US 20070205719A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2007/0205719 A1

Kim (43) Pub. Date: Sep. 6, 2007

(54) ELECTROLUMINESCENT DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

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(21) Appl. No.: **11/283,762**

(22) Filed: **Nov. 22, 2005**

(30) **Foreign Application Priority Data**

Nov. 25, 2004 (KR) 10-2004-0097510

Publication Classification

(51) **Int. Cl.**
H05B 33/04 (2006.01)

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

(57) **ABSTRACT**

An electroluminescent display device and a method of manufacturing the same are provided. The electroluminescent display device includes a substrate having a display region and a terminal unit; a sealing substrate arranged above the substrate; and an encapsulant arranged on at least a portion of an edge of the substrate to seal at least the display region.

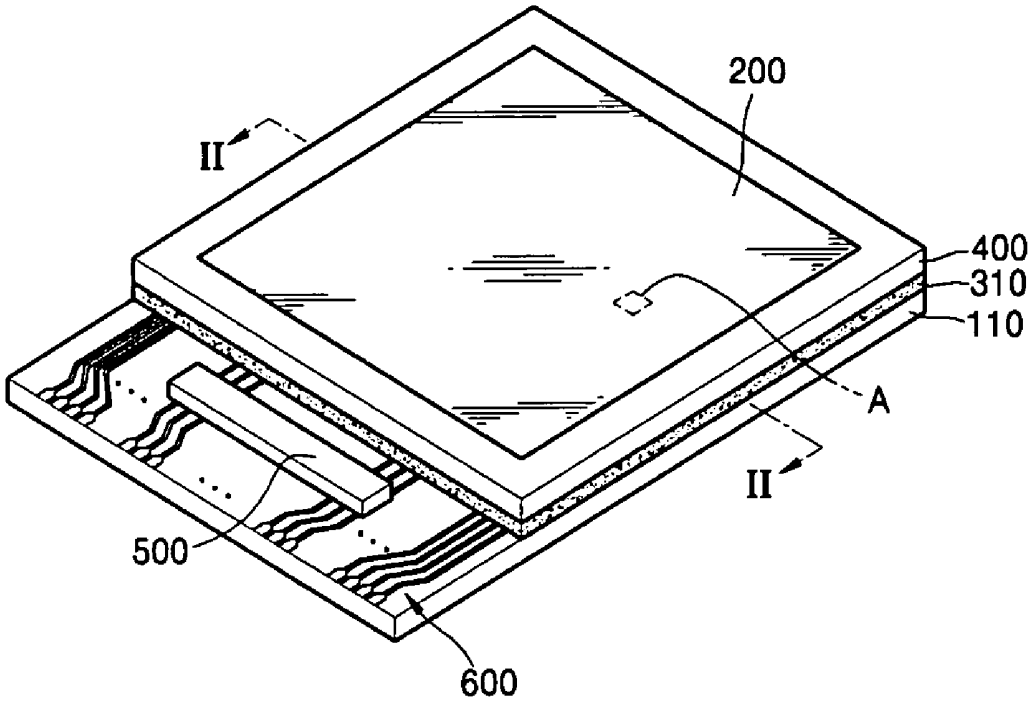


FIG. 1A (PRIOR ART)

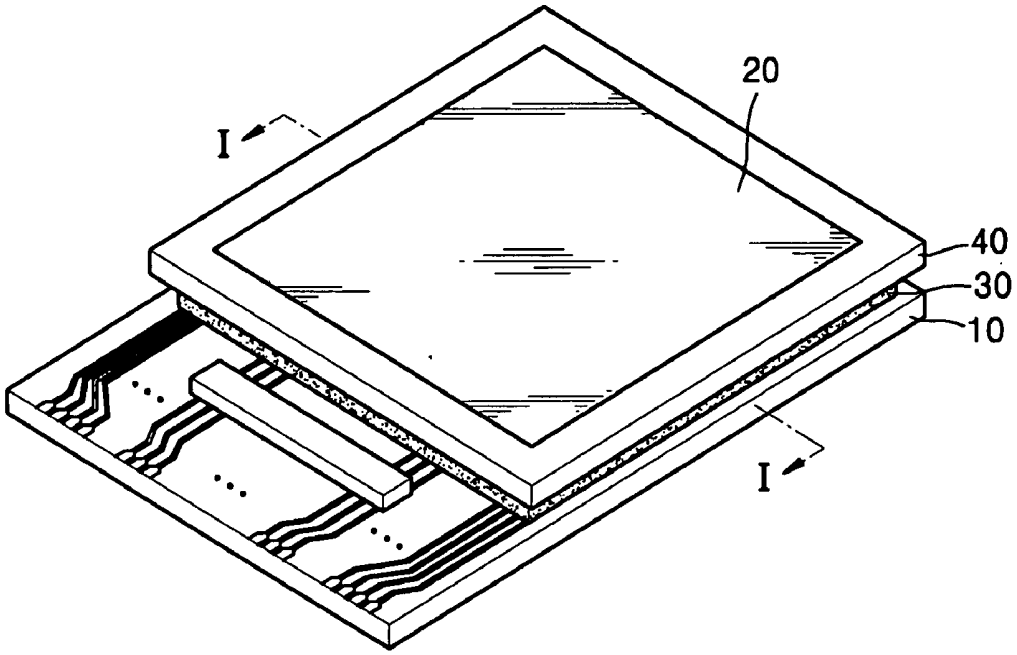


FIG. 1B (PRIOR ART)

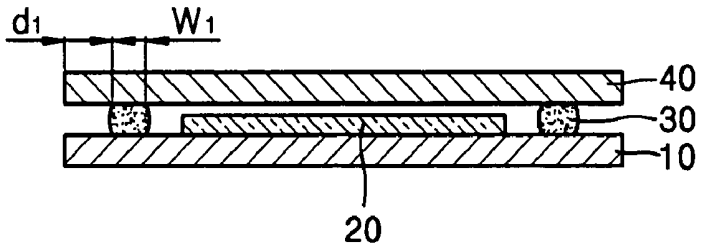


FIG. 2A

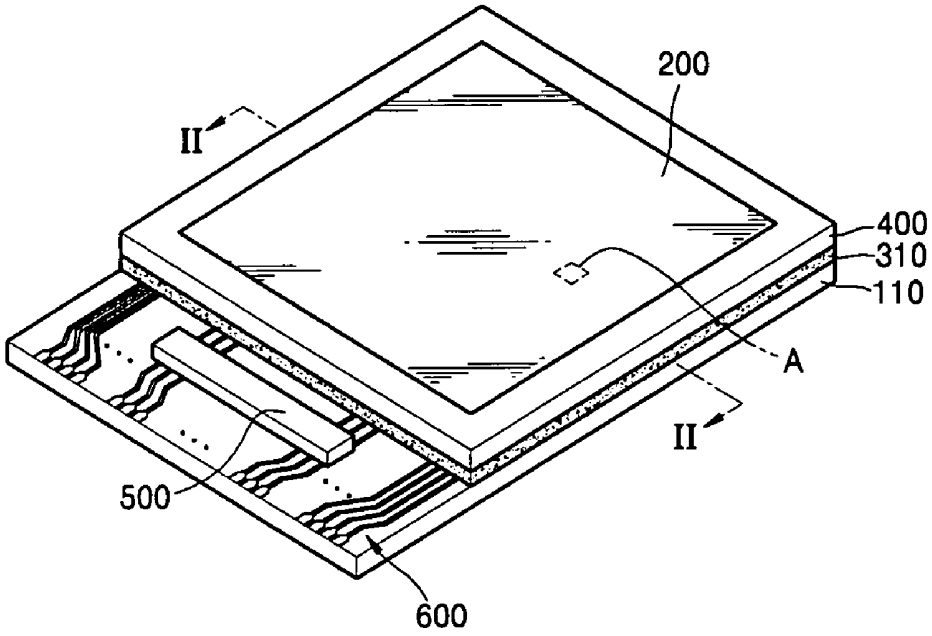


FIG. 2B

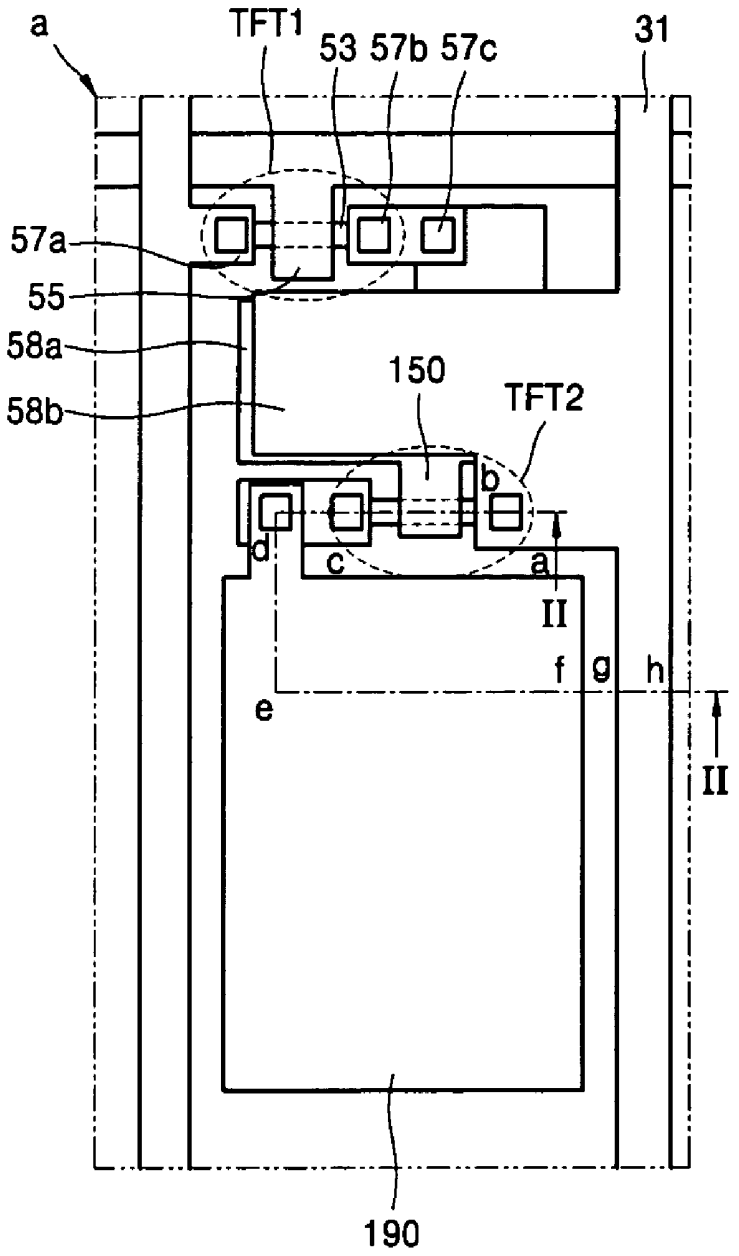


FIG. 2C

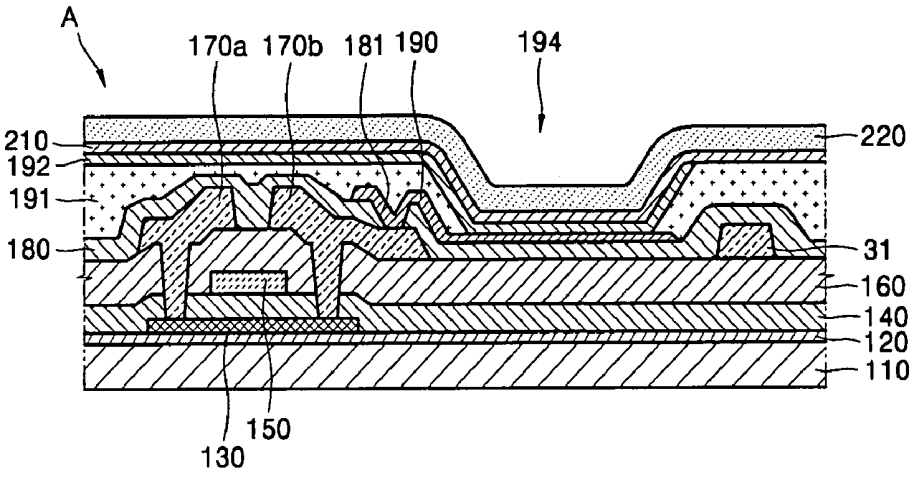

A
170a
170b
181
190
194
210
192
191
180
220
31
160
140
120
110
150
130

FIG. 2D

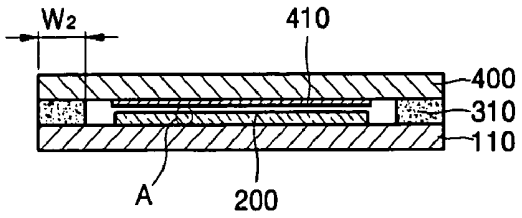

W2
410
400
310
110
A
200

FIG. 3A

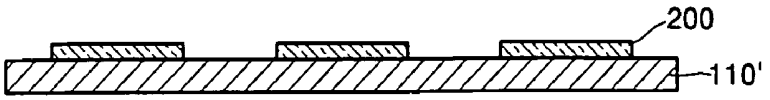


FIG. 3B

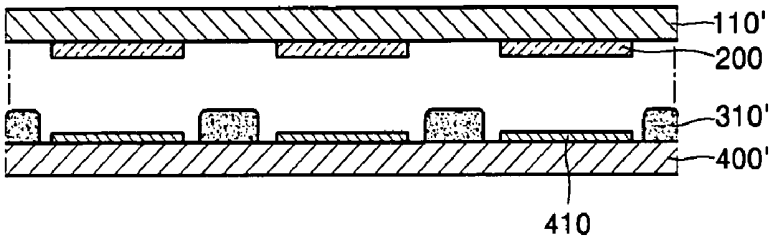


FIG. 3C

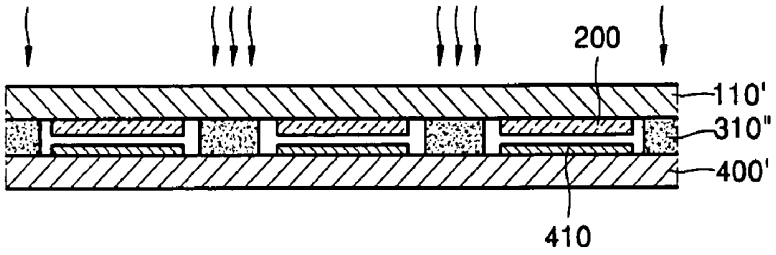


FIG. 3D

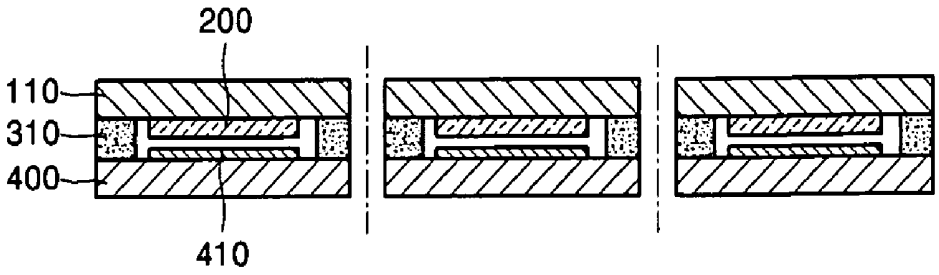


FIG. 4A

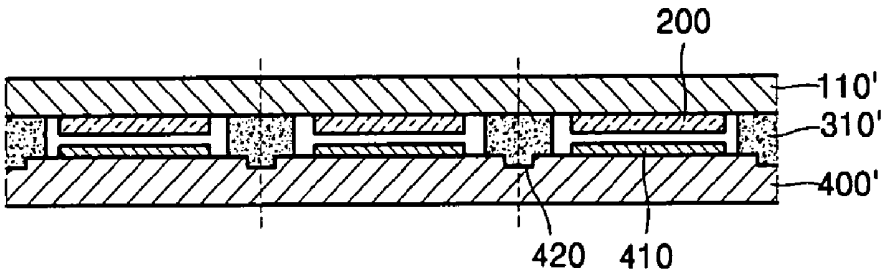
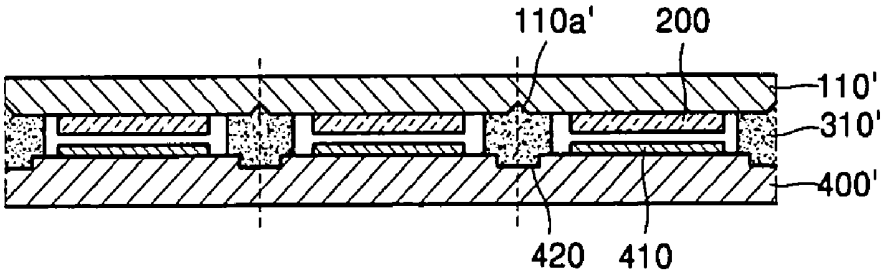


FIG. 4B



ELECTROLUMINESCENT DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2004-0097510, filed on Nov. 25, 2004, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to an electroluminescent display device, and more particularly, to an electroluminescent display device having a wide region where an encapsulant is disposed, which decreases and/or prevents deterioration caused by moisture, leakage, or the like.

[0004] 2. Description of the Related Art

[0005] Flat display devices including liquid crystal display devices, organic electroluminescent devices, inorganic electroluminescent devices, and the like are categorized into passive matrix (PM) displays and active matrix (AM) displays according to a type of driving method used therewith. In PM flat display devices, anodes may form columns and cathodes may form rows. A row driving circuit supplies a scanning signal to one of the rows, thereby selecting said row, and a column driving circuit supplies a data signal to each pixel of the selected row. Alternatively, in AM flat display devices, a thin film transistor (TFT) controls an input signal of each pixel. Therefore, AM flat display devices are suitable for processing a sufficiently large amount of signals, thus having a competitive edge over PM flat displays for displaying moving images.

[0006] For example, among flat display devices, an organic electroluminescent display device includes an organic emission layer having an organic material formed between an anode and a cathode. When an anode voltage and a cathode voltage are applied to the anode and the cathode, respectively, holes injected from the anode move to the organic emission layer through a hole transport layer and electrons injected from the cathode move to the organic emission layer through an electron transport layer. In the organic emission layer, the holes and electrons recombine to generate excitons. The excitons drop from an exited state to a ground state. Therefore, luminous molecules of the organic emission layer emit light, thus forming an image. In order to form a full-color image, an organic electroluminescent display device includes pixels emitting color; e.g., a red (R) color, a green (G) color, and a blue (B) color.

[0007] According to a conventional method of manufacturing an electroluminescent display device, a mother substrate having a plurality of display regions and a sealing mother substrate are coupled together to form entirely integrated display regions. The integrated display regions are scribed, thus forming individual display devices.

[0008] FIG. **1**A is a perspective view of a conventional electroluminescent display device, and FIG. **1**B is a sectional view taken along line I-I in FIG. **1**A. Referring to FIG. **1**A and FIG. **1**B, a display region **20** is formed on a surface of a substrate **10**, and sealed between the substrate **10** and a sealing substrate **40** by an encapsulant **30**.

[0009] Such an electroluminescent display device can be obtained by scribing, e.g., cutting a grid-like pattern, the mother substrate and the sealing mother substrate. The encapsulant **30** arranged between the mother substrate **10** and the sealing substrate **40** is positioned between a scribing region d**1** and the display region **20**. The encapsulant **30** has a predetermined width w**1** and may be arranged in a limited region of the electroluminescent display device. In addition, a subsequent process for hardening the encapsulant **30** results in an additional expansion of the encapsulant **30**. Therefore, due to such expansion, a region where the encapsulant **30** is initially formed must be reduced. In addition, the encapsulant **30** may overflow into the display region **20** when the region for the encapsulant **30** is increased to increase sealing ability.

SUMMARY OF THE INVENTION

[0010] The invention provides an electroluminescent display device with a sufficiently wide region where an encapsulant is disposed, thus having improved sealing properties relative to a conventional electroluminescent display device, and a method of manufacturing the same.

[0011] Additional features of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention.

[0012] The present invention discloses an electroluminescent display device, including a substrate comprising a display region and a terminal unit; a sealing substrate arranged above the substrate; and an encapsulant arranged at an edge region of the substrate and sealed with the display region.

[0013] The present invention also discloses a method of manufacturing an electroluminescent display device, including forming a display region on a mother substrate; forming an encapsulant on a portion of a scribed region on a sealing mother substrate; hardening the encapsulant; sealing the mother substrate with the sealing mother substrate; and cutting the mother substrate and the sealing mother substrate along the scribed region.

[0014] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0016] FIG. **1**A is a perspective view of a conventional electroluminescent display device.

[0017] FIG. **1**B is a sectional view taken along line I-I shown in FIG. **1**A.

[0018] FIG. **2**A is a perspective view of an electroluminescent display device according to an embodiment of the invention.

[0019] FIG. 2B is a plan view of a pixel of a portion "A" shown in FIG. 2A.

[0020] FIG. 2C is a sectional view taken along line II-II shown in FIG. 2B.

[0021] FIG. 2D is a sectional view taken along line II-II shown in FIG. 2A.

[0022] FIGS. 3A, 3B, 3C, and 3D are sectional views showing a method of manufacturing an organic electroluminescent display device including a sealing layer according to an embodiment of the invention.

[0023] FIG. 4A and FIG. 4B are sectional views showing methods of manufacturing organic electroluminescent display devices including sealing layers according to other embodiments of the invention.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0024] The invention is described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure is thorough, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

[0025] It is understood that when an element or layer is referred to as being "on" or "connected to" or "connected with" another element or layer, it can be directly on or directly connected to or with the other element or layer or intervening elements or layers may be present.

[0026] FIG. 2A is a perspective view of an electroluminescent display device according to an embodiment of the invention. Referring to FIG. 2A, a display region **200** including at least one pixel is arranged on a substrate **110**. A pad unit **600** including at least a terminal is arranged outside of the display region **200**. An encapsulant **310** is arranged between the display region **200** and the pad unit **600**. The substrate **110** and a sealing substrate **400** are sealed together by at least the encapsulant **310**, resulting in a sealed space that includes at least the display region **200**. As illustrated in FIG. 2A, the encapsulant **310** is arranged on at least a portion of an edge area of the substrate **110**.

[0027] An absorbing layer **410** (shown in FIG. 2D) may be arranged in the sealed space to absorb moisture or the like, thus reducing the risk of damage to an organic electroluminescent emission unit. The absorbing layer **410** may be composed of Ba, active alumina, or an alkali earth peroxide, such as kalium oxide, or barium oxide.

[0028] Meanwhile, an electric device that transmits an electric signal to the organic electroluminescent display region **200** may be arranged in the sealing region formed between the display region **200** and a sealing unit. Alternatively, the electric device, which may be a horizontal driving circuit **500** as shown in FIG. 2A, may be arranged outside of the sealing region. For example, the electric device may be a vertical/horizontal driving circuit unit such as a scan driver/data driver that transmits a scan signal and/or a data signal to a pixel of the display region **200**. Such a vertical/horizontal circuit unit is disposed on a chip on glass (COG), a flexible printed circuit (FPC), or the like.

[0029] FIG. 2B is a plan view of a pixel of a portion "A" shown in FIG. 2A. Referring to FIG. 2B, the pixel includes two top-gate type thin film transistors (TFTs) and a capacitor, but is not limited thereto.

[0030] A gate electrode **55** of TFT**1**, e.g., a first TFT, which selects a pixel, extends from a scan line that applies a scan signal. When an electric signal, such as a scan signal, is applied to the scan line, a data signal input through a data line is transferred from a source electrode **57***a* of the TFT**1** to a drain electrode **57***b* of the TFT**1** through a semiconductor active layer **53**.

[0031] An extended portion **57***c* of the drain electrode **57***b* of the first TFT TFT**1** is connected, e.g., coupled, with an end of a first electrode **58***a* of a capacitor. The other end of the first electrode **58***a* of the capacitor forms a gate electrode **150** of TFT**2**, e.g., a second TFT, which is a driving TFT. The second electrode **58***b* of the capacitor is electrically connected, e.g., coupled, with a driving line **31** that is coupled with a driving power supply line (not shown).

[0032] FIG. 2C is a sectional view taken along line II-II shown in FIG. 2B. A sectional view through points (a)-(e) of the line II-II illustrates TFT**2**, which is a driving thin film transistor. A sectional view through points (e)-(f) illustrates a pixel opening **194**. A sectional view through points (g)-(h) illustrates a driving line.

[0033] Referring to FIG. 2C, in the TFT**2**, a buffer layer **120** is arranged on a surface of the substrate **110**, and a semiconductor active layer **130** of the TFT**2** is arranged on the buffer layer **120**. The semiconductor active layer **130** may include amorphous silicon or polycrystal silicon. The semiconductor active layer **130** may include a source region and a drain region respectively doped with an N+ type dopant or a P+ type dopant and a channel region, which are not shown in FIG. 2C. The semiconductor active layer **130** may be an organic semiconductor, but is not limited thereto.

[0034] A gate electrode **150** of the TFT**2** is arranged over the semiconductor active layer **130**. A material of the gate electrode **150** is selected according to various criteria, such as adherence to an adjacent layer, smoothness of a layer to be deposited, ease of processing, etc. The gate electrode **150** may include MoW, Al/Cu, or the like, but is not limited thereto.

[0035] The gate electrode **150** is insulated from the semiconductor active layer **130** by a gate insulator **140** arranged therebetween. An interlayer **160** acting as an insulator may be formed on the gate electrode **150** and the gate insulator **140**. The interlayer **160** may be a single layer and/or a plurality of layers. A source electrode **170***a* and a drain electrode **170***b* of the TFT**2** are arranged on the interlayer **160**. The source electrode **170***a* and the drain electrode **170***b* may be formed of a metal, such as MoW or the like, and may be subsequently thermally treated, e.g., heat treated, such that the source electrode **170***a* and the drain electrode **170***b* form a smooth ohmic contact with the semiconductor active layer **130**.

[0036] A protecting layer **180** is formed on the source and drain electrodes **170***a* and **170***b*. The protecting layer **180** may operate as a passivation layer and/or a planarization

layer for protection and/or planarization. A first electrode layer **190** is arranged on the protecting layer, and is electrically connected, e.g., coupled, with the source electrode **170***a* and the drain electrode **170***b* through a via hole **181** that is formed in the protecting layer **180**. For example, in a rear emission type display, the first electrode layer **190** may be made of a transparent material, such as indium-tin-oxide (ITO) or the like. Alternatively, in a front emission type display, the first electrode layer **190** may be made of a reflecting material such as Al/Ca, or a transparent material such as ITO or the like. Although in the embodiment discussed above and shown in FIGS. **2**A, **2**B, **2**C, and **2**D, the first electrode **190** is an anode electrode, it is understood that the first electrode **190** may be as a cathode electrode in other embodiments of the invention.

[**0037**] The protecting layer **180** may have various structures. For example, the protecting layer **180** may be made of an inorganic material or an organic material. In addition, the protecting layer **180** may be a single layer or a double layer. When the protecting layer **180** is a double layer, a lower layer may include SiNx and an upper layer may include an organic material, such as benzocyclobutene (BCB), acryl, or the like.

[**0038**] A pixel defining layer **191** is arranged on the protecting layer **180**; however, the pixel defining layer **191** is not arranged at a pixel opening **194** corresponding to the first electrode layer **190** to define a pixel. An organic electroluminescent emission unit **192** including an emission layer is arranged on the first electrode **190**.

[**0039**] The organic electroluminescent emission unit **192** may include a low molecular weight organic layer or a polymer organic layer. For example, the low molecular weight organic layer may be a hole injection layer (HIL), a hole transport layer (HTL), an organic emission layer (EML), an electron transport layer (ETL), an electron injection layer (EIL), a combination of these, or the like can be used. The organic layer may be made of copper phthalocyanine (CuPc), N,N'-Di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), tris-8-hydroxyquinoline aluminum (Alq3), or the like. The low molecular weight organic layer may be formed by a vacuum deposition process.

[**0040**] When the organic electroluminescent emission unit **192** includes a polymer organic layer, the polymer organic layer may include a HTL and an EML. The HTL may be made of PEDOT, and the EML may be made of Poly-Phenylenevinylenes (PPVs), polyfluorenes, or the like. The polymer organic layer may be formed by a screen printing process, an inkjet printing process, or the like.

[**0041**] A second electrode layer **210** operating as a cathode electrode may be arranged on the upper surface of the organic electroluminescent unit **192**. However, the location of the second electrode layer **210** is not limited thereto. The second electrode layer **210** may be made of Al/Ca, ITO, Mg—Ag, or the like, according to the emission type of the electroluminescent display device. However, because the second electrode layer **210** may include a plurality of layers, the second electrode layer **210** may also include an alkali layer made of LiF or the like, or an alkali earth metal fluoride layer.

[**0042**] FIG. **2**D is a sectional view taken along line II-II shown in FIG. **2**A. Referring to FIG. **2**D, a width w**2** of the encapsulant **310** of the organic electroluminescnece display device is greater than a width of the encapsulant **30** of the conventional electroluminescent display device shown in FIG. **1**B.

[**0043**] FIGS. **3**A, **3**B, **3**C, and **3**D are sectional views showing a method of manufacturing the organic electroluminescent display device illustrated in FIG. **2**A. Referring to FIG. **3**A, at least one display region **200** is arranged on an upper surface of a mother substrate **100'**.

[**0044**] Referring to FIG. **3**B, an absorbing layer **410** and an encapsulant **310'** are arranged on a sealing mother substrate **400'**. The encapsulant **310'** that is formed on the sealing mother substrate **400'** covers at least a portion of a scribing region.

[**0045**] Referring to FIG. **3**C, after forming the encapsulant **310'**, the encapsulant **310'** is hardened by a hardening process, such as UV radiation, thermal radiation, or the like, thus forming a hardened encapsulant **310"**.

[**0046**] Referring to FIG. **3**D, the resulting structure is scribed, e.g., cut, along the scribing region. Therefore, the mother substrate **110'** and sealing mother substrate **400'** are divided into organic electroluminescent display devices, each including a substrate **110** and a sealing substrate **400**.

[**0047**] According to another embodiment of the invention, a recess may be formed at an edge region of a substrate and/or a sealing substrate where an encapsulant is to be disposed. The recess simplifies the manufacturing process.

[**0048**] FIG. **4**A is a sectional view showing methods of manufacturing organic electroluminescent display devices having edges regions with recesses where encapsulants are to be formed.

[**0049**] Referring to FIG. **4**A, a mother substrate **110'** faces a sealing mother substrate **400'**. The mother substrate **110'** and the sealing mother substrate **400'** are sealed by an encapsulant **300'** that is not yet hardened. A display region **200** is then formed on a surface of the mother substrate **100'**, and an absorbing layer **410** is then formed on a surface of the sealing mother substrate **400'**.

[**0050**] A portion of the surface of the sealing substrate **400'** where the encapsulant **300'** is to be formed includes a recess **420**. The recess **420** prevents the encapsulant **300'** that is not yet hardened from flowing or releasing into an adjacent display region **200**. The recess **420** directs stress applied to the sealing mother substrate **400'** during a scribing process toward the recess **420**. Therefore, the risk of damaging the mother sealing substrate **400'** is reduced, e.g., cracking is reduced.

[**0051**] The recess **420** of the sealing mother substrate **400'** may have a substantially rectangular shape, as shown in FIG. **4**A; however, the recess is not limited to such shape. Manufacturing the recess **420** is easier when a side surface of the recess **420** is substantially perpendicular to a surface of the mother sealing substrate **400'** that is to be divided by scribing. However, it is understood that the recess **420** may have various shapes. For example, the width of the recess **420** may widen near the upper surface of the mother sealing substrate **400'** so that stress applied to the recess **420** is more focused at scribing region.

[**0052**] In addition, a recess may be formed at an edge of an individual display device that is manufactured by scribing

of a substrate. For example, referring to FIG. **4**B, a mother substrate recess **110***a*' is formed at a portion of a mother substrate **110**' corresponding to the recess **420** formed in the sealing mother substrate **400**'.

[**0053**] In addition, the recess may be formed continuous or discontinuous along an edge where an encapsulant is formed. When the recess is continuously formed, excellent processing properties are obtained. Alternatively, when the recess is discontinuous formed, the risk of damaging the mother substrate and/or the sealing mother substrate is reduced because the weight, e.g., force, of the mother substrate and/or the sealing mother substrate is focused toward the recess.

[**0054**] Although several embodiments of the invention are described and shown above, such embodiments are not intended to limit the scope of the invention. For example, although AM-type organic electroluminescent display devices are shown in the embodiments, the invention can also be applied to inorganic electroluminescent display devices, PM type electroluminescent display devices, and the like.

[**0055**] According to the present invention, the following effects can be obtained.

[**0056**] Moisture and/or oxygen leakage in a sealed space of the display device may be reduced or prevented by disposing an encapsulant on at least a portion of an edge of a substrate such that a region where the encapsulant is disposed may be increased.

[**0057**] Cracks that may generate in a display region may be decreased or prevented by forming a recess on a substrate and/or a sealing substrate such that overflowing of the encapsulant into a display region when the encapsulant is formed may be prevented.

[**0058**] It will be apparent to those skilled in the art that various modifications and variation can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

1. An electroluminescent display device, comprising:

a substrate comprising a display region and a terminal unit;

a sealing substrate arranged above the substrate; and

the encapsulant arranged at edge regions of the substrate and the sealing substrate and sealed with the display region.

2. The electroluminescent display device of claim 1, wherein the edge regions where the encapsulant is arranged are positioned to face each other.

3. The electroluminescent display device of claim 1, wherein an edge region of the substrate and/or the sealing substrate on which the encapsulant is formed comprises a recess.

4. The electroluminescent display device of claim 3, wherein the recess is discontinuous along the edge region where the encapsulant is arranged.

5. The electroluminescent display device of claim 3, wherein the recess is continuous along the edge region where the encapsulant is arranged.

6. The electroluminescent display device of claim 3, wherein a side surface of the recess is substantially perpendicular to the surface of the substrate and/or the sealing substrate.

7. The electroluminescent display device of claim 3, wherein the recess widens toward the surface of the substrate and/or the sealing substrate.

8. A method of manufacturing an electroluminescent display device, comprising:

forming a display region on a mother substrate;

forming an encapsulant on a portion of a scribed region on a sealing mother substrate;

hardening the encapsulant;

sealing the mother substrate with the sealing mother substrate; and

cutting the mother substrate and the sealing mother substrate along the scribing region.

9. The method of claim 8, further comprising:

forming a recess in a portion of the scribing region of the mother substrate before forming the display region.

10. The method of claim 9, wherein the recess is continuous along a region where the encapsulant is formed on the mother substrate.

11. The method of claim 9, wherein the recess is discontinuous along a region where the encapsulant is formed on the mother substrate.

12. The method of claim 9, wherein a side surface of the recess is substantially perpendicular to a surface of the mother substrate and/or the mother sealing substrate.

13. The method of claim 9, wherein the recess widens toward a surface of the mother substrate.

14. The method of claim 8, further comprising:

forming a recess at a portion of the scribing region of the sealing mother substrate before forming the encapsulant.

15. The method of claim 14, wherein the recess is continuous along a region where the encapsulant is formed on the sealing mother substrate.

16. The method of claim 14, wherein the recess is discontinuous along a region where the encapsulant is formed on the sealing mother substrate.

17. The method of claim 14, wherein a side surface of the recess is substantially perpendicular to a surface of the mother substrate and/or the mother sealing substrate.

18. The method of claim 14, wherein the recess widens toward the surface of the sealing mother substrate.

* * * * *

专利名称(译)	电致发光显示装置及其制造方法		
公开(公告)号	US20070205719A1	公开(公告)日	2007-09-06
申请号	US11/283762	申请日	2005-11-22
申请(专利权)人(译)	三星SDI CO.，LTD.		
当前申请(专利权)人(译)	三星移动显示器有限公司.		
[标]发明人	KIM JONG JIN		
发明人	KIM, JONG-JIN		
IPC分类号	H05B33/04		
CPC分类号	H01L51/5237 H01L2251/566 H01L51/56 H01L27/3244 H01L51/524 H01L51/5246		
优先权	1020040097510 2004-11-25 KR		
外部链接	Espacenet USPTO		

摘要(译)

提供了一种电致发光显示装置及其制造方法。该电致发光显示装置包括具有显示区域和终端单元的基板;密封基板，设置在基板上方;和密封剂，设置在基板边缘的至少一部分上，以至少密封显示区域。