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(54) **LIQUID CRYSTAL DISPLAY HAVING A REPAIR LINE WITH REDUCED PARASITIC CAPACITANCE AND METHOD FOR MANUFACTURING THE SAME**

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(57) **ABSTRACT**

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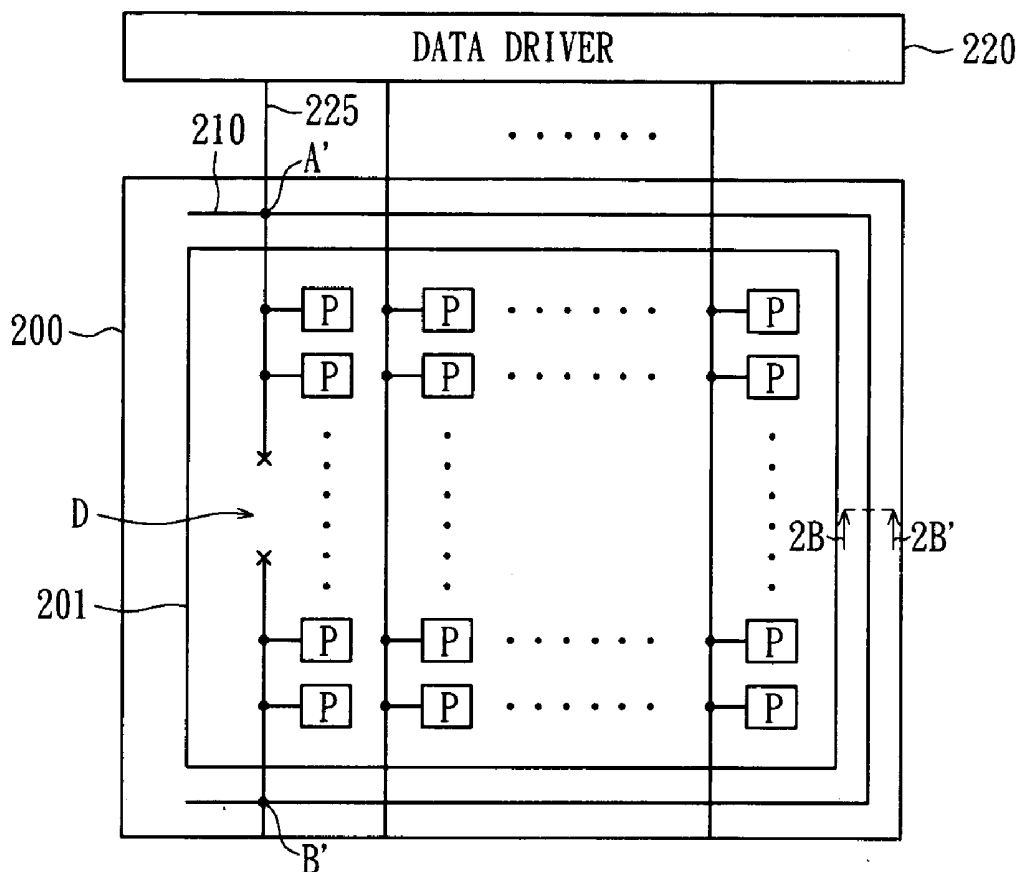
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A liquid crystal display having a repair line with reduced parasitic capacitance and a method for manufacturing the same. The liquid crystal display includes a first substrate, a second substrate, a plurality of crystal liquid molecules, a repair line, and a protrusion. The first substrate includes a color filter. The second substrate, disposed substantially parallel to the first substrate, includes an active matrix having a plurality of scan lines and signal lines interlaced each other. The crystal liquid molecules are disposed between the first and second substrates. The repair line is disposed on an outer side of the active matrix. The protrusion is opposite to the repair line and disposed on a side of the first substrate that is opposite to the second substrate.

20

10

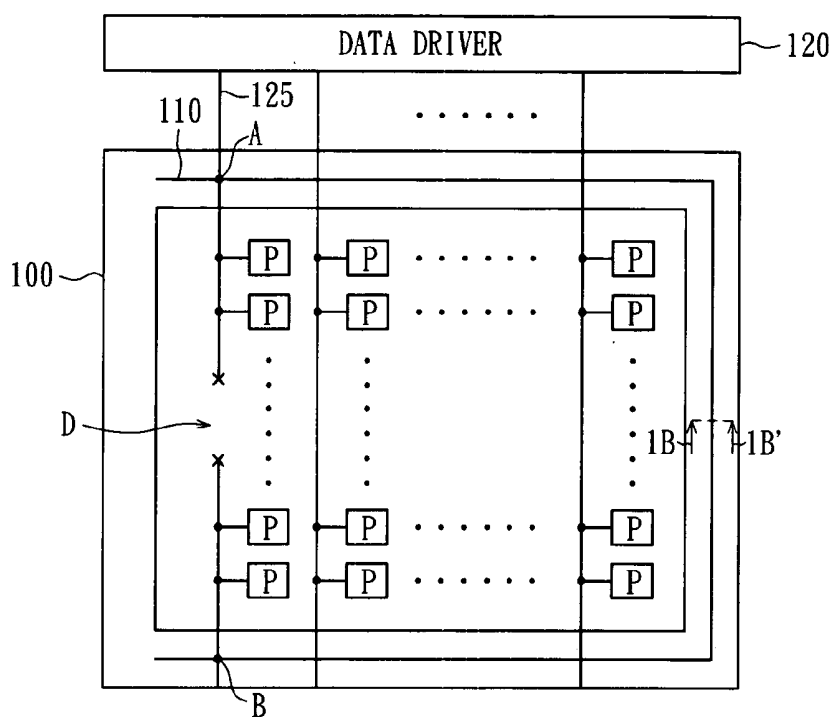


FIG. 1A(RELATED ART)

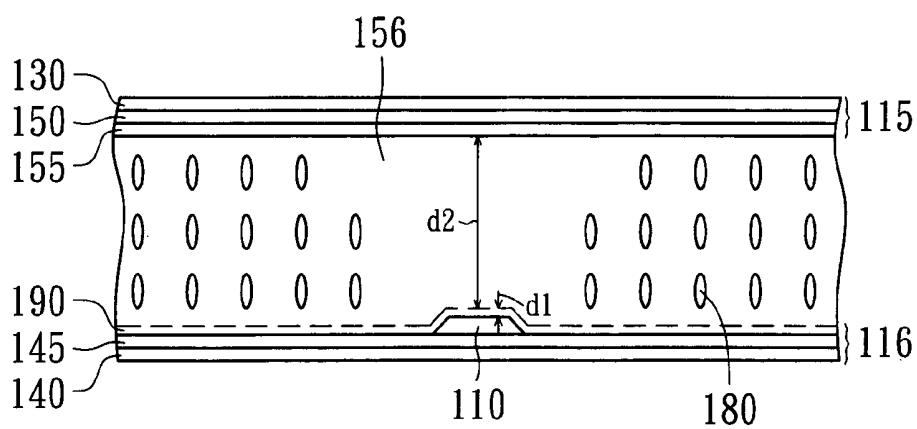


FIG. 1B(RELATED ART)

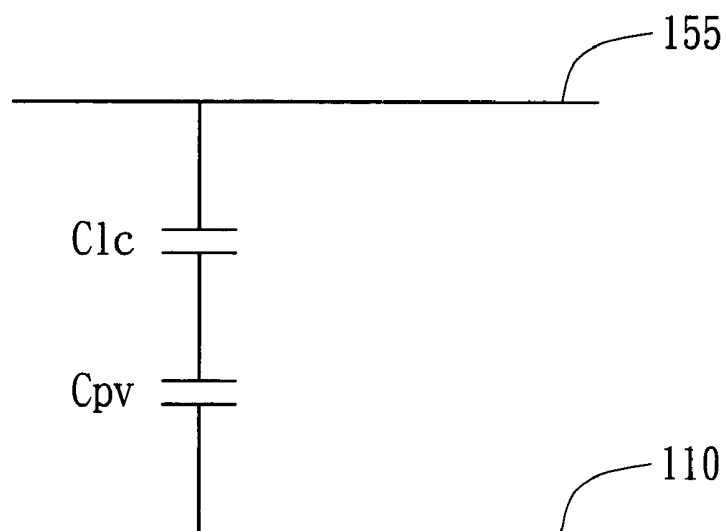


FIG. 1C(RELATED ART)

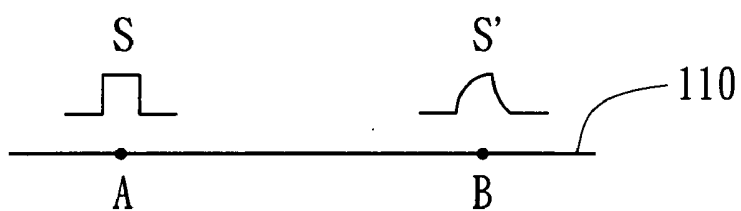


FIG. 1D(RELATED ART)

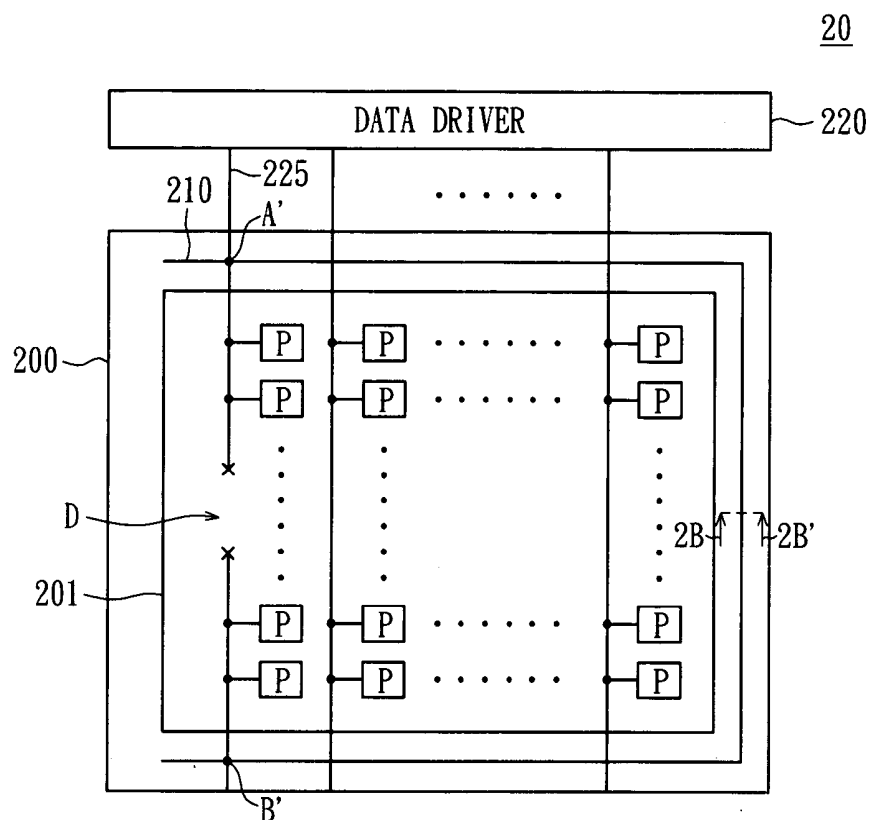


FIG. 2A

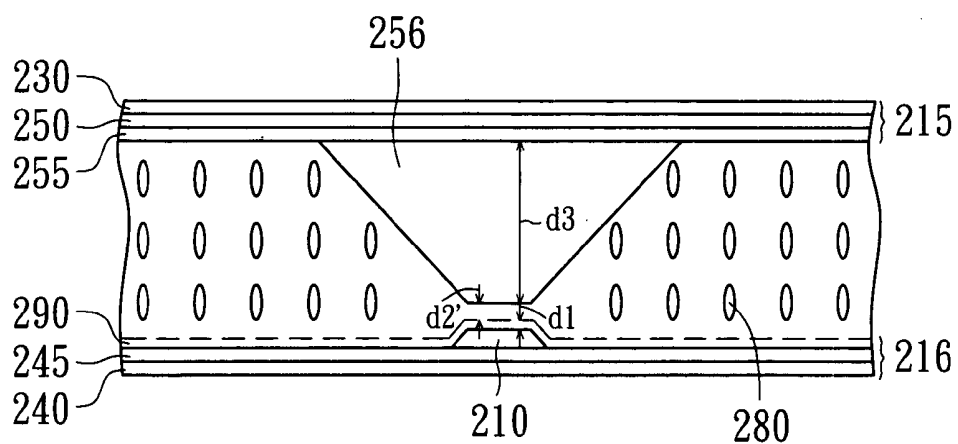


FIG. 2B

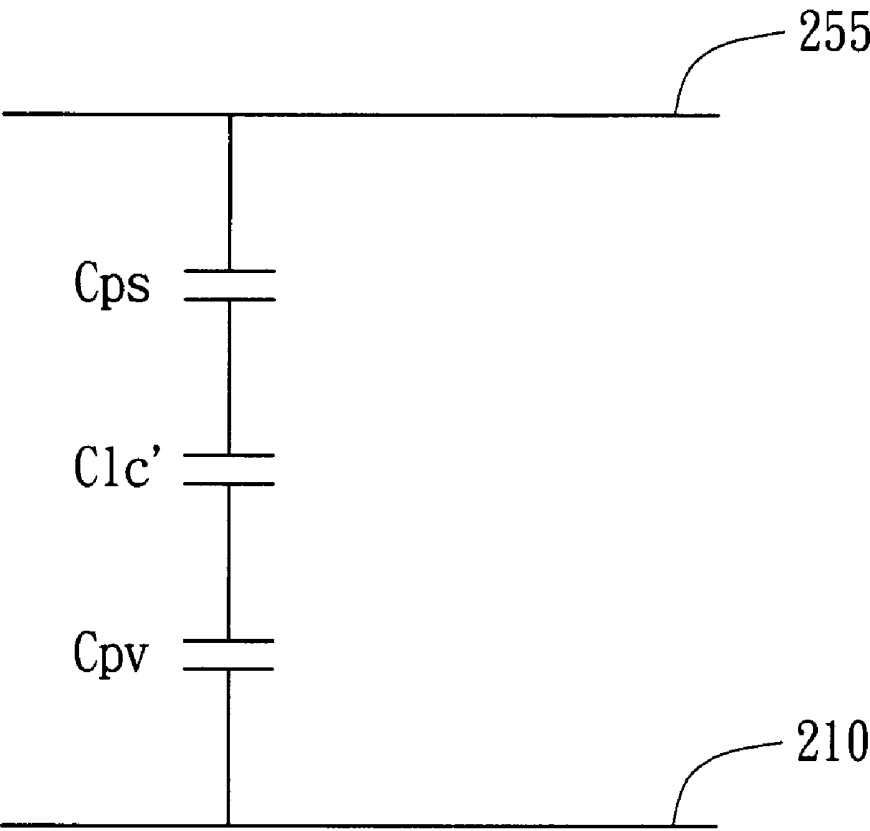


FIG. 3

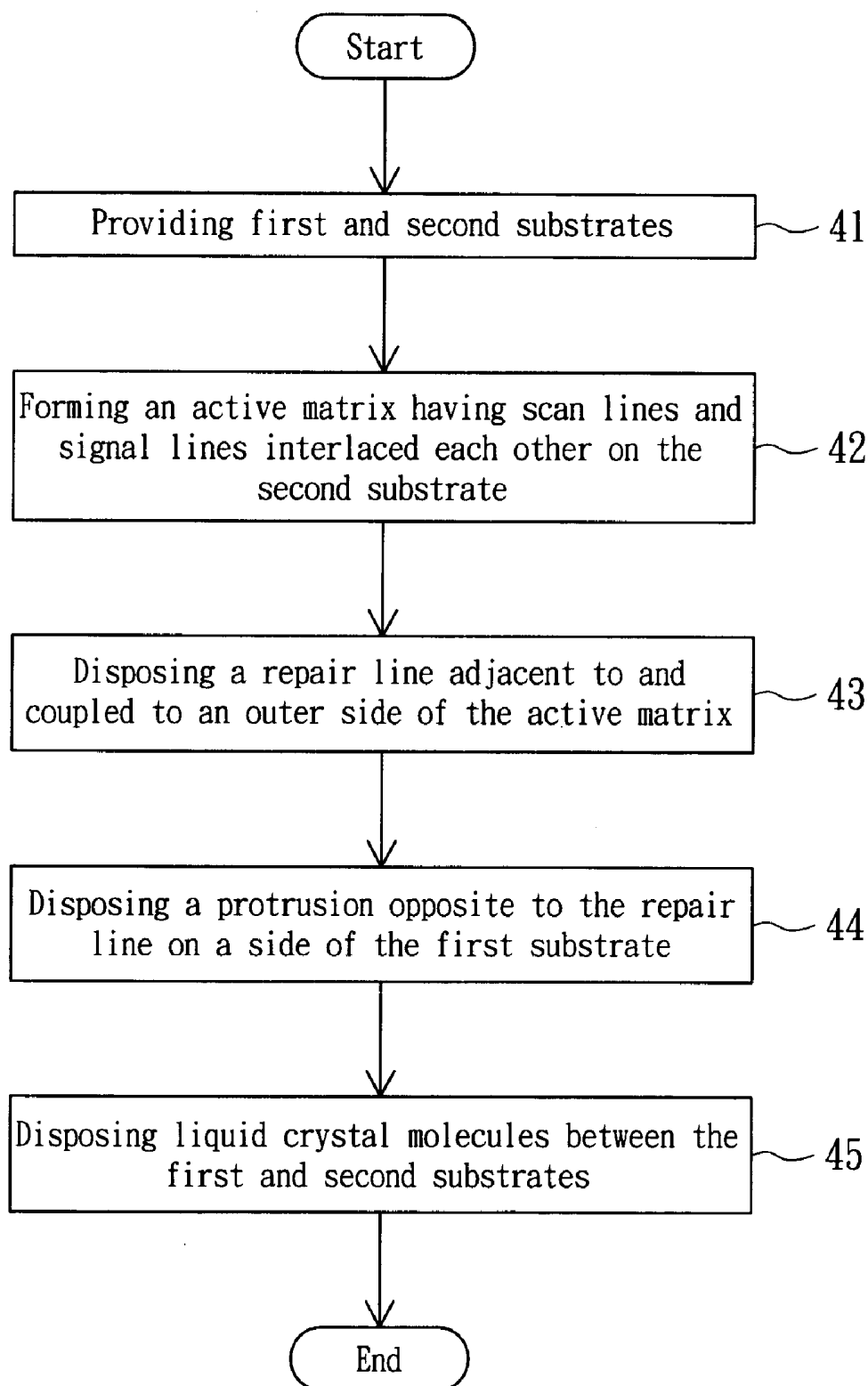


FIG. 4

LIQUID CRYSTAL DISPLAY HAVING A REPAIR LINE WITH REDUCED PARASITIC CAPACITANCE AND METHOD FOR MANUFACTURING THE SAME

[0001] This application claims the benefit of Taiwan application Serial No. 94106352, filed Mar. 2, 2005, the subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates in general to a liquid crystal display (LCD) and a method for manufacturing thereof, and more particularly to an LCD having a repair line with reduced parasitic capacitance.

[0004] 2. Description of the Related Art

[0005] **FIG. 1A** illustrates a conventional structure of an LCD. The conventional LCD **10** includes a data driver **120**, signal lines **125**, and conventional LCD panel **100**. The data driver **120** drives the conventional LCD panel **100** through the signal lines **125** so as to display video frames. One of the signal lines **125** is electrically connected to a plurality of pixel electrodes. When one of the signal lines **125** is broken, as shown at location D, display deficiency occurs because some of the related pixel electrodes fail to electrically connect to the data driver **120** and cannot receive data signals. A conventional approach to repairing the broken one of the signal lines **125** is to dispose a repair line **110** on the borders of the conventional LCD panel **100**. When one of the signal lines **125** is broken, two opening ends of the broken signal line, for example A and B as shown in **FIG. 1A**, can be made connected to the repair line **110** by using laser welding. In this way, video data from the data driver **120** can be fed into the pixel electrodes that previously failed to be connected to the data driver **120** due to the broken one of the signal lines **125**.

[0006] The influence of the repair line **110** on the conventional LCD panel **100** can be analyzed in terms of the physical structure of the conventional LCD panel **100**. **FIG. 1B** is cross-sectional view of the LCD taken along line 1B-B', where a first substrate **115**, a second substrate **116**, and a repair line **110** of the conventional LCD panel **100** are illustrated. The second substrate **116** includes an active matrix (not shown in **FIG. 1B**) formed by interlacing the signal lines and scan lines, and the repair line **110** is disposed on an outer side of the active matrix. Liquid crystal molecules **180** are sandwiched between the first substrate **115** and second substrate **116**, and the second substrate **116** is disposed substantially parallel to the first substrate **115**. The first substrate **115** includes a first glass substrate **130**, color filter **150**, and common electrodes **155**. The second substrate **116** includes pixel electrodes (not shown in **FIG. 1B**), a second glass substrate **140**, a silicon nitride (Si_3N_4) layer **145**, and a passivation layer **190**. Since parasitic capacitance is formed between the repair line **110** and the common electrodes **155** which are opposite to the repair line **110**, signal distortion and delay may occur on the repair line **110**.

[0007] **FIG. 1C** illustrates an equivalent circuit formed between common electrodes and a repair line. As observed from the cross-sectional view of the conventional LCD panel, the liquid crystal molecules **180** sandwiched between the first substrate **115** and second substrate **116** can be

regarded as liquid crystal equivalent capacitance C_{lc} , and the passivation layer **190** as passivation layer equivalent capacitance C_{pv} . In terms of the two equivalent capacitances, the parasitic capacitance between the common electrodes **155** and repair line **110** can be viewed as a capacitance formed by the serial connection of the liquid crystal equivalent capacitance C_{lc} to the passivation layer equivalent capacitance C_{pv} .

[0008] Additionally, the formula of capacitance is $C = \epsilon_0 \times \epsilon \times A / d$, where ϵ_0 stands for the dielectric constant of vacuum, ϵ stands for the dielectric constant of the material, A represents the capacitor area, and d is referred to as the thickness of the material. For the same capacitor area A and dielectric constant of vacuum ϵ_0 , the passivation layer equivalent capacitance C_{pv} depends on the dielectric constant of the passivation layer ϵ_1 and the height of the passivation layer between the common electrodes **155** and repair line **110**, that is, $C_{pv} = \epsilon_0 \times \epsilon_1 \times A / d_1$. Likewise, liquid crystal equivalent capacitance C_{lc} depends on the dielectric constant of the liquid crystal molecules and the height of the liquid crystal molecule layer between the common electrodes **155** and repair line **110**, that is, $C_{lc} = \epsilon_0 \times \epsilon_2 \times A / d_2$. For example, if $\epsilon_1 = 6.6$, $\epsilon_2 = 7.5$, $d_1 = 0.2 \mu\text{m}$, $d_2 = 4 \mu\text{m}$, the parasitic capacitance between the common electrodes **155** and repair line **110** in the conventional LCD panel **100** is about $1.77\epsilon_0 A$ according to the above formula of capacitance.

[0009] **FIG. 1D** illustrates the transmission of the electrical signals on the repair line. Since the parasitic capacitance, as seen from the equivalent circuit diagram, exists between the common electrodes **155** and repair line **110**, signal distortion occurs on the repair line **110** through which video data on the one of signal lines **125** is transmitted from A to B, for example. As illustrated in **FIG. 1D**, at one end of the repair line **110**, such as location A of the repair line **110**, a square waveform, indicated by S, of a video data signal is transmitted initially in a fine shape. However, at the terminating end of the repair line **110**, such as location B of the repair line **110**, the square waveform is seriously distorted, as indicated by S', since the resistance and capacitance (RC) loading is formed on the repair line **110** by the resistance and the parasitic capacitance of the repair line **110**.

[0010] Thus, it is desirable for LCD manufacturers to effectively reduce signal distortion occurred on the terminating end of the repair line due to RC loading when the repair line is employed to repair broken signal lines of an LCD.

SUMMARY OF THE INVENTION

[0011] It is therefore an object of the invention to provide a liquid crystal display apparatus having a repair line with reduced parasitic capacitance and a method for manufacturing the same.

[0012] According to the object of the invention, a liquid crystal display apparatus having a repair line with reduced parasitic capacitance is provided. The liquid crystal display apparatus includes a first substrate, a second substrate, a plurality of crystal liquid molecules, a repair line, and a protrusion. The first substrate includes a color filter. The second substrate, disposed substantially parallel to the first substrate, includes an active matrix having a plurality of scan lines and signal lines interlaced each other. The crystal

liquid molecules are disposed between the first and second substrates. The repair line is disposed on an outer side of the active matrix. The protrusion is opposite to the repair line and disposed on a side of the first substrate that is opposite to the second substrate.

[0013] According to another object of the invention, a method for manufacturing a liquid crystal display apparatus having a repair line with reduced parasitic capacitance is provided. First, a first substrate and a second substrate are provided. Next, an active matrix having a plurality of scan lines and signal lines interlaced each other is formed on the second substrate. A repair line is disposed on an outer side of the active matrix. After that, a protrusion is disposed on a side of the first substrate that is opposite to the second substrate so that the protrusion is opposite to the repair line. Finally, a plurality of crystal liquid molecules are disposed between the first and second substrates.

[0014] Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1A** (Related Art) illustrates a conventional structure of an LCD.

[0016] **FIG. 1B** (Related Art) is cross-sectional view of the LCD taken along line 1B-1B'.

[0017] **FIG. 1C** (Related Art) illustrates an equivalent circuit formed between common electrodes and repair lines.

[0018] **FIG. 1D** (Related Art) illustrates the transmission of the electrical signals on the repair lines.

[0019] **FIG. 2A** shows a top view of an LCD having repair lines with reduced parasitic capacitance according to an embodiment of the invention.

[0020] **FIG. 2B** show a cross-sectional view of an LCD having repair lines with reduced parasitic capacitance, taken along line 2B-2B' in **FIG. 2A**.

[0021] **FIG. 3** illustrates an equivalent circuit formed between common electrodes and repair lines according to the embodiment of the invention.

[0022] **FIG. 4** shows a manufacturing process of an LCD having repair lines with reduced parasitic capacitance according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] An LCD having a repair line with reduced parasitic capacitance 20 is shown in **FIGS. 2A and 2B** according to an embodiment of the invention, where **FIG. 2A** shows a top view of the LCD and **FIG. 2B** shows a cross-sectional view of the LCD taken along line 2B-2B' in **FIG. 2A**. An LCD panel 200 includes a first substrate 215, a second substrate 216, liquid crystal molecules 280, a repair line 210 and a protrusion 256. The first substrate 215 includes a color filter 250. The second substrate 216 includes an active matrix 201 formed with scan lines (not shown in the drawings) and signal lines 225 interlaced each other. The repair line 210 is disposed on an outer side of the active matrix 201. The second substrate 216 is disposed substantially parallel to the first substrate 215. The liquid crystal molecules 280 are

disposed between the first substrate 215 and second substrate 216. The protrusion 256 is opposite to the repair line 210 and disposed on a side of the first substrate 215 that is opposite to the second substrate 216. The protrusion 256 is made of a low dielectric constant material, whose dielectric constant is required to be lower than the dielectric constant of the liquid crystal molecules 280, for example, acrylic or photo-resistor.

[0024] In addition, the first substrate 215 includes a first glass substrate 230, the color filter 250 and common electrodes 255. The second substrate 216 includes a second glass substrate 240, the signal lines 225, a silicon nitride (Si_3N_4) layer 245, the repair line 210, and a passivation layer 290. When one of the signal lines 225 has broken, such as the one shown in **FIG. 2A**, the broken signal line can be repaired by connecting two opening ends of the broken signal line to the repair line 210 through laser welding.

[0025] **FIG. 3** illustrates an equivalent circuit formed between common electrodes and repair lines according to the embodiment of the invention. While the repair line 210 is employed to repair a broken one of the signal lines 225 in order for a signal to be transmitted from point A' to point B', a parasitic capacitance, including three equivalent capacitance, is formed between the repair line 210 and the common electrodes 255 because the repair line 210 is opposite to the common electrodes 255. The first equivalent capacitance is formed by the liquid crystal molecules 280 between the first substrate 215 and second substrate 216, referred to as a liquid crystal equivalent capacitance Clc' . The second equivalent capacitance is formed by the passivation layer 290, referred to as a passivation layer equivalent capacitance Cpv . The third one, formed by the protrusion 256, is called a low dielectric constant material equivalent capacitance Cps . Thus, the equivalent parasitic capacitance between the common electrodes 255 and repair line 210 can be defined in terms of the three equivalent capacitances in series, that is, the liquid crystal equivalent capacitance Clc' , passivation layer equivalent capacitance Cpv , and low dielectric constant material equivalent capacitance Cps , connected in series.

[0026] Further, the capacitance of a capacitor is defined by $C = \epsilon_0 \times \epsilon \times A / d$, where ϵ_0 and ϵ stand for the dielectric constant of vacuum and the material, respectively, A represents the capacitor area, and d is referred to as the thickness or height of the material. For the same capacitor area A and ϵ_0 , the passivation layer equivalent capacitance Cpv depends on the dielectric constant of the passivation layer ϵ_1 and the height of the passivation layer between the common electrodes 255 and repair line 210, d_1 , that is, $\text{Cpv} = \epsilon_0 \times \epsilon_1 \times A / d_1$. The liquid crystal equivalent capacitance Clc' depends on the dielectric constant of the liquid crystal molecules, denoted by ϵ_2 , and the height of the liquid crystal molecule layer between the common electrodes 255 and repair line 210, d_2' , that is, $\text{Clc}' = \epsilon_0 \times \epsilon_2 \times A / d_2'$. The capacitance of the Cps depends on the dielectric constant of the low dielectric constant material, ϵ_3 , and the height of the low dielectric constant material between the common electrodes 255 and repair line 210, d_3 , that is, $\text{Cps} = \epsilon_0 \times \epsilon_3 \times A / d_3$. For example, if $\epsilon_1 = 6.6$, $\epsilon_2 = 7.5$, $\epsilon_3 = 4$, $d_1 = 0.2 \mu\text{m}$, $d_2' = 0.4 \mu\text{m}$, and $d_3 = 3.6 \mu\text{m}$, the parasitic capacitance is about $1.02\epsilon_0 A$ according to the above formula of capacitance.

[0027] As compared with the conventional LCD panel 100, the LCD panel 200 with the disposition of the protrusion 256 on an inner side of the first substrate 215 opposite to the repair line 210 reduces the parasitic capacitance from

1.77 ϵ_0 A to 1.02 ϵ_0 A, under the above conditions. That is, the parasitic capacitance has been reduced by about 42%.

[0028] Since reduced parasitic capacitance is achieved, when the repair line 210 is used to repair a broken one of the signal lines 225 in order for a signal to transmit from point A' to point B' in the embodiment according to the invention, the signal waveform would be less distorted by RC loading.

[0029] Referring to FIG. 4, a manufacturing process of an LCD having a repair line with reduced parasitic capacitance is shown according to one embodiment of the invention. The manufacturing process includes the following steps. First, in step 41, a first substrate 215 and a second substrate 216 are provided. Next, an active matrix having scan lines and signal lines 225 interlaced each other is formed on the second substrate 216, as indicated by step 42. A repair line 210 is then disposed adjacent to and coupled to an outer side of the active matrix, as in step 43. After that, in step 44, a protrusion 256 is disposed opposite to the repair line 210 and on a side of the first substrate 215 opposite to the second substrate 216. Finally, liquid crystal molecules 280 are disposed between the first substrate 215 and second substrate 216. Further, for the sake of manufacturing simplicity, the repair line 210 can be formed on the second substrate 216 while the active matrix is being formed. The steps above, such as steps 42 and 43, can be performed in any possible sequence in order to form an active matrix with a repair line with reduced parasitic capacitance according to the invention.

[0030] The embodiments above have disclosed a liquid crystal display having a repair line with reduced parasitic capacitance and a method for manufacturing the same. The parasitic capacitance between the repair line and common electrodes has been greatly reduced through the disposition of a low dielectric constant material on an inner side of the first substrate. In this way, RC loading due to the parasitic capacitance in the embodiments becomes not so significant as the conventional one and the signal on the terminating end of the repair line would be less distorted by the RC loading.

[0031] While the invention has been described by way of example and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A display apparatus, comprising:

a first substrate, comprising a color filter;

a second substrate, disposed substantially parallel to the first substrate, the second substrate comprising an

active matrix having a plurality of scan lines and signal lines interlaced each other;

a plurality of crystal liquid molecules, disposed between the first and second substrates;

a repair line, disposed on an outer side of the active matrix; and

a protrusion, opposite to the repair line and disposed on a side of the first substrate that is opposite to the second substrate.

2. The display apparatus according to claim 1, wherein the repair line serves for electrically connecting to a signal line that is broken.

3. The display apparatus according to claim 1, wherein the protrusion is made of a low dielectric constant material.

4. The display apparatus according to claim 3, wherein the protrusion has a dielectric constant which is lower than the dielectric constant of the crystal liquid molecules.

5. The display apparatus according to claim 1, wherein the protrusion comprises acrylic.

6. The display apparatus according to claim 1, wherein the protrusion comprises photo-resistor.

7. A method for manufacturing a display apparatus, comprising the steps of:

providing a first substrate and a second substrate;

forming an active matrix having a plurality of scan lines and signal lines interlaced each other on the second substrate and disposing a repair line on an outer side of the active matrix;

disposing a protrusion on a side of the first substrate that is opposite to the second substrate so that the protrusion is opposite to the repair line; and

disposing a plurality of crystal liquid molecules between the first and second substrates.

8. The method according to claim 7, wherein the repair line serves for electrically connecting to a signal line that is broken.

9. The method according to claim 7, wherein the protrusion comprises a low dielectric constant material.

10. The method according to claim 9, wherein the protrusion has a dielectric constant which is lower than the dielectric constant of the crystal liquid molecules.

11. The method according to claim 10, wherein the protrusion comprises acrylic.

12. The method according to claim 10, wherein the protrusion comprises photo-resistor.

* * * * *

专利名称(译)	具有减小的寄生电容的修复线的液晶显示器及其制造方法		
公开(公告)号	US20060197885A1	公开(公告)日	2006-09-07
申请号	US11/206790	申请日	2005-08-19
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外部链接	Espacenet USPTO		

摘要(译)

一种具有寄生电容减小的修复线的液晶显示器及其制造方法。液晶显示器包括第一基板，第二基板，多个晶体液体分子，修复线和突起。第一基板包括滤色器。基本上平行于第一基板设置的第二基板包括有源矩阵，该有源矩阵具有彼此交错的多条扫描线和信号线。晶体液体分子设置在第一和第二基板之间。修复线设置在有源矩阵的外侧。突起与修复线相对并且设置在第一基板的与第二基板相对的一侧上。

