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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0104814 A1****Choi et al.**(43) **Pub. Date: May 19, 2005**(54) **ACTIVE MATRIX TYPE ORGANIC ELECTROLUMINESCENT DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME**(30) **Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.⁷** **G09G 3/30**(52) **U.S. Cl.** **345/76**(76) **Inventors:** **Beom-Rak Choi**, Seoul (KR);
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WOODBURY, NY 11797 (US)(57) **ABSTRACT**

Disclosed are an active matrix type organic electroluminescent display device and a manufacturing method thereof. At least two capacitors having different functions from each other are disposed in a vertically stacked structure within a unit pixel region. When a compensation circuit needing two or more capacitors having different functions from each other per pixel is applied, the two or more capacitors are vertically stacked, thereby preventing the aperture ratio from being lowered due to the increase in the number of capacitors within the pixel.

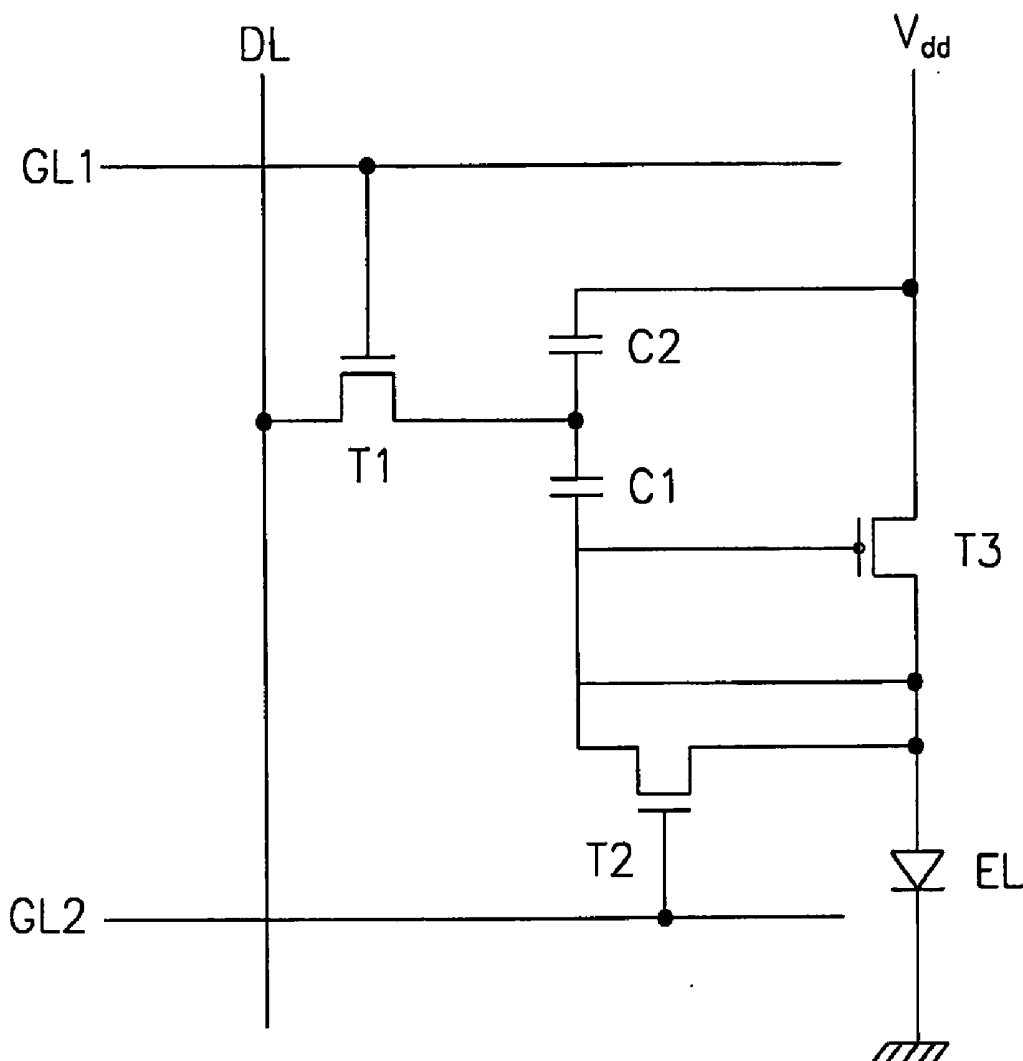
(21) **Appl. No.:** **10/505,644**(22) **PCT Filed:** **Dec. 10, 2002**(86) **PCT No.:** **PCT/KR02/02323**

FIG. 1
(PRIOR ART)

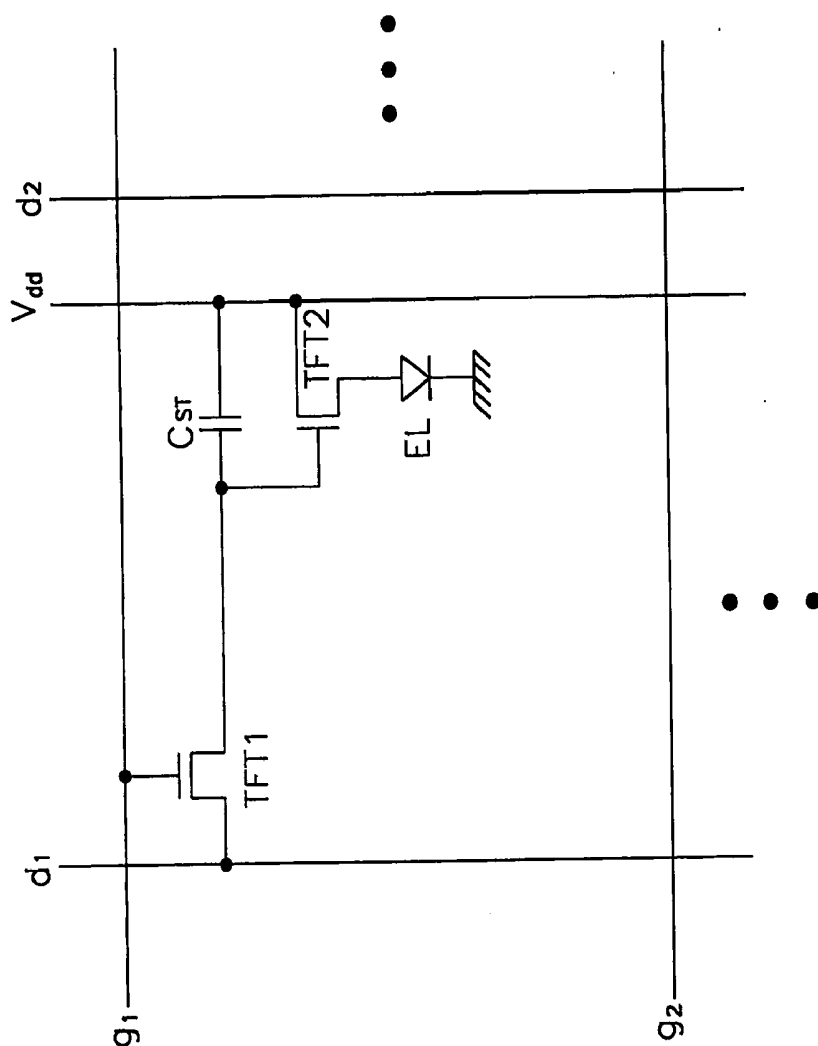


FIG. 2

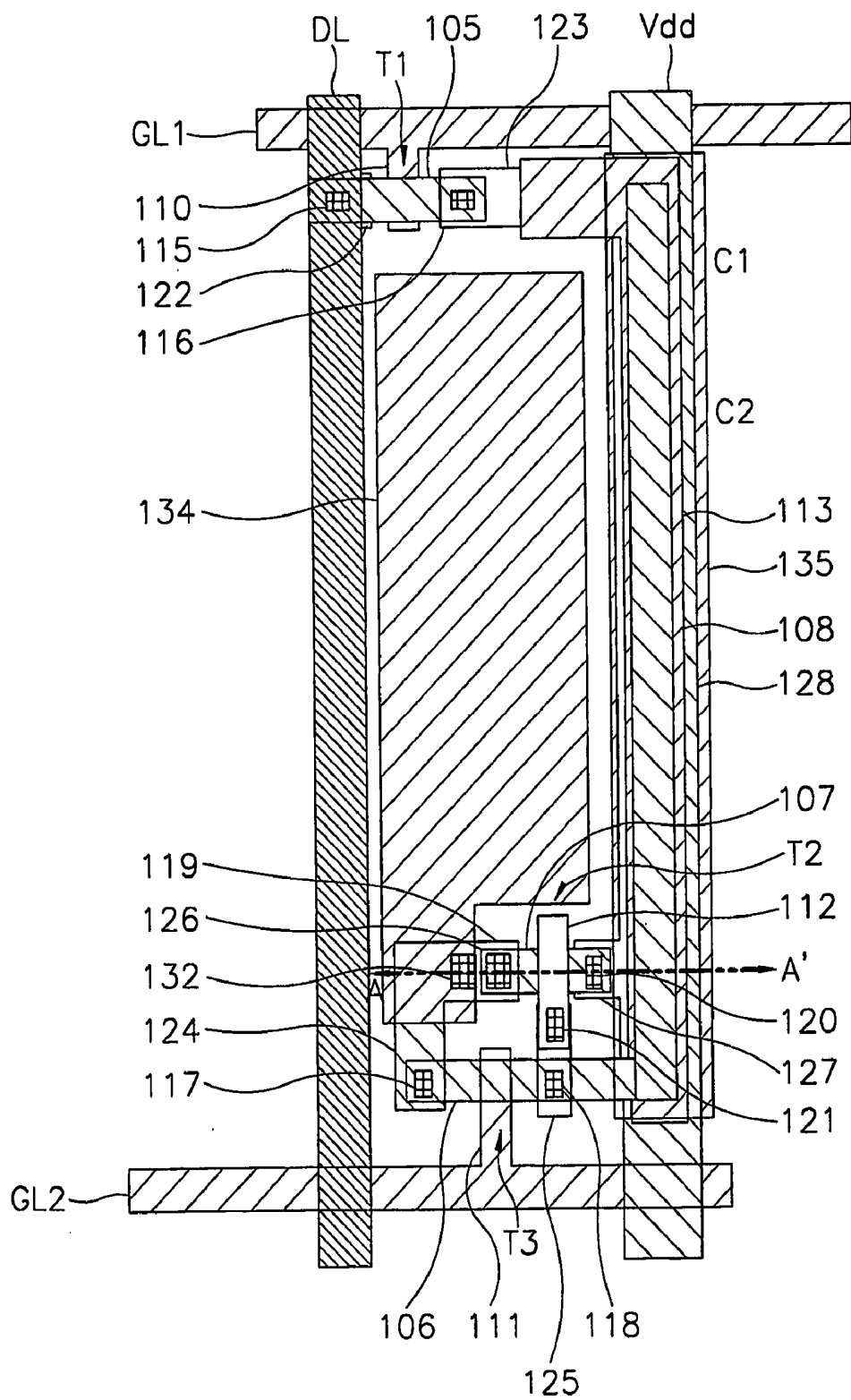


FIG. 3

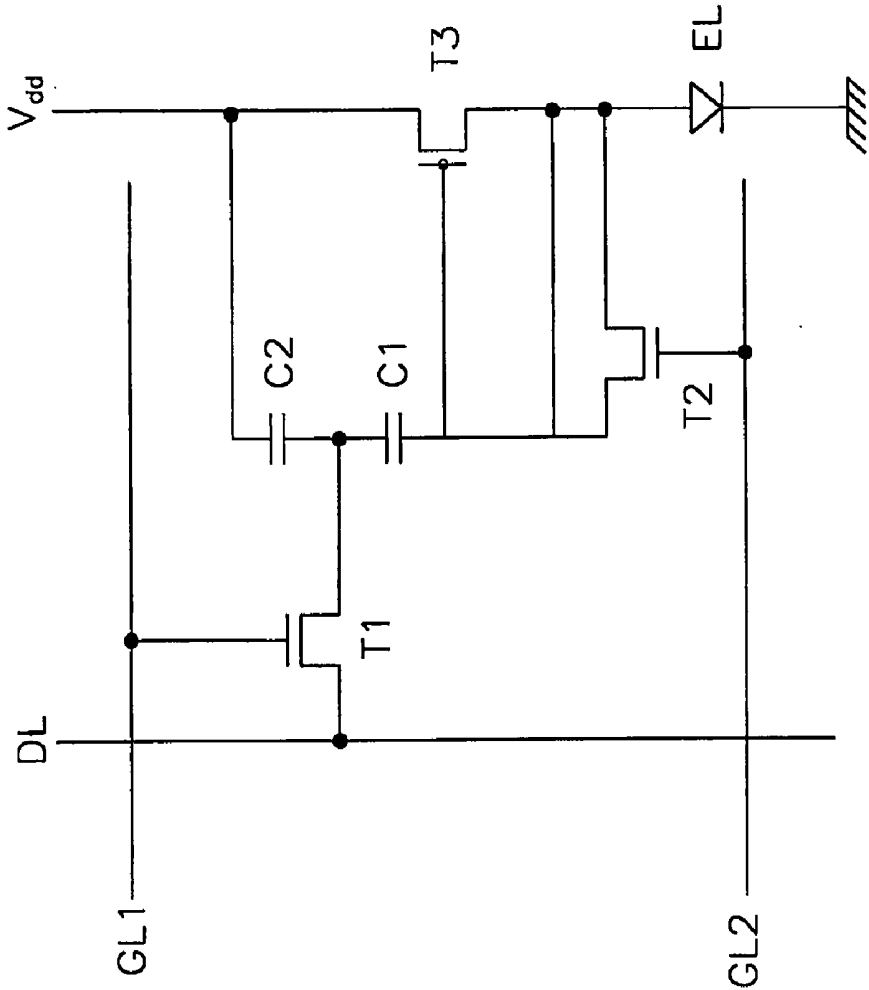


FIG. 4

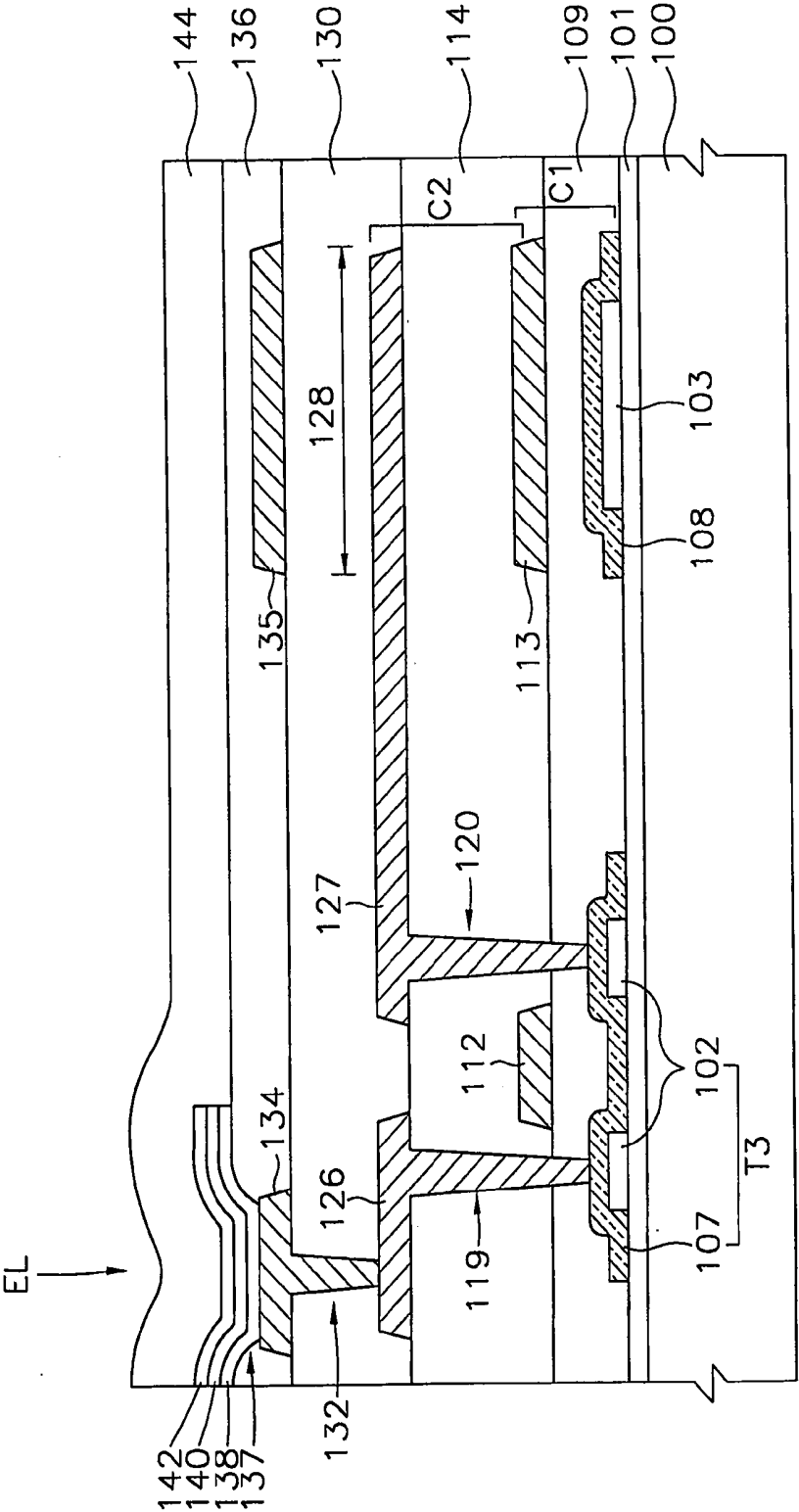


FIG. 5A

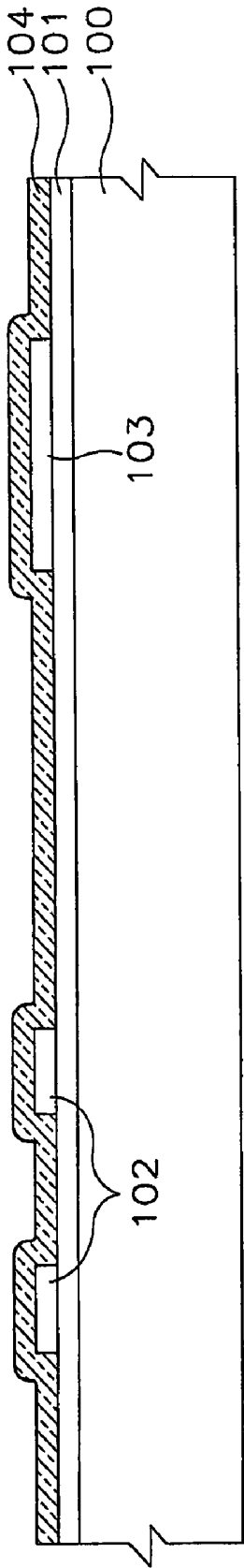


FIG. 5B

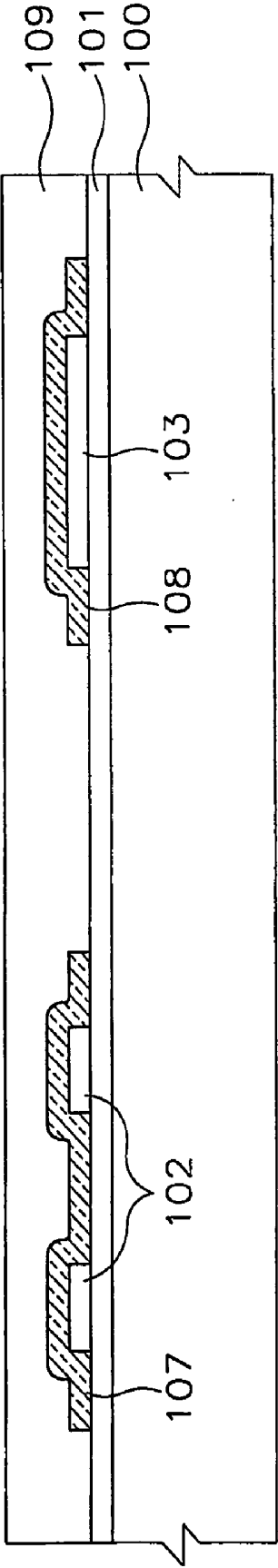


FIG. 5C

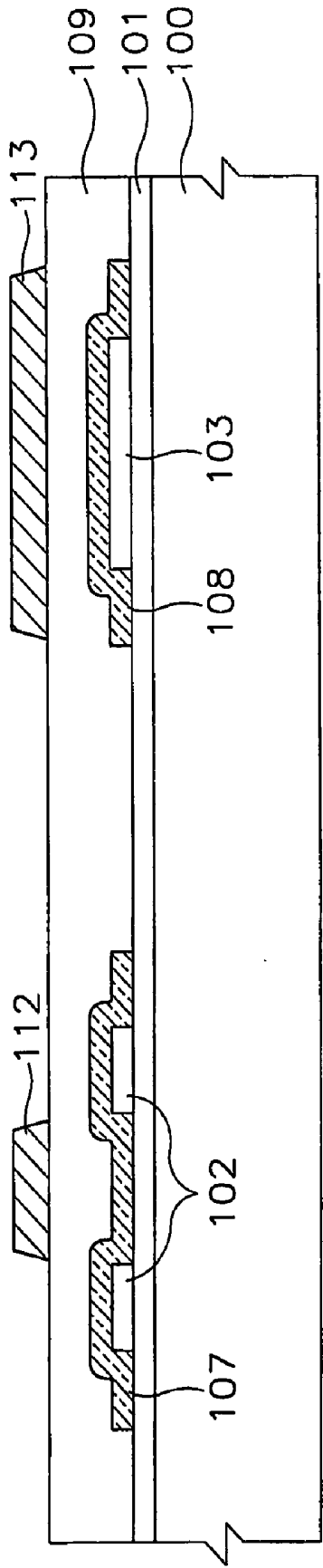
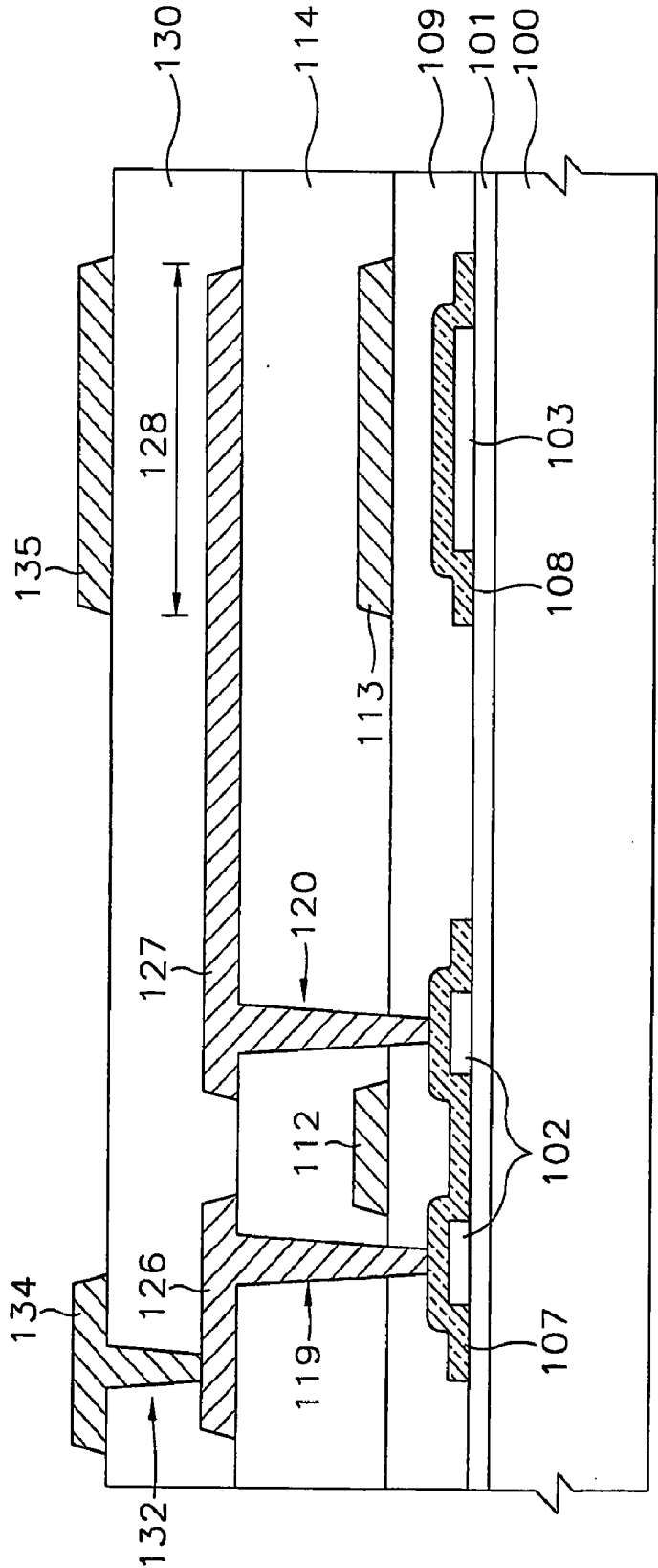


FIG. 5E



ACTIVE MATRIX TYPE ORGANIC ELECTROLUMINESCENT DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to an active matrix type organic electroluminescent display (AMOLED) device and method of manufacturing the same, and more particularly, to an AMOLED device and a method of manufacturing the same capable of preventing the aperture ratio from being lowered when compensation circuits needing two or more capacitors per pixel are applied.

BACKGROUND ART

[0002] In the information society of these days, electronic display devices are more important as information transmission media and various electronic display devices are widely applied for industrial apparatus or home appliances. Such electronic display devices are being continuously improved to have new appropriate functions for various demands of the information society.

[0003] In general, electronic display devices display and transmit various pieces of information to users who utilize such information. That is, the electronic display devices convert electric information signals outputted from electronic apparatus into light information signals recognized by users through their eyes.

[0004] In the electronic display devices dividing into an emissive display device and a non-emissive display device, the emissive display device displays light information signals through a light emission phenomena thereof and the non-emissive display device displays the light information signals through a reflection, a scattering or an interference thereof. The emissive display device includes a cathode ray tube (CRT), a plasma display panel (PDP), a light emitting diode (LED) and an electroluminescent display (ELD). The emissive display device is called as an active display device. Also, the non-emissive display device, called as a passive display device, includes a liquid crystal display (LCD), an electrochemical display (ECD) and an electrophoretic image display (EPID).

[0005] The CRT has been used for a television receiver or a monitor of a computer as the display device for a long time since it has a high quality and a low manufacturing cost. The CRT, however, has some disadvantages such as a heavy weight, a large volume and high power consumption.

[0006] Recently, the demand for a new electronic display device is greatly increased such as a flat panel display device having excellent characteristics, for example, thin thickness, light weight, low driving voltage and low power consumption. Such flat panel display devices can be manufactured according to the rapidly improved semiconductor technology.

[0007] An electroluminescent (EL) element is attracting attention of interested person as one of the flat panel displays. The EL element is generally divided into an inorganic EL element and an organic EL element depending on used materials.

[0008] The inorganic EL element is a device in which a high electric field is applied to a light emitting part and

electrons are accelerated in the applied high electric field to collide with a light emitting center, so that the light emitting center may be excited to emit a light beam.

[0009] The organic EL element is a device in which electrons and holes are injected into a light emitting part from cathode and anode, respectively, and the injected electrons and holes are combined with each other to generate excitons, thereby emitting light when these excitons are transited from an excited state to a base state.

[0010] Owing to the above operation mechanism, the inorganic EL element needs a high driving voltage of 100-200 V, whereas the organic EL element operates at a low voltage of 5-20 V. The above advantage of the organic EL element is activating researches on the organic EL. Also, the organic EL element has superior properties such as wide viewing angle, high response speed, high contrast and the like.

[0011] The organic EL elements can be applied to both of the active matrix type display device and the passive matrix type display device. The active matrix organic EL display device is a display device that independently drives EL elements corresponding to a plurality of pixels using switching elements such as a thin film transistor. The organic EL display device is also referred to as an organic electroluminescent display (OELD) device or an organic light emitting device (OLED). Hereinafter, the active matrix organic EL display device is referred to as AMOLED device.

[0012] FIG. 1 is an equivalent circuit diagram of a conventional AMOLED device.

[0013] Referring to FIG. 1, a unit pixel circuit of a conventional AMOLED device includes two thin film transistors TFT1 and TFT2, and one capacitor Cst.

[0014] Specifically, a plurality of gate lines g1 and g2 and a plurality of data lines d1 and d2 are arranged to cross each other, thereby defining a unit pixel region. Between the adjacent data lines d1 and d2, there is arranged a direct current signal line Vdd to be parallel to the data lines d1 and d2. A maximum value of a display signal is applied to the Vdd line in the form of direct current.

[0015] A first thin film transistor TFT1 as a switching element is connected at a cross point of the gate line g1 and the data line d1. A gate electrode of the TFT1 is connected to the gate line g1 and a source electrode of the TFT1 is connected to the data line d1.

[0016] Between a drain electrode of the TFT1 and the Vdd line, there is connected a storage capacitor Cst. Also, between the drain electrode of the TFT1 and the Vdd line, there is connected a second thin film transistor TFT2 as a driving element which is in parallel with the storage capacitor Cst. A gate electrode of the TFT2 is connected to the drain electrode of the TFT1, a source electrode thereof is connected to the Vdd line and a drain electrode thereof is connected to an organic EL element.

[0017] If the TFT1 is turned on, the TFT2 is turned on depending on a display signal value of the data line d1, so that a direct current signal value of the Vdd line is applied to the organic EL element, thereby driving the organic EL element.

[0018] However, in the above AMOLED device to which the circuit using the two TFTs is applied, there occurs a

problem in that brightness of the panel becomes non-uniform due to a deflection in the characteristics of the driving TFT, for example, variation in the threshold voltage.

[0019] In order to compensate for the deflection in the characteristics of the driving TFT, there were proposed compensation circuits to which a separate thin film transistor is added. However, in case that these compensation circuits are applied, the number of the thin film transistors increases and thus, an area occupied by the thin film transistors in a unit pixel region increases to thereby decrease the aperture ratio. Further, since a part of the compensation circuits needs two capacitors having different functions from each other, the number of the thin film transistors and the capacitors arranged in a unit pixel increases to cause the reduction of the aperture ratio. The reduction in the aperture ratio lowers the brightness, and requires a high current driving so that the life of the circuit is shortened.

DISCLOSURE OF THE INVENTION

[0020] Accordingly, it is an object of the present invention to provide an active matrix type organic electroluminescent display (AMOLED) device capable of preventing the aperture ratio from being lowered when compensation circuits needing two or more capacitors per pixel are applied.

[0021] It is another object of the invention to provide a method for manufacturing an AMOLED device capable of preventing the aperture ratio from being lowered when compensation circuits needing two or more capacitors per pixel are applied.

[0022] In one aspect, there is provided an AMOLED in which at least two capacitors having different functions from each other are disposed in a vertically stacked structure within a unit pixel region.

[0023] According to another aspect of the invention, there is provided an AMOLED in which a unit pixel is defined by first and second gate lines extending in a first direction, and a data line and a direct current signal line extending in a second direction perpendicular to the first direction. A first thin film transistor has a first gate electrode connected to the first gate line and a first source electrode connected to the data line. A second thin film transistor has a second gate electrode connected to the second gate line. A third thin film transistor has a third source electrode connected to the direct current signal line. An organic EL element is connected between a third drain electrode of the third thin film transistor and a ground terminal. A first capacitor includes a first electrode and a second electrode, the first electrode being connected to a third gate electrode of the third thin film transistor and a second source electrode of the second thin film transistor, and the second electrode being connected to a drain electrode of the first thin film transistor. A second capacitor includes a third electrode connected to the second electrode and the direct current signal line. The first and second capacitors are formed in a vertically stacked structure, and have different functions from each other.

[0024] In a further another aspect of an AMOLED according to the present invention, a unit pixel is defined by first and second gate lines extending in a first direction, and a data line and a direct current signal line extending in a second direction perpendicular to the first direction. A first thin film transistor includes a first active pattern disposed

adjacent to a cross point of the first gate line and the data line, a first gate electrode prolonged from the first gate line and crossing over the first active pattern, a first source electrode prolonged from the data line and connected to the first active pattern at one side of the first gate electrode, and a first drain electrode connected to the first active pattern at the other side of the first gate electrode. A second thin film transistor includes a second active pattern disposed adjacent to a cross point of the second gate line and the data line, a second gate electrode prolonged from the second gate line and crossing over the second active pattern, a second source electrode connected to the second active pattern at one side of the second gate electrode, and a second drain electrode connected to the second active pattern at the other side of the second gate electrode. A third thin film transistor includes a third active pattern disposed within the unit pixel, a third gate electrode passing over the third active pattern, a third source electrode prolonged from the direct current signal line and connected to the third active pattern at one side of the third gate electrode, and a third drain electrode prolonged from the second drain electrode and connected to the third active pattern at the other side of the third gate electrode. A first capacitor includes a first electrode and a second electrode. The first electrode is prolonged from the second active pattern and disposed parallel to the direct current signal line below the direct current signal line. The second electrode is formed on the first electrode and connected to the first drain electrode. A second capacitor includes the second electrode and a third electrode formed on the second electrode. The third electrode is connected to the direct current signal line. The second capacitor has a different function from that of first capacitor. A pixel electrode connected to the third drain electrode is disposed within the unit pixel.

[0025] In a method of manufacturing an AMOLED according to the present invention, a first electrode and active patterns are formed on each of pixel regions on a substrate. A gate insulating layer is formed on the active patterns, the first electrode and the substrate. First, second and third gate electrodes are formed on a gate insulating layer above the active pattern and a second electrode is formed on the gate insulating layer above the first electrode to form a first capacitor including the first electrode, the gate insulating layer and the second electrode. An insulating interlayer is formed on the first, second and third gate electrodes, the second electrode and the gate insulating layer. First, second and third source electrodes, and first, second and third drain electrodes are formed on the insulating interlayer above the active pattern to form a first thin film transistor including the first gate electrode, the first source electrode and the first drain electrode, a second thin film transistor including the second gate electrode, the second source electrode and the second drain electrode, and a third thin film transistor including the third gate electrode, the third source electrode and the third drain electrode. At the same time, a third electrode is formed on the insulating interlayer above the first electrode to form a second capacitor vertically stacked on the first capacitor and including the second electrode, the insulating interlayer and the third electrode. A passivation layer is formed on the first, second and third thin film transistors, the first and second capacitors and the insulating interlayer. A pixel electrode is formed on the passivation layer. An organic EL element is formed on the pixel electrode.

[0026] According to the present invention, when compensation circuits needing two or more capacitors having different functions from each other per pixel are applied, the capacitors are stacked in a vertical direction to thereby prevent the aperture ratio from being lowered due to the increase in the number of the capacitors in the pixel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The above objects and other advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

[0028] **FIG. 1** is a circuit diagram of a conventional AMOLED device;

[0029] **FIG. 2** is a plan view of an AMOLED device in accordance with one embodiment of the present invention;

[0030] **FIG. 3** is an equivalent circuit diagram of **FIG. 2**;

[0031] **FIG. 4** is a cross-sectional view taken along the line A-A' of **FIG. 2**; and

[0032] **FIGS. 5A to 5E** are cross-sectional views for illustrating a method of manufacturing the AMOLED device shown in **FIG. 4**.

BEST MODE FOR CARRYING OUT THE INVENTION

[0033] Now, exemplary embodiments of the present invention will be described in detail with reference to the annexed drawings.

[0034] **FIG. 2** is a plan view of an AMOLED device in accordance with one embodiment of the present invention, **FIG. 3** is an equivalent circuit diagram of **FIG. 2**, and **FIG. 4** is a cross-sectional view taken along the line A-A' of **FIG. 2**.

[0035] Referring to **FIGS. 2 to 4**, a unit pixel circuit of an AMOLED in accordance with the present invention includes three thin film transistors T1, T2 and T3, two capacitors C1 and C2, and four interconnection lines GL1, GL2, D1 and Vdd.

[0036] Particularly, a unit pixel is defined by first and second gate lines GL1 and GL2 extending in a first direction and a data line DL and a direct current signal line Vdd extending in a second direction perpendicular to the first direction.

[0037] The first gate line GL1 plays a role of turning on/off the first thin film transistor T1 as a switching element to thereby apply an initial data voltage and a gray level voltage through the data line DL. The second gate line GL2 plays a role of turning on/off the second thin film transistor T2 to thereby compensate the characteristics of the third thin film transistor T3 as a driving element. A maximum value of the display signal is constantly applied to the direct current signal line Vdd in a direct current state.

[0038] The first thin film transistor T1 includes a first active pattern 105 disposed adjacent to a cross point of the first gate line GL1 and the data line DL, a first gate electrode 110 prolonged from the first gate line GL1 and crossing over the first active pattern 105, a first source electrode 122 prolonged from the data line DL and connected to the first

active pattern 105 at one side (a first side) of the first gate electrode 110, and a first drain electrode 123 connected to the first active pattern 105 at the other side (a second side that is opposite to the first side) of the first gate electrode 110. The first gate electrode 110 of the first thin film transistor T1 is connected to the first gate line GL1 and the first source electrode 122 thereof is connected to the data line DL.

[0039] The second thin film transistor T2 includes a second active pattern 106 disposed adjacent to a cross point of the second gate line GL2 and the data line DL, a second gate electrode 111 prolonged from the second gate line GL2 and crossing over the second active pattern 106, a second source electrode 125 connected to the second active pattern 106 at one side of the second gate electrode 111, and a second drain electrode 124 connected to the second active pattern 106 at the other side of the second gate electrode 111. The second gate electrode 111 of the second thin film transistor T2 is connected with the second gate line GL2.

[0040] The third thin film transistor T3 includes a third active pattern 107 disposed within the unit pixel, a third gate electrode 112 crossing over the third active pattern 107, a third source electrode 127 prolonged from the direct current signal line Vdd and connected to the third active pattern 107 at one side of the third gate electrode 112, and a third drain electrode 126 prolonged from the second drain electrode 124 and connected to the third active pattern 107 at the other side of the third gate electrode 112. The third gate electrode 112 of the third thin film transistor T3 is connected with the second source electrode 125 of the second thin film transistor T2, the third source electrode 127 thereof is connected with the direct current signal line Vdd, and the third drain electrode 126 thereof is connected with the second drain electrode 124 of the second thin film transistor T2 and an organic EL element.

[0041] Preferably, the third thin film transistor T3 is in a p-type, and the first and second thin film transistors T1 and T2 are in either n-type or p-type.

[0042] The first capacitor C1 includes a first electrode 108, a gate insulating layer 109 and a second electrode 113. The first electrode 108 is prolonged from the second active pattern 106 of the second thin film transistor T2 and disposed parallel to the direct current signal line Vdd below the direct current signal line Vdd. The second electrode 113 is overlapped with the first electrode 108. The first electrode 108 is formed from the same layer as in the active patterns 105, 106 and 107 of the first, second and third thin film transistors T1, T2 and T3. The second electrode 113 is formed from the same layer as in the gate line GL. The first electrode 108 of the first capacitor C1 is connected with the third gate electrode 112 of the third thin film transistor T3 and the second source electrode 125 of the second thin film transistor T3. The second electrode 113 of the first capacitor C1 is connected with the first drain electrode 123 of the first thin film transistor T1. The first capacitor C1 functions to store a voltage compensating for the characteristics of the third thin film transistor T3 and to transfer a data voltage to the third gate electrode 112 of the third thin film transistor T3.

[0043] The second capacitor C2 includes the second electrode 113, an insulating interlayer layer and a third electrode 128 overlapped with the second electrode 113. The third

electrode **128** of the second capacitor **C2** is connected to the direct current signal line **Vdd**.

[0044] The third electrode **128** is formed from the same layer as in the data line **DL**. The second capacitor **C2** is connected between the direct current signal line **Vdd** and the first drain electrode **123** of the first thin film transistor **T1**. The second capacitor **C2** functions to maintain the data voltage at a constant level during a frame time.

[0045] Accordingly, the first capacitor **C1** and the second capacitor **C2** have a different function from each other. While sharing a common electrode, i.e., the second electrode **113** connected to the first drain electrode **123** of the first thin film transistor **T1**, the first and second capacitors **C1** and **C2** are formed in a stacked structure in a vertical direction.

[0046] Within a unit pixel region of the present invention, there is formed a pixel electrode **134** connected to the third drain electrode **126** of the third thin film transistor **T3**. Also, a fourth electrode **135** formed from the same layer as in the pixel electrode **134** is formed to be overlapped with the third electrode **128** of the second capacitor **C2**. When it is requested that the second capacitor **C2** has a high capacitance, the insulating interlayer **114** and the passivation layer **130** disposed between the second electrode **113** and the fourth electrode **135** serve as a dielectric layer of the capacitor, thereby securing a necessary capacitance.

[0047] The pixel circuit of the present invention operates as follows.

[0048] If the first thin film transistor **T1** is turned on by the first gate line **GL1**, the third thin film transistor **T3** is turned on according to a display signal value of the data line **DL**, so that a direct current signal value of the direct current signal line **Vdd** is applied to the organic **EL** element to thereby drive the organic **EL** element. At this time, if a compensation voltage is applied to the second gate line **GL2** to turn on the second thin film transistor **T2**, the third gate electrode **112** and the third drain electrode **126** of the third thin film transistor **T3** are connected to each other, so that a difference in the characteristics of the third thin film transistor **T3** as a driving element is reduced.

[0049] Hereinafter, there is described a method of manufacturing the AMOLED having the aforementioned structure in accordance with the present invention.

[0050] FIGS. 5A to 5E are cross-sectional views for illustrating the AMOLED shown in FIG. 4.

[0051] Referring to FIG. 5A, on an insulating substrate **100** such as glass, quartz or sapphire, silicon oxide is deposited to a thickness of an approximately 2,000 Å by a plasma-enhanced chemical vapor deposition (PECVD), to form a blocking layer **101**. The blocking layer **101** is preferably used to prevent heat loss during a subsequent crystallization process of an amorphous silicon film.

[0052] An n-type doped amorphous silicon is deposited to a thickness of about 800 Å by the PECVD on the blocking layer **101**, and then, patterned using a photolithography process to form buffer layers **102** and **103** on a thin film transistor region and a capacitor region within the unit pixel.

[0053] Thereafter, on the buffer layers **102** and **103** and the blocking layer **101**, an amorphous silicon is deposited to a thickness of about 500 Å by a low pressure chemical vapor

deposition (LPCVD) or a PECVD method to thereby form an active layer **104**. Then, a laser annealing or a furnace annealing is carried out to crystallize the active layer **104** into a polycrystalline silicon layer.

[0054] Referring to FIG. 5B, through a photolithography process, the polycrystalline silicon active layer **104** is patterned to form a first active pattern (**105** in FIG. 2), a second active pattern (**106** in FIG. 2) and a third active pattern **107** on the thin film transistor region within the unit pixel. At the same time, a first electrode **108** made of the polycrystalline silicon active layer is formed on the capacitor region within the unit pixel.

[0055] Then, on the entire surface of the resultant structure on which the active patterns **105**, **106** and **107** and the first electrode **108** are formed, silicon oxide is deposited to a thickness of about 1000-2000 Å by the PECVD method, thereby forming a gate insulating layer **109**.

[0056] Referring to FIG. 5C, on the gate insulating layer **109**, a gate layer such as AlNd is deposited to a thickness of approximately 3000 Å by a sputtering method. Then, the gate layer is patterned via a photolithography process. As a consequence, there are formed first and second gate lines (**GL1** and **GL2** in FIG. 2) extending in a first direction, a first gate electrode (**110** in FIG. 2) of the first thin film transistor **T1** branched from the first gate line **GL1**, a second gate electrode (**111** in FIG. 2) of the second thin film transistor **T2** branched from the second gate line **GL2**, a third gate electrode **112** of the third thin film transistor **T3** arranged within the unit pixel. At the same time, the second electrode **113** made from the gate layer is formed to be overlapped with the first electrode **108**. The second electrode **113** is used as a common electrode of the stack type first and second capacitors **C1** and **C2**.

[0057] Then, by performing an impurity ion implantation using a photo mask used in the patterning process of the gate layer, source/drain regions (not shown) of the first, second and third thin film transistors **T1**, **T2** and **T3** are formed. Preferably, the third thin film transistor **T3** is in p-type, and the first and second thin film transistors **T1** and **T2** are in n-type or p-type.

[0058] Referring to FIG. 5D, in order to activate the doped ions in the source and drain regions and cure damages of the silicon layer, a laser annealing or a furnace annealing is performed. Then, silicon nitride is deposited on the entire surface of the resultant structure to a thickness of approximately 8,000 Å to thereby form an insulating interlayer **114**.

[0059] Thereafter, the insulating interlayer **114** is etched by a photolithography process to form contact holes **115**, **116**, **117**, **118**, **119** and **120** exposing the source/drain regions of the first, second and third thin film transistors **T1**, **T2** and **T3**. At this time, a contact hole **121** exposing a predetermined portion of the third gate electrode **112** of the third thin film transistor **T3** is also formed.

[0060] A data layer such as MoW or AlNd layer is deposited on the contact holes **115**, **116**, **117**, **118**, **119**, **120** and **121** and the insulating interlayer **114** to a thickness of about 3000-6000 Å, and then, patterned by a photolithography process. As a consequence, there are formed a data line **DL** and a direct current signal line **Vdd** which are extended in a second direction perpendicular to the first direction, first source/drain electrodes (**122** and **123** of FIG.

2) of the first thin film transistor T1, second source/drain electrodes (125 and 124 of FIG. 2) of the second thin film transistor T2, and third source/drain electrodes 127 and 126 of the third thin film transistor T3, which are connected to the source/drain regions through the contact holes. At the same time, the third electrode 128 made from the data layer is formed to be overlapped with the second electrode 113. The third electrode 128 is comprised of the direct current signal line Vdd, and connected to the third source electrode 127 of the third thin film transistor T3. Preferably, using a single electrode pattern, the second drain electrode 124 of the second thin film transistor T2 and the third drain electrode 126 of the third thin film transistor T3 are formed at the same time. Also, the second source electrode 125 of the second thin film transistor T2 is formed to make contact with the third gate electrode 112 of the third thin film transistor T3.

[0061] Referring to FIG. 5E, silicon nitride is deposited on the data line DL, the direct current signal line Vdd, the source/drain electrodes 122, 123, 124, 125, 126 and 127 and the insulating interlayer 130 to a thickness of approximately 2000-3000 Å to form a passivation layer 130. Thereafter, the passivation layer 130 is etched away using a photolithography process to form a via hole 132 exposing the third drain electrode 126 of the third thin film transistor T3.

[0062] A transparent conductive layer such as indium tin oxide (ITO) or indium zinc oxide (IZO) is deposited to a thickness of approximately 300-500 Å on the via hole 132 and the passivation layer 130, and then, patterned by a photolithography process. By doing so, a pixel electrode 134 is formed to be connected with the third drain electrode 126 of the third thin film transistor T3 through the via hole 132. At the same time, a fourth electrode 135 made of the transparent conductive layer is formed to be overlapped with the third electrode 128.

[0063] As shown in FIG. 4, after forming an organic insulating layer 136 on the pixel electrode 134, the fourth electrode 135 and the passivation layer 130, the organic insulating layer 136 is exposed and developed to thereby form an opening 137 having the same shape as the pixel electrode 134. Preferably, the opening 137 is formed to have a width smaller than that of the pixel electrode 134.

[0064] Then, a hole transfer layer (HTL) 138, a luminescent layer 140 and an electron transfer layer (ETL) 142 are sequentially formed on the opening 137 and the organic insulating layer 136. A cathode electrode 144 is formed thereon to thereby complete an organic EL element.

[0065] As described above, according to the present invention, when a compensation circuit needing two or more capacitors having different functions from each other per pixel is applied, the two or more capacitors are vertically stacked, thereby preventing the aperture ratio from being lowered due to the increase in the number of capacitors within the pixel.

[0066] Also, it is apparent that a stack type capacitor of the invention can be applied to any other pixel circuits using two or more capacitors having different functions from each other.

[0067] While the present invention has been described in detail, it should be understood that various changes, substi-

tutions and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

1. An active matrix type organic electroluminescent display device comprising at least two capacitors disposed in a vertically stacked structure within a unit pixel region, the at least two capacitors having different functions from each other.

2. The active matrix type organic electroluminescent display device as claimed in claim 1, wherein the two capacitors share a single electrode.

3. The active matrix type organic electroluminescent display device as claimed in claim 1, further comprising at least three thin film transistors and a single organic electroluminescent element which are formed within the unit pixel region.

4. An active matrix type organic electroluminescent display device in which a unit pixel is defined by first and second gate lines extending in a first direction, and a data line and a direct current signal line extending in a second direction perpendicular to the first direction, said active matrix type organic electroluminescent display device comprising:

a first thin film transistor having a first gate electrode connected to the first gate line and a first source electrode connected to the data line;

a second thin film transistor having a second gate electrode connected to the second gate line;

a third thin film transistor having a third source electrode connected to the direct current signal line;

an organic electroluminescent element connected between a third drain electrode of the third thin film transistor and a ground terminal;

a first capacitor including a first electrode and a second electrode, the first electrode being connected to a third gate electrode of the third thin film transistor and a second source electrode of the second thin film transistor, and the second electrode being connected to a first drain electrode of the first thin film transistor; and

a second capacitor including the second electrode and a third electrode connected to the direct current signal line,

wherein the first and second capacitors are formed in a vertically stacked structure and have different functions from each other.

5. An active matrix type organic electroluminescent display device in which a unit pixel is defined by first and second gate lines extending in a first direction, and a data line and a direct current signal line extending in a second direction perpendicular to the first direction, the active matrix type organic electroluminescent display device comprising:

a first thin film transistor including a first active pattern disposed adjacent to a cross point of the first gate line and the data line, a first gate electrode prolonged from the first gate line and crossing over the first active pattern, a first source electrode prolonged from the data line and connected to the first active pattern at a first

side of the first gate electrode, and a first drain electrode connected to the first active pattern at a second side of the first gate electrode;

a second thin film transistor including a second active pattern disposed adjacent to a cross point of the second gate line and the data line, a second gate electrode prolonged from the second gate line and crossing over the second active pattern, a second source electrode connected to the second active pattern at a first side of the second gate electrode, and a second drain electrode connected to the second active pattern at a second side of the second gate electrode;

a third thin film transistor including a third active pattern disposed within the unit pixel, a third gate electrode crossing over the third active pattern, a third source electrode prolonged from the direct current signal line and connected to the third active pattern at a first side of the third gate electrode, and a third drain electrode prolonged from the second drain electrode and connected to the third active pattern at a second side of the third gate electrode;

a first capacitor including a first electrode and a second electrode, the first electrode being prolonged from the second active pattern and disposed parallel to the direct current signal line below the direct current signal line, and the second electrode being formed on the first electrode and connected to the first drain electrode;

a second capacitor including the second electrode and a third electrode formed on the second electrode, the third electrode being connected to the direct current signal line, the second capacitor having a different function from that of the first capacitor; and

a pixel electrode disposed within the unit pixel so as to be connected to the third drain electrode.

6. The active matrix type organic electroluminescent display device as claimed in claim 5, wherein the first electrode, and the first, second and third active patterns are formed from a same layer.

7. The active matrix type organic electroluminescent display device as claimed in claim 5, wherein the second electrode and the gate line are formed from a same layer.

8. The active matrix type organic electroluminescent display device as claimed in claim 5, wherein the third electrode and the data line are formed from a same layer.

9. The active matrix type organic electroluminescent display device as claimed in claim 5, further comprising a fourth electrode formed from a same layer as in the pixel electrode on the direct current signal line.

10. The active matrix type organic electroluminescent display device as claimed in claim 5, wherein the second source electrode of the second thin film transistor is connected with the third gate electrode of the third thin film transistor.

11. A method of manufacturing an active matrix type organic electroluminescent display device, the method comprising the steps of:

forming an active pattern and a first electrode in a pixel region of a substrate;

forming a gate insulating layer on the active pattern, the first electrode and the substrate;

forming first, second and third gate electrodes on the gate insulating layer above the active pattern and simultaneously, forming a second electrode on the gate insulating layer above the first electrode to form a first capacitor including the first electrode, the gate insulating layer and the second electrode;

forming an insulating interlayer on the first, second and third gate electrodes, the second electrode and the gate insulating layer;

forming first, second and third source electrodes, and first, second and third drain electrodes on the insulating interlayer above the active patterns to form a first thin film transistor including the first gate electrode, the first source electrode and the first drain electrode, a second thin film transistor including the second gate electrode, the second source electrode and the second drain electrode, and a third thin film transistor including the third gate electrode, the third source electrode and the third drain electrode, and simultaneously, to form a third electrode on the insulating interlayer above the first electrode to form a second capacitor vertically stacked on the first capacitor and including the second electrode, the insulating interlayer and the third electrode;

forming a passivation layer on the first, second and third thin film transistors, the first and second capacitors and the insulating interlayer;

forming a pixel electrode on the passivation layer; and

forming an organic electroluminescent element on the pixel electrode.

12. The method as claimed in claim 11, wherein the second drain electrode of the second thin film transistor and the third drain electrode of the third thin film transistor are formed from a single electrode pattern.

13. The method as claimed in claim 11, wherein the second source electrode of the second thin film transistor is formed to make contact with the third gate electrode of the third thin film transistor.

14. The method as claimed in claim 11, wherein a fourth electrode is formed to be overlapped with the third electrode in the step of forming the pixel electrode.

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摘要(译)

公开了一种有源矩阵型有机电致发光显示装置及其制造方法。具有彼此不同功能的至少两个电容器以单位像素区域内的垂直堆叠结构设置。当应用每个像素需要彼此具有不同功能的两个或更多个电容器的补偿电路时，两个或更多个电容器垂直堆叠，从而防止由于像素内的电容器数量的增加而降低孔径比。

