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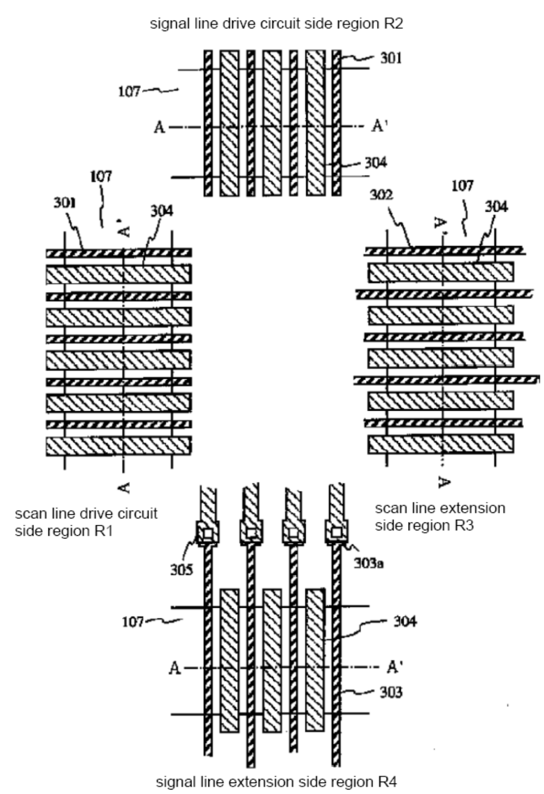
(54) [Title of Invention] Liquid crystal display device

(57) [Abstract]
[Problem] To improve the yield and reliability of a liquid crystal display device by making the level difference of the sealant uniform.
[Solution means] The starting film of the scan lines is patterned, square-pillar-shaped first-layer dummy wiring 301 that is not electrically connected is formed on region R1 and region R2, wiring 302 that extends from the pixel part is formed in region R3, and wiring 303, which has a connection terminal part 303a, is formed in region R4. After an inter-layer insulating film is formed on these surfaces, the starting film of the signal line is patterned, second-layer dummy wiring 304 is formed so as to close the gap between wirings 301 to 303, and the wiring 303 is connected with wiring 305, which extends from the pixel part. As a result, the cross-sectional composition along line A-A' in a sealant formation region 107 can be made uniform.



[Claims]

[Claim 1] In a liquid crystal display device that has
an element substrate that has a matrix circuit;
a facing substrate that faces the element substrate; and
sealant for bonding together the element substrate and the facing substrate,
a liquid crystal display device that is characterized in that in the element substrate, a substrate spacing correction means that has a laminated structure of at least one layer is disposed in the region in which the sealant is formed.

[Claim 2] In claim 1, a liquid crystal display device that is characterized in that the substrate spacing correction means includes at least a support member made of the same material as the wiring of the matrix circuit.

[Claim 3] In claim 1, a liquid crystal display device that is characterized in that the matrix circuit has a layered wiring structure that is insulated in each layer by an insulating film, and the substrate spacing correction means at least has the same laminar structure as the layered wiring.

[Claim 4] In claim 1, a liquid crystal display device that is characterized in that the maximum value of the thickness of the substrate spacing correction means is approximately equal to the maximum value of the thickness of the matrix circuit.

[Claim 5] In the element substrate recited in claim 1, a liquid crystal display device that is characterized in that a peripheral circuit for driving the matrix circuit is disposed between the matrix circuit and the sealant.

[Claim 6] In a liquid crystal display device that has
an element substrate that has a matrix circuit that is disposed in a matrix form, has signal lines and scan lines that are separated into layers by a first inter-layer insulating film, is disposed at the intersections of the signal lines and the scan lines, and has pixel electrodes separated into layers with the signal lines by a second inter-layer insulating film, as well as a peripheral drive circuit for controlling the matrix circuit;
a facing substrate that faces the element substrate; and
sealant for surrounding the matrix circuit and bonding together the element substrate and the facing substrate,
a liquid crystal display device that is characterized in that in the element substrate it has, in the sealant formation region, at least a first support means made of the same material as the signal lines, a second support means made of the same material as the first inter-layer insulating film and the signal lines, and a substrate spacing correction means in which the second inter-layer insulating films are formed in mutually different layers.

[Claim 7] A liquid crystal display device that is characterized in that, in the element substrate recited in claim 6, the peripheral circuit for driving the matrix circuit is disposed between the matrix circuit and the sealant.

[Claim 8] A liquid crystal display device that is characterized in that, in the substrate spacing correction means recited in claim 6, the end face of the first support member and the end face of the second support member do not overlap.

[Claim 9] A liquid crystal display device that is characterized in that the substrate spacing correction means recited in claim 6 at least has in the matrix the same laminar structure as in the region where the signal lines and the scan lines overlap.

[Claim 10] A liquid crystal display device that is characterized in that, in claim 6, the maximum value of the thickness of the substrate spacing correction means is approximately equal to the maximum value of the thickness of the matrix circuit.

[Claim 11] A liquid crystal display device that is characterized in that, in claim 6, the wiring for connecting the circuit disposed inside the sealant, the circuit disposed outside the sealant on the element substrate, or the circuit outside the element substrate, is formed integrally with the first support member, and the first support member extends to the outside of the sealant.

[Claim 12] A liquid crystal display device that is characterized in that, in claim 6, the wiring for connecting the circuit disposed inside the sealant, the circuit disposed outside the sealant on the element substrate, or the circuit outside the element substrate, is connected inside the sealant with the first support member, and the first support member extends to the outside of the sealant.

[Claim 13] A liquid crystal display device that is characterized in that, in claim 6, the second support member is not electrically connected with the circuit that is disposed inside the sealant, the circuit that is disposed outside the sealant on the element substrate, and the circuit outside the element substrate.

[Claim 14] A liquid crystal display device that is characterized in that, in the substrate spacing correction means recited in claim 6, in the first support member the linear wiring is disposed with equal spacing, and in the second wiring layer the linear wiring that is parallel to the signal lines or scan lines is disposed with equal spacing in the gaps of the first wiring layer.

[Claim 15] A liquid crystal display device that is characterized in that, in claim 6, the first support member has a shape that zigzags approximately equally with the width of the sealant.

[Claim 16] A liquid crystal display device that is characterized in that, in claim 6, in the first support member, the pitch of the rix second support member is roughly equal to the pitch of the pixel electrodes.

[Claim 17] A liquid crystal display device that is characterized in that that matrix circuit recited in claim 6 has pixel electrodes that are connected to the signal lines and thin-film transistors that drive the pixel electrodes; the first support member is formed simultaneously with the scan lines; and the second support member is formed simultaneously with the signal lines.

[Claim 18] In a liquid crystal display device that has
an element substrate that has a matrix circuit that is disposed in a matrix form, has signal lines and scan lines that are separated into layers by a first inter-layer insulating film, is disposed at the intersections of the signal lines and the scan lines, and has pixel electrodes separated into layers with the signal lines by a second inter-layer insulating film, as well as thin-film transistors for driving the pixel electrodes, as well as a peripheral drive circuit for controlling the matrix circuit;
a facing substrate that faces the element substrate; and
sealant for surrounding the matrix circuit and bonding together the element substrate and the facing substrate,
a liquid crystal display device that is characterized in that in the element substrate it has, in the sealant formation region,

at least a support means made of the same material as the scan lines, and a substrate spacing correction means in which the first inter-layer insulating film and the second inter-layer insulating film are formed in mutually different layers.

[Claim 19] A liquid crystal display device that is characterized in that, in the element substrate recited in claim 18, a peripheral circuit for driving the matrix circuit is disposed between the matrix circuit and the sealant.

[Claim 20] A liquid crystal display device that is characterized in that, in claim 18, the wiring for connecting the circuit disposed inside the sealant, the circuit disposed outside the sealant on the element substrate, or the circuit outside the element substrate, is formed integrally with the support member, and the first support member extends to the outside of the sealant.

[Claim 21] A liquid crystal display device that is characterized in that, in claim 18, the wiring for connecting the circuit disposed inside the sealant, the circuit disposed outside the sealant on the element substrate, or the circuit outside the element substrate, is connected to the support member inside the sealant, and the support member extends to the outside of the sealant.

[Claim 22] A liquid crystal display device that is characterized in that, in claim 18, the support member is a linear member that has multiple branches along the edge of the element substrate.

[Claim 23] It is characterized in that, in claim 22, the branches of the support member are formed inside the region in which the sealant is formed and outside the element substrate.

[Detailed Description of the Invention]

[0001]

[Field of technology to which the invention belongs] The present invention concerns an active matrix type liquid crystal display device, and its purpose is to reduce the nonconformities that occur when substrates are attached together. In particular, it concerns a liquid crystal display device that is integral with it peripheral circuitry.

[0002]

[Prior art] In a conventional active matrix type liquid crystal display device, a display is obtained by controlling the transparence and other optical properties of a liquid crystal material that is sandwiched in between pixel electrodes, making use of the switching effects of two-terminal elements like MIMs [metal-insulator-metal] or three-terminal elements like TFTs [thin-film transistors], which are arranged in a pixel [picture element] part in a matrix layout. In general, TFTs, which use amorphous silicon, are widely used as switching elements for pixel electrodes.

[0003] But because the electric field effect mobility of amorphous silicon is low, being about 0.1 cm/Vs to 1 cm/Vs, a TFT that uses amorphous silicon cannot be disposed in a peripheral drive circuit that controls the TFTs that are connected to the picture element electrodes.

[0004] Thus with a conventional active matrix type liquid crystal display device, a peripheral drive circuit made up of semiconductor integrated circuits is externally attached to the liquid crystal panel by a method such as tape automatic bonding (TAB) or chip-on-glass (COG).

[0005] FIG. 16 is a front view of a sketch of an active matrix type liquid crystal panel in a first conventional example, in which a peripheral drive circuit is attached to the outside. As shown in FIG. 16, arranged in a matrix on an element substrate 1 of glass, quartz, or the like are scan lines 2 and signal lines 3, and, in the pixel part 4, connected to the intersections of this wiring are pixel electrodes and pixel TFTs for switching of the pixel electrodes. Each scan line 2 and signal line 3 extends to the outside of the sealant region 5, and because of this, the number of wiring lines that cross the sealant is only the number of scan lines 2 and signal lines 3. The ends of these wiring lines serve themselves as leader terminals 6, and peripheral circuitry, which is not pictured, is connected to the leader terminals 6. In addition, the element substrate 1 and a facing substrate, which is not pictured, are joined together by a sealant that is formed in the sealant region 5, and a liquid crystal material is sealed between these substrates by a sealant.

[0006] Also, in recent years much research has been done in technology for fabricating TFTs using crystalline silicon in order to obtain a TFT which a high electric field effect mobility. With a TFT that makes use of crystalline silicon, faster operation is possible than with an amorphous silicon TFT, and with crystalline silicon, not just NMOS TFTs but also PMOS TFTs are obtained in the same way, making it possible to form a CMOS circuit. Therefore peripheral drive circuitry can be fabricated together with the display unit on the same substrate.

[0007] FIG. 17 is a front view of a sketch of an active matrix type liquid crystal display device in a second conventional example, in which a peripheral drive circuit and the display unit are integrated in the panel. As shown in FIG. 17, a pixel part 12 is disposed on an element substrate 11 of glass, quartz, or the like, and around the pixel part 12, a signal line drive circuit 13 is provided on the upper side, and a scan line drive circuit 14 is provided on the left side. Signal lines 15 and scan lines 16 are connected to the signal line drive circuit 13 and the scan line drive circuit 14, respectively. The signal lines 15 and the scan lines 16 form a grid in the pixel part 12, and ends that are not connected to the signal line drive circuit 13 and the scan line drive circuit 14 extend as far as the outside of the sealant region 17, and control circuitry, power source, and the like, which are not pictured, are connected. Also, the element substrate 11 and the facing substrate 18 are bonded together by a sealant that is formed in the sealant region 17, and a liquid crystal material is sealed between these substrates 11 and 18 by a sealant form. In addition, an external terminal 19 is provided on the element substrate 11.

[0008]

[Problems that the invention is to solve] In the first conventional example shown in FIG. 16, the wiring structure around the four sides of the pixel part 4 are symmetrical up-down and left-right as shown in the drawing, so the level difference of the seal unit is uniform, and thus the substrate spacing can be made equal.

[0009] But with the first conventional example, there is the problem that because peripheral drive circuitry is connected outside of the sealant, a large number of wiring lines cross the sealant, moisture gets in from the interface between the sealant and the wiring that is connected to the pixel part from the drive circuit, and this degrades the liquid crystal display material. Also, because the peripheral drive circuitry is on the outside, the device itself is larger than it otherwise would be.

[0010] In order to avoid these problems, in the second conventional example, shown in FIG. 17, which is an active matrix type liquid crystal display device of the type that is integrated with peripheral drive circuitry, a peripheral drive circuit is disposed inside the sealant region 17. Also, in general a one-side drive method is adopted, in which no redundant circuitry is provided. Because of this, as shown in FIG. 13, only the wiring lines on the right side and lower side of the element substrate 11 cross the sealant, so the wiring structure no longer has any up-down and left-right symmetry as would be shown in the drawing, and the level difference of the sealant is different on the peripheral drive circuit side and the side where the wiring lines extend. Therefore when the substrates are attached together, the pressure on the substrates is not uniform, making it difficult to make the substrate spacing uniform. This causes display unevenness, which reduces the picture quality.

[0011] In particular, because the level difference of the sealant on the peripheral drive circuit side is low, when the substrates are attached together, the wiring might short out between top and bottom in the peripheral drive circuit, making it more likely for line defects to occur. These problems create new causes for lower yield and lower reliability in a liquid crystal display device that is integrated with a peripheral drive circuit.

[0012] And in the pixel part, the part that juts out the farthest is the region where a scan line and a signal line overlap, and in this region what is laminated together is not just the scan lines, the signal lines, and the inter-layer insulating film for keeping them apart from each other, but also the pixel electrodes, the black matrix, and other parts. In general, cylindrical fibers for maintaining the substrate spacing are mixed into the sealant. The dimensions of the fibers are set, taking a margin into consideration, to values that combine the thickness of the protruding part of the pixel part and the dimensions of the spacers that are dispersed within the sealant, so as to make the level difference of the sealant higher than the pixel part, but a spacer is disposed on the protruding part of a pixel part, this part will be higher than the sealant, so if the substrates are attached together in this state, because of the spacer the scan line and the signal line will short out between top and bottom, causing point defects and line defects.

[0013] The purpose of the present invention is to solve the above problems by providing a liquid crystal display device that is integrated with a peripheral drive circuit and that offers excellent picture quality and high reliability.

[0014]

[Means for solving the problems] In order to solve the above problems, the composition of the liquid crystal display device of the present invention is characterized in that -- in a liquid crystal display device that has an element substrate that has a matrix circuit;

a facing substrate that faces the element substrate; and sealant for bonding together the element substrate and the facing substrate -- in the element substrate, a substrate spacing correction means that has a laminated structure of at least one layer is disposed in the region in which the sealant is formed.

[0015] Also, another composition of the present invention is characterized in that -- in a liquid crystal display device that has an element substrate that has a matrix circuit that is disposed in a matrix form, has signal lines and scan lines that are separated into layers by a first inter-layer insulating film, is disposed at the intersections of the signal lines and the scan lines, and has pixel electrodes separated into layers with the signal lines by a second inter-layer insulating film, as well as a peripheral drive circuit for controlling the matrix circuit; a facing substrate that faces the element substrate; and sealant for surrounding the matrix circuit and bonding together the element substrate and the facing substrate -- in the element substrate it has, in the sealant formation region, at least a first support means made of the same material as the signal lines, a second support means made of the same material as the first inter-layer insulating film and the signal lines, and a substrate spacing correction means in which the second inter-layer insulating films are formed in mutually different layers.

[0016] In addition, another composition of the liquid crystal display device of the present invention is characterized in that -- in a liquid crystal display device that has an element substrate that has a matrix circuit that is disposed in a matrix form, has signal lines and scan lines that are separated into layers by a first inter-layer insulating film, is disposed at the intersections of the signal lines and the scan lines, and has pixel electrodes separated into layers with the signal lines by a second inter-layer insulating film, and thin-film transistors for driving the pixel electrodes, as well as a peripheral drive circuit for controlling the matrix circuit; a facing substrate that faces the element substrate; and sealant for surrounding the matrix circuit and bonding together the element substrate and the facing substrate -- in the element substrate it has, in the sealant formation region, at least a support means made of the same material as the scan lines, and a substrate spacing correction means in which the first inter-layer insulating film and the second inter-layer insulating film are formed in mutually different layers.

[0017]

[Embodiments of the invention] Embodiments of the present invention are described using the drawings. FIG. 1 is a front view of a sketch of the element substrate of an active matrix type liquid crystal display device of this working example; peripheral circuits 103 and 102 and a display unit 102 are disposed on an element substrate 101.

[0018] As shown in FIG. 1, on the right side and lower side as shown in the drawing, signal line 105 and scan line 106 cut across the sealant formation region 107, but these wiring lines do not cut across in the sealant formation region 107 on the side of the peripheral circuits 103 and 104. Because of this, in the present invention, a substrate spacing correction means is formed that makes the level difference of the lower structure of the sealant uniform.

[0019] FIG. 6 is a cross-sectional view, in the sealant width direction, of a substrate spacing maintenance means. As shown in FIG. 6, first support members 301, 302, and 303, which are made of the same material as the scan line 106, first inter-layer insulating film 220, which separates the signal line 105 and the scan line 106, and second support member 304, which is made of the same material as the signal line 105, are laminated together. In particular, because it was arranged that there be no second support member 304 on top of the first support members 301, 302, and 303, the cross-sectional composition of the substrate spacing maintenance means along the edge of the sealant formation region 107 becomes constant, and thus the level difference of the sealant can be made uniform.

[0020] FIG. 15 is a cross-sectional view, in the sealant width direction, of another substrate spacing maintenance means. As shown in FIG. 15, on the sealant formation region 107 are laminated first support members 301, 302, and 303, which are made of the same material as the scan line 106, a first inter-layer insulating film 220, which separates the signal line 105 and the scan line 106, and a second support member 701, which is made of the same material as the signal line 105. The region where the thickness of the matrix circuit is greatest is the region where the signal line 105 and the scan line 106 overlap, which is where at least the signal line, the inter-layer insulating film, the scan line, and a passivation film are laminated together on the element substrate. Therefore in the present invention, by adopting an arrangement in which the first support members 301, 302, and 303, and the second support member 701, are piled atop each other, the level difference of the substrate spacing holding means and the height of the region in which the thickness of the matrix circuit is at its maximum can be made approximately equal, and thus the level difference of the matrix circuit including spacers becomes lower than the sealant, so the pressure when attaching the substrates together can be supported by the sealant, and thereby it is possible, with the spacers, to prevent scan lines and signal lines from shorting out between top and bottom. Moreover, because the pixel electrodes, the black matrix, and the like are also laminated in the region where the signal line 105 and the scan line 106 overlap, the pixel electrodes, black matrix, and the like may likewise be laminated in the substrate spacing formation means as well.

[0021] FIG. 4 is a top view of a substrate spacing correction means; disposed in the sealant formation region 107, in alternation with equal spacing, are the linear first support members 301, 302, and 303, and the second support member 304

[0022] In the region R3 where the scan line that is extended from the matrix circuit crosses the sealant formation region 107, it is formed integrally with the first support member 302, and is extended to the outside of the sealant formation region 107. On the other hand, the signal line 305, which is extended from the matrix circuit 102, is connected inside the sealant formation region 107 to the first support member 303, which crosses the sealant formation region 107.

[0023] In this way, with the present invention, because a wiring pattern that crosses the sealant formation region 107 and is electrically connected with a circuit outside the element substrate consists only of the first support members 302 and 303, the level difference of the sealant can be made more uniform.

[0024] Also, as shown in FIG. 8, in the regions R1 and R2 where the wiring from the matrix circuit 102 or from the peripheral circuits 103 and 104 does not cross the sealant formation region 107, it is formed in the shape of a square wave and is approximately equal to the width of the sealant formation region 107, without partitioning into sections the first wiring layer 401. In this way, because a first wiring layer is present in the cross-sectional composition in any width direction of the sealant formation region 107, the seeping in of moisture from the outside can be prevented.

[0025] Also, in the present invention, the substrate spacing maintenance means is formed together with the thin-film transistors that drive the pixel electrodes, the first wiring layer is formed simultaneously with the signal lines, and the second wiring layer is formed simultaneously with the signal lines.

[0026]

[Working examples] The present invention is described in detail, referring to the working examples in the drawings.

[0027] FIG. 1 is a front view of a sketch of the element substrate of an active matrix type liquid crystal display device of working examples 1 to 5; the display unit is made integral with the peripheral circuits. As shown in FIG. 1, a pixel part 102 is disposed on an element substrate 101 of glass, quartz, or the like, and around the pixel part 102, a signal line drive circuit 103 is provided on the top side, and a scan line drive circuit 104 is provided on the left side. The signal line drive circuit 103 and the scan line drive circuit 104 are connected to the pixel part 102 by signal lines 105 and scan lines 106, respectively, the signal lines 105 and the scan lines 106 form a grid in the pixel part 102, and connected respectively in series to their intersections are a liquid crystal cell 111 and a pixel TFT 112. In the pixel TFT 112, the gate electrode is connected to the signal line 105, the source electrode is connected to the scan line 106, and the drain electrode is connected to the electrode of a liquid crystal cell 111.

[0028] In addition, a sealant region 107 is disposed so as to surround the pixel part 102, the signal line drive circuit 103, and the scan line drive circuit 104; the element substrate 101 and a facing substrate that is not pictured are bonded together by the sealant that is formed in the sealant region 107; and a liquid crystal material is sealed in between these substrates.

[0029] On the right side and lower side as shown in the drawing, signal lines 105 and scan lines 106 are extended to outside the sealant formation region 107 and are connected to a panel external control circuit and the like. In addition, an external terminal 108 is provided on the element substrate 101, and the signal line drive circuit 103 and the scan line drive circuit 104 are each connected to the external terminal 108 by a wiring line 109.

[0030] [Working example 1] With this working example, in the active matrix type liquid crystal display device shown in FIG. 1, it is characterized in that in order to make the level difference of the sealant uniform, it is made uniform by disposing in the sealant formation region 107 a wiring pattern (dummy wiring structure) that is shaped from the starting films of signal lines 103 and scan lines 104 and is substantially insulated electrically. Also, with this working example, such a wiring pattern is fabricated simultaneously with the TFTs that are arranged on the liquid crystal panel.

[0031] Referring to FIG. 2 to 6, we describe the fabrication steps for the active matrix type liquid crystal panel of this

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