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(54) **ELECTROLUMINESCENCE DISPLAY DEVICE**

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(51) **Int. Cl.**^{7} **H01J 5/48**; H01J 5/50; H01J 1/62

(52) **U.S. Cl.** **313/51**; 313/505

(58) **Field of Search** 349/139, 149, 349/151–152, 69–70; 313/51, 505–506

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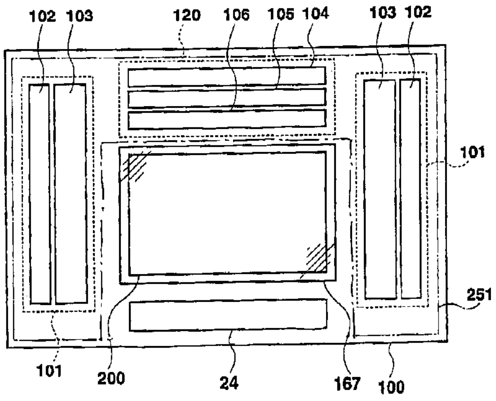
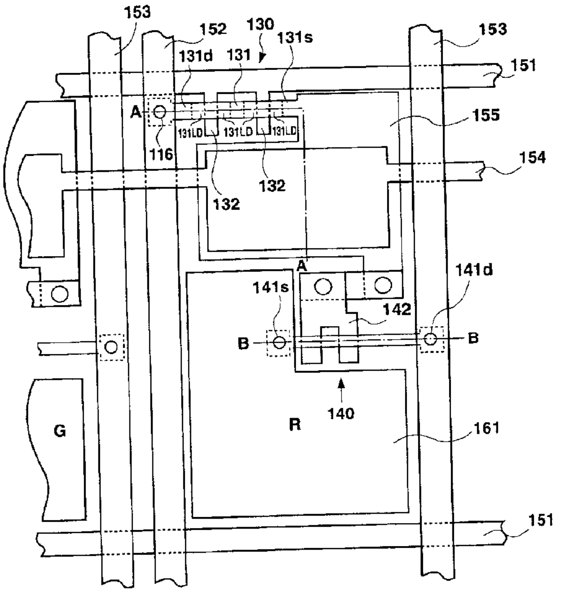
(74) *Attorney, Agent, or Firm*—Cantor Colburn LLP

(57) **ABSTRACT**

An insulator substrate (**110**) is provided with a display pixel region (**200**) comprising an electroluminescence element (**160**) having a cathode (**167**), emissive layer (**166**), and anode (**161**), and with first and second TFTs for driving the element. Surrounding the display pixel region (**200**), a peripheral drive circuit region (**251**) having a third TFT for driving each pixel is further provided on the insulator substrate (**110**). The cathode (**167**) is disposed in a region other than the peripheral drive circuit region (**251**). With this arrangement, generation of a back channel by applying the EL element potential to the cathode is prevented in a complementary TFT employed in the peripheral drive circuit region for controlling the display region, thereby suppressing changes in threshold values due to such back channel generation. As a result, an EL display device with reduced generation of penetration current and minimized increased current consumption is achieved.

23 Claims, 9 Drawing Sheets





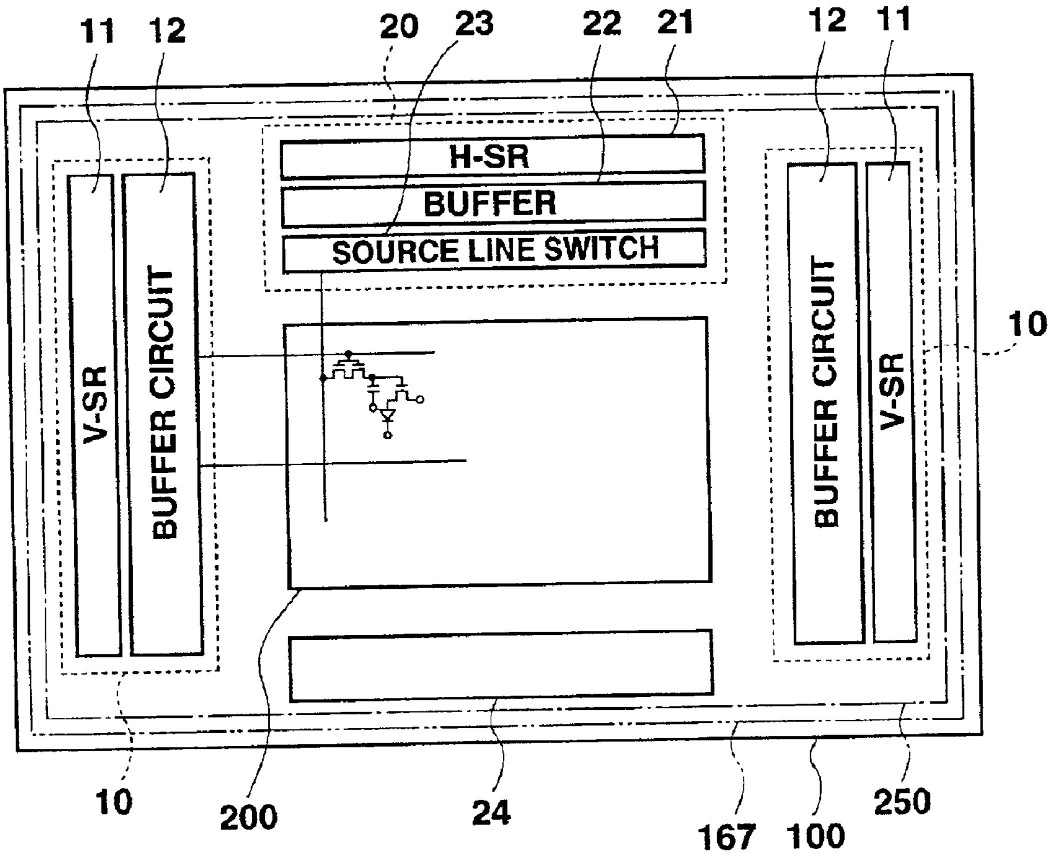


Fig. 1 RELATED ART

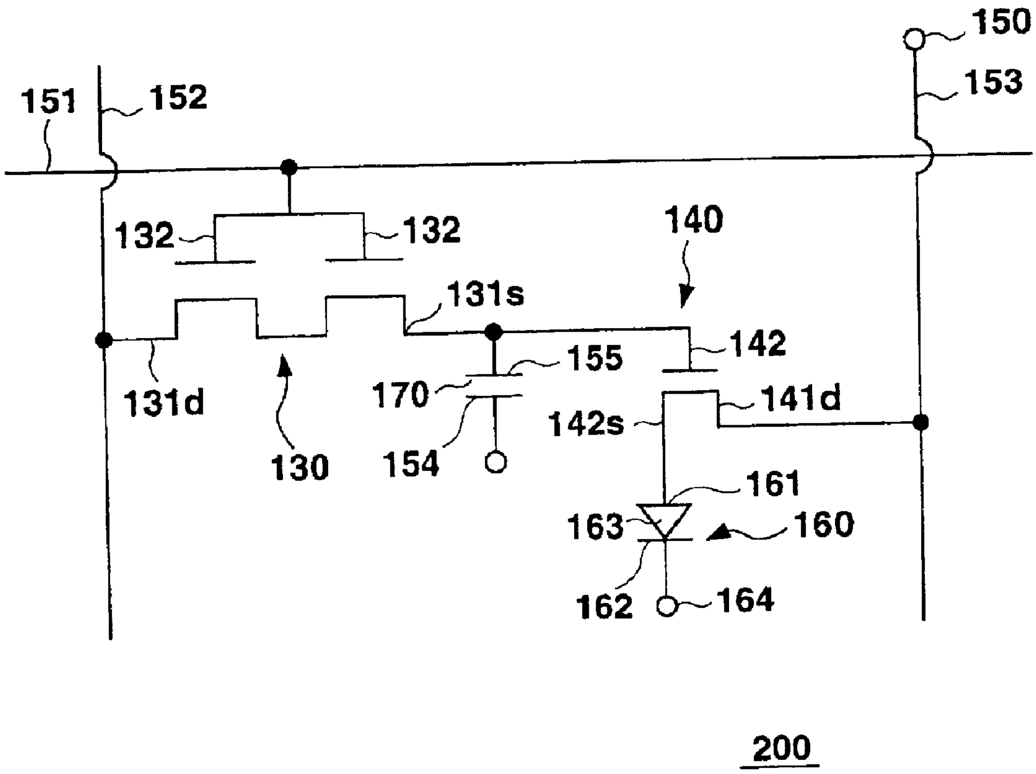


Fig. 2 RELATED ART

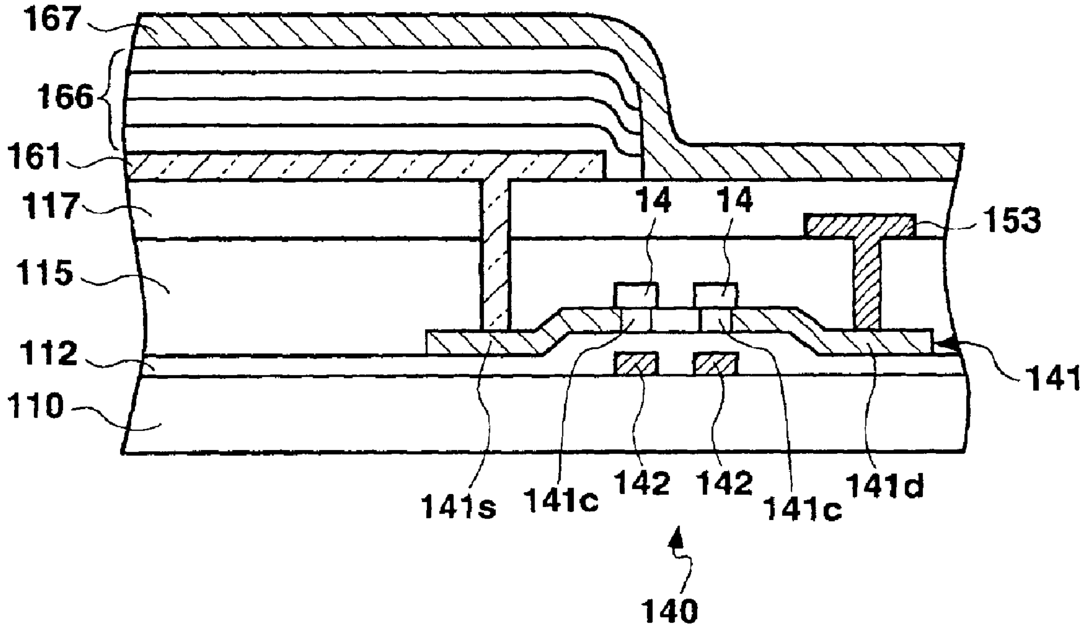


Fig. 3 RELATED ART

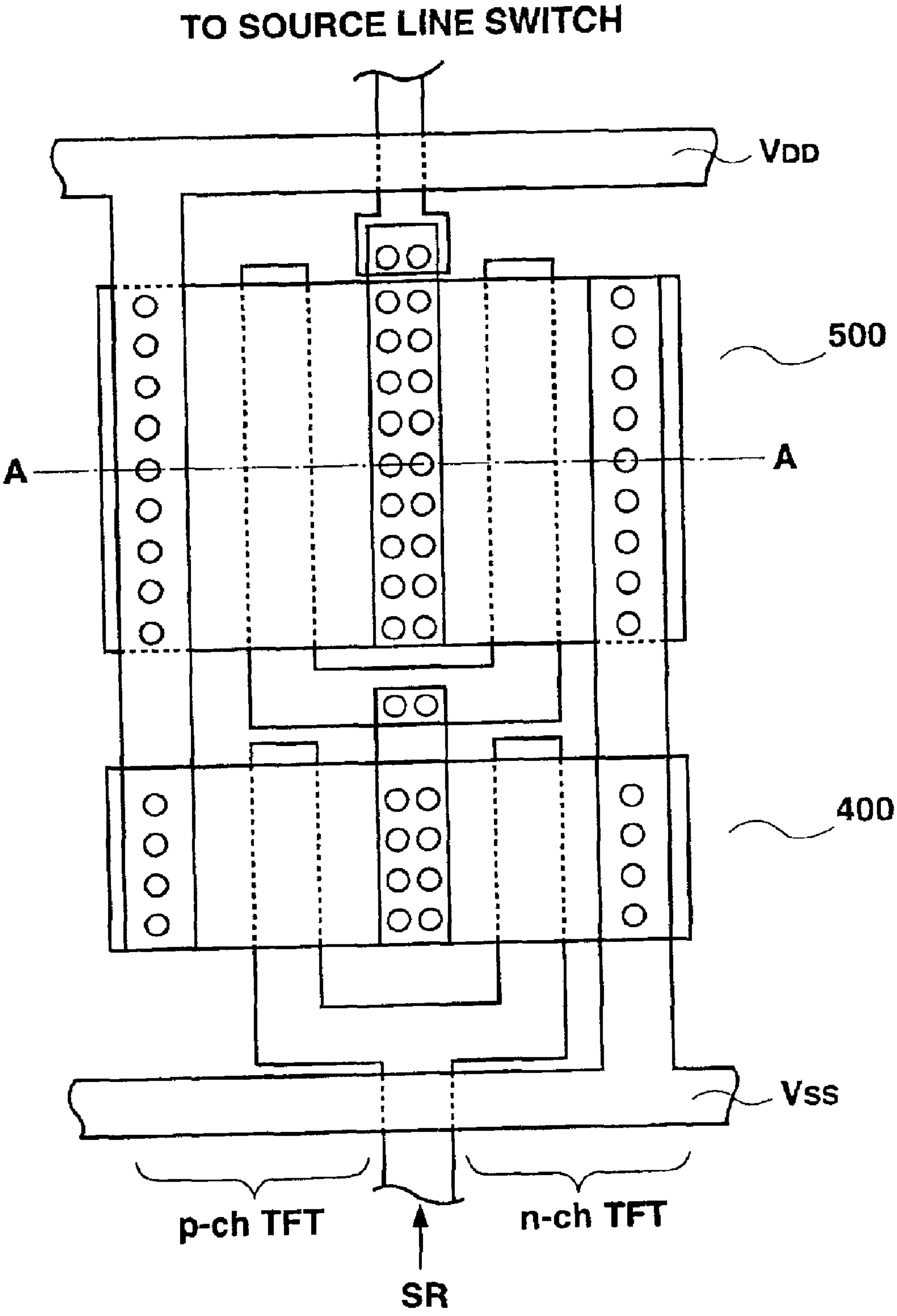


Fig. 4

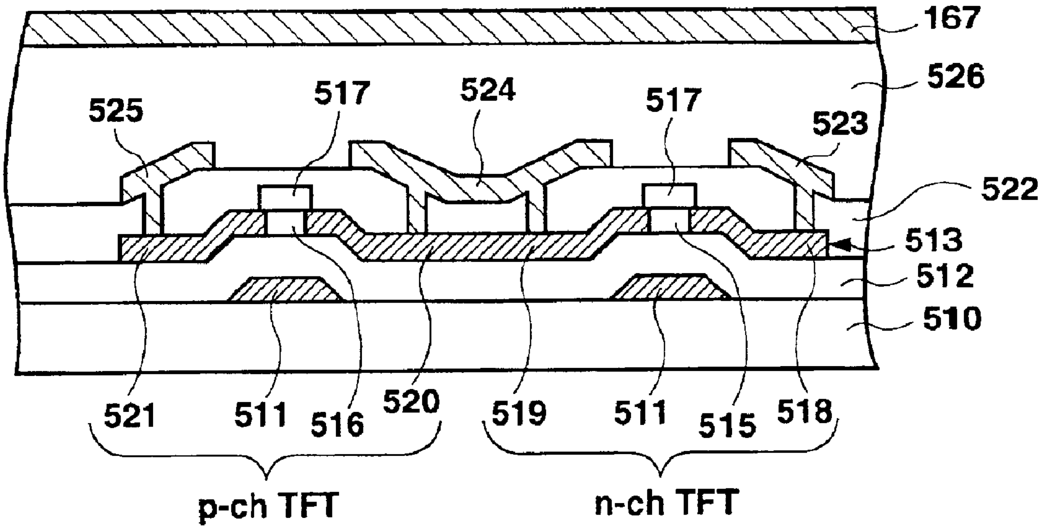

167
526
525
517
524
517
523
522
513
512
510
521
511
516
520
519
511
515
518
p-ch TFT
n-ch TFT

Fig. 5

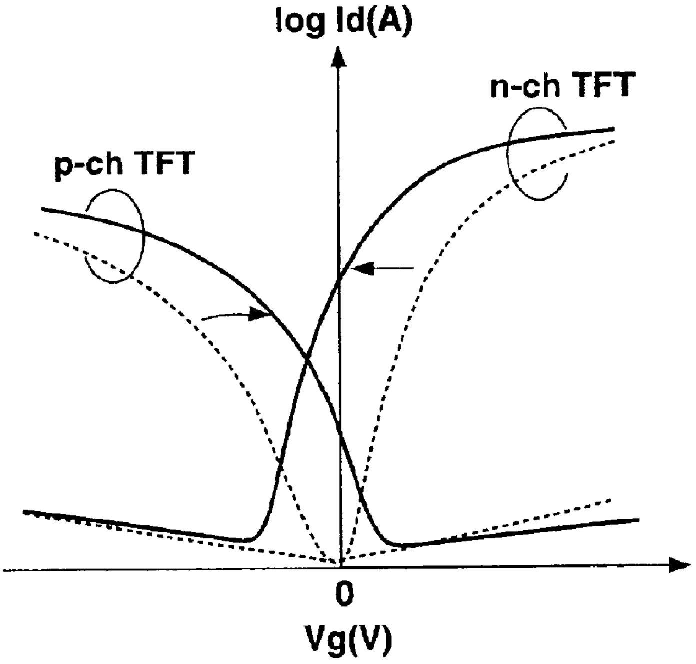

log Id(A)
n-ch TFT
p-ch TFT
0
Vg(V)

Fig. 6

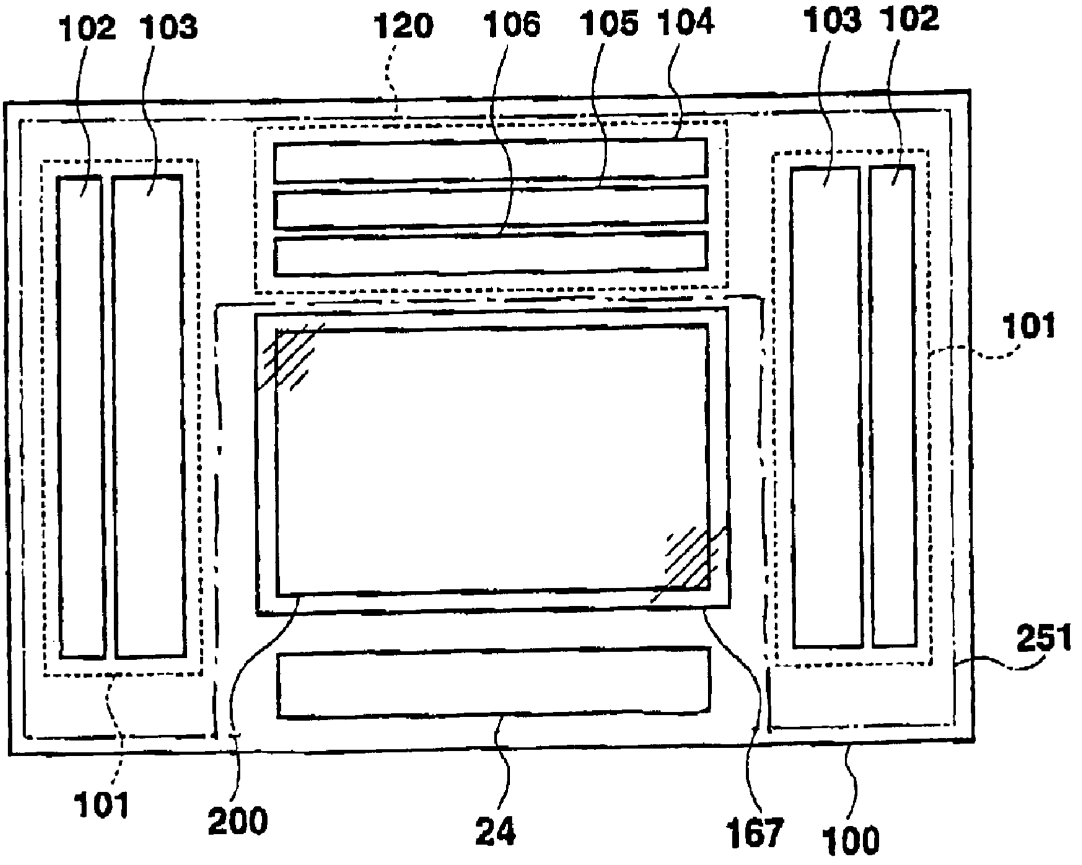


Fig. 7

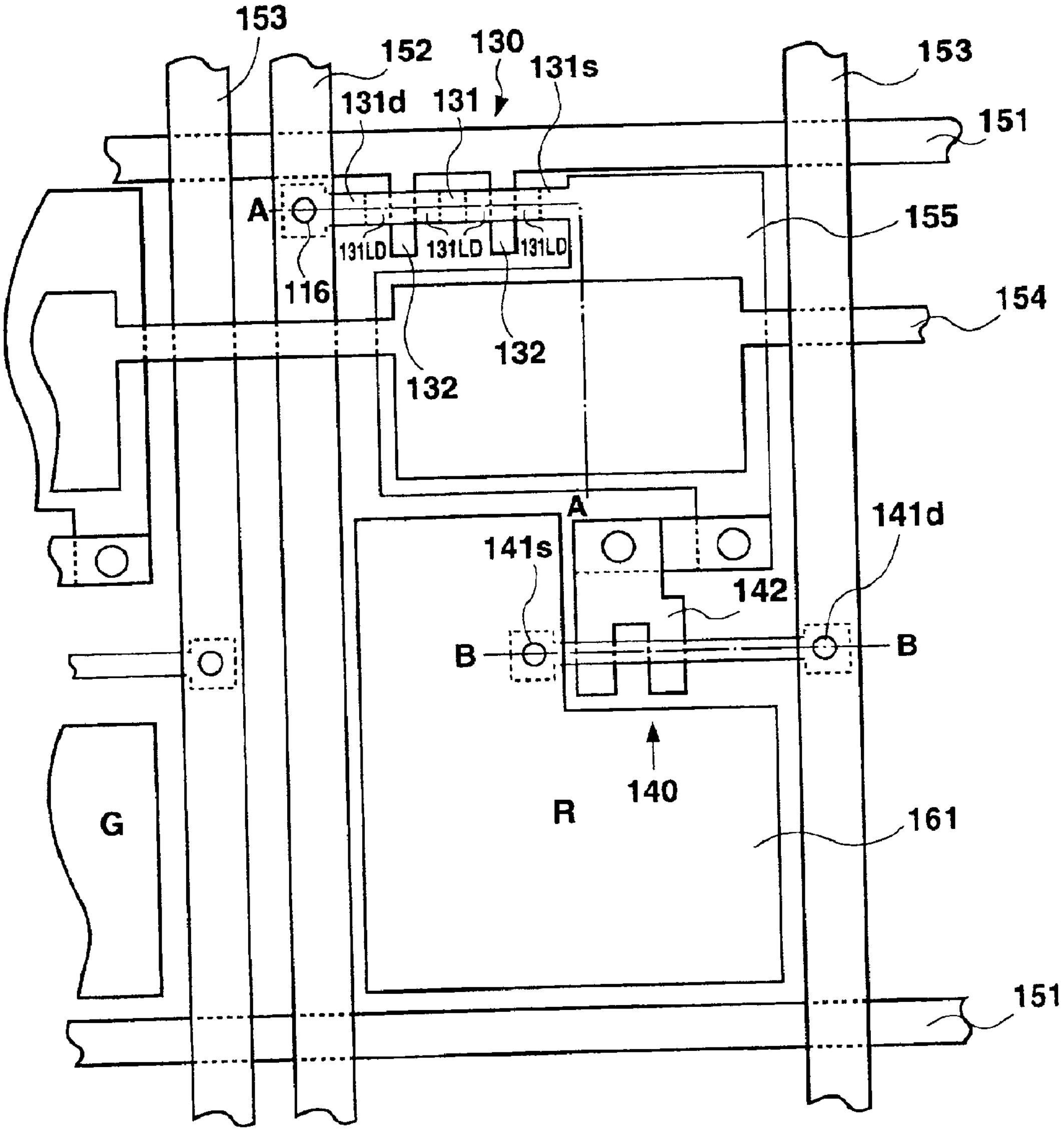

153
152
130
131s
131d
131
153
151
A
155
116
131LD
131LD
131LD
154
132
132
A
141d
141s
142
B
B
140
G
R
161
151

Fig. 8

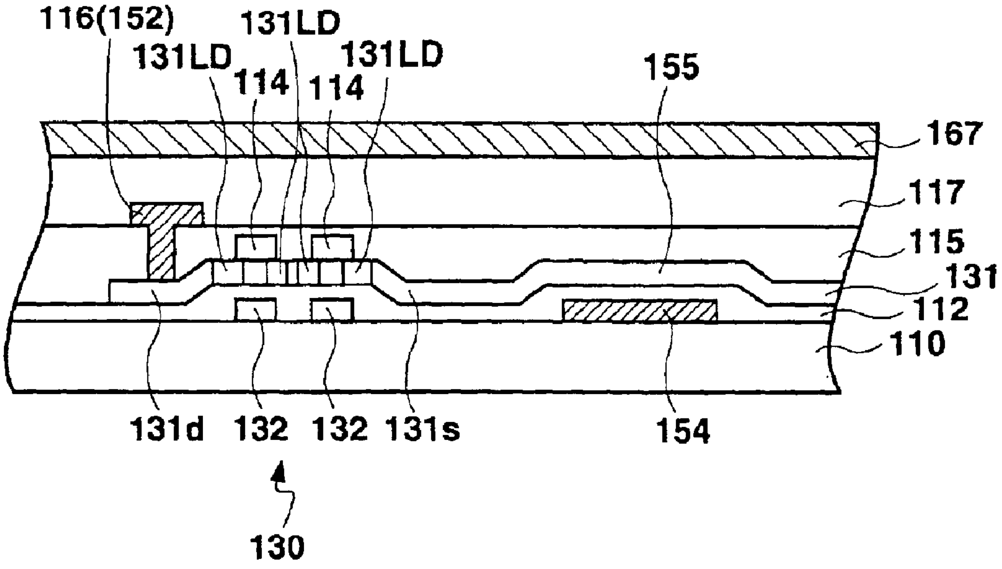

116(152)
131LD
131LD
131LD
114
114
155
167
117
115
131
112
110
131d
132
132
131s
154
130

Fig. 9A

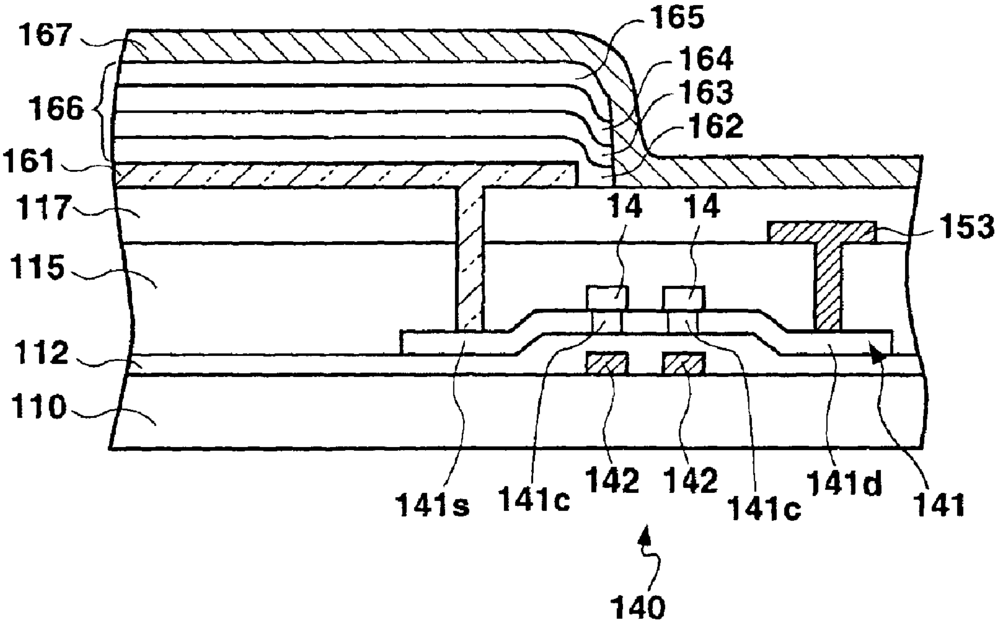

167
166
161
117
115
112
110
165
164
163
162
14
14
153
141s
141c
142
142
141c
141d
141
140

Fig. 9B

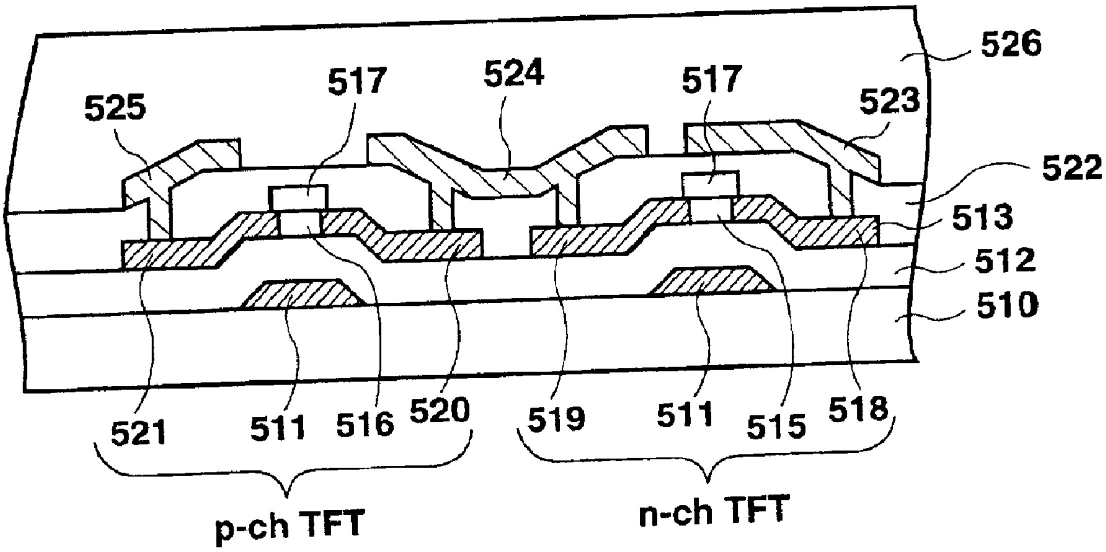

526
525
517
524
517
523
522
513
512
510
521
511
516
520
519
511
515
518
p-ch TFT
n-ch TFT

Fig. 10

ELECTROLUMINESCENCE DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electroluminescence display device employing an electroluminescence element and a thin film transistor.

2. Description of the Related Art

In recent years, electroluminescence (EL) display devices comprising EL elements have gained attention as potential replacement for CRT and LCD devices. Some research has been directed to the development of EL display devices using, for example, thin film transistors (referred to hereinafter as "TFT") as switching elements to drive the EL elements.

FIG. **1** shows a plan view of a related organic EL display device.

As shown in the Figure, the organic EL display device comprises a display pixel region **200** having first and second TFTs for driving an organic EL element of the display pixel. The organic EL display device further comprises a peripheral drive circuit region **250** indicated by a single-dot broken line. The peripheral drive circuit region **250** includes vertical drive circuits **10** and horizontal drive circuit **20** for driving the TFT of the display pixel region.

FIG. **2** shows an equivalent circuit of a related single display pixel using an organic EL element. In the display pixel region **200**, a single display pixel is surrounded by a gate signal line **151** and a drain signal line **152**. A first TFT **130** is a switching element disposed near a junction of those lines. Source **131***s* of TFT **130** is connected to gate **142** of a second TFT **140** for driving the organic EL element **160**. A storage capacitor **170** is provided between source **131***s* and gate **142** for retaining for a predetermined period a voltage applied to gate **142**. Source **141***s* of the second TFT **140** is connected to the anode **161** of the organic EL element **160**. Drain **141***d* of TFT **140** is connected to the drive power line **153** that supplies a drive current to the organic EL element **160**.

FIG. **3** shows a cross-sectional structure including the second TFT **140** and the organic EL element **160** among components of a single display pixel. Gate electrodes **142** made of refractory metal such as chromium (Cr) or molybdenum (Mo) are formed on an insulator substrate **110** made of quartz glass, non-alkali glass, or a similar material. Sequentially formed over the gate electrodes **142** are a gate insulating film **112** and an active layer **141** using poly-silicon (referred to hereinafter as "p-Si") film. The active layer **141** comprises intrinsic or substantially intrinsic channels **141***c* formed above the gate electrodes **142**, and the source **141***s* and drain **141***d* formed on respective sides of these channels **141***c* by ion doping.

An interlayer insulating film **115** formed by a sequential deposit of a SiO_2 film, a SiN film, and a SiO_2 film covers the gate insulating film **112** and the active layer **141**. A contact hole formed in the interlayer insulating film **115** in a region corresponding to the drain **141***d* is filled with metal such as aluminum (Al), forming the drive power line **153** connecting to a drive power supply **150**. Further, a planarizing insulating film **117** made of an organic resin is formed over the entire substrate to planarize the surface. In a region corresponding to the source **141***s*, a contact hole is formed penetrating through both the planarizing insulating film **117** and the interlayer insulating film **115**. A transparent electrode that contacts the source **141***s* through this contact hole is formed on the planarizing insulating film **117**. The transparent electrode is made of ITO (indium tin oxide), and functions as the anode **161** of the organic EL element **160**.

The organic EL element **160** is configured by sequentially forming, in order, the anode **161** made of ITO or similar material connected to the source **141***s* of the above-mentioned second TFT **140**, an element emissive layer **166** composed using an organic compound, and a cathode **167** composed using an alloy of magnesium and indium. In such an organic EL element **160**, a hole injected from the anode and an electron injected from the cathode recombines in an emissive layer within the element emissive layer **166**. As a result, organic compound molecules in the emissive layer are excited, generating excitons. Through a process of these excitons undergoing radiation until deactivation, light is emitted from the emissive layer. This light radiates outward through the transparent anode **161** and the transparent insulator substrate **110**.

As shown in FIG. **3**, the anode **161** is discretely formed for each display pixel, and the element emissive layer **166** is formed slightly larger than the anode **161** so as to cover the entire anode **161**. The cathode **167** can be formed as one common electrode over the entire substrate because the operation of the cathode can be electrically in common for all pixels. More specifically, as the cathode can be configured as a common electrode, according to the related art the cathode **167** can easily be provided by forming it in the region surrounded by a double-dot broken line in FIG. **1**, this being the entire region of the substrate **110**.

A TFT using poly-silicon as the active layer can be employed not only as a pixel TFT within the display pixel region **200**, but also as a TFT for peripheral drive circuit to drive the display pixel region **200** on the substrate **110**. In other words, circuit for driving the display pixel region **200** may be formed on the same substrate **110** as the pixel region. FIG. **4** illustrates a peripheral drive circuit disposed in a surrounding region of the display pixel region **200** as shown in FIG. **1**, which is configured using the third TFT. The peripheral drive circuit is described below referring to FIGS. **1** and **4**. Peripheral drive circuits configured using the third TFT comprise vertical drive circuits **10** and a horizontal drive circuit **20**. A vertical drive circuit **10** includes a vertical shift register (V-SR) **11** and a buffer circuit **12**, while a horizontal drive circuit **20** includes a horizontal shift register (H-SR) **21**, a buffer **22**, and a source line switch **23**.

FIG. **4** is a plan view showing the TFT of the buffer constituting the horizontal drive circuit. FIG. **5** shows a cross-sectional view taken along line A—A of FIG. **4**.

As shown in FIG. **4**, the buffer comprises inverters **400** and **500**.

The configuration of the respective TFT of the buffer is next described according to FIG. **5**.

Sequentially formed on an insulator substrate **510** composed of a material such as silica glass or non-alkali glass are gate electrodes **511** made of refractory metal such as chromium (Cr) or molybdenum (Mo), a gate insulating film **512**, and an active layer **513** composed of poly-silicon film.

The active layer **513** comprises channels **515**,**516** positioned above the gate electrodes **511**. Further within the active layer, sources **518**,**521** and drains **519**,**520** are formed on respective sides of these channels **515**,**516** by performing ion dope using stoppers **517** located above the channels **515**,**516** as masks. In this example, the TFT drawn towards the right of the figure is a n-type channel TFT having impurity ions such as phosphorus (P) implanted in source **518** and drain **519**, while the TFT on the left is a p-type channel TFT having impurity ions such as boron (B) implanted in source **521** and drain **520**.

An interlayer insulating film **522** formed by sequentially depositing a SiO_2 film, a SiN film, and a SiO_2 film is provided on the entire surface over the gate insulating film **512**, the active layer **513**, and the stoppers **517**. Contact holes formed in the interlayer insulating film **522** in regions corresponding to the sources **518,521** and the drains **519,520** are filled with metal such as Al, forming source electrodes **523,525** and a drain electrode **524**. The drain electrode **524** connected to the drains **519,520** is provided in common for the n-type channel TFT and the p-type channel TFT. A planarizing insulating film **526** made of an organic resin is formed over the entire surface for planarization.

Above this, the magnesium-indium alloy cathode **167** of the organic EL display element **161** illustrated in FIG. **3** is formed over the entire surface.

The inverter **500** composed on an n-type channel TFT and a p-type channel TFT is configured as described above. The other inverter **400** has a similar structure.

In the manner described above, an organic EL display device comprising a horizontal drive circuit with inverters **400,500**, a vertical drive circuit, and a display pixel can be created.

However, when the cathode **167** of the organic EL element **161** is provided on the entire surface over the peripheral drive circuit region and the display pixel region of the organic EL display device as described above, a back channel is created in each TFT because of the cathode **167**. The existence of a back channel unduly influences the device, especially in the TFT of the peripheral drive circuit having a C-MOS structure. This is explained below.

FIG. **7** shows Vg-Id characteristics of n-type and p-type channel TFT. In the figure, the dotted lines indicate the initial characteristics, while the solid lines indicate characteristics after power is switched on.

As shown in the FIG. **7**, there is at first no current leakage in either the n-type or p-type channel TFT when the gate voltage Vg is 0 V. However, when power is turned on, the potential applied to the cathode causes the characteristic of p-type channel TFT to shift to the right and the characteristic of n-type channel TFT to shift to the left. As a result, current leaks in both TFTs when Vg=0 V.

In a peripheral drive circuit, the TFT has a complementary structure composed with a p-type channel and an n-type channel. Accordingly, a change in the threshold voltage of the p-type channel TFT is caused when a high voltage is applied, while a change in the threshold voltage of n-type channel TFT is caused when the signal voltage is low. As a result, current flow, namely, a penetration current, is generated even when the gate voltage Vg=0. Generation of penetration current due to such changes disadvantageously causes an increase in power consumption.

SUMMARY OF THE INVENTION

The present invention was created in light of the above disadvantages. The purpose of the present invention is to stabilize operational threshold values of a thin film transistor for driving an emissive element such as an organic EL element so as to prevent characteristic changes in a peripheral drive circuit.

The present invention provides an electroluminescence display device comprising a display pixel region disposed on a substrate and having an electroluminescence element including an emissive layer between first and second electrodes and a drive circuit region disposed on the same substrate and having thin film transistors for driving said electroluminescence element wherein said first electrode entirely overlaps said display pixel region, but is absent in at least said drive circuit region.

In another aspect of the present invention, an emissive display device comprises a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes and a drive circuit region disposed on the same substrate surrounding said display pixel region, said drive circuit region having thin film transistors for driving said emissive element, wherein said first electrode overlaps the entire display pixel region, but is absent from at least said drive circuit region.

According to a further aspect of the present invention, said first electrode is formed as a common electrode in said display pixel region.

In a still further aspect of the present invention, said display pixel region includes first and second thin film transistors for driving said electroluminescence element, an insulating film is formed overlapping said first and second thin film transistors and said thin film transistors of said drive circuit region, and said first electrode is formed over said insulating film in a position opposing said display pixel region.

According to another aspect of the present invention, said first electrode is a common cathode and said second electrode is a discrete anode.

In yet another of the present invention, an electroluminescence display device comprises a display pixel region disposed on a substrate, said display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and further having first and second thin film transistors for driving said electroluminescence element, and a peripheral drive circuit region disposed surrounding said display pixel region and having third thin film transistors for driving said first and second thin film transistors, wherein said cathode is disposed in said display pixel region, but is absent from said drive circuit region.

According to another aspect of the present invention, said cathode on said substrate is formed over the entire display pixel region as a common electrode, but is absent at least from said peripheral drive circuit region.

According to the present invention, when a first electrode or cathode of an emissive element such as an electroluminescence element is formed as a common electrode in a display pixel region, the first electrode or cathode overlaps the display pixel region but is absent in the drive circuit region, as described above. Characteristic changes are easily caused in a drive circuit using a thin film transistor, and such changes tend to significantly influence power consumption and display quality of the device. By disallowing an electrode of the emissive element to overlap the drive circuit region according to the present invention, influences of the electrode of the emissive element on the drive circuit can be eliminated. Accordingly, the operational threshold values of the thin film transistor in the drive circuit can be stabilized, suppressing any increase in the devices power consumption and thereby achieving a high-performance device with low power consumption.

According to a further aspect of the present invention, a circuit in said drive circuit region includes a CMOS connection structure in which a p-type channel thin film transistor and an n-type channel thin film transistor are complementarily connected.

A circuit having a CMOS structure is favorable as a drive circuit. However, due to the presence of both p-type and n-type transistors, changes in the threshold voltage are likely to be caused in at least one of the types of the transistors during application of either high or low voltage to a gate of a CMOS transistor. Avoiding overlap of the drive circuit and an electrode of the emissive element can suppress characteristic changes of thin film transistors for a reliable drive circuit.

In a still further aspect of the present invention, said thin film transistors of said drive circuit region are bottom gate type transistors having gate electrodes located beneath an active layer, and said first electrode or said cathode is formed over an insulating layer extending on the entire substrate on the side of said active layer opposite from that which said gate electrodes are located, so as to overlap said display pixel region.

When an electrode such as the electrode of an emissive element of the present invention is located in an overlying layer of such a bottom gate type transistor, back channel tends to be generated in a position where the electrode of the element and the active layer of the transistor overlap. Avoiding overlap of the drive circuit having such a transistor and the electrode of the emissive element can suppress characteristic changes of thin film transistors for a reliable drive circuit.

In a further different aspect of the present invention, said emissive layer is a layer using an organic compound as an emissive material.

Forming the emissive layer using an organic compound can be extremely advantageous in a color display device because organic compounds can provide many variations in emitted colors and can be formed from a wide selection of possible materials.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view illustrating an EL display device of a related art.

FIG. **2** is a diagram showing an equivalent circuit in a display pixel of an EL display device of a related art.

FIG. **3** shows a cross-sectional view of an EL element and a transistor for supplying electric power to this element in an EL display device of a related art.

FIG. **4** is a schematic plan view of a buffer circuit among peripheral drive circuits of a related art EL display device.

FIG. **5** shows a cross-sectional view taken along line A—A of FIG. **4**.

FIG. **6** is a graph showing Vg-Ig characteristics of n-type and p-type channel TFTs.

FIG. **7** is a plan view illustrating an EL display device according to the present invention.

FIG. **8** is a plan view showing one pixel in the display pixel region of FIG. **7**.

FIG. **9**A shows a cross-sectional view taken along line A—A of FIG. **8**.

FIG. **9**B shows a cross-sectional view taken along line B—B of FIG. **8**.

FIG. **10** is a schematic plan view of a buffer circuit among peripheral drive circuits of an EL display device according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An EL display device of the present invention will now be described.

FIG. **7** shows a plan view of an organic EL display device. An example in which the EL display device of the present invention is implemented in an organic EL display device is explained referring to this figure.

In the organic EL display device, as shown in FIG. **7**, an insulator substrate **100** is provided with a peripheral drive circuit **251** including horizontal drive circuit **120** and vertical drive circuits **101** configured using third TFTs. Also formed on the insulator substrate **100** is a display pixel region **200** including display pixels of the organic EL display. The third TFTs are formed within the peripheral drive circuit region. Each vertical drive circuit **101** includes a vertical shift register (V-SR) **102** and a buffer circuit **103**. A horizontal drive circuit **120** includes a horizontal shift register (H-SR) **104**, a buffer **105**, and a source line switch **106**.

A pixel in the display pixel region **200** has a circuit configuration similar to the above-described FIG. **2** and a plan configuration shown in the example in FIG. **8**. FIG. **9**A shows a cross-sectional view taken along line A—A of FIG. **8**. FIG. **9**B shows a cross-sectional view taken along line B—B of FIG. **8**.

Each pixel comprises a gate signal line **151**, a drain signal line **152**, a first TFT **130** formed near the junction of these signal lines **151**,**152**, a storage capacitor **170**, a second TFT **140**, and an organic EL element **160**. The pixels are formed in a matrix arrangement within region **200** on the substrate **110**.

Source **131***s* of the first TFT **130** simultaneously serves as a capacitor electrode **155** that, together with the opposing storage capacitor electrode **154**, forms a capacitor. Gate electrode **142** of the second TFT **140** that drives the organic EL element **160** is connected to source **141***s* of the second TFT **140**, and the source **141***s* contacts with the anode **161** of the organic EL element **160**. The drain **141***d* of the second TFT **140** is connected to a drive power line **153**, while the drive power line **153** is connected to a drive power supply **150** that supplies current to the organic EL element **160**.

Near the TFT, a storage capacitor electrode **154** is disposed in parallel with the gate signal line **151**. The storage capacitor electrode **154** is made of a material such as chromium. A capacitor for storing charges is formed between the storage capacitor electrode **154** and the capacitor electrode **155** connected to source **131***s* of the first TFT **130** via a gate insulating film **112**. This storage capacitor **170** is provided for retaining voltage applied to the gate **142** of the second TFT **140**.

The first TFT **130**, or the switching TFT, will next be described. As shown in FIG. **9**A, a gate signal line **151** made of refractory metal such as chromium (Cr) or molybdenum (Mo), which also serves as gate electrodes **132**, is formed on an insulator substrate **110** made of quartz glass, non-alkali glass, or a similar material.

Above these layers, a gate insulating film **112** and an active layer **131** composed of poly-silicon film are sequentially formed. The active layer **131** comprises the so-called LDD (Lightly Doped Drain) structure. Specifically, low-concentration regions **131**LD are formed on both sides of each gate **132**. The source **131***s* and the drain **131***d*, which are high-concentration regions, are further disposed on the outboard sides of the low-concentration regions **131**LD.

An interlayer insulating film **115** formed by a sequential lamination of a SiO_2 film, a SiN film, and a SiO_2 film is provided on the entire surface over the gate insulating film **112** and the active layer **131**. A contact hole formed in a position corresponding to the drain **141***d* is filled with metal such as Al, forming a drain electrode **116** constituting one continuous component with a drain signal line **152**. Further, a planarizing insulating film **117** made of an organic resin or a similar material is formed over the entire surface for planarization.

The second TFT **140**, or the TFT for driving the organic EL element, will next be described.

As shown in FIG. 9B, gate electrodes **142** composed of refractory metal such as Cr or Mo are formed on an insulator substrate **110** made of silica glass, non-alkali glass, or a similar material. On top of these, a gate insulating film **112** and an active layer **141** composed of poly-silicon film are sequentially formed. The active layer **141** comprises intrinsic or substantially intrinsic channels **141***c* formed above the gate electrodes **142**, and the source **141***s* and drain **141***d* formed on respective sides of these channels **141***c* by ion doping.

An interlayer insulating film **115** formed by a sequential lamination of a SiO_2 film, a SiN film, and a SiO_2 film is provided on the entire surface over the gate insulating film **112** and the active layer **141**. A contact hole formed in a position corresponding to the drain **141***d* is filled with metal such as Al, thereby forming the drive power line **153** connecting to a drive power supply **150**. Further, a planarizing insulating film **117** made of an organic resin or a similar material is formed over the entire surface for planarization. A contact hole is formed in the planarizing insulating film **117** in a position corresponding to the source **141***s*. A transparent electrode made of ITO that contacts the source **141***s* through this contact hole, namely, the anode **161** of the organic EL element, is formed on the planarizing insulating film **117**.

The organic EL element **160** is formed by first laminating the anode **161** constituted by a transparent electrode made of ITO or similar material. The emissive element layer **166** is then superimposed. The emissive element layer **166** comprises a first hole-transport layer **162** composed of a material such as MTDATA (4,4',4"-tris(3-methylphenylphenylamino)triphenylamine), a second hole-transport layer **163** composed of a material such as TPD (N,N'-diphenyl-N,N'-di(3-mthylphenyl)-1,1'-biphenyl-4,4'-diamine), an emissive layer **164** composed of, for example, $Bebq_2$ (bis(10-hydroxybenzo[h]quinolinato)beryllium) including quinacridone derivatives, and an electron transport layer **165** composed of $Bebq_2$ or similar material. Subsequently, the cathode **167** is formed which may be composed of a magnesium-indium alloy. The above-mentioned layers of the organic EL element **160** are laminated in the described order.

In the present embodiment, the cathode **167** extends covering the entire display pixel region **200** as shown in FIG. **7**, but does not reach the drive circuit region **251** disposed surrounding region **200**. The cathode **167** is formed in a contour corresponding to or slightly larger than the display pixel region **200**.

The structure of the peripheral drive circuit region **251** indicated by a single-dot broken line and located outside the display pixel region **200** in FIG. **7** will now be explained. As described above, region **251** includes a horizontal drive circuit **120**, vertical drive circuits **101**, and an input wiring terminal **24** for supplying electric power (voltage, current) from an external power supply.

In the following, the TFT of the buffer shown in FIG. **4** (inverter **500**) is used as an example of a circuit constituting the peripheral drive circuit region **251** to explain a configuration according to the present embodiment. FIG. **10** shows the cross-sectional configuration of the inverter **500** of FIG. **4** according to the present embodiment.

As seen in the FIG. **10**, the structure of the inverter corresponds with that shown in FIG. **5** concerning the layers from the gate electrodes **511** to the planarizing insulating film formed on the insulator substrate **110**.

However, differing from the structure shown in FIG. **5**, the cathode **167** of the organic EL element **160** formed in the display pixel region **200** is not present over the planarizing insulating film **526**.

When forming the cathode **167**, a metal mask or a similar component that can cover the peripheral drive circuit region **251** excluding the display pixel region **200** is placed on the planarizing insulating film **526**. Subsequently, a magnesium-indium alloy, which is the material constituting the cathode **167**, is deposited on the planarizing insulating film **526** using an evaporation method. The cathode **167** can thereby be formed only in the display pixel region **200** without extending in the peripheral drive circuit region **251**.

By forming the cathode **167** only in the display pixel region, characteristic changes after turning on the power can be prevented in the inverter and clocked inverter with a CMOS configuration using the n-type and p-type channel TFT employed in the peripheral drive circuit region **251**.

As changes in threshold voltages of the inverters can be minimized, generation of penetration current can be suppressed, thereby preventing increase of power consumption.

Although the above embodiment was described concerning an example using the so-called bottom gate type TFT having gate electrodes disposed beneath the active layer close to the substrate, the present invention is not limited to such a structure. The present invention may be implemented using a top gate type TFT having gate electrodes disposed above the active layer, and similar effects as that of the example using a bottom gate type TFT can be achieved.

It is noted that the peripheral drive circuit region **251** is defined as a region comprising third TFT constituting vertical drive circuits **101** and horizontal drive circuit **120** for supplying signals to drive the first and second TFT **130,140** located within the display pixel region **200**.

The cathode **167** of the organic EL element need only be formed in at least the display pixel region **200**. The cathode **167** may also be formed, for example, in a position between the horizontal drive circuit **120** and a vertical drive circuit **101** in the plan view, as long as the cathode **167** is not formed in a region where the peripheral drive circuits are present. Preferably, the cathode **167** is formed only within the display pixel region **200** as described above.

The cathode **167** of the organic EL element may be present over the signal wiring region **24** that supplies signals to the substrate **100** on which the organic EL element is formed. However, to minimize negative influences such as generation of parasitic capacitance in signal wires, it is preferable that the cathode **167** be absent over region **24**.

Further, although the above embodiment was explained using an organic EL display device as an example, the present invention is not limited to organic EL displays. Similar effects can be obtained by implementing the present invention in an inorganic EL display device which uses, as an emissive element instead of organic EL elements, inorganic EL elements comprising inorganic emissive materials. Alternatively, the present invention may be applied in a vacuum fluorescent display (VFD) having a fluorescent layer as the emissive layer between two electrodes.

Concerning the first and second TFT **130**,**140** formed in the display pixel region **200** and the third TFT constituting the peripheral drive circuit **251** in the above-described embodiment, corresponding structures such as gate electrodes, gate insulating films, and active layers can be formed in the same manufacturing processes. For example, the active layers of those TFT composed using poly-silicon can be formed in one process. An amorphous silicon film may be formed on the entire substrate and then polycrystallized by a method such as laser annealing. The polysilicon film created in this way may be used as an active layer in each TFT.

What is claimed is:

1. An electroluminescence display device comprising:

a display pixel region disposed on a substrate and having an electroluminescence element including an emissive layer between first and second electrodes; and

a drive circuit region having a peripheral drive circuit that is integrated on said substrate, said drive circuit region having thin film transistors for driving said electroluminescence element; wherein

said first electrode entirely overlaps said display pixel region and is absent from at least said drive circuit region, said first electrode is a common cathode, and said second electrode is a discrete anode.

2. The device defined in claim **1** wherein:

said display pixel region includes first and second thin film transistors for driving said electroluminescence element;

an insulating film is formed overlapping said first and second thin film transistors and said thin film transistors of said drive circuit region; and

said first electrode is formed over said insulating film in a position opposing said display pixel region.

3. The device defined in claim **2** wherein a circuit in said drive circuit region includes a CMOS connection structure in which a p-type channel thin film transistor and a n-type channel thin film transistor are complementarily connected.

4. The device defined in claim **1** wherein:

said thin film transistors of said drive circuit region are bottom gate type transistors having gate electrodes located beneath an active layer; and

said first electrode is formed over an insulating layer extending on the entire substrate on an opposite side of said active layer from which said gate electrodes are located, said first electrode formed overlapping said display pixel region.

5. The device as defined in claim **1**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

6. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element; and

a drive circuit region having a peripheral drive circuit that is integrated on said substrate, said drive circuit region having third thin film transistors for driving said first and second thin film transistors; wherein

said cathode is disposed in said display pixel region and is absent from said drive circuit region.

7. The device defined in claim **6** wherein said cathode on said substrate is formed over the entire display pixel region as a common electrode, and is absent from at least said drive circuit region.

8. The device defined in claim **6** wherein a circuit in said drive circuit region includes a CMOS connection structure in which a p-type channel thin film transistor and a n-type channel thin film transistor are complementarily connected.

9. The device defined in claim **6** wherein:

said third thin film transistors of said drive circuit region are bottom gate type transistors having gate electrodes located beneath an active layer; and

said cathode is formed over an insulating layer extending on the entire substrate on an opposite side of said active layer from which said gate electrodes are located, said cathode formed overlapping said display pixel region.

10. The device as defined in claim **6**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

11. An emissive display device comprising:

a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes; and

a drive circuit region having a peripheral drive circuit that is integrated on said substrate, said drive circuit region having thin film transistors for driving said emissive element;

wherein

said first electrode overlaps the entire display pixel region and is absent from at least said drive circuit region, said first electrode is a common cathode, and said second electrode is a discrete anode.

12. The device as defined in claim **11**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

13. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element, said cathode is formed in a layer extending above a layer in which said anode is formed; and

a drive circuit region having a peripheral drive circuit that is integrated on said substrate, said drive circuit region having third thin film transistors for driving said first and second thin film transistors; wherein

is disposed in said display pixel region and is absent from said drive circuit region.

14. The device as defined in claim **13**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

15. An electroluminescence display device comprising:

a display pixel region disposed on a substrate and having an electroluminescence element including an emissive layer between first and second electrodes; and

a drive circuit region having vertical and horizontal drive circuits that are located in a peripheral drive circuit region formed surrounding said display pixel region and are integrated on said substrate, said drive circuit region having thin film transistors for driving said electroluminescence element; wherein

said first electrode entirely overlaps said display pixel region and is absent from at least said drive circuit region,

said first electrode is a common cathode, comprises an opaque metal material, and constitutes an uppermost layer of said electroluminescence element, and said second electrode is a discrete anode.

16. The device as defined in claim **15**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

17. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element; and

a drive circuit region having vertical and horizontal drive circuits that are located in a peripheral drive circuit region formed surrounding said display pixel region and are integrated on said substrate, said drive circuit region having third thin film transistors for driving said first and second thin film transistors,

wherein said cathode is disposed in said display pixel region and is absent from said drive circuit region,

said cathode comprises an opaque metal material and constitutes an uppermost layer of said electroluminescence element.

18. The device as defined in claim **17**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

19. An emissive display device comprising:

a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes; and

a drive circuit having vertical and horizontal drive circuits that are located in a peripheral drive circuit region formed surrounding said display pixel region and are integrated on said substrate, said drive circuit region having thin film transistors for driving said emissive element;

wherein said first electrode overlaps the entire display pixel region and is absent from at least said drive circuit region, said first electrode is a common cathode, and said second electrode is a discrete anode,

said cathode comprises an opaque metal material and constitutes an uppermost layer of said electroluminescence element.

20. The device as defined in claim **19**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

21. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element, said cathode is formed in a layer extending above a layer in which said anode is formed; and

a drive circuit region having vertical and horizontal drive circuits that are located in a peripheral drive circuit region formed surrounding said display pixel region and are integrated on said substrate, said drive circuit region having third thin film transistors for driving said first and second thin film transistors,

wherein said cathode is disposed in said display pixel region and is absent from said drive circuit region, and

said cathode comprises an opaque metal material and constitutes an uppermost layer of said electroluminescence element.

22. The device as defined in claim **21**, wherein said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

23. An emissive display device comprising:

a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes; and

a drive circuit region disposed on the same substrate surrounding said display pixel region, said drive circuit region having thin film transistors for driving said emissive element;

wherein said first electrode overlaps the entire display pixel region and is absent from at least said drive circuit region, said first electrode is a common cathode, and said second electrode is a discrete anode, and

said cathode includes an end portion that extends to an area between said display pixel region and said drive circuit region.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,940,214 B1
DATED : September 6, 2005
INVENTOR(S) : Komiya et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 9,

Lines 14-25, delete and substitute the following:

-- 1. An electroluminescence display device comprising:

a display pixel region disposed on a substrate and comprising an electroluminescence element having, between first and second electrodes, an emissive layer including an organic compound; and

a peripheral drive circuit disposed on said substrate, for controlling said electroluminescence element located in said display pixel region, said peripheral drive circuit being integrated in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit having a plurality of thin film transistors; wherein

said second electrode of said electroluminescence element is a discrete anode;

said emissive layer is formed overlapping said second electrode;

said first electrode is formed overlapping said emissive layer as a common electrode for said display pixel region, said first electrode disposed overlapping said display pixel region, terminating in a substrate region on an inside with respect to said peripheral region, and being absent from said peripheral region. --.

Lines 32, 36 and 40, before “drive”, insert -- peripheral --.
Lines 32, 36 and 40, after “circuit”, delete “region”.
Line 35, after “wherein”, delete “a circuit in”.
Line 51, before “region”, delete “drive circuit” and insert -- peripheral --.
Lines 52-63, delete and substitute the following:

-- 6. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element, said emissive layer includes an organic compound; and

a peripheral drive circuit integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit having third thin film transistors for driving said first and second thin film transistors; wherein

said anode is formed overlapping said emissive layer,

said cathode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral region, and is absent from said peripheral region. --.

Line 65, after “electrode”, delete “, and is absent from at least said drive”.
Line 66, delete “circuit region”.

Column 10,

Lines 2 and 6, before “drive”, insert -- peripheral --.
Lines 2 and 6, after “circuit”, delete “region”.
Line 11, after “located”, delete “, said”.

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CERTIFICATE OF CORRECTION

PATENT NO. : 6,940,214 B1
DATED : September 6, 2005
INVENTOR(S) : Komiya et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 10 (cont'd),
Line 12, delete "cathode formed overlapping said display pixel region".
Line 15, before "region", delete "drive circuit" and insert -- peripheral --.
Lines 16-28, delete and substitute the following:

-- 11. An emissive display device comprising:

a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes, said emissive layer includes an organic compound; and

a peripheral drive circuit integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit having thin film transistors for driving said emissive element;

wherein said first electrode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral region, and is absent from said peripheral region, said first electrode is a common cathode, and said second electrode is formed overlapping said emissive layer, said second electrode is a discrete anode. --.

Line 31, after "said", delete "drive circuit" and insert -- peripheral --.
Lines 33-46, delete and substitute the following:

-- 13. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element, said cathode is formed in a layer extending above a layer in which said anode is formed, said emissive layer includes an organic compound; and

a peripheral drive circuit integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit having third thin film transistors for driving said first and second thin film transistors; wherein

said anode is formed overlapping said emissive layer,

said cathode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral region, and is absent from said peripheral region. --.

Line 49, after "said", delete "drive circuit" and insert -- peripheral --.

Column 10, line 51 through Column 11, line 1,
Delete and substitute the following:

-- 15. An electroluminescence display device comprising:

a display pixel region disposed on a substrate and having an electroluminescence element including an emissive layer between first and second electrodes, said emissive layer includes an organic compound; and

a peripheral drive circuit region integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit region having vertical and horizontal drive circuits, said peripheral drive circuit region having thin film transistors for driving said electroluminescence element; wherein

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CERTIFICATE OF CORRECTION

PATENT NO. : 6,940,214 B1
DATED : September 6, 2005
INVENTOR(S) : Komiya et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 10, line 51 through Column 11, line 1 (cont'd),

said first electrode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral drive circuit region, and is absent from said peripheral drive circuit region,

said first electrode is a common cathode, comprises an opaque metal material, and constitutes an uppermost layer of said electroluminescence element, and

said second electrode is formed overlapping said emissive layer, said second electrode is a discrete anode. --.

Column 11,
Line 4, before "drive" insert -- peripheral --.
Lines 6-23, delete and substitute the following:

-- 17. An electroluminescence display device comprising a substrate provided with:

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element, said emissive layer includes an organic compound; and

a peripheral drive circuit region integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit region having vertical and horizontal drive circuits, said peripheral drive circuit region having third thin film transistors for driving said first and second thin film transistors,

wherein said anode is formed overlapping said emissive layer,

said cathode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral drive circuit region, and is absent from said peripheral drive circuit region,

said cathode comprises an opaque metal material and constitutes an uppermost layer of said electroluminescence element. --.

Line 26, before "drive" insert -- peripheral --.
Lines 28-43, delete and substitute the following:

-- 19. An emissive display device comprising:

a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes, said emissive layer includes an organic compound; and

a peripheral drive circuit integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit having vertical and horizontal drive circuits, said peripheral drive circuit having thin film transistors for driving said emissive element;

wherein said first electrode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral region, and is absent from said peripheral region, said first electrode is a common cathode, and said second electrode is formed overlapping said emissive layer, said second electrode is a discrete anode,

said cathode comprises an opaque metal material and constitutes an uppermost layer of said electroluminescence element. --.

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CERTIFICATE OF CORRECTION

PATENT NO. : 6,940,214 B1
DATED : September 6, 2005
INVENTOR(S) : Komiya et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 12,
Line 3, after "said", delete "drive circuit" and insert -- peripheral --.
Lines 5-23, delete and substitute the following:

-- **21. An electroluminescence display device comprising a substrate provided with:**

a display pixel region having an electroluminescence element including an emissive layer between an anode and a cathode, and first and second thin film transistors for driving said electroluminescence element, said emissive layer includes an organic compound, said cathode is formed in a layer extending above a layer in which said anode is formed; and

a peripheral drive circuit region integrated on said substrate in a peripheral region on an outside of said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit region having vertical and horizontal drive circuits, said peripheral drive circuit region having third thin film transistors for driving said first and second thin film transistors,

wherein said anode is formed overlapping said emissive layer,

said cathode overlaps said display pixel region, terminates in a substrate region on an inside of said peripheral drive circuit region, and is absent from said peripheral drive circuit region, and

said cathode comprises an opaque metal material and constitutes an uppermost layer of said electroluminescence element. --.

Line 26, before "drive" insert -- peripheral --.
Lines 28-42, delete and substitute the following:

-- **23. An emissive display device comprising:**

a display pixel region disposed on a substrate and having an emissive element including an emissive layer between first and second electrodes, said emissive layer includes an organic compound; and

a peripheral drive circuit region disposed on said substrate and is formed in a region around said display pixel region and between said display pixel region and edges of said substrate, said peripheral drive circuit region having thin film transistors for driving said emissive element;

wherein said first electrode overlaps the entire display pixel region, terminates in a substrate region on an inside of said peripheral drive circuit region, and is absent from at least said peripheral drive circuit region, said first electrode is a common cathode, and said second electrode is a discrete anode, and

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CERTIFICATE OF CORRECTION

PATENT NO. : 6,940,214 B1
DATED : September 6, 2005
INVENTOR(S) : Komiya et al.

Page 5 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 12 (cont'd),

said cathode includes an end portion that extends to an area between said display pixel region and said peripheral drive circuit region. --.

Signed and Sealed this

Thirteenth Day of June, 2006

Jon W. Dudas

JON W. DUDAS
Director of the United States Patent and Trademark Office

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摘要(译)

绝缘基板（110）设置有显示像素区域（200），显示像素区域（200）包括具有阴极（167），发光层（166）和阳极（161）的电致发光元件（160），以及用于驱动的第一和第二TFT元素。围绕显示像素区域（200），在绝缘基板（110）上还设置具有用于驱动每个像素的第三TFT的外围驱动电路区域（251）。阴极（167）设置在除外围驱动电路区域（251）之外的区域中。利用这种配置，在用于控制显示区域的外围驱动电路区域中采用的互补TFT中，防止了通过将EL元件电位施加到阴极而产生反向沟道，从而抑制了由于这种反向沟道产生引起的阈值的变化。结果，实现了具有减少的穿透电流的产生和最小化的增加的电流消耗的EL显示装置。