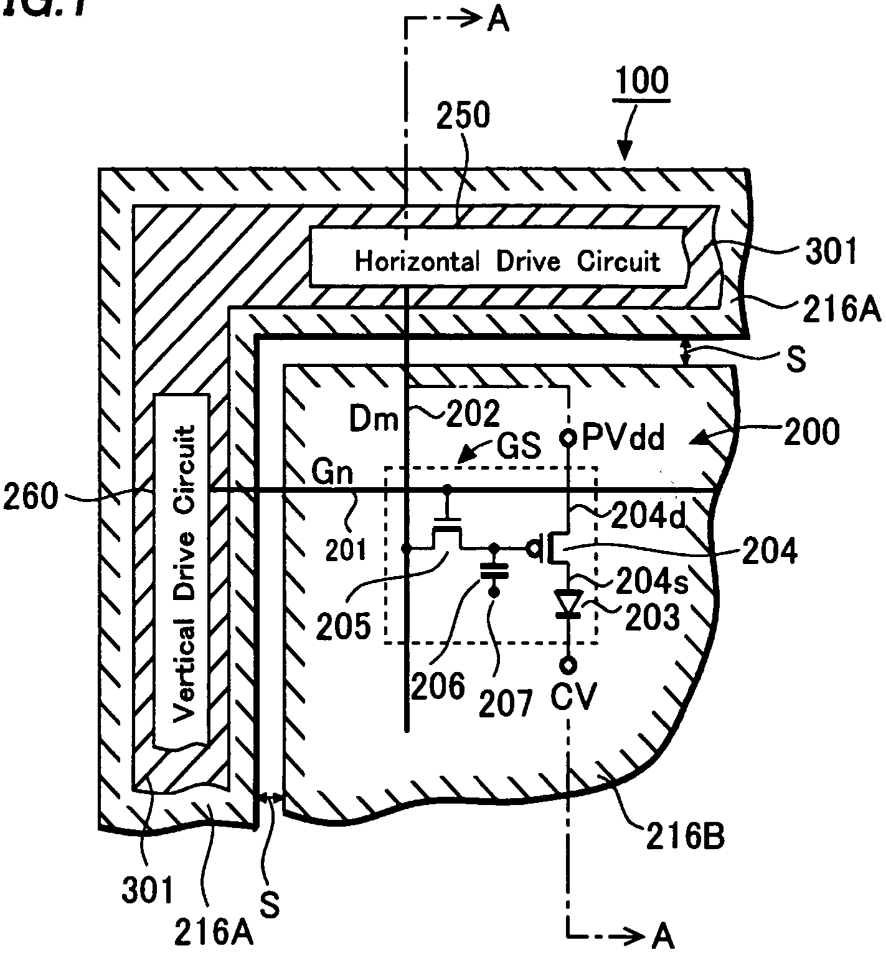

A
100
250
Horizontal Drive Circuit
301
216A
S
Dm
202
PVdd
200
GS
Gn
260
Vertical Drive Circuit
201
204d
204
204s
205
203
206
207
CV
216B
301
216A
S
A

FIG.2

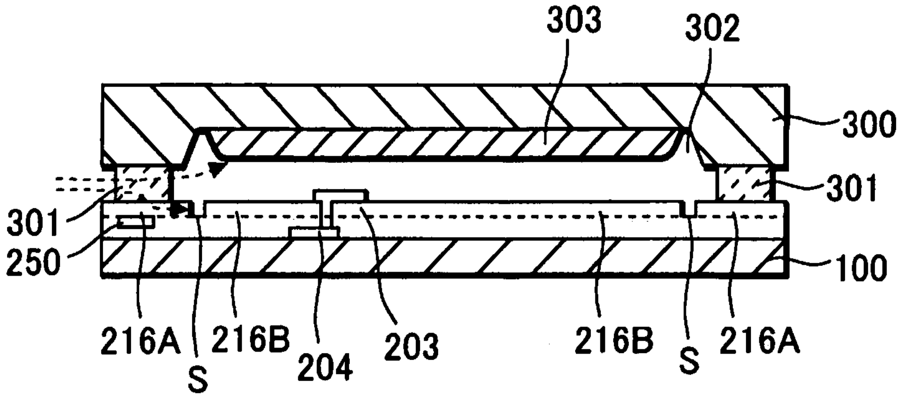

303
302
300
301
301
250
100
216A
S
216B
204
203
216B
S
216A

FIG.3

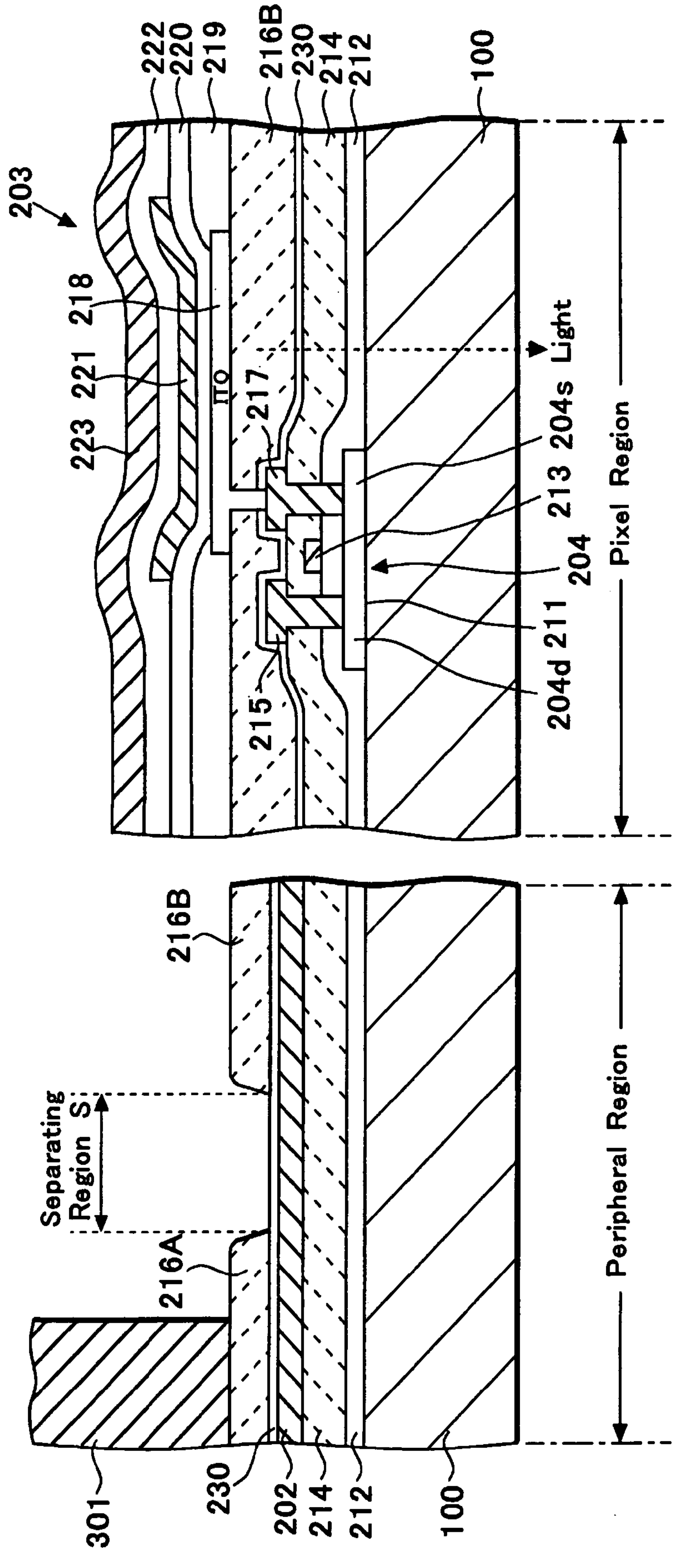

222
220
219
216B
230
214
212
100
203
218
221
223
ITO
217
215
213
204s
204
211
204d
Light
Pixel Region
216B
Separating Region S
216A
301
230
202
214
212
100
Peripheral Region

FIG.4

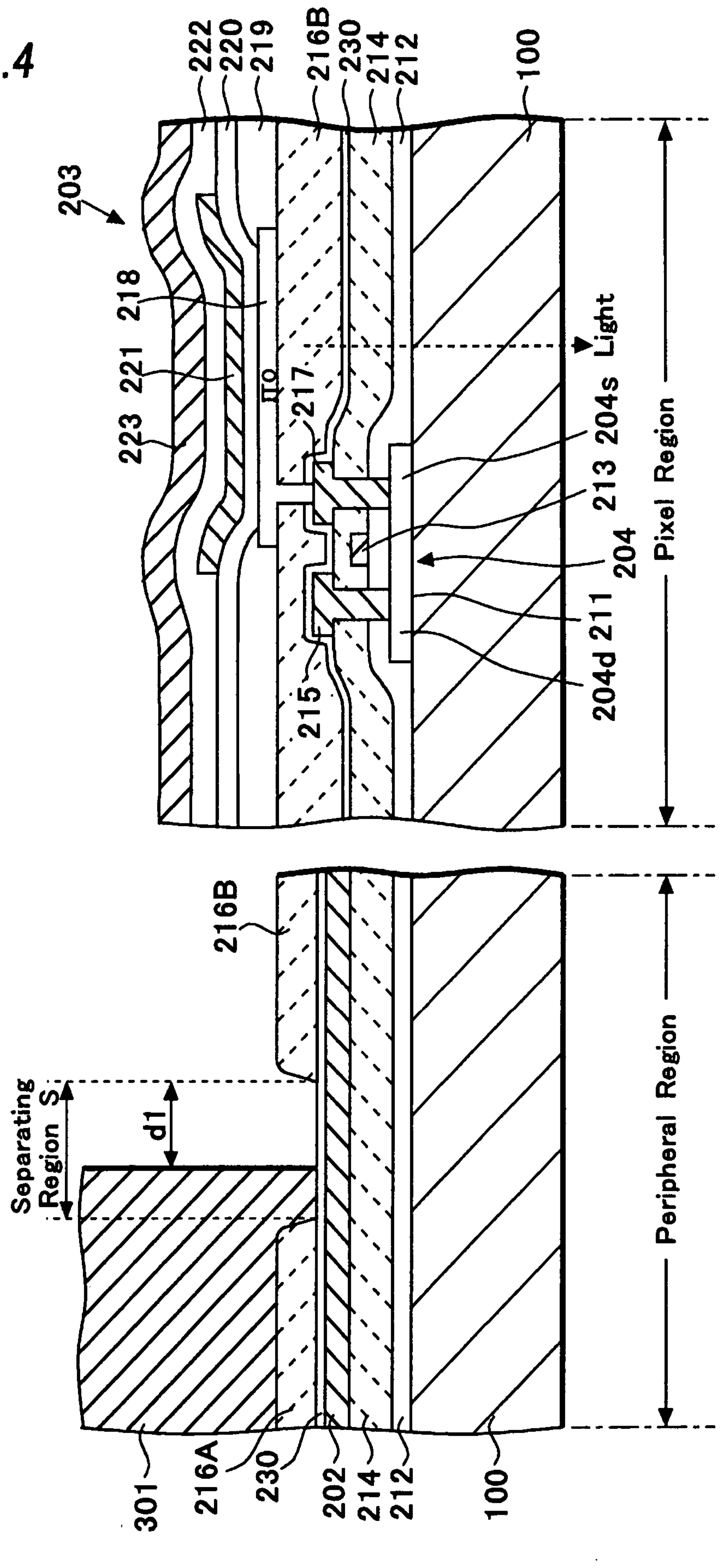

222
220
219
216B
230
214
212
100
203
218
221
223
217
215
204s
213
204
211
204d
Light
Pixel Region
216B
Separating Region S
d1
Peripheral Region
301
216A
230
202
214
212
100

FIG.5

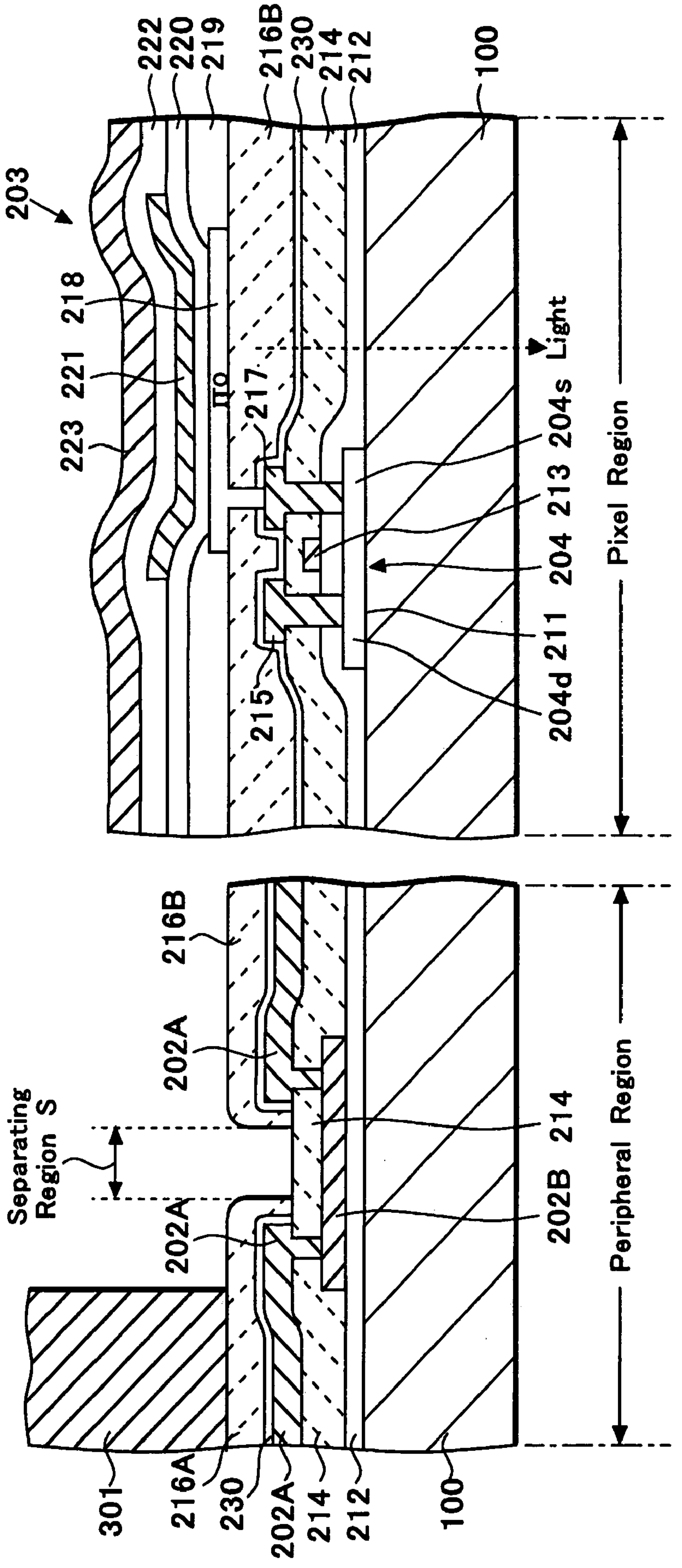

222
220
219
216B
230
214
212
100
203
218
221
223
ITO
217
Light
215
204s
213
204
211
204d
Pixel Region
216B
202A
Separating Region S
202A
214
202B
Peripheral Region
301
216A
230
202A
214
212
100

FIG.6

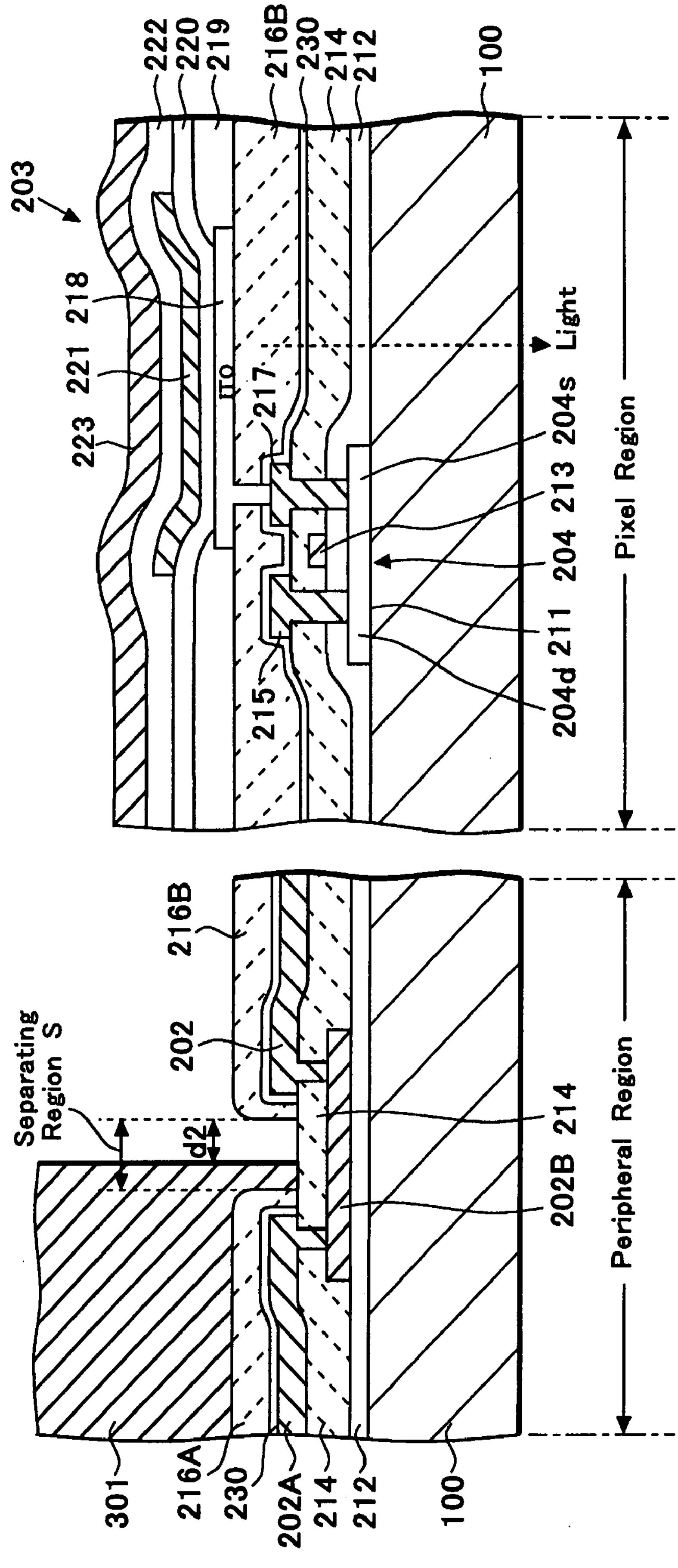

222
220
219
216B
230
214
212
100
203
223
221
218
ITO
217
Light
204s
213
204
211
204d
215
Pixel Region
Separating Region S
d2
216B
202
214
202B
Peripheral Region
301
216A
230
202A
214
212
100

FIG.7

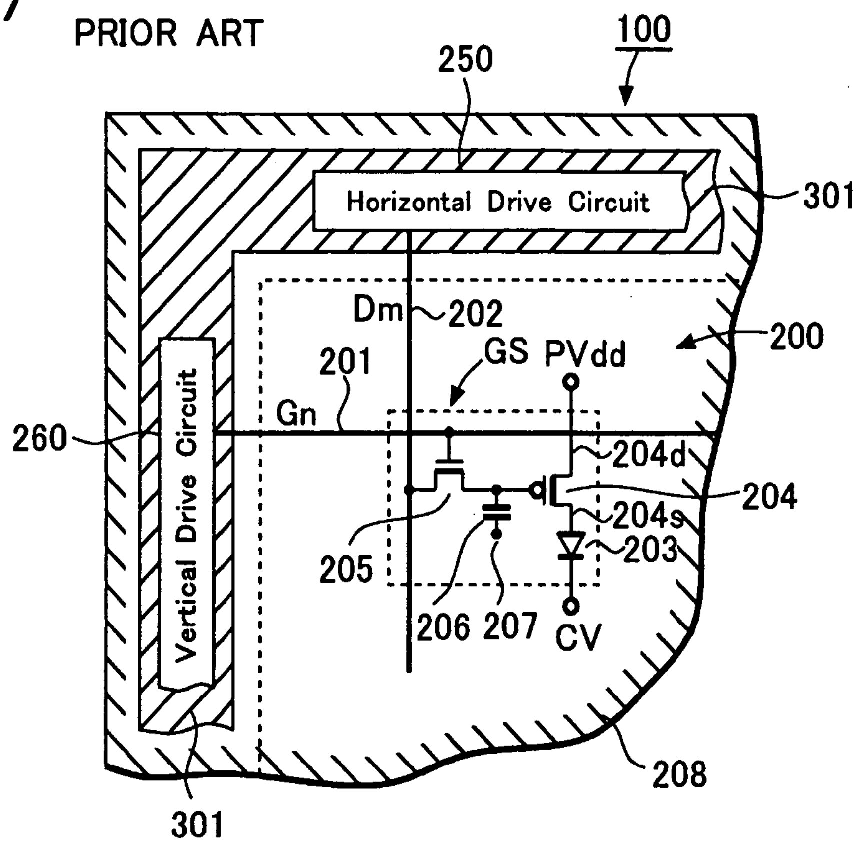

PRIOR ART
100
250
Horizontal Drive Circuit
301
Dm
202
200
GS
PVdd
201
Gn
260
Vertical Drive Circuit
204d
204
204s
203
205
206
207
CV
208
301

FIG.8

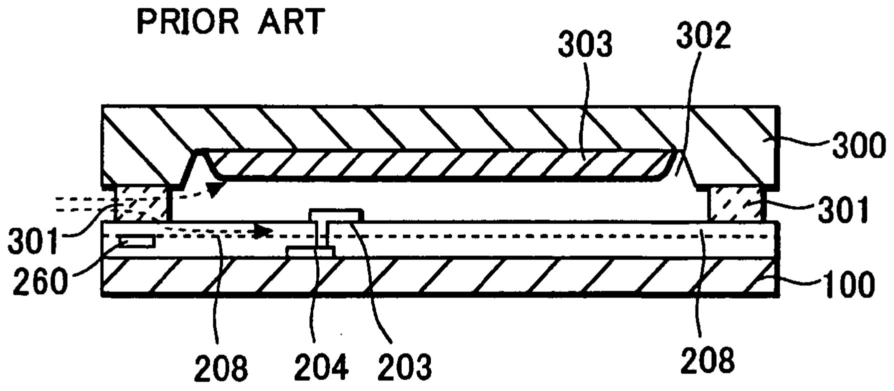
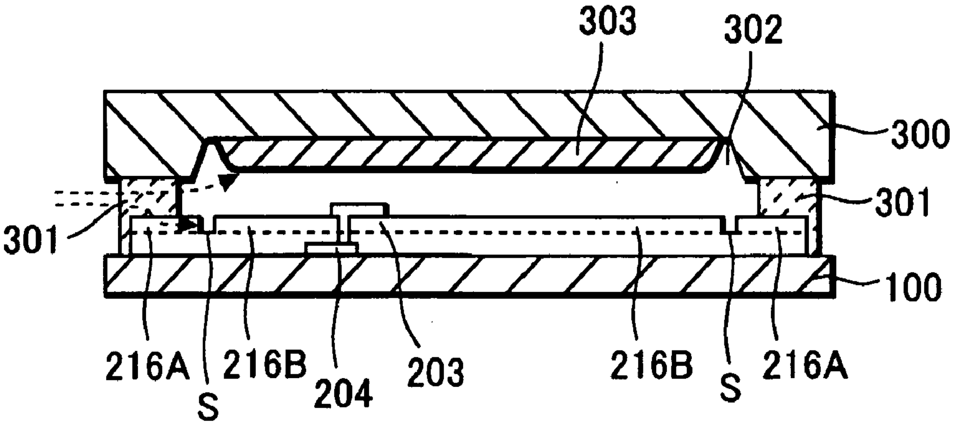

PRIOR ART
303
302
300
301
301
260
100
208
204
203
208

FIG.9



ORGANIC EL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to an organic EL (electroluminescent) display device, particularly to an organic EL display device in which a plurality of pixels is disposed on a device substrate to form a pixel region and each of the pixels has an organic EL element and a driving transistor for driving the organic EL element.

[0003] 2. Description of the Related Art

[0004] In recent years, an organic EL display device using organic EL elements has been receiving attention as a new display device to replace a CRT or an LCD. For example, research and development of an EL display device having thin film transistors (hereafter, referred to as TFTs) as switching elements for driving the organic EL elements are being pursued.

[0005] **FIG. 7** is a partial plan view of such an organic EL display device, and **FIG. 8** is a cross-sectional view thereof. A pixel region **200** is disposed on a device glass substrate **100**, and a horizontal drive circuit **250** and a vertical drive circuit **260** serving as a drive circuit are disposed on a periphery of the pixel region **200**. The vertical drive circuit **260** supplies a gate signal Gn as a pixel selecting signal to each of the pixels in the pixel region **200**. The horizontal drive circuit **250** supplies a display signal Dm to each of the pixels in the pixel region **200** based on a horizontal scanning signal. Each of the vertical and horizontal drive circuits is configured of shift resistors.

[0006] The plurality of pixels is disposed in a matrix in the pixel region **200**. **FIG. 7** shows a pixel GS only. A structure of this pixel GS will be explained as follows. A gate signal line **201** supplying the gate signal Gn and a drain signal line **202** supplying the display signal Dm intersect each other. An organic EL element **203**, a driving TFT **204** for driving the organic EL element **203**, and a pixel selecting TFT **205** for selecting the pixel GS are disposed on a periphery of an intersection of these signal lines.

[0007] A drain **204***d* of the driving TFT **204** is supplied with positive power supply voltage PVdd. A source **204***s* of the driving TFT **204** is connected with an anode of the organic EL element **203**. A gate of the pixel selecting TFT **205** is connected with the gate signal line **201**, and supplied with the gate signal Gn from the gate signal line **201**. A drain of the pixel selecting TFT **205** is connected with the drain signal line **202**, and supplied with the display signal Dm from the drain signal line **202**. A source of the pixel selecting TFT **205** is connected with a gate of the driving TFT **204**.

[0008] The organic EL element **203** includes an anode, a cathode, and an emissive layer formed between the anode and the cathode. The cathode is supplied with negative power supply voltage CV.

[0009] Furthermore, the gate of the driving TFT **204** is connected with a storage capacitor **206**. That is, one electrode of the storage capacitor **206** is connected with the gate of the driving TFT **204**, and another electrode thereof is connected with a storage capacitor electrode **207**. The storage capacitor **206** stores the display signal Dm applied to the gate of the driving TFT **204** through the pixel selecting TFT **205** for a field period by storing electric charge corresponding to the display signal Dm.

[0010] Operation of the EL display device having the above-described structure will be described. Here, the driving TFT **204** is of P-channel type, and the pixel selecting TFT **205** is of N-channel type.

[0011] When the gate signal Gn is high level for a predetermined horizontal period, the pixel selecting TFT **205** turns on. Then, the display signal Dm is applied from the drain signal line **202** to the gate of the driving TFT **204** through the pixel selecting TFT **205**. According to the display signal Dm supplied to the gate, conductance between the source and the drain of the driving TFT **204** changes. A drive current corresponding to the changed conductance is supplied to the organic EL element **203** through the driving TFT **204**, thereby exiting the organic EL element **203**.

[0012] The organic EL element **203** degrades its characteristics by absorbing moisture. Therefore, as shown in **FIG. 8**, the above-described device glass substrate **100** and the sealing glass substrate **300** are attached to each other by using sealing resin **301** made of, for example, an epoxy resin. Furthermore, a concave portion **302** is formed on a surface of the sealing glass substrate **300**, which is on the side facing the device glass substrate **100**, and a desiccant layer **303** is attached on a bottom of the concave portion **302**. This technology is disclosed in the Japanese Patent Application Publication No. 2002-175029.

[0013] As shown in **FIGS. 7 and 8**, an organic interlayer insulating film **208** is formed on and covers the driving TFT **204**. The source **204***s* of the driving TFT **204** is connected with the anode of the organic EL element **203** through a contact hole provided in this organic interlayer insulating film **208**. The organic interlayer insulating film **208** has appropriate characteristics as an interlayer insulating film, since it can be formed thick with its low stress and permittivity, and also costs low. On the other hand, however, the organic interlayer insulating film **208** has an adverse characteristic, i.e., high moisture transmittance.

[0014] Therefore, moisture infiltrating through the sealing resin **301** from outside of the organic EL display device partially reaches the pixel region **200** through this organic interlayer insulating film **208**, thereby degrading the characteristics of the organic EL element **203**.

SUMMARY OF THE INVENTION

[0015] In an organic EL display device of the invention, a plurality of pixels is disposed in a matrix on a device substrate to form a pixel region. Each of the pixels in the pixel region is provided with an organic EL element and a driving transistor for driving the organic EL element. Furthermore, organic interlayer insulating films are formed on the driving transistor and under the organic EL element. The device substrate and a sealing substrate are attached with a sealing member disposed on a peripheral region of the pixel region. The organic interlayer insulating films are separated by a separating region provided between the sealing member and the pixel region. Accordingly, even when moisture is infiltrated from outside to the organic interlayer insulating film through the sealing resin, the moisture filtration stops at the separating region and the moisture is prevented from infiltrating into the pixel region.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a partial plan view of an organic EL display device of a first embodiment of the invention.

[0017] **FIG. 2** is a cross-sectional view of the organic EL display device of the first embodiment of the invention along A-A line shown in **FIG. 1**.

[0018] **FIG. 3** is a partial cross-sectional view along A-A line in **FIG. 1** showing a pixel region and its peripheral region of the organic EL display device of the first embodiment of the invention.

[0019] **FIG. 4** is a partial cross-sectional view along A-A line in **FIG. 1** showing a pixel region and its peripheral region of an organic EL display device of a second embodiment of the invention.

[0020] **FIG. 5** is a partial cross-sectional view along A-A line in **FIG. 1** showing a pixel region and its peripheral region of an organic EL display device of a third embodiment of the invention.

[0021] **FIG. 6** is a partial cross-sectional view along A-A line in **FIG. 1** showing a pixel region and its peripheral region of an organic EL display device of a fourth embodiment of the invention.

[0022] **FIG. 7** is a partial plan view of an organic EL display device of a conventional art.

[0023] **FIG. 8** is a cross-sectional view of the organic EL display device of the conventional art.

[0024] **FIG. 9** is a partial cross-sectional view along A-A line in **FIG. 1** of a modified organic EL display device of the first embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] An embodiment of the invention will be described with reference to the drawings in detail. **FIG. 1** is a partial plan view of an organic EL display device of a first embodiment of the invention, and **FIG. 2** is a cross-sectional view thereof. Note that the same numerals are provided to the same components as those of **FIGS. 7 and 8**, and the descriptions of the components will be omitted.

[0026] Organic interlayer insulating films **216**A and **216**B are formed on a driving TFT **204**, and a drain of a driving TFT **204** is connected with an anode of an organic EL element **203** through a contact hole provided in the organic interlayer insulating film **216**B. The organic interlayer insulating films **216**A and **216**B are made of an acrylic resin, for example.

[0027] The organic interlayer insulating films **216**A and **216**B are separated by a separating region S provided between sealing resin **301** and a pixel region **200**. That is, the organic interlayer insulating film **216**B covers the pixel region **200**, and the organic interlayer insulating film **216**A covers a peripheral region of the pixel region **200**, extending to an edge of the device substrate **100**. The organic interlayer insulating films **216**A and **216**B are not formed in the separating region S.

[0028] Furthermore, a horizontal drive circuit **250** and a vertical drive circuit **260** are disposed on the periphery of the pixel region **200**, and the separating region S is disposed between the horizontal drive circuit **250** and the pixel region **200** and between the vertical drive circuit **260** and the pixel region **200**. The sealing resin **301** is interposed between the device substrate **100** and the sealing substrate **300**, and disposed in a region including the horizontal drive circuit **250** and the vertical drive circuit **260** as shown in **FIG. 1**. The edge of the organic interlayer insulating films **216**A may be covered by the sealing resin **301** as shown in **FIG. 9**.

[0029] Thus, in this embodiment, the organic interlayer insulating films **216**A and **216** B are separated by the separating region S provided between the sealing resin **301** and the pixel region **200**. Therefore, even when moisture is infiltrated from outside to the organic interlayer insulating film **216**A on the periphery of the pixel region **200** through the sealing resin **301**, the moisture filtration stops at the separating region S and the moisture does not infiltrate into the organic interlayer insulating film **216**B on the side of the adjacent pixel region **200**.

[0030] Furthermore, as shown in **FIG. 2**, moisture entering a space between the device substrate **100** and the sealing substrate **300** through the sealing resin **301** and so on is absorbed by the desiccant layer **303**. This prevents moisture infiltration into the organic EL element **203** in the pixel region **200** and degrading of characteristics thereof.

[0031] Next, a structure of the pixel region **200** and its peripheral region will be described in more detail. **FIG. 3** is a partial cross-sectional view showing the driving TFT **204** of one of the pixels GS in the pixel region **200** and its peripheral region. The driving TFT **204** and the organic EL element **203** are formed on a transparent insulating substrate **100** made of a silica glass or a non-alkali glass. The driving TFT **204** is formed by laminating an active layer **211** formed by poly-crystalizing an amorphous silicon film by irradiation of laser beams, a gate insulating film **212** laminated with an SiO_2 film and an SiN film in this order, and a gate electrode **213** made of metal having a high melting point such as Cr (chromium) and Mo (molybdenum), in this order. The active layer **211** is provided with a channel, a source **204***s*, and a drain **204***d*, the source **204***s* and the drain **204***d* being disposed on each side of the channel.

[0032] An first interlayer insulating film **214** laminated with an SiO_2 film, an SiN_x film and an SiO_2 film in this order is formed on the whole surfaces of the gate insulating film **212** and the active layer **211**. A drain electrode **215** is formed by filling with a metal such as Al (aluminum) a contact hole provided correspondingly to the drain **204***d*. This drain electrode **215** is connected with a driving power supply PVdd. A source electrode **217** is formed by filling with a metal such as Al a contact hole provided correspondingly to the source **204***s*.

[0033] Furthermore, a protection film **230** made of an SiN film and an organic interlayer insulating film **216**B as a second interlayer insulating film are formed on a whole surface. This organic interlayer insulating film **216**B is formed with the contact hole in a position corresponding to the source **204***s* of the driving TFT **204**. A transparent electrode made of ITO (indium tin oxide), i.e., an anode layer **218** of the organic EL element **203**, is formed on the organic interlayer insulating film **216**B, being in contact with the source electrode **217** through the contact hole. This anode layer **218** is formed in each of the pixels GS, being isolated as an island.

[**0034**] Furthermore, a third interlayer insulating film **219** is formed on a periphery of the anode layer **218**, being removed above the anode layer **218**. The organic EL element **203** is formed by laminating the anode layer **218**, a hole transport layer **220**, an emissive layer **221**, an electron transport layer **222**, and a cathode layer **223** in this order.

[**0035**] On the other hand, in the peripheral region, the gate insulating film **212** and the first interlayer insulating film **214** in the pixel region **200** extend to the peripheral region of the transparent insulating substrate **100**, and a drain signal line **202** is formed on the first interlayer insulating film **214**. The drain signal line **202** is formed of Al or Al alloy, and covered with the protection film **230**.

[**0036**] The organic interlayer insulating films **216**A and **216**B are formed on the protection film **230** formed on the drain signal line **202**. The organic interlayer insulating film **216**B extends from the pixel region **200** to this peripheral region, and the organic interlayer insulating films **216**A and **216**B are separated by the separating region S. An end of the sealing resin **301** is on the organic interlayer insulating film **216**A. The separating region S has a width enough to prevent moisture infiltrated from the sealing resin **301** from infiltrating further into the adjacent organic interlayer insulating film **216**B through the organic interlayer insulating film **216**A, for example, 5 μm or larger.

[**0037**] Next, a second embodiment of the invention will be described. Although the end of the sealing resin **301** is positioned on the organic interlayer insulating film **216**A in the first embodiment, the end of the sealing resin **301** is positioned inside the separating region S between the organic interlayer insulating films **216**A and **216**B in this embodiment as shown in **FIG. 4**. In this structure, too, the end of the sealing resin **301** is kept off from the organic interlayer insulating film **216**B on the side of the pixel region **200** by a predetermined distance d1, so that moisture infiltrating in the sealing resin **301** can be prevented from infiltrating further into the organic interlayer insulating film **216**B.

[**0038**] Next, a third embodiment of the invention will be described. Although the drain signal line **202** is formed of a single layer of Al in the first and second embodiments as shown in **FIGS. 3 and 4**, the drain wiring **202** in this embodiment is formed of upper wiring **202**A made of Al, and lower wiring **202**B disposed across the first interlayer insulating film **214** from the upper wiring **202**A as shown in **FIG. 5**.

[**0039**] That is, the lower wiring **202**B is formed in the same process step as the gate electrode **213** of the driving TFT **204**, and made of a same material as the gate electrode **213**. Contact holes are formed in both ends of the first interlayer insulating film **214** on the lower wiring **202**B, and the upper wiring **202**A is connected with both ends of the lower wiring **202**B through these contact holes. The separating region S between the organic interlayer insulating films **216**A and **216**B is located on the first interlayer insulating film **214** formed on the lower wiring **202**B, and the organic interlayer insulating films **216**A and **216**B cover the upper wiring **202**A.

[**0040**] This configuration is employed because the drain signal line **202** is not covered with the thick organic interlayer insulating films **216**A and **216**B at the separating region S in the case where the drain signal line **202** is formed of a single layer of Al as in the first and second embodiments. In this structure of the first and second embodiments, when the anode layer **218** is etched to partially remain at a predetermined region, the drain signal line **202** therebelow may be damaged by etching the protection film **230**. In this embodiment, the upper wiring **202**A is bypassed to the lower wiring **202**B at the separating region S, and the upper wiring **202**A is covered with the upper interlayer insulating films **216**A and **216**B, so that the drain signal line **202** can be prevented from receiving such etching damage.

[**0041**] Next, a fourth embodiment of the invention will be described. Although the end of the sealing resin **301** is positioned on the organic interlayer insulating film **216**A in the third embodiment, the end of the sealing resin **301** is positioned inside the separating region S between the organic interlayer insulating films **216**A and **216**B in this embodiment as shown in **FIG. 6**. In this structure, too, the end of the sealing resin **301** is kept off from the organic interlayer insulating film **216**B on the side of the pixel region **200** by a predetermined distance d2, so that moisture infiltrating in the sealing resin **301** is prevented from infiltrating into the organic interlayer insulating film **216**B.

[**0042**] Although the separating region S for separating the organic interlayer insulating films **216**A and **216**B is provided in the above-described embodiments, the invention is not limited to such interlayer insulating films. The invention can be applied to an organic insulating film for other use, for example, an organic insulating film to be used as a protection film or a planarization insulating film, and prevent moisture infiltration by the similarly provided separating region.

[**0043**] Furthermore, although the organic interlayer insulating film **216**A is disposed under the almost the whole surface of the sealing resin **301** in the above embodiments, the invention does not necessarily have such a structure. As described above, the organic interlayer insulating film **216**A has a function of protecting wiring such as the drain signal line **202** from etching damage when the anode layer **218** in the pixel region is etched. That is, the organic interlayer insulating film **216**A is not necessarily formed in a region having no wiring made of Al or Al alloy such as the drain signal line **202**. Therefore, the organic interlayer insulating film **216**A can be patterned in accordance with wiring designs. In this case, although the patterned organic interlayer insulating film **216**A is disposed under the sealing resin **301**, a separating region having a predetermined width or distance d1 is provided between the organic interlayer insulating film **216**B and the organic interlayer insulating film **216**A or the sealing resin **301**.

[**0044**] Still furthermore, a glass is used as a material of the sealing substrate **300** in the above embodiments, the invention is not limited to such a material and can employ plastic or non-transparent materials. However, it is preferable that the material has a high adhesion to the sealing resin.

[**0045**] Although the organic EL display device of bottom emission type is exemplified for description of the above embodiments, the invention can be applied to an organic EL display device of top emission type.

What is claimed is:

1. An organic EL display device comprising:

a device substrate;

a pixel region comprising a plurality of pixels formed on the device substrate, each of the pixels having an organic EL element;

a sealing substrate;

a sealing member disposed on the device substrate and outside the pixel region and attaching the device substrate to the sealing substrate;

a first organic insulating film disposed on the device substrate and within the pixel region; and

a second organic insulating film disposed on the device substrate and outside the pixel region so that a separation is formed between the first and second organic insulating films.

2. The organic EL display device of claim 1, wherein the first organic insulating film or the second organic insulating film is made of an acrylic resin.

3. An organic EL display device comprising:

a device substrate;

a pixel region comprising a plurality of pixels formed on the device substrate, each of the pixels having an organic EL element and a driving transistor for driving the organic EL element;

a first organic interlayer insulating film disposed between the driving transistor and the organic EL element;

a sealing substrate;

a sealing member disposed on the device substrate and outside the pixel region and attaching the device substrate to the sealing substrate; and

a second organic interlayer insulating film disposed on the device substrate and outside the pixel region so that a separation is formed between the first and second organic interlayer insulating films.

4. The organic EL display device of claim 3, wherein the first organic interlayer insulating film or the second organic interlayer insulating film is made of an acrylic resin.

5. The organic EL display device of claim 3, wherein a horizontal drive circuit is disposed on the device substrate and outside the pixel region, and the separation is located between the horizontal drive circuit and the pixel region.

6. The organic EL display device of claim 3, wherein a vertical drive circuit is disposed on the device substrate and outside the pixel region, and the separation is located between the vertical drive circuit and the pixel region.

7. The organic EL display device of claim 3, wherein the second organic interlayer insulating film disposed under the sealing member is patterned in accordance with a pattern of wiring disposed under the second organic interlayer insulating film.

8. The organic EL display device of claim 5, further comprising a drain signal line extending from the horizontal drive circuit to the pixel region and supplying a display signal to the driving transistor, wherein at least part of the drain signal line is located under the separation between the first and second organic interlayer insulating films.

9. The organic EL display device of claim 8, wherein the drain signal line includes an upper wiring and a lower wiring connected with the upper wiring, the lower wiring is disposed below the separation and covered with a non-organic insulating film, and the upper wiring is covered with the first and second organic interlayer insulating films.

10. An organic EL display device comprising:

a device substrate;

a pixel region comprising a plurality of pixels formed on the device substrate, each of the pixels having an organic EL element and a driving transistor for driving the organic EL element;

a first organic interlayer insulating film disposed between the driving transistor and the organic EL element;

a second organic interlayer insulating film disposed on the device substrate and outside the pixel region so that a separation is formed between the first and second organic interlayer insulating films;

a sealing substrate; and

a sealing member disposed on the device substrate and outside the pixel region so that part of the sealing member partially fills the space between the first and second organic interlayer insulating films, the sealing member attaching the device substrate to the sealing substrate.

11. The organic EL display device of claim 10, wherein the first organic interlayer insulating film or the second organic interlayer insulating film is made of an acrylic resin.

12. The organic EL display device of claim 10, wherein a horizontal drive circuit is disposed on the device substrate and outside the pixel region, and the separation is located between the horizontal drive circuit and the pixel region.

13. The organic EL display device of claim 10, wherein a vertical drive circuit is disposed on the device substrate and outside the pixel region, and the separation is located between the vertical drive circuit and the pixel region.

14. The organic EL display device of claim 10, wherein the second organic interlayer insulating film disposed under the sealing member is patterned in accordance with a pattern of wiring disposed under the second organic interlayer insulating film.

15. The organic EL display device of claim 12, further comprising a drain signal line extending from the horizontal drive circuit to the pixel region and supplying a display signal to the driving transistor, wherein at least part of the drain signal line is located under the separation between the first and second organic interlayer insulating films.

16. The organic EL display device of claim 12, wherein the drain signal line includes an upper wiring and a lower wiring connected with the upper wiring, the lower wiring is disposed below the separation and covered with a non-organic insulating film, and the upper wiring is covered with the first and second organic interlayer insulating films.

* * * * *

专利名称(译)	有机EL显示装置		
公开(公告)号	US20050023964A1	公开(公告)日	2005-02-03
申请号	US10/836627	申请日	2004-05-03
[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.		
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摘要(译)

本发明防止水分渗入像素区域并提高有机EL显示装置的可靠性。多个像素以矩阵形式设置在器件衬底上以形成像素区域。像素区域中的每个像素设置有有机EL元件和用于驱动有机EL元件的驱动晶体管。此外，有机层间绝缘膜形成在驱动晶体管上和有机EL元件下面。器件基板和密封基板附接有设置在像素区域的外围区域上的密封构件。有机层间绝缘膜通过设置在密封构件和像素区域之间的分离区域分开。