



US008610868B2

(12) **United States Patent**
Saitou et al.

(10) **Patent No.:** **US 8,610,868 B2**
(45) **Date of Patent:** **Dec. 17, 2013**

(54) **LIQUID CRYSTAL DISPLAY DEVICE AND
MANUFACTURING METHOD THEREOF**

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,710,839 B2 *	3/2004	Komeno et al.	349/149
2008/0123005 A1 *	5/2008	Sohn et al.	349/40
2008/0204619 A1	8/2008	Saitou et al.	

FOREIGN PATENT DOCUMENTS

JP	06-258665	9/1994
JP	2001-21909	1/2001
JP	2008-203761	9/2008

* cited by examiner

Primary Examiner — Dung Nguyen

(74) *Attorney, Agent, or Firm* — Antonelli, Terry, Stout & Kraus, LLP.

(75) Inventors: **Terunori Saitou**, Mobara (JP);
Hidekazu Miyake, Mobara (JP); **Takuo**
Kaitoh, Mobara (JP); **Yoshiharu**
Owaku, Mobara (JP)

(73) Assignees: **Hitachi Displays, Ltd.**, Chiba (JP);
Panasonic Liquid Crystal Display Co.,
Ltd., Hyogo-ken (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 127 days.

(21) Appl. No.: **13/042,490**

(22) Filed: **Mar. 8, 2011**

(65) **Prior Publication Data**

US 2011/0221985 A1 Sep. 15, 2011

(30) **Foreign Application Priority Data**

Mar. 9, 2010 (JP) 2010-051862

(51) **Int. Cl.**
G02F 1/1345 (2006.01)

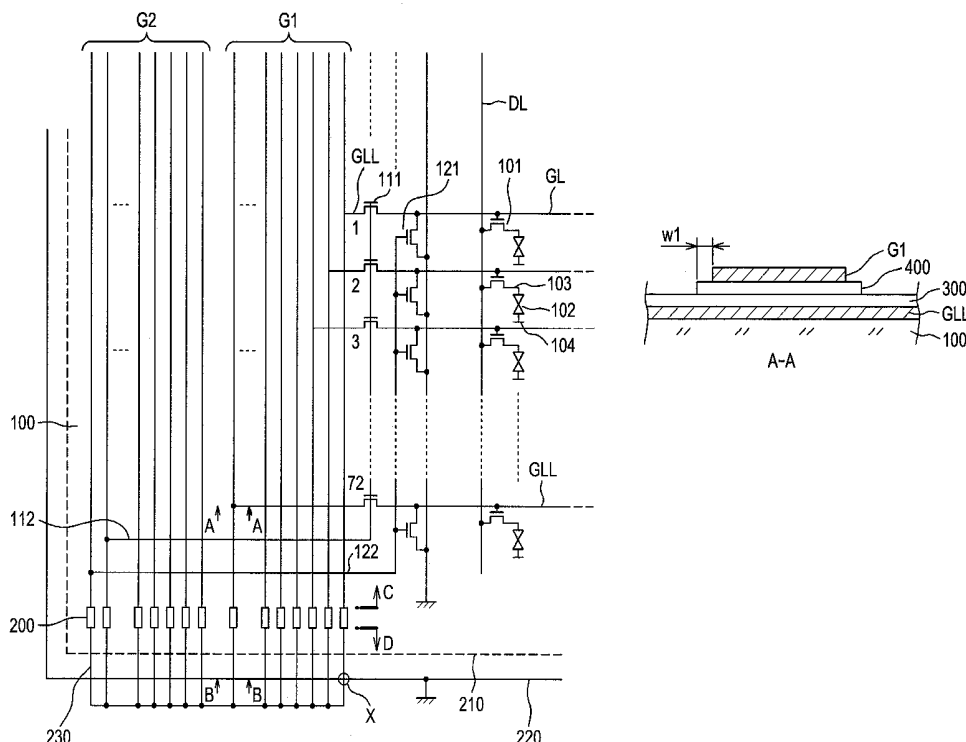
(52) **U.S. Cl.**
USPC **349/149**; 349/151

(58) **Field of Classification Search**
USPC 349/149–152
See application file for complete search history.

(57) **ABSTRACT**

In order to prevent dielectric breakdown of TFT or an interlayer insulating film by static electricity with a reduced area at low cost, a liquid crystal display device has a configuration in which an interlayer insulating film and an a-Si film are formed in a display area and a control area inside terminals. Image signal lines and scan lines are insulated from each other through the interlayer insulating film and a-Si film in their intersections. On the other hand, only the interlayer insulating film is formed between static electricity protection lines and an earth line outside the terminals. When static electricity is induced, dielectric breakdown is caused to occur in the area outside the terminals. Thus, the display area and the control area are protected from the static electricity.

9 Claims, 4 Drawing Sheets



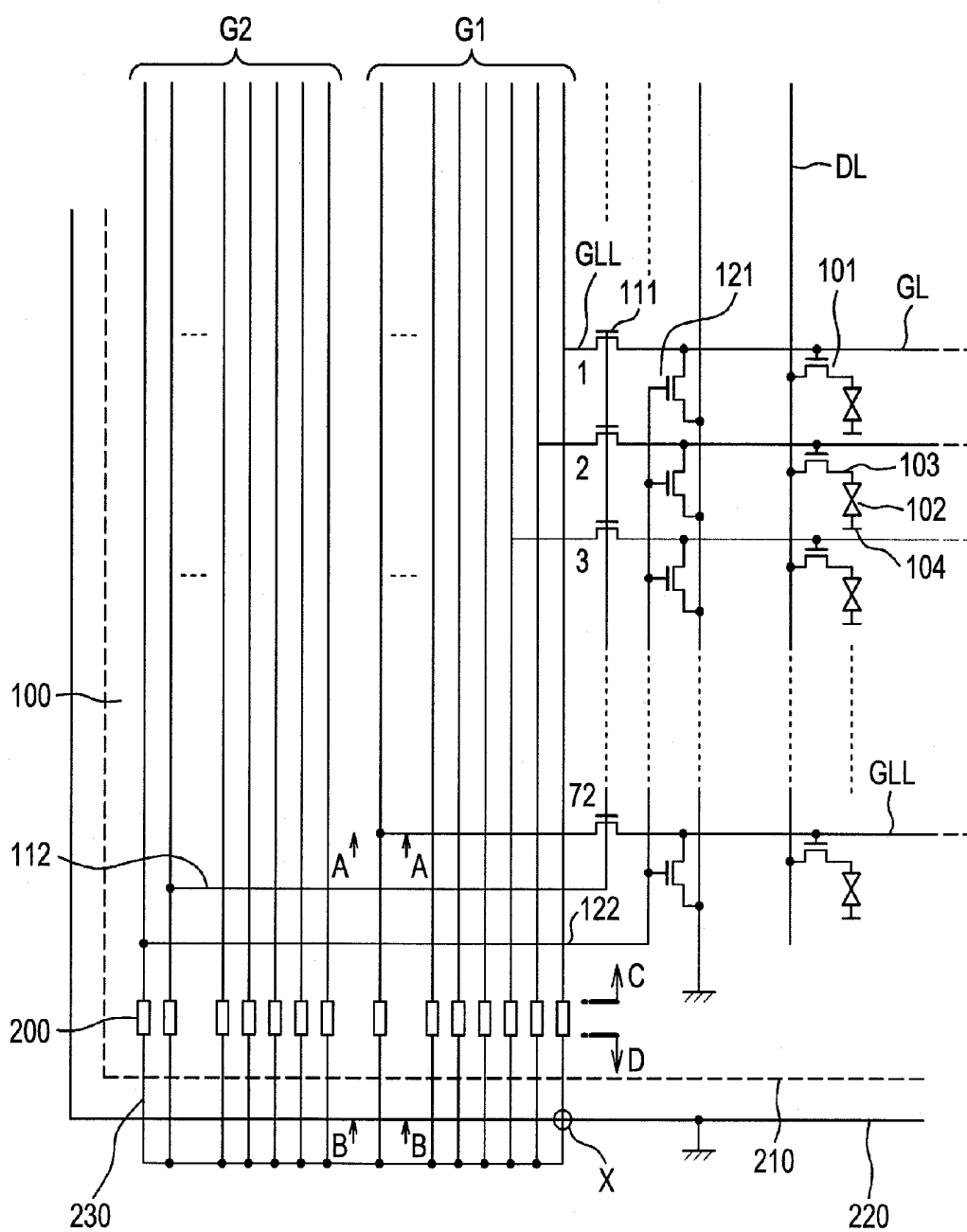


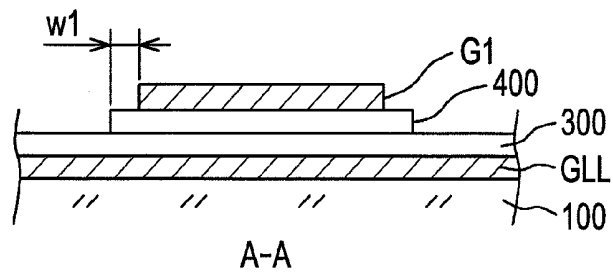
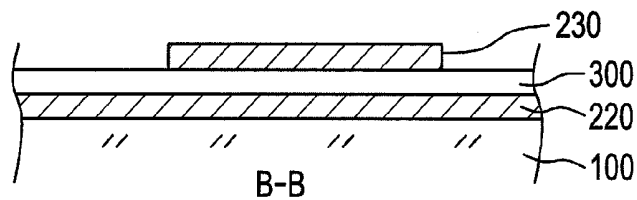
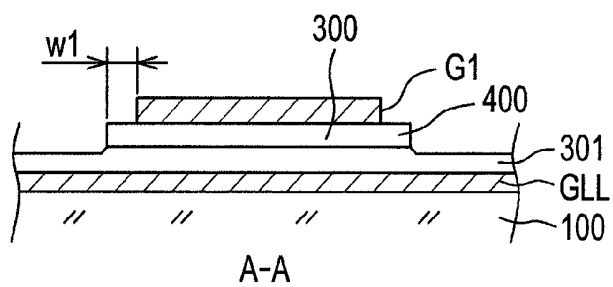
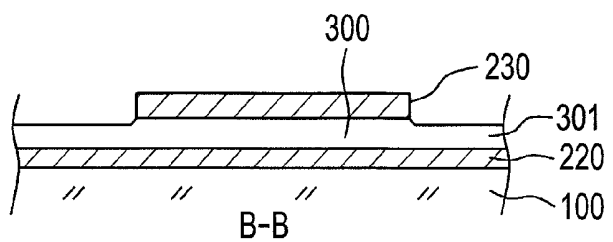
FIG. 2*FIG. 3**FIG. 4**FIG. 5*

FIG. 6

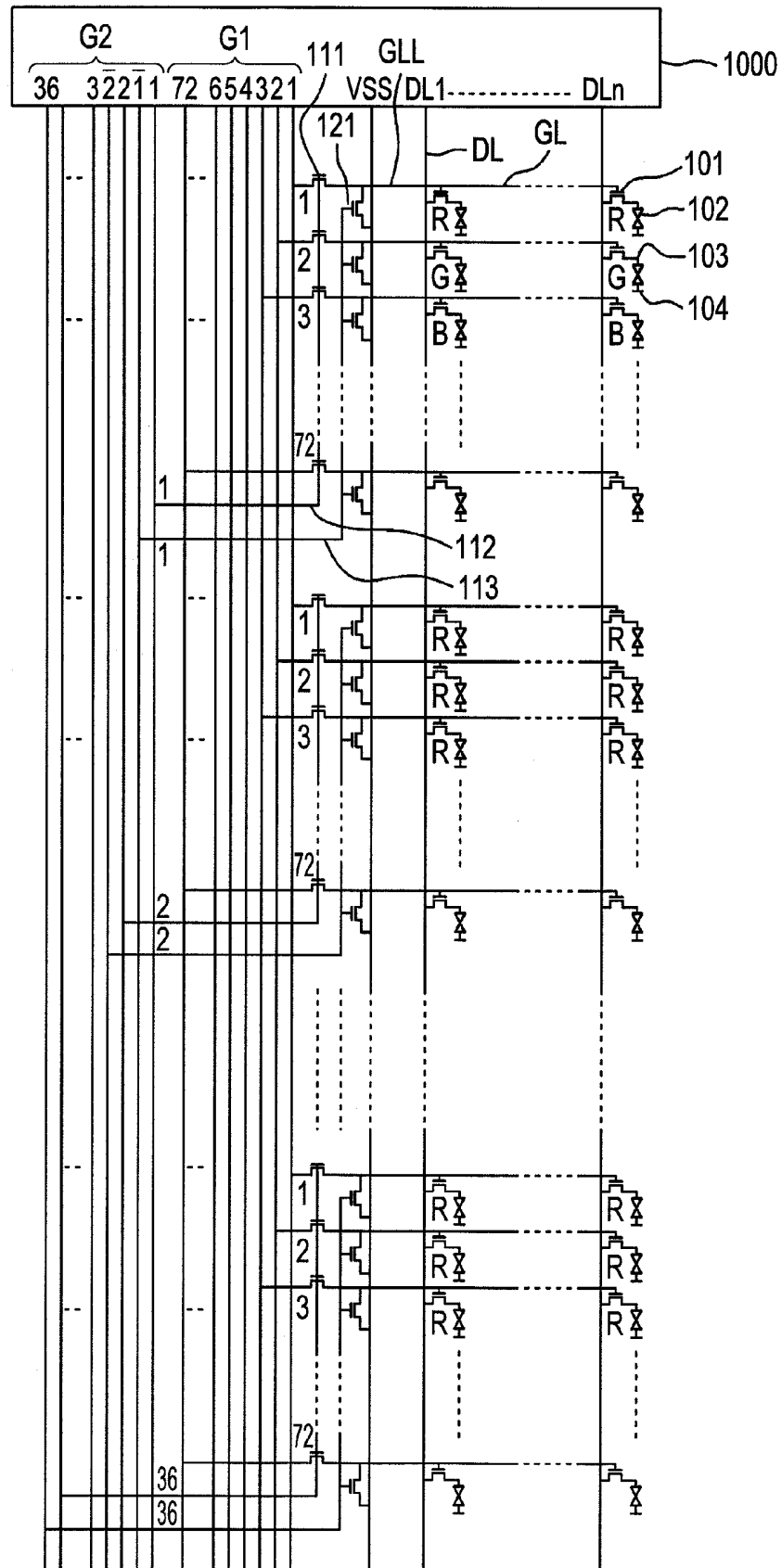


FIG. 7
PRIOR ART

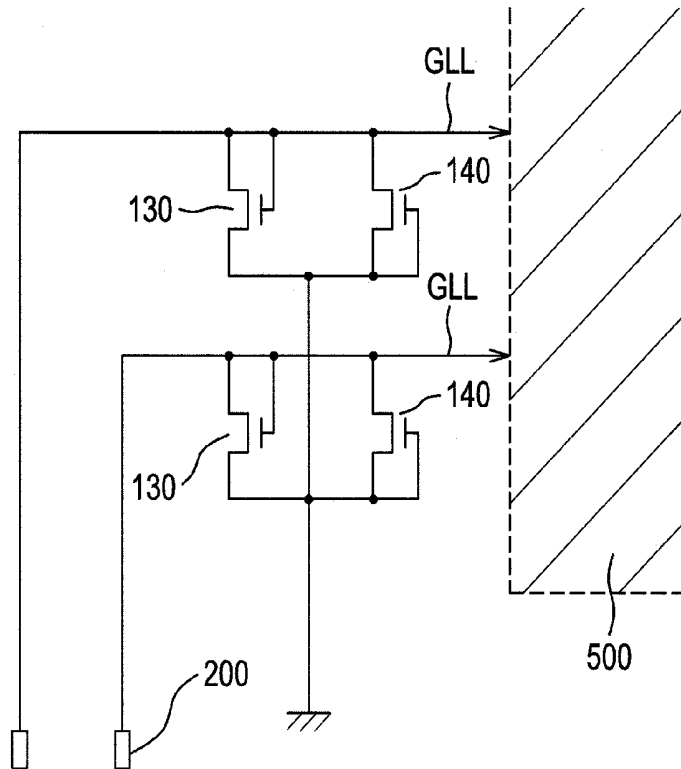
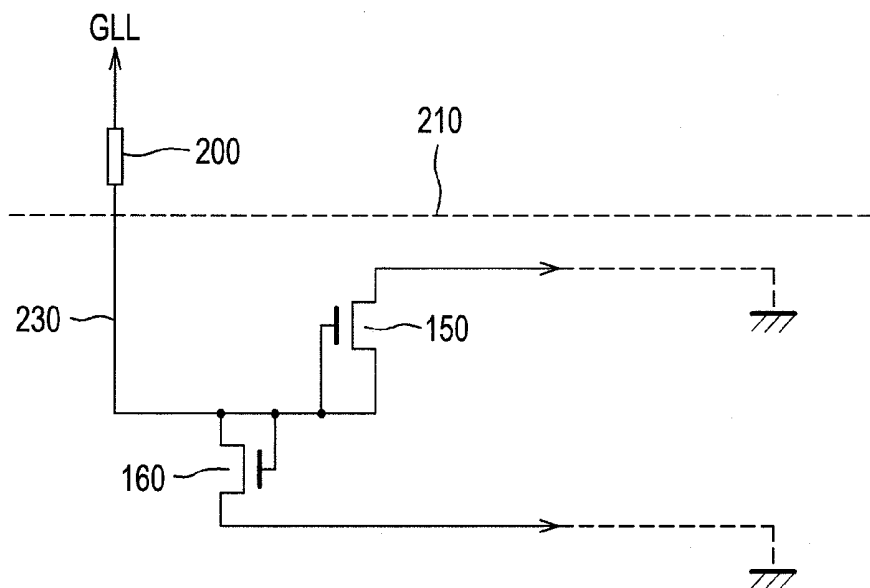


FIG. 8
PRIOR ART



LIQUID CRYSTAL DISPLAY DEVICE AND MANUFACTURING METHOD THEREOF

CLAIM OF PRIORITY

The present application claims priority from Japanese Patent Application JP 2010-051862 filed on Mar. 9, 2010, the content of which is hereby incorporated by reference into this application.

FIELD OF THE INVENTION

The present invention relates to a display device, and more particularly to a display device configured to prevent a reduction in the yield due to dielectric breakdown by static electricity generated in the manufacturing process.

BACKGROUND OF THE INVENTION

In a liquid crystal display device, a TFT substrate and a counter substrate are disposed opposite to each other with a liquid crystal interposed between the two substrates. The TFT substrate is a substrate in which pixels are arranged in a matrix form. Each of the pixels includes a pixel electrode, a thin film transistor (TFT), and the like. The counter substrate is a substrate in which color filters and the like are formed at locations corresponding to the pixel electrodes of the TFT substrate. With this configuration, the liquid crystal display device forms an image by controlling the transmittance of light of the liquid crystal molecules for each pixel.

There are various photolithography processes, in particular, in the formation of the TFT substrate of the liquid crystal display device. However, static electricity can easily be generated in the photolithography processes such as film formation and drying using a spinner. In the TFT substrate, a large number of scan lines and image signal lines intersect each other through an interlayer insulation film. Further, a large number of TFTs are formed to control these lines. When static electricity is generated in the manufacturing process, the interlayer insulation film is destroyed. As a result, a short circuit occurs between the scan line and the image signal line, or the TFT is destroyed. For this reason, the static electricity generated in the manufacturing process has a significant influence on the manufacturing yield.

In order to prevent the dielectric breakdown and TFT destruction caused by static electricity, measures are taken that prevent static electricity from entering a display area in which pixels and the like are formed, for example, by allowing the static electricity to flow to earth before entering the display area. JP-A No. 203761/2008 describes a configuration that protects a scan line drive circuit and the like provided in the vicinity of the display area, from external static electricity. In this configuration, a conductive film is coated on the surface of the scan line drive circuit and the like, and is grounded through an insulating film. Further, JP-A No. 21909/2001 describes an example of a diode circuit for protection against static electricity produced in the vicinity of the display area.

TFT using a-Si film is used in relatively large displays such as TV screens. On the other hand, TFT using poly-Si is used in relatively small displays such as mobile phones and portable game consoles. In the case of a liquid crystal display device using poly-Si TFT, the mobility of poly-Si is high, so that a drive circuit is formed by the TFT. Then, a scan line GL drive circuit and the like are mounted in a substrate.

The large liquid crystal display device using the a-Si TFT and the small liquid crystal display device using the poly-Si

TFT are different in the configuration for protection against static electricity due to the difference in the space of the substrate. The large liquid crystal display device using the a-Si TFT has a relatively large space. Thus, a diode circuit is formed outside a display area **500** in which pixels are arranged in a matrix form, to protect the display area **500** from static electricity. FIG. 7 shows the circuit configuration.

In FIG. 7, a static electricity protection circuit is formed between the display area **500** and a terminal **200** coupled to a scan line GL. In FIG. 7, the static electricity protection circuit is formed using diode. The diode is formed by coupling a gate and a drain or source of a TFT. In FIG. 7, when large positive static electricity enters from the terminal **200**, a diode **130** is turned on. When large negative static electricity enters, a diode **140** is turned on. This allows the static electricity to flow to earth, preventing destruction of the TFT in the display area **500**, or preventing dielectric breakdown of an interlayer insulating film **300**.

The small liquid crystal display device using the poly-Si TFT has a small substrate. In addition, a portion of the drive circuit formed by the TFT is mounted in the substrate. Thus, it is difficult to provide the static electricity protection circuit within the substrate. Such a small liquid crystal display device is manufactured by the following steps. First, a large number of substrates are formed on a mother panel. Then, the substrates are separated from the mother panel by scribing or other means. In this way, individual liquid crystal display devices are formed.

Thus, in the small liquid crystal display device using the poly-Si TFT, a small space is formed between the individual substrates, in which a static electricity protection circuit and the like are formed. At the time of scribing, the small space is removed and discarded. Because large static electricity is generated in the manufacturing process, the static electricity protection circuit is not used after completion of the product.

FIG. 8 shows the configuration of the static electricity protection circuit in the small liquid crystal display device described above. In FIG. 8, the substrate is located above a scribing line **210**. Although the substrate includes the terminals **200** and the display area **500** or other components, only one terminal is shown in FIG. 8.

In FIG. 8, a static electricity protection line **230** extends beyond the scribing line **210** to the outside of the substrate. The static electricity protection line **230** is coupled to a diode **150** as well as a diode **160**. Each of the diodes **150** and **160** is formed by coupling a gate and a drain or source of the TFT. Here, it is assumed that large static electricity is induced in the vicinity of the terminal **200**. The diodes **150** and **160** are turned on to allow the static electricity to flow to earth. Thus, the TFT of the display area **500** or the interlayer insulating film and the like in the substrate is protected from the static electricity.

However, the higher the resolution demanded in the display the more the number of pixels. As a result, the number of scan lines GL, the number of signal lines DL and the like increase. For example, if the number of scan lines GL increases, it is difficult to form the static electricity protection circuit for each scan line GL in the limited space.

Meanwhile a selector driving method has been developed to address the increase in the number of scan lines GL due to the increased resolution. The selector driving method is a method for dividing the scan lines GL into a plurality of blocks, and scanning the scan lines GL for each block to reduce the number of leader lines of the scan lines GL. However, in the case of the selector driving method, the number of control TFTs increases to control the scan lines GL for each block. As a result, it is necessary to have a space for the

control TFTs. Thus, the problem of lack of space for the static electricity protection circuit still remains.

SUMMARY OF THE INVENTION

The present invention provides a configuration that can prevent the TFT or the interlayer insulating film **300** from being destroyed by static electricity, even if the number of pixels increases due to the increased resolution.

The present invention overcomes the above problem by means described in detail below.

(1) There is provided a liquid crystal display device including a substrate. The substrate includes a display area, a control area adjacent to the display area, and terminals. In the display area, scan lines extend in a first direction and are arranged in a second direction. Further, image signal lines extend in the second direction and are arranged in the first direction. In addition, pixels are formed in each area surrounded by the scan lines and the image signal lines. In the control area, scan leaders coupled to the scan lines extend in the first direction and are arranged in the second direction. Further, control lines extend in the second direction and are arranged in the first direction. Then, the terminals are coupled to the control lines. An interlayer insulating film and an a-Si film are formed below the image signal line in the display area and below a line formed in the same layer as the image signal line in the control area. A line is formed in the same layer as the image signal line outside the terminal. The line is electrically coupled to the terminal. The interlayer insulating film is formed below the line outside the terminal. However, the a-Si film is not formed below the line outside the terminal.

(2) In the liquid crystal display device described in (1), a width of the a-Si film is greater than a width of the image signal line, or greater than a width of the line formed in the same layer as the image signal line in the control area.

(3) There is provided a method of manufacturing a liquid crystal display device. The liquid crystal display device includes a substrate having a display area, a control area adjacent to the display area, and terminals. In the display area, scan lines extend in a first direction and are arranged in a second direction. Further, image signal lines extend in the second direction and are arranged in the first direction. In addition, pixels are formed in each area surrounded by the scan lines and the image signal lines. In the control area, scan leaders coupled to the scan lines extend in the first direction and are arranged in the second direction. Further, control lines extend in the second direction and are arranged in the first direction. Then, the terminals are coupled to the control lines. The manufacturing method of the liquid crystal display device includes the steps of: forming an interlayer insulating film and an a-Si film below the image signal line in the display area and below a line formed in the same layer as the image signal line in the control area; forming a scribing line outside the terminal to separate the substrate; forming an earth line in the same layer as the scan line outside the scribing line; forming the interlayer insulating film outside the terminal, without forming the a-Si film on the interlayer insulating film; forming a static electricity protection line electrically coupled to the terminal on the interlayer insulating film; forming the static electricity protection line so as to be coupled to other static electricity protection lines outside the earth line; and after the above steps, separating the substrate along the scribing line.

(4) In the manufacturing method of the liquid crystal display device described in (3), a width of the a-Si film below the image signal line in the display area is greater than a width of the image signal line. The width of the a-Si film below a line

formed in the same layer as the image signal line in the control area is greater than a width of the line formed in the same layer of the image signal line.

(5) There is provided a liquid crystal display device includes a substrate. The substrate includes a display area, and terminals for supplying signals to the display area. In the display area, scan lines extend in a first direction and are arranged in a second direction. Further, image signal lines extending in the second direction and are arranged in the first direction. In addition, pixels are formed in each area surrounded by the scan lines and the image signal lines. Then, an interlayer insulating film and an a-Si film are formed between the image signal line and the scan line in the display area. A line is formed in the same layer as the image signal line outside the terminal. The line is electrically coupled to the terminal. The interlayer insulating film is formed below the line outside the terminal. However, the a-Si film is not formed below the line outside the terminal.

(6) There is provided a method of manufacturing a liquid crystal display device. The liquid crystal display device includes a substrate having a display area, and terminals for supplying signals to the display area. In the display area, scan lines extend in a first direction and are arranged in a second direction. Further, image signal lines extend in the second direction and are arranged in the first direction. In addition, pixels are formed in each area surrounded by the scan lines and the image signal lines. The manufacturing method of the liquid crystal display device includes the steps of: forming an interlayer insulating film and an a-Si film below the image signal line in the display area; forming a scribing line outside the terminal to separate the substrate; forming an earth line in the same layer as the scan line outside the scribing line; forming the interlayer insulating film outside the terminal, without forming the a-Si film on the interlayer insulating film; forming a static electricity protection line electrically coupled to the terminal on the interlayer insulating film; forming the static electricity protection line so as to be coupled to other static electricity protection lines outside the earth line; and after the above steps, separating the substrate along the scribing line.

According to the present invention, it is possible to form a static electricity protection circuit without using a diode circuit. Thus, the space for the static electricity protection circuit can be significantly reduced. Further, according to the present invention, the static electricity protection circuit can be achieved in practice without using any circuit element, resulting in a significant reduction in the manufacturing costs.

Furthermore, according to the present invention, it is possible to significantly reduce the space for the static electricity protection circuit. Thus, a high-resolution and highly reliable display with a large number of pixels can be manufactured at low cost.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic plan view of a liquid crystal display device according to the present invention;

FIG. 2 is a cross-sectional view in a scan line control area according to a first embodiment;

FIG. 3 is a cross-sectional view of the intersection between a static electricity protection line and an earth line according to the first embodiment;

FIG. 4 is a cross-sectional view in the scan line control area according to a second embodiment;

FIG. 5 is a cross-sectional view of the intersection between the static electricity protection line and the earth line according to the second embodiment;

5

FIG. 6 is a circuit diagram of the liquid crystal display device using a selector driving method;

FIG. 7 is an example of a protection circuit using diode; and

FIG. 8 is another example of the protection circuit using diode.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be described in detail with reference to preferred embodiments.

First Embodiment

FIG. 1 is a circuit diagram of a static electricity protection circuit according to the present invention. FIG. 1 shows only a portion of a liquid crystal display device. The liquid crystal display device shown in FIG. 1 uses a selector driving method. The selector driving method can reduce the number of lines for coupling between a scan line GL and a scan line GL drive circuit, compared to the conventional driving method. However, although it is possible to reduce the number of scan lines GL or the number of lines for controlling the scan lines GL, the number of TFTs for controlling the scan lines GL increases. Hence protection against static electricity is still an important issue.

Before describing the circuitry shown in FIG. 1, the selector driving method will be described with reference to FIG. 6. In FIG. 6, a drive circuit 1000 for scan lines GL and image signal lines DL is located on the upper side of the figure. Then, a control area for driving the scan lines GL is located on the left side. In FIG. 6, the right side is a display area 500, in which pixels each including a pixel electrode 103, a pixel TFT 101, and the like, are arranged in a matrix form. In the display area 500 in FIG. 6, the scan lines GL extend in the horizontal direction and are arranged in the vertical direction. Further, the image signal lines DL extend in the vertical direction and are arranged in the horizontal direction. In addition, the pixels are formed in each area surrounded by the scan lines GL and the image signal lines DL.

The pixel TFT 101 is formed in each pixel. The drain of the pixel TFT 101 is coupled to the image signal line DL. The gate of the pixel TFT 101 is coupled to the scan line GL. The source of the pixel TFT 101 is coupled to the pixel electrode 103. A liquid crystal layer 102 is present between the pixel electrode 103 and a common electrode 104. A constant voltage is applied to the common electrode 104, and a voltage corresponding to an image signal from the image signal line DL is applied to the pixel electrode 103. In this way, the orientation state of the liquid crystal layer 102 is changed to control the transmittance of light of the liquid crystal layer 102 for each pixel. Thus, an image is formed.

The left side of FIG. 6 is the control circuit of the scan signal lines. In the conventional driving method, the same number of control lines of the scan lines GL as the number of scan lines GL should be provided on the lower side of FIG. 6. Thus, it is necessary to have a large space to provide the control lines of the scan lines GL. On the other hand, in the selector driving method shown in FIG. 6, the scan lines GL are divided into blocks to scan the scan lines GL for each block. Thus, the number of control lines of the scan lines GL is significantly reduced.

In FIG. 6, 72 scan lines GL constitute one block. In this specification, the scan line GL in the display area 500 is referred to as scan line GL, and the portion extending from the display area 500 to the outside in the horizontal direction is referred to as scan leader GLL. The scan leader is coupled to

6

the scan line GL in the display area 500. Then, a first control TFT 111 and a second control TFT 121 are coupled to the scan leader GLL. On the left side of FIG. 6, 72 first control lines G1 extend in the vertical direction. Similarly, 72 second control lines G2 extend in the vertical direction. In addition, 36 first gate lines 112 and 36 second gate lines 122, which are coupled to the second control lines G2, extend in the horizontal direction, respectively. Each scan line block containing 72 scan lines GL is selected by the first and second gate lines 112, 122.

As shown in FIG. 6, the 72 first control TFTs 111 are controlled at the same time by the first gate line 112. Also, 72 second control TFTs 121 are controlled at the same time by the second gate line 122. When the first control TFTs 111 are turned on, the second control TFTs are turned off. On the other hand, when the first control TFTs 111 are turned off, the second control TFTs 121 are turned on.

Here, for example, the top 72 scan lines GL are supposed to be a first block. When the first control TFTs 111 in the first block are turned on, the first control TFTs 111 in the second and subsequent blocks are turned off. Then, the scan lines GL in the second and subsequent blocks are in the off state during the scan of the scan lines GL in the first block.

When the scan of the first block is completed, all the first control TFTs 111 in the first block are turned off. Then, the first control TFTs 111 in the second block are turned on. Then, the scan lines GL in the second block are scanned. At this time, the scan lines GL in the first block and in the third and subsequent blocks are all in the off state.

It is to be noted that, for example, when the first control TFTs 111 in the first block are turned on and when the scan lines GL in the first block are scanned, the second TFTs 121 are turned off. Thus, the scan signal is transmitted to the scan lines GL of the display area 500. When the scan of the first block is completed and when the writing to the pixels existing in the first block is completed, the second control TFTs 121 are turned on. Then, the scan lines GL are changed to VSS level.

As described above, also in the selector driving method, the scan of the scan lines GL is performed in the same manner as in the normal driving method. In the normal driving, the necessary number of control lines for controlling the scan lines GL is, for example, $72 \times 36 = 2592$ lines. However, in the selector driving method, the necessary number of control lines is only $72 \times 2 = 144$ lines. For this reason, the number of control lines of the scan lines GL can be significantly reduced in the selector driving method compared to the conventional method.

However, the selector driving method requires a large number of first control TFTs 111 and second control TFTs 121 in order to control the control lines of the scan lines GL. For example, in FIG. 6, the necessary number of first control TFTs 111 is $72 \times 36 = 2592$, and the necessary number of second control TFTs 121 is $72 \times 36 = 2592$. The space occupied by the first control TFTs 111 and by the second control TFTs 121 is much smaller than the space for providing the control lines of the scan lines GL. However, the size of the substrate 100 is limited, so that the problem of space arises when the number of pixels increases.

The present invention prevents the TFT or the interlayer insulating film 300 from being destroyed by static electricity, only by the configuration of the static electricity protection lines 230 as shown in FIG. 1, without using the diode circuit as a circuit for protecting against static electricity. FIG. 1 is an enlarged view of the scan lines GL in the bottommost 36th block in FIG. 6, together with the terminals 200, the scribing line 210, the earth line 220, and the static electricity protec-

tion lines 230. In other words, FIG. 1 is an enlarged view of the lower left portion of the liquid crystal display device. It is to be noted that the particular potential VSS in FIG. 6 corresponds to the earth potential in FIG. 1.

In FIG. 1, the right side shows the display area 500 in which pixels are arranged in a matrix form. Each pixel includes the pixel TFT 101, the pixel electrode 103, the liquid crystal layer 102, the common electrode 104, and the like. The scan leaders GLL extend from the scan lines GL of the display area 500 to the left side. Both of the first TFT 111 and the second TFT 121 are coupled to the scan leader GLL.

The 72 first control TFTs 111 are controlled by the second control line G2 that transmits the 36th positive signal. The 72 second control TFTs 121 are controlled by the second control line G2 that transmits the 36th negative signal. When the first control TFTs 111 are turned on, the second control TFTs 121 are turned off. On the other hand, when the first control TFTs 111 are turned off, the second control TFTs 121 are turned on. The selector driving method is the same as described with reference to FIG. 6.

In FIG. 1, the 72 first control lines G1 extend in the vertical direction. Similarly, the 72 second control lines G2 extend in the vertical direction. The first control TFTs 111 and the second control TFTs 121 are coupled to the terminals 200 formed in an end portion of the substrate 100. The dotted line drawn on the outside of the terminals 200 represents the scribing line 210. In other words, after completion of the substrate 100, the substrate 100 is separated from the mother panel along the scribing line 210.

In FIG. 1, the earth line 220 is formed outside the scribing line 210 to surround the scribing line 210. FIG. 1 only shows the lower left portion of the liquid crystal display device. However, actually, the earth line 220 surrounds the entire circumference of the scribing line 210. The earth line 220 is formed in the same layer as the scan line GL in the display area 500.

Each of the static electricity protection lines 230 extends from each terminal 200 beyond the scribing line 210 to the outside of the earth line 220. Then, each of the static electricity protection lines 230 is coupled together outside the earth line 220. FIG. 1 shows a state in which the static electricity protection lines 230 are coupled to each other outside the earth line 220. This is the state of the manufacturing process. After completion of the substrate 100, the portion outside the substrate 100 is removed along the scribing line 210. In this way, the terminals 200 are insulated from each other after completion of the substrate 100.

The static electricity protection line 230 is formed in the same layer as the image signal line DL in the display area 500. Thus, the interlayer insulating film 300 is formed between the earth line 220 and the static electricity protection line 230. In general, the interlayer insulating film 300 is formed using SiN. For example, the lower line formed in the same layer as the scan line GL, namely, the earth line 220, is formed using MoW. Further, for example, the upper line formed in the same layer as the image signal line DL, namely, the static electricity protection line 230, is formed by Al alloy.

In the area inside the terminals 200 in FIG. 1, namely, in the area indicated by C in FIG. 1, the first and second control lines G1, G2, intersect the scan leaders GLL as well as the first and second gate lines 112, 122, through the interlayer insulating film 300 and the a-Si film 400. In the display area 500, the scan lines GL and the image signal lines DL intersect each other also through the interlayer insulating film 300 and the a-Si film 400.

As described above, in the area inside the terminals 200, not only the interlayer insulating film 300 but also the a-Si

film 400 is provided between the upper and lower lines, to prevent short circuit in the intersections between the upper and lower lines. In other words, the a-Si film 400 undoped with impurities has a high electrical resistivity, and is the same as the insulation material. Thus, the a-Si film 400 has the same effect as the interlayer insulating film 300. In other words, in the intersection between the upper and lower lines, there is the same effect as forming two layers of the interlayer insulation film 300.

FIG. 2 is a view of the state described above. FIG. 2 shows, for example, an A-A cross-sectional view of FIG. 1. In FIG. 2, the scan leader GLL, which is the lower line, extends in the horizontal direction on the substrate 100. The interlayer insulating film 300 is formed on the scan leader GLL. The a-Si film 400 is formed on the interlayer insulating film 300. Then, the first control line G1, which is the upper line, extends on the a-Si film 400 vertically on the paper. It is to be noted that the intersection between the scan line GL and the image signal line DL in the display area 500 has the same configuration as shown in FIG. 2.

The a-Si film 400 is slightly smaller than the first control line G1, extending below the first control line G1 in the same direction as the first control line G1. As shown in FIG. 2, the width of the a-Si film 400 is greater by about $w1=1\text{ }\mu\text{m}$ on one side, than the width of the first control line G1. Here, the thickness of the interlayer insulating film 300 is, for example, about 200 nm. The thickness of the a-Si film 400 is, for example, about 50 nm. The withstanding voltage between the upper line G1 and the lower line GLL is increased by the presence of the a-Si film 400 in the area inside the terminals 200, taking into account the case in which a certain amount of static electricity enters the area.

While in the area outside the terminal 200, namely, in the area indicated by D in FIG. 1, the earth line 220, which is the lower line, intersect each static electricity protection line 230, which is the upper line. The interlayer insulating film 300 is formed between the earth line 220 and the static electricity protection line 230. However, unlike the area C, the a-Si film 400 is not formed on the interlayer insulating film 300 in the intersecting portion.

FIG. 3 is a view of the state described above. In FIG. 3, the earth line 220, which is the lower line, extends in the horizontal direction on the substrate 100. The interlayer insulating film 300 is present on the earth line 220. Then, the static electricity protection line 230 extends on the interlayer insulating film 300 vertically on the paper. Only the interlayer insulating film 300, but not the a-Si film 400, is present between the earth line 220 and the static electricity protection line 230.

When FIG. 2 and FIG. 3 are compared, the interlayer insulating film 300 does not exist between the lower and upper lines in FIG. 3. Thus, when static electricity enters, dielectric breakdown is more likely to occur in the configuration of FIG. 3 than in the configuration of FIG. 2. In other words, when static electricity enters, dielectric breakdown occurs in the intersection X between the earth line 220 and the static electricity protection line 230 in FIG. 1. This allows the static electricity to escape to the earth line 220. As a result, the control area formed in the area C in FIG. 1, as well as the interlayer insulating film and the TFT in the display area 500, can be protected from the static electricity.

As shown in FIG. 1, the feature of the present invention is to provide protection against such static electricity only by the three-dimensional wiring structure without using the diode circuit. As the present invention does not use the diode circuit, it is possible to significantly reduce the space for the protection circuit against static electricity. In addition, as the present

invention does not use the diode circuit or the like and has a simple configuration, it is possible to form the protection circuit at a low cost and to prevent the manufacturing yield from lowering due to the protection circuit.

Second Embodiment

There is also a process in which the interlayer insulating film **300** is slightly etched during etching of the a-Si film **400**. FIG. **4** shows an example of this case in FIG. **1**. FIG. **4** shows a portion corresponding to the A-A cross section of the area C inside the terminals **200** in FIG. **1**. Further, FIG. **5** shows a portion corresponding to the B-B cross section of the area D outside the terminal **200** in FIG. **1**.

In FIG. **4**, the interlayer insulating film **300** keeps the original film thickness below the a-Si film **400**. However, in the portion not covered with the a-Si film **400**, namely, in the portion indicated by **301**, the thickness of the interlayer insulating film is smaller than the original film thickness. However, in FIG. **4**, the width of the a-Si film **400** is greater than the width of the upper line. For this reason, the withstanding voltage between the lower line GLL and the upper line G1 is hardly reduced.

FIG. **5** is a cross-sectional view of the intersection between the earth line **220** and the static electricity protection line **230** outside the terminal **200**. In FIG. **5**, the interlayer insulating film keeps the original film thickness below the static electricity protection line **230**. However, in the portion other than the portion below the static electricity protection line **230**, namely, in the portion indicated by **301**, the thickness of the interlayer insulating film is smaller than the original film thickness. In FIG. **5**, the thickness of the interlayer insulating film **300** is reduced in an end portion of the static electricity protection line **230**. Thus, the withstanding voltage is reduced in this portion.

As described above, using the process to slightly reduce the thickness of the interlayer insulating film **300** during the etching of the a-Si film **400**, the difference in the withstanding voltage further increases between the area inside the terminal **200** in FIG. **1**, namely, the area C, and the area outside the terminal **200** in FIG. **1**, namely, the area D.

Thus, according to this embodiment, when static electricity is generated, the protection of the TFT or the interlayer insulating film in the display area **500** and the control area can be further ensured.

The above description assumes that the liquid crystal display device uses the selector driving method, but the present invention is not limited to this example. The present invention may also be applied to a liquid crystal display device having a configuration in which the lower lines such as the scan lines GL, and the upper lines such as the image signal lines DL, intersect each other through the interlayer insulating film **300**.

Further, the above description assumes that the a-Si film **400** is formed on the interlayer insulating film **300** and below the upper lines in the display area **500** and in the control area. However, the same effect can be obtained when poly-Si is formed.

What is claimed is:

1. A liquid crystal display device comprising a substrate, wherein the substrate includes a display area, a control area adjacent to the display area, and terminals, wherein the display area includes: scan lines extending in a first direction and arranged in a second direction; image signal lines extending in the second direction and arranged in the first direction; and

pixels each formed in an area surrounded by the scan lines and the image signal lines,

wherein the control area includes:

scan leaders extending in the first direction and arranged in the second direction, each of the scan leaders being coupled to one of the scan lines;

first lines extending in the second direction and arranged in the first direction, each of the first lines being coupled to at least one of the scan leaders and intersecting a plurality of others of the scan leaders which it is not coupled to, and

second lines extending to an edge of the substrate, wherein the terminals are coupled to the first lines, at a first location which is away from the edge of the substrate, and are coupled to the second lines at second location which is closer to the edge of the substrate than the first location,

wherein an interlayer insulating film and an a-Si film are formed below the first lines,

wherein each of the first lines intersects the plurality of the other scan leaders to which it is not coupled via the interlayer insulating film and the a-Si film,

wherein the interlayer insulating film is formed below the second lines, and

wherein the a-Si film is not formed below the second line.

2. The liquid crystal display device according to claim 1, wherein a width of the a-Si film is greater than a width of a corresponding one of the first lines which it covers.

3. The liquid crystal display device according to claim 2, wherein the a-Si film has a plurality of strips extending in the second direction,

each of the strips is disposed respectively below one of the first lines, and

the interlayer insulating film is disposed below the plurality of strips.

4. The liquid crystal display device according to claim 1, wherein the scan lines intersect the image signal lines via the interlayer insulating film and the a-Si film.

5. The liquid crystal display device according to claim 1, wherein the first and second lines are formed in the same layer as the image signal lines.

6. The liquid crystal display device according to claim 1, wherein the scan leaders are formed in the same layer as the scan lines.

7. The liquid crystal display device according to claim 1, wherein the substrate is separated from a mother substrate along a scribing line which surrounds the substrate, the mother substrate has an earth line outside the scribe line, and third lines coupled to the second lines,

the interlayer insulating film is formed below the third lines,

the earth line intersects the third lines through the interlayer insulating film, and

the a-Si film is not formed below the third lines.

8. A liquid crystal display device comprising a substrate, wherein the substrate includes a display area, and terminals for supplying signals to the display area,

wherein the display area includes:

scan lines extending in a first direction and arranged in a second direction;

image signal lines extending in the second direction and arranged in the first direction; and

pixels each formed in an area surrounded by the scan lines and the image lines,

wherein the image signal lines intersect the scan lines via an interlayer insulating film and an a-Si film in the display area,

wherein the terminals are coupled to the scan lines at a first location which is away from an edge of the substrate, and are coupled to first lines at a second location which is closer to the edge of the substrate than the first location, wherein the first lines are formed in the same layer as the image signal lines, and extend to the edge of the substrate, wherein the interlayer insulating film is formed below the first lines, and wherein the a-Si film is not formed below the first lines. 10

9. The liquid crystal display device according to claim 8, wherein the substrate is separated from a mother substrate along a scribing line which surrounds the substrate, the mother substrate has an earth line outside the scribing line, and second lines coupled to the first lines, 15 the interlayer insulating film are formed below the second lines, the earth line intersects the second lines through the interlayer insulating film, and the a-Si film is not formed below the second lines. 20

* * * * *

专利名称(译)	液晶显示装置及其制造方法		
公开(公告)号	US8610868	公开(公告)日	2013-12-17
申请号	US13/042490	申请日	2011-03-08
[标]申请(专利权)人(译)	株式会社日立显示器		
申请(专利权)人(译)	日立显示器有限公司.		
当前申请(专利权)人(译)	日立显示器有限公司. 松下液晶显示CO., LTD.		
[标]发明人	SAITOU TERUNORI MIYAKE HIDEKAZU KAITOH TAKUO OWAKU YOSHIHARU		
发明人	SAITOU, TERUNORI MIYAKE, HIDEKAZU KAITOH, TAKUO OWAKU, YOSHIHARU		
IPC分类号	G02F1/1345		
CPC分类号	G02F1/13458 G02F1/136204 G02F1/1333 G02F2001/133388 G02F2202/103 G02F2202/22		
审查员(译)	NGUYEN, 龚便		
优先权	2010051862 2010-03-09 JP		
其他公开文献	US20110221985A1		
外部链接	Espacenet USPTO		

摘要(译)

为了通过低成本减小面积的静电来防止TFT或层间绝缘膜的介电击穿，液晶显示装置具有在显示区域中形成层间绝缘膜和a-Si膜的结构。和终端内的控制区域。图像信号线和扫描线在它们的交叉点中通过层间绝缘膜和a-Si膜彼此绝缘。另一方面，在静电保护线和端子外部的地线之间仅形成层间绝缘膜。当感应出静电时，在端子外部的区域中发生介电击穿。因此，保护显示区域和控制区域免受静电影响。

