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(54) **Liquid crystal display device and driving method thereof**

Flüssigkristallanzeigevorrichtung und Verfahren zu ihrer Ansteuerung

Dispositif d'écran à cristaux liquides et appareil de commande correspondant

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Description

BACKGROUND

[0001] The present disclosure relates to a liquid crystal display (LCD) device and a driving method thereof, and more particularly, to an LCD device that can control a viewing angle and improve brightness of an image, and a driving method thereof.

[0002] Since liquid crystals (LCs) have dielectric anisotropy and refractive index anisotropy, the arrangement of the LCs is controlled according to an electric field applied thereto, and the polarization of light changes according to the arrangement. The LCD device applies an electric field to LCs having dielectric anisotropy and refractive index anisotropy to control light transmittance, thereby displaying an image.

[0003] Fig. 1 is a view of a related art LCD device.

[0004] Referring to Fig. 1, the LCD device includes an upper substrate 11 including a color filter array 19, and a lower substrate 1 including a thin film transistor (TFT) array 9, the upper substrate 11 and the lower substrate 1 being attached to face each other, and LCs 16 filling cell gaps disposed between the two substrates 11 and 1.

[0005] The color filter array 19 includes a black matrix 12, a color filter layer 13, an overcoat layer 14 for planarizing the upper substrate 11, and a common electrode 15 for forming an electric field in cooperation with a pixel electrode 7. The color filter array 19 further includes an upper alignment layer for uniformly aligning the LCs 16.

[0006] The TFT array 9 includes gate lines 2 and data lines 3 crossing each other to define pixels on the lower substrate 1, a TFT 6 connected to the gate line 2 and the data line 3, and the pixel electrode 7 connected to the TFT 6. The TFT array 9 further includes a lower alignment layer for uniformly aligning the LCs 16.

[0007] The TFT 6 supplies a data signal from the data line 3 to the pixel electrode 7 in response to a gate signal from the gate line 2. An electric field is generated between the pixel electrode 3 to which the data signal has been supplied through the TFT 6, and the common electrode 15 to which a reference voltage has been supplied. The light transmittance of the LCs 16 arranged between the lower substrate 1 and the upper substrate 11 is controlled by this electric field, so that an image is displayed.

[0008] The LCD device has been developed in an aspect of improving a viewing angle characteristic so that an image can be viewed in any direction. However, an excellent viewing angle characteristic causes a side effect such as private information leakage in the case where a computer system is used for a private purpose or security-oriented businesses such as tasks at a bank are performed.

[0009] Accordingly, development of an LCD device that can selectively control a viewing angle is required. That is, development of the LCD providing a wide viewing angle mode allowing an image to be viewed to a user at various viewing angles, and providing a narrow viewing angle mode limiting displaying of an image to a user at a specific viewing angle, is required.

[0010] Prior art document US2007/0040780 discloses a liquid crystal display with vertically aligned liquid crystal material arranged between pixel electrodes and a common electrode, wherein each pixel comprises three RGB subpixels and an additional viewing angle control subpixel. The viewing angle control pixels are controlled by additional side electrodes. This arrangement not only allows switching between a wide angle and narrow angle viewing mode (the latter then having a hight intensity due to the narrower angle), but also directing the light of the pixel to a left an/or right direction.

[0011] However, according to this prior art the side electrodes are arranged on the same substrate as the pixel electrodes.

SUMMARY

[0012] Embodiments provide an LCD device that can control a viewing angle and a driving method thereof.

[0013] Embodiments also provide an LCD device that improves brightness of an image and a driving method thereof.

[0014] In one embodiment, a liquid crystal display device is provided as defined in claim 1.

[0015] In another embodiment, a method for driving a liquid crystal display device is provided as defined in claim 11.

[0016] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Fig. 1 is a view of a related art LCD device.

[0018] Fig. 2 is a plan view illustrating a TFT array of an LCD device according to an embodiment.

[0019] Fig. 3 is a cross-sectional view of a TFT taken along the line I-I' of Fig. 2.

[0020] Fig. 4 is a plan view illustrating a color filter array of an LCD device according to an embodiment.

[0021] Fig. 5 is a cross-sectional view of a color filter array taken along the lines I-I' and II-II' of Fig. 4.

[0022] Fig. 6 is a view explaining an LCD device in a no voltage application state.

[0023] Figs. 7A and 7B are views explaining a wide viewing angle mode of an LCD device according to an embodiment.

[0024] Figs. 8A and 8B are views explaining a narrow viewing angle mode of an LCD device according to an embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0025] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment,"

etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0026] Hereinafter, preferred embodiments are described with reference to Figs. 2 to 8B.

[0027] An LCD device according to an embodiment is formed by attaching a first substrate including a TFT array, and a second substrate including a color filter array such that those arrays face each other. An LC layer is interposed between the first and second substrates.

[0028] Fig. 2 is a plan view illustrating a TFT array according to an embodiment, and Fig. 3 is a cross-sectional view taken along the line I-I' of Fig. 2. The line I-I' is a line representing a horizontal direction of a display surface.

[0029] Referring to Figs. 2 and 3, the TFT array according to an embodiment includes a plurality of pixels formed on the first substrate. The pixels include subpixels Pr, Pg, Pb, and Pv defined by crossing of a plurality of gate lines 112 and a plurality of data lines 115. One pixel includes data displaying subpixels Pr, Pg, and Pb for realizing red (R), green (G), and blue (B) pixels, respectively, and a viewing angle controlling subpixel Pv for controlling a viewing angle.

[0030] The data displaying subpixels Pr, Pg, and Pb include a TFT connected to a crossing of the gate line 112 and the data line 115, and a first pixel electrode 117 connected to the TFT.

[0031] The viewing angle controlling subpixel Pv includes a TFT connected to a crossing of the gate line 112 and the data line 115, and a second pixel electrode 517 connected to the TFT.

[0032] The gate line 112 and the data line 115 cross each other such that they are insulated from each other with a gate insulating layer 113 interposed. The gate line 112 supplies a scan voltage to the TFT, and the data line 115 supplies a data voltage to the TFT.

[0033] The TFTs of the data displaying subpixels Pr, Pg, and Pb allow R, G, and B data voltages of the data line 115 to charge the first pixel electrode 117 in response to a scan voltage of the gate line 112. For this purpose, the TFTs of the data displaying subpixels Pr, Pg, and Pb include a gate electrode 112a branching from the gate line 112, a source electrode 115a branching from the data line 115, and a drain electrode 115b connected to the first pixel electrode 117. A semiconductor pattern 114 ohmic-contacts the source electrode 115a and the drain electrode 115b. The data line 115 and the semiconductor pattern 114 are protected by a passivation layer 116 covering them.

[0034] The first electrode 117 is connected to the drain electrode 115b through a first contact hole 119 passing through the gate insulating layer 113 and exposing the drain electrode 115b.

[0035] R, G, and B data voltages passing through the TFTs of the data displaying subpixels Pr, Pg, and Pb are supplied to the first pixel electrode 117. Accordingly, a potential difference is generated between the first pixel electrode 117 and a common electrode of the color filter array. This potential difference drives LCs contained in the data displaying subpixels Pr, Pg, and Pb to realize the pixel.

[0036] The TFT of the viewing angle controlling subpixel Pv allows a viewing angle controlling data voltage of the data line 115 to charge the second pixel electrode 517 in response to a scan voltage of the gate line 112. For this purpose, the TFT of the viewing angle controlling subpixel Pv includes a gate electrode 512a branching from the gate line 112, a source electrode 515a branching from the data line 115, and a drain electrode 515b connected to the second pixel electrode 517. A semiconductor pattern 514 ohmic-contacts the source electrode 515a and the drain electrode 515b. The data line 115 and the semiconductor pattern 514 are protected by a passivation layer 116 covering them.

[0037] The second electrode 517 is connected to the drain electrode 515b through a second contact hole 519 passing through the gate insulating layer 113 and exposing the drain electrode 515b.

[0038] A viewing angle controlling data voltage passing through the TFT of the viewing angle controlling subpixel Pv is supplied to the second pixel electrode 517. Accordingly, a potential difference is generated between the second pixel electrode 517 and the common electrode of the color filter array. This potential difference drives the LCs contained in the viewing angle controlling subpixel Pv to control the viewing angle and the brightness of the pixel.

[0039] The TFT array 111 according to the embodiment can be manufactured through a plurality of mask processes including a photolithography process and an etching process. An example of a TFT array manufacturing method is schematically described.

[0040] During a first mask process, a gate conductive pattern including the gate line 112 and the gate electrodes 112a and 512a is formed on the first substrate 110.

[0041] The gate conductive pattern can be a single layer or a multiple layer formed by stacking one or more metal such as Mo, Ti, Cu, AlNd, Al, Cr, an Mo alloy, a Cu alloy, and an Al alloy.

[0042] The gate insulating layer 113 covering the gate conductive pattern is formed on the first substrate 110 including the gate insulating layer 113. After that, during a second mask process, a source/drain conductive pattern including the semiconductor patterns 114 and 514, the data line 115, the source electrodes 115a and 515a, and the drain electrodes 115b and 515b.

[0043] The gate insulating layer 113 can be generally

formed of an inorganic insulating material such as SiO_x and SiN_x. The semiconductor pattern can be formed in a structure where amorphous silicon and amorphous silicon doped with impurities (n+ or p+) are stacked. An amorphous silicon layer is exposed between the source electrode 115a/515a and the drain electrode 115b/515b.

[0044] The source/drain conductive pattern can be a single layer or a multiple layer formed by stacking one or more metal such as Mo, Ti, Cu, AlNd, Al, Cr, an Mo alloy, a Cu alloy, and an Al alloy.

[0045] During the second mask process, the semiconductor patterns 114 and 514, and the source/drain conductive pattern can be formed through one mask process using a half tone mask or a diffraction exposure mask. Accordingly, the semiconductor patterns 114 and 514 overlap each other under the source/drain conductive pattern.

[0046] The passivation layer 116 covering the semiconductor patterns 114 and 514 and the source/drain conductive pattern is formed on the gate insulating layer 113. Subsequently, contact holes 119 and 519 are formed during a third mask process.

[0047] The passivation layer 116 can be formed of an inorganic insulating material such as SiO_x and SiN_x, or an organic insulating material such as benzo cyclobutene (BCB), perfluorocyclobutane (PFBC), Teflon, and cytop.

[0048] A transparent conductive pattern including the second pixel electrode 517 and the first pixel electrode 117 is formed on the passivation layer 116 through a fourth mask process.

[0049] The transparent conductive pattern can be formed of indium-tin-oxide (ITO), tin-oxide (TO), indium-zinc-oxide (IZO), or indium-tin-zinc-oxide (ITZO).

[0050] Fig. 4 is a view illustrating a color filter array of an LCD device according to an embodiment, and Fig. 5 is a cross-sectional view taken along the lines I-I' and II-II' of Fig. 4. The line I-I' is a line representing the horizontal direction of a display surface, and the line II-II' is a line representing a vertical direction of the display surface.

[0051] Referring to Figs. 4 and 5, a color filter array 121 according to an embodiment includes a plurality of pixels formed on a second substrate 120. The pixel includes subpixels Pr, Pg, Pb, and Pv divided by a black matrix (BM) 122. One pixel includes data displaying subpixels Pr, Pg, and Pb for realizing red (R), green (G), and blue (B) pixels, respectively, and a viewing angle controlling subpixel Pv for controlling a viewing angle.

[0052] The BM 122 divides the subpixels Pr, Pg, Pb, and Pv, and prevents generation of light leakage at regions where gate lines, data lines, and TFTs are formed, and the adjacent regions thereof of a TFT array.

[0053] Common electrodes 225 are formed in the subpixels Pr, Pg, Pb, and Pv. The common electrodes 225 according to an embodiment are independently formed in pixel rows in the form of a row arrangement of the subpixels Pr, Pg, Pb, and Pv, respectively, or independently formed in pixel columns in the form of a column arrangement of the subpixels Pr, Pg, Pb, and Pv, respectively. The drawing for explaining the embodiment illustrates that the common electrodes 225 are independently formed in pixel rows, respectively.

[0054] Protusions 227 and 527 (also called "ribs" in the following) formed of an organic insulating material having a low dielectric constant are formed at the centers of the subpixels Pr, Pg, Pb, and Pv. The ribs 227 and 527 distort an electric field formed in the subpixels Pr, Pg, Pb, and Pv to allow LCs to be symmetrically arranged with respect to the ribs 227 and 527.

[0055] Color filter patterns 123 are formed in data displaying subpixels Pr, Pg, and Pb of the subpixels Pr, Pg, Pb, and Pv. The color filter patterns 123 include a red layer formed on the R subpixel Pr, a green layer formed on the G subpixel Pg, and a blue layer formed on the B subpixel Pb, and transmit R, G, and B light, respectively.

[0056] A side electrode 520 separated from the common electrode 225 is formed in a viewing angle controlling subpixel Pv of the subpixels Pr, Pg, Pb, and Pv. The side electrode 520 distorts an electric field formed in the viewing angle controlling subpixel Pv to contribute to brightness improvement of the pixel during a narrow viewing angle mode. For this purpose, the side electrode 520 includes a pair of side electrodes facing each other with the common electrode 225 interposed. The side electrode 520 overlaps the BM 122 and connects to a control line 524 avoiding (that is, not overlapping) the data displaying subpixels Pr, Pg, and Pb to receive a control signal.

[0057] The color filter patterns 123 and the BM 122 are covered with an overcoat layer 129. The overcoat layer 129 planarizes height differences generated by the forming of the BM 122 and the color filter patterns 123.

[0058] The color filter array 121 according to the embodiment can be manufactured through a plurality of mask processes including a photolithography process and an etching process. An example of a color filter array manufacturing method is schematically described.

[0059] During a first mask process, the BM 122 is formed on the second substrate 120. The BM 122 can be formed of an opaque metal including Cr, or a black resin.

[0060] After that, the color filter patterns 123 are formed through a second mask process. The color filter patterns 123 can be red, green, and blue color resists. A second mask process includes a process of shifting a second mask to sequentially pattern the R, G, and B color resists.

[0061] The BM 122 and the color filter pattern 123 are covered with the overcoat layer 129.

[0062] The overcoat layer 129 can be a transparent resin.

[0063] A transparent conductive pattern including the common electrode 225, the control line 524, and the side electrode 520 is formed on the overcoat layer 129 through a third mask process.

[0064] The transparent conductive pattern can be formed of indium-tin-oxide (ITO), tin-oxide (TO), indium-

zinc-oxide (IZO), or indium-tin-zinc-oxide (ITZO).

[0065] Ribs 227 and 527 are formed on portions of the common electrode 225 corresponding to the centers of the subpixels Pr, Pg, Pb, and Pv. The ribs 227 and 527 are formed of an acryl-based organic compound having a low dielectric constant.

[0066] A method for manufacturing an LCD device according to an embodiment includes forming the TFT array 111 and the color filter array 121 described in Figs. 2 to 5. The method further includes a process of attaching the first substrate 110 and the second substrate 120 to each other such that the TFT array 111 and the color filter array 121 face each other, an LC forming process, and a polarizer attaching process.

[0067] For reference, LCs can be dropped on the TFT array 111 or the color filter array 121 before the first and second substrates 110 and 120 are attached to each other. Also, after the first and second substrates 110 and 120 are attached to each other, the LCs can be dropped in a space between the TFT array 111 and the color filter array 121. The LCs can be formed in various ways.

[0068] During a process of attaching the first and second substrates 110 and 120 to each other such that the TFT array 111 and the color filter array 121 face each other, the subpixels Pr, Pg, Pb, and Pv contained in the arrays 111 and 121 face each other, and the BM 122 of the color filter array 121 overlaps the TFT of the TFT array 111, the gate lines 112, and the data lines 115.

[0069] The polarizer includes a first polarizer and a second polarizer attached on the outer surfaces of the two substrates, respectively. The transmission axes of the first polarizer and the second polarizer are perpendicular to each other.

[0070] The LCD device according to an embodiment includes a vertical alignment (VA) mode LC layer. That is, the LC layer according to the embodiment is a negative type LC layer having negative dielectric anisotropy, and includes LC molecules vertically aligned at an initial alignment.

[0071] The LCD device according to the embodiment display black on a screen when a signal is not applied. That is, the LCD device is in a normally black mode.

[0072] Figs. 6, 7A, and 8A are views explaining a viewing angle mode according to an embodiment, taken along the line I-I' representing the horizontal direction of a display surface, after a process of attaching the first and second substrates 110 and 120 to each other, an LC forming process, and a process of attaching the first and second polarizers 161 and 162.

[0073] Fig. 6 is a view illustrating an LCD device during an off-state when a voltage is not applied to the subpixels Pr, Pg, Pb, and Pv.

[0074] Referring to Fig. 6, when a voltage is not applied to the subpixels Pr, Pg, Pb, and Pv, the LCs 132 formed in the subpixels Pr, Pg, Pb, and Pv maintain an initial alignment state. Accordingly, the subpixels Pr, Pg, Pb, and Pv display block.

[0075] The LCD device according to the embodiment controls a viewing angle using the viewing angle controlling subpixel Pv when realizing an image through the data displaying subpixels Pr, Pg, and Pb. Also, the LCD device according to an embodiment improves the brightness of a unit pixel using the viewing angle controlling subpixel Pv.

[0076] Figs. 7A and 7B are views explaining a wide viewing angle mode of an LCD device according to an embodiment.

[0077] Referring to Figs. 7A and 7B, an image realized through the data displaying subpixels Pr, Pg, and Pb during the wide viewing angle mode is viewed not only at a front viewing angle direction but also at left and right viewing angle directions. The image viewed at the left and right viewing angle directions is realized by transmitting the image through the viewing angle controlling subpixel Pv in the left and right viewing angle directions.

[0078] To realize the image, a common voltage is supplied to the common electrodes 225 of the subpixel Pr, Pg, and Pb. R, G, and B data voltages are applied to the first pixel electrodes 117 of the data displaying subpixels Pr, Pg, and Pb. A vertical electric field is formed between the common electrode 225 to which the common voltage has been applied, and the first pixel electrodes 117 to which the R, G, and B data voltages have been applied. The LCs 132 of the data displaying subpixels Pr, Pg, and Pb are driven to an alignment surface to form a right angle to the electric field, and light transmittance is controlled according to a driving state of the LCs, so that an image is displayed. At this point, since the vertical electric field is distorted by the ribs 227, the LCs 132 are radially distributed to be symmetrical in the vertical and horizontal directions of a display surface around the ribs 227.

[0079] During the wide viewing angle mode according to the embodiment, the viewing angle controlling subpixel Pv substantially directly transmits light from the data displaying subpixels Pr, Pg, and Pb in the left and right viewing angle directions, and improves the brightness of an image displayed in the front direction.

[0080] To realize the wide viewing angle mode and improve the brightness of an image, a wide viewing angle data voltage is applied to the second electrode 517 of the viewing angle controlling subpixel Pv, and a voltage having the same potential as that of the common voltage is applied to the side electrode 520. Accordingly, a vertical electric field is generated between the second pixel electrode 517 and the common electrode 225. The LCs 132 contained in the viewing angle controlling subpixel Pv is driven to an alignment layer to form a right angle with the electric field. At this point, since the vertical electric field is distorted by the rib 527, the LCs 132 are radially distributed to be symmetrical in the vertical and horizontal directions of a display surface around the rib 527. For reference, when the long axis of the LC 132 is in parallel to the transmission axes x and y of the first and second polarizers 161 and 162, light incident onto the viewing angle controlling subpixel Pv is not displayed on the display surface. Since light incident in the front viewing angle

direction of the viewing angle controlling subpixel Pv passes through the LCs 132 whose long axes are arranged in a radial direction, the light passes through the second polarizer 162 and is displayed on the display surface. Accordingly, the viewing angle controlling subpixel Pv contributes to improving the brightness of an image during the wide viewing angle mode. Also, since an image incident from the left and right viewing angle directions of the viewing angle controlling subpixel Pv passes through the LCs 132 arranged nearly horizontal on the display surface without phase delay in response to a wide viewing angle data voltage applied to the second pixel electrode 517, substantially the same image is displayed in the left and right viewing angle direction.

[0081] Figs. 8A and 8B are views explaining a narrow viewing angle mode of an LCD device according to an embodiment.

[0082] Referring to Figs. 8A and 8B, an image realized through the data displaying subpixels Pr, Pg, and Pb is displayed in the front viewing angle direction, and distorted in the left and right viewing angle directions and displayed as different information during the narrow viewing angle mode according to the embodiment. The image displayed in the left and right viewing angle direction is realized by transmitting light through the viewing angle controlling subpixel Pv in the left and right viewing angle direction.

[0083] To realize the image, a common voltage is supplied to the common electrodes 225 of the subpixel Pr, Pg, and Pb. R, G, and B data voltages are applied to the first pixel electrodes 117 of the data displaying subpixels Pr, Pg, and Pb. A vertical electric field is formed between the common electrode 225 to which the common voltage has been applied, and the first pixel electrodes 117 to which the R, G, and B data voltages have been applied. The LCs 132 of the data displaying subpixels Pr, Pg, and Pb are driven to an alignment surface to form a right angle to the electric field, and light transmittance is controlled according to a driving state of the LCs, so that an image is displayed. At this point, since the vertical electric field is distorted by the ribs 227, the LCs 132 are radially distributed to be symmetrical in the vertical and horizontal directions of a display surface around the ribs 227.

[0084] During the narrow viewing angle mode according to the embodiment, the viewing angle controlling subpixel Pv delays the phase of light from the data displaying subpixels Pr, Pg, and Pb in the left and right viewing angle directions, and improves the brightness of an image displayed in the front direction.

[0085] To realize the narrow viewing angle mode and improve the brightness of an image, a narrow viewing angle data voltage is applied to the second electrode 517 of the viewing angle controlling subpixel Pv, and a voltage having a potential difference with respect to the common voltage is applied to the side electrode 520. Accordingly, a vertical electric field formed between the second pixel electrode 517 and the common electrode 225 is distorted by a voltage supplied to the side electrode 520, so that the long axes of the LCs 132 are arranged such that the display surface faces the vertical direction. Simultaneously, since the electric field formed in the viewing angle controlling subpixel Pv is distorted by the rib 527, the LCs 132 are arranged to be symmetric around the rib 527. Light incident in the front viewing angle direction of the viewing angle controlling subpixel Pv passes through the second polarizer 162 through portions where the long axes of the LCs 132 are not parallel to the transmission axes x and y of the first and second polarizers 161 and 162 (that is, the left and right portions of the viewing angle controlling subpixel Pv) and is displayed on the display surface. Accordingly, the viewing angle controlling subpixel Pv contributes to improving the brightness of an image during the narrow viewing angle mode. Also, since an image incident from the left and right viewing angle directions of the viewing angle controlling subpixel Pv passes through the LCs 132 arranged nearly vertical on the display surface in response to a narrow viewing angle data voltage applied to the second pixel electrode 517, the phase of the image is considerably delayed and distorted information is displayed in the left and right viewing angle directions.

[0086] The degree by which the long axes of the LCs 132 are driven in the left and right viewing angle directions is controlled by a viewing angle control data voltage applied to the second pixel electrode 517, so that the wide viewing angle mode and the narrow viewing angle mode can be selectively realized. A light transmittance amount through the viewing angle controlling subpixel Pv in the front direction is also controlled by a voltage applied to the second pixel electrode 517.

[0087] As described above, the LCD device according to the embodiment controls the arrangement of the LCs using the viewing angle controlling subpixel to selectively realize the wide viewing angle mode and the narrow viewing angle mode.

[0088] Also, in the LCD device according to the embodiment, the viewing angle controlling subpixel controls the arrangement of the LCs using the ribs and the side electrode to improve brightness reduction of the pixels.

[0089] Also, since the LCD device according to the embodiment does not require a separate viewing angle controlling panel, manufacturing costs reduce. Also, since misalignment in attaching of the viewing angle controlling panel is not generated, so that manufacturing yield can increase, and the LCD device can he manufactured in a lightweight and slim profile.

[0090] While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The preferred embodiments should be considered in descriptive sense only and not for purposes of limitation. Therefore, the scope of the invention is defined not by the detailed description of the invention but by the appended

claims, and all differences within the scope will be construed as being included in the present invention.

Claims

1. A liquid crystal display device including a plurality of pixels
, each pixel including data displaying subpixels (Pr, Pg, Pb) and a viewing angle controlling subpixel (Pv) the subpixels being defined by gate lines (112) and data lines (115), wherein
the data displaying subpixels (Pr, Pg, Pb) comprise a liquid crystal layer of a vertical alignment mode comprising liquid crystals (132) having negative dielectric anisotropy and being interposed between respective first pixel electrodes (117) to which red, green, and blue data voltages are applied, and a common electrode (225) to which a common voltage is applied,
the viewing angle controlling subpixel Pv comprises the liquid crystal layer of the vertical alignment mode drivable in response to a voltage applied to the common electrode, a side electrode (520) separated from the common electrode (225) and arranged on the same substrate (120) as the common electrode (225), and a second pixel electrode (517),
each of the subpixels (Pr, Pg, Pb, Pv) comprises a protrusion (227, 527) distorting an electric field applied to the liquid crystal layer, and the side electrode (520) is arranged to receive one of the same voltage as the common voltage during a wide viewing angle mode and
a voltage different from the common voltage during a narrow viewing angle mode.

2. The liquid crystal display device according to claim 1, wherein the common electrode (225) is formed along the subpixels (Pr, Pg, Pb, Pv) in each row, and the common electrodes (225) of the rows are spaced apart from each other.

3. The liquid crystal display device according to claim 1, wherein the common electrode (225) is formed along the subpixels (Pr, Pg, Pb, Pv) in each column, and the common electrodes (225) of the columns are spaced apart from each other.

4. The liquid crystal display device according to claim 1, wherein the subpixels (Pr, Pg, Pb, Pv) comprise a thin film transistor array (111) and a color filter array (121) facing each other with the liquid crystal layer interposed therebetween.

5. The liquid crystal display device according to claim 4, wherein the thin film transistor array (111) comprises:

thin film transistors connected to the gate lines (112) and the data lines (115), and the first pixel electrodes (117) are connected to respective thin film transistors in the respective data displaying subpixel (Pr, Pg, Pb), and the second pixel electrode (517) is connected to the thin film transistor in the viewing angle controlling subpixel (Pv).

6. The liquid crystal display device according to claim 4, wherein the color filter array (121) comprises:

a black matrix (122) dividing the subpixels (Pr, Pg, Pb, Pv);
red, green, and blue color filter patterns (123) on the data displaying subpixels (Pr, Pg, Pb); and
an overcoat layer (129) covering the color filter patterns (123) and the black matrix (122).

7. The liquid crystal display device according to claim 6, wherein the common electrode (225) and the side electrode (520) are on the overcoat layer (129).

8. The liquid crystal display device according to claim 1, wherein the protrusion (227, 527) is formed in a center of each subpixel (Pr, Pg, Pb, Pv).

9. The liquid crystal display device according to claim 1, further comprising: a control line (524) electrically connecting to side electrodes (520) of adjacent viewing angle controlling subpixels (Pv) and avoiding the data displaying subpixels (Pr, Pg, Pb), the side electrode (520) comprising a pair of side electrodes (520) facing each other in each viewing angle controlling subpixel (Pv) with the common electrode (225) interposed, and the control line (524) comprising a pair of control lines (524) on one side and the other side of a pixel row comprising a row arrangement of the subpixels (Pr, Pg, Pb).

10. The liquid crystal display device according to claim 9, wherein the side electrode (520) overlaps the second pixel electrode (517).

11. A method for driving a liquid crystal display device including a plurality of pixels
, each pixel including data displaying subpixels (Pr, Pg, Pb) and a viewing angle controlling subpixel (Pv) the subpixels being defined by gate lines (112) and data lines (115), the data displaying subpixels (Pr, Pg, Pb) comprising a liquid crystal layer of a vertical alignment mode using liquid crystals (132) having negative dielectric anisotropy between respective first pixel electrodes to which red, green, and blue data voltages are applied, and a common electrode (225) to which a common voltage is applied, and the viewing angle controlling subpixel (Pv) comprising

the liquid crystal layer of the vertical alignment mode driven in response to the voltage applied to the common electrode (225), a side electrode (520) separated from the common electrode (225) and arranged on the same substrate (120) as the common electrode (225), and a second pixel electrode (517), the method comprising:

applying the common voltage to the data displaying subpixels (Pr, Pg, Pb) and applying the common voltage to a side electrode (520) of the viewing angle controlling subpixel (Pv) to substantially directly pass light from the data displaying subpixels (Pr, Pg, Pb) through the viewing angle controlling subpixel (Pv) during a wide viewing angle mode; and

applying the common voltage to the data displaying subpixels (Pr, Pg, Pb) and applying a voltage different from the common voltage to the side electrode (520) of the viewing angle controlling subpixel (Pv) to delay, at the viewing angle controlling subpixel (Pv), phase of light from the data displaying subpixels (Pr, Pg, Pb) during a narrow viewing angle mode.

Patentansprüche

1. Flüssigkristallanzeigevorrichtung, die eine Mehrzahl von Pixeln aufweist, wobei jedes Pixel Datenanzeigesubpixel (Pr, Pg, Pb) und ein Betrachtungswinkelsteuerungssubpixel (Pv) aufweist, wobei die Subpixel durch Gate-Leitungen (112) und Datenleitungen (115) definiert sind, wobei

die Datenanzeigesubpixel (Pr, Pg, Pb) eine Flüssigkristallschicht einer Vertikalausrichtungsart aufweist, die Flüssigkristalle (132) mit negativer dielektrischer Anisotropie aufweist und zwischen jeweiligen ersten Pixelelektroden (117), an die Rot-, Grün- und Blaudatenspannungen angelegt werden, und eine gemeinsame Elektrode (225), an die eine gemeinsame Spannung angelegt wird, eingefügt ist,

das Betrachtungswinkelsteuerungssubpixel (Pv) die Flüssigkristallschicht der Vertikalausrichtungsart aufweist, die als Antwort auf eine an die gemeinsame Elektrode, eine von der gemeinsamen Elektrode (225) getrennte und auf demselben Substrat (120) wie die gemeinsame Elektrode (225) angeordnete Seitenelektrode (520) und eine zweite Pixelelektrode (517) angelegte Spannung antreibbar ist,

wobei jedes der Subpixel (Pr, Pg, Pb, Pv) einen Vorsprung (227, 527) aufweist, der ein an die Flüssigkristallschicht angelegtes elektrisches Feld verzerrt, und die Seitenelektrode (520) eingerichtet ist, während einer Weiter-Betrachtungswinkel-Betriebsart die gemeinsame Spannung und während einer Enger-Betrachtungswinkel-Betriebsart eine von der gemeinsamen Spannung verschiedene Spannung zu empfangen.

2. Flüssigkristallanzeigevorrichtung gemäß Anspruch 1, wobei die gemeinsame Elektrode (225) entlang der Subpixel (Pr, Pg, Pb, Pv) in jeder Zeile ausgebildet ist und die gemeinsamen Elektroden (225) der Zeilen durch einen Abstand voneinander getrennt sind.

3. Flüssigkristallanzeigevorrichtung gemäß Anspruch 1, wobei die gemeinsame Elektrode (225) entlang der Subpixel (Pr, Pg, Pb, Pv) in jeder Spalte ausgebildet ist und die gemeinsamen Elektroden (225) der Spalten durch einen Abstand voneinander getrennt sind.

4. Flüssigkristallanzeigevorrichtung gemäß Anspruch 1, wobei die Subpixel (Pr, Pg, Pb, Pv) ein Dünnfilmtransistorarray (111) und ein Farbfilterarray (121) aufweisen, die sich gegenüberliegen, wobei die Flüssigkristallschicht dazwischen eingefügt ist.

5. Flüssigkristallanzeigevorrichtung gemäß Anspruch 4, wobei das Dünnfilmtransistorarray (111) mit den Gate-Leitungen (112) und den Datenleitungen (115) verbundene Dünnfilmtransistoren aufweist und die ersten Pixelelektroden (117) mit jeweiligen Dünnfilmtransistoren in dem jeweiligen Datenanzeigesubpixel (Pr, Pg, Pb) verbunden sind und die zweite Pixelelektrode (517) mit dem Dünnfilmtransistor in dem Betrachtungswinkelsteuerungssubpixel (Pv) verbunden ist.

6. Flüssigkristallanzeigevorrichtung gemäß Anspruch 4, wobei das Farbfilterarray (121) aufweist:

eine Schwarzmatrix (122), die die Subpixel (Pr, Pg, Pb, Pv) trennt;

Rot-, Grün- und Blaufarbfilterstrukturen (123) auf den Datenanzeigesubpixeln (Pr, Pg, Pb); und

eine Überzugsschicht (129), die die Farbfilterstrukturen (123) und die Schwarzmatrix (122) bedeckt.

7. Flüssigkristallanzeigevorrichtung gemäß Anspruch 6, wobei die gemeinsame Elektrode (225) und die Seitenelektrode (520) auf der Überzugsschicht (129) sind.

8. Flüssigkristallanzeigevorrichtung gemäß Anspruch 1, wobei der Vorsprung (227, 527) in der Mitte jedes Subpixels (Pr, Pg, Pb, Pv) ausgebildet ist.

9. Flüssigkristallanzeigevorrichtung gemäß Anspruch 1, ferner aufweisend: eine Steuerleitung (524), die mit Seitenelektroden (520) benachbarter Betrachtungswinkelsteuerungssubpixel (Pv) elektrisch ver-

bunden ist und die Datenanzeigesubpixel (Pr, Pg, Pb) meidet, wobei die Seitenelektrode (520) ein Paar Seitenelektroden (520) aufweist, die sich in jedem Betrachtungswinkelsteuerungssubpixel (Pv) gegenüberliegen, wobei die gemeinsame Elektrode (225) dazwischen eingefügt ist, und wobei die Steuerleitung (524) ein Paar Steuerleitungen (524) aufweist auf der einen Seite und der anderen Seite einer Pixelzeile, die eine Zeilenanordnung der Subpixel (Pr, Pg, Pb) aufweist.

10. Flüssigkristallanzeigevorrichtung gemäß 9, wobei die Seitenelektrode (520) die zweite Pixelelektrode (517) überlappt.

11. Verfahren zum Treiben einer Flüssigkristallanzeigevorrichtung, die eine Mehrzahl von Pixeln aufweist, wobei jedes Pixel Datenanzeigesubpixel (Pr, Pg, Pb) und ein Betrachtungswinkelsteuerungssubpixel (Pv) aufweist, wobei die Subpixel durch Gate-Leitungen (112) und Datenleitungen (115) definiert sind, wobei die Datenanzeigesubpixel (Pr, Pg, Pb) eine Flüssigkristallschicht einer Vertikalausrichtungsart, die Flüssigkristalle (132) mit negativer dielektrischer Anisotropie verwendet, aufweisen zwischen jeweiligen ersten Pixelelektroden, an die Rot-, Grün- und Blaudatenspannungen angelegt werden, und einer gemeinsame Elektrode (225), an die eine gemeinsame Spannung angelegt wird, und wobei das Betrachtungswinkelsteuerungssubpixel (Pv) die Flüssigkristallschicht der Vertikalausrichtungsart aufweist, die als Antwort auf die an die gemeinsame Elektrode (225), eine von der gemeinsamen Elektrode (225) getrennte und auf demselben Substrat (120) wie die gemeinsame Elektrode (225) angeordnete Seitenelektrode (520) und eine zweite Pixelelektrode (517) angelegte Spannung angetrieben wird, das Verfahren aufweisend:

Anlegen der gemeinsamen Spannung an die Datenanzeigesubpixel (Pr, Pg, Pb) und Anlegen der gemeinsamen Spannung an eine Seitenelektrode (520) des Betrachtungswinkelsteuerungssubpixels (Pv), so dass während einer Weiter-Betrachtungswinkel-Betriebsart Licht von den Datenanzeigesubpixeln (Pr, Pg, Pb) im Wesentlichen direkt durch das Betrachtungswinkelsteuerungssubpixel (Pv) geführt wird;
und
Anlegen der gemeinsamen Spannung an die Datenanzeigesubpixel (Pr, Pg, Pb) und Anlegen einer von der gemeinsamen Spannung verschiedenen Spannung an die Seitenelektrode (520) des Betrachtungswinkelsteuerungssubpixels (Pv), so dass während einer Enger-Betrachtungswinkel-Betriebsart die Phase des Lichts von den Datenanzeigesubpixeln (Pr, Pg, Pb) in dem Betrachtungswinkelsteuerungssubpixel (Pv) verzögert wird.

Revendications

1. Dispositif d'affichage à cristaux liquides comprenant une pluralité de pixels, chaque pixel comprenant des sous-pixels d'affichage de données (Pr, Pg, Pb) et un sous-pixel de contrôle d'angle de vision (Pv), les sous-pixels étant définis par des lignes de grille (112) et des lignes de données (115), dans lequel
les sous-pixels d'affichage de données (Pr, Pg, Pb) comprennent une couche de cristaux liquides d'un mode d'alignement vertical comprenant des cristaux liquides (132) présentant une anisotropie diélectrique négative et étant intercalée entre des premières électrodes de pixel respectives (117) sur lesquelles des tensions de données rouge, verte et bleue sont appliquées, et une électrode commune (225) sur laquelle une tension commune est appliquée,
le sous-pixel de contrôle d'angle de vision Pv comprend la couche de cristaux liquides du mode d'alignement vertical pouvant être commandée en réponse à une tension appliquée à l'électrode commune, à une électrode latérale (520) séparée de l'électrode commune (225) et agencée sur le même substrat (120) en tant qu'électrode commune (225), et à une seconde électrode de pixel (517),
chacun des sous-pixels (Pr, Pg, Pb, Pv) présente une saillie (227, 527) déformant un champ électrique appliqué à la couche de cristaux liquides, et l'électrode latérale (520) est conçue pour recevoir l'une de la tension identique à la tension commune pendant un mode d'angle de vision large et d'une tension différente de la tension commune pendant un mode d'angle de vision étroit.

2. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel l'électrode commune (225) est formée le long des sous-pixels (Pr, Pg, Pb, Pv) dans chaque rangée, et les électrodes communes (225) des rangées sont espacées les unes par rapport aux autres.

3. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel l'électrode commune (225) est formée le long des sous-pixels (Pr, Pg, Pb, Pv) dans chaque colonne, et les électrodes communes (225) des colonnes sont espacées les unes par rapport aux autres.

4. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel les sous-pixels (Pr, Pg, Pb, Pv) comprennent un réseau de transistors à film mince (111) et un réseau de filtres colorés (121) se faisant face, la couche de cristaux liquides étant intercalée entre eux.

5. Dispositif d'affichage à cristaux liquides selon la revendication 4, dans lequel le réseau de transistors à film mince (111) comprend :

des transistors à film mince connectés aux lignes de grille (112) et aux lignes de données (115), et les premières électrodes de pixel (117) sont connectées aux transistors à film mince respectifs dans le sous-pixel d'affichage de données respectif (Pr, Pg, Pb), et la seconde électrode de pixel (517) est connectée au transistor à film mince dans le sous-pixel de contrôle d'angle de vision (Pv).

6. Dispositif d'affichage à cristaux liquides selon la revendication 4, dans lequel le réseau de filtres colorés (121) comprend :

une matrice noire (122) divisant les sous-pixels (Pr, Pg, Pb, Pv) ;
des modèles de filtres colorés rouges, verts et bleus (123) sur les sous-pixels d'affichage de données (Pr, Pg, Pb) ; et
une couche de finition (129) couvrant les modèles de filtres colorés (123) et la matrice noire (122).

7. Dispositif d'affichage à cristaux liquides selon la revendication 6, dans lequel l'électrode commune (225) et l'électrode latérale (520) sont sur la couche de finition (129).

8. Dispositif d'affichage à cristaux liquides selon la revendication 1, dans lequel la saillie (227, 527) est formée au centre de chaque sous-pixel (Pr, Pg, Pb, Pv).

9. Dispositif d'affichage à cristaux liquides selon la revendication 1, comprenant en outre : une ligne de commande (524) établissant la connexion électrique avec les électrodes latérales (520) des sous-pixels de contrôle d'angle de vision adjacent (Pv) et évitant les sous-pixels d'affichage de données (Pr, Pg, Pb), l'électrode latérale (520) comprenant une paire d'électrodes latérales (520) se faisant face dans chaque sous-pixel de contrôle d'angle de vision (Pv) avec l'électrode commune (225) intercalée, et la ligne de commande (524) comprenant une paire de lignes de commande (524) d'un côté et de l'autre d'une rangée de pixels comprenant un agencement de rangées des sous-pixels (Pr, Pg, Pb).

10. Dispositif d'affichage à cristaux liquides selon la revendication 9, dans lequel l'électrode latérale (520) chevauche la seconde électrode de pixel (517).

11. Procédé de commande d'un dispositif d'affichage à cristaux liquides comprenant une pluralité de pixels, chaque pixel comprenant des sous-pixels d'affichage de données (Pr, Pg, Pb) et un sous-pixel de contrôle d'angle de vision (Pv), les sous-pixels étant définis par des lignes de grille (112) et des lignes de données (115), les sous-pixels d'affichage de données (Pr, Pg, Pb) comprenant une couche de cristaux liquides d'un mode d'alignement vertical utilisant des cristaux liquides (132) présentant une anisotropie diélectrique négative entre les premières électrodes de pixel respectives sur lesquelles des tensions de données rouge, verte et bleue sont appliquées, et une électrode commune (225) sur laquelle une tension commune est appliquée, et le sous-pixel de contrôle d'angle de vision (Pv) comprenant la couche de cristaux liquides du mode d'alignement vertical commandée en réponse à la tension appliquée à l'électrode commune (225), à une électrode latérale (520) séparée de l'électrode commune (225) et agencée sur le même substrat (120) en tant qu'électrode commune (225), et à une seconde électrode de pixel (517), le procédé consistant à :

appliquer la tension commune aux sous-pixels d'affichage de données (Pr, Pg, Pb) et appliquer la tension commune à une électrode latérale (520) du sous-pixel de contrôle d'angle de vision (Pv) pour faire passer sensiblement directement la lumière des sous-pixels d'affichage de données (Pr, Pg, Pb) à travers le sous-pixel de contrôle d'angle de vision (Pv) pendant un mode d'angle de vision large ; et
appliquer la tension commune aux sous-pixels d'affichage de données (Pr, Pg, Pb) et appliquer une tension différente de la tension commune à l'électrode latérale (520) du sous-pixel de contrôle d'angle de vision (Pv) pour retarder, au niveau du sous-pixel de contrôle d'angle de vision (Pv), la phase de lumière provenant des sous-pixels d'affichage de données (Pr, Pg, Pb) pendant un mode d'angle de vision étroit.

Fig.1

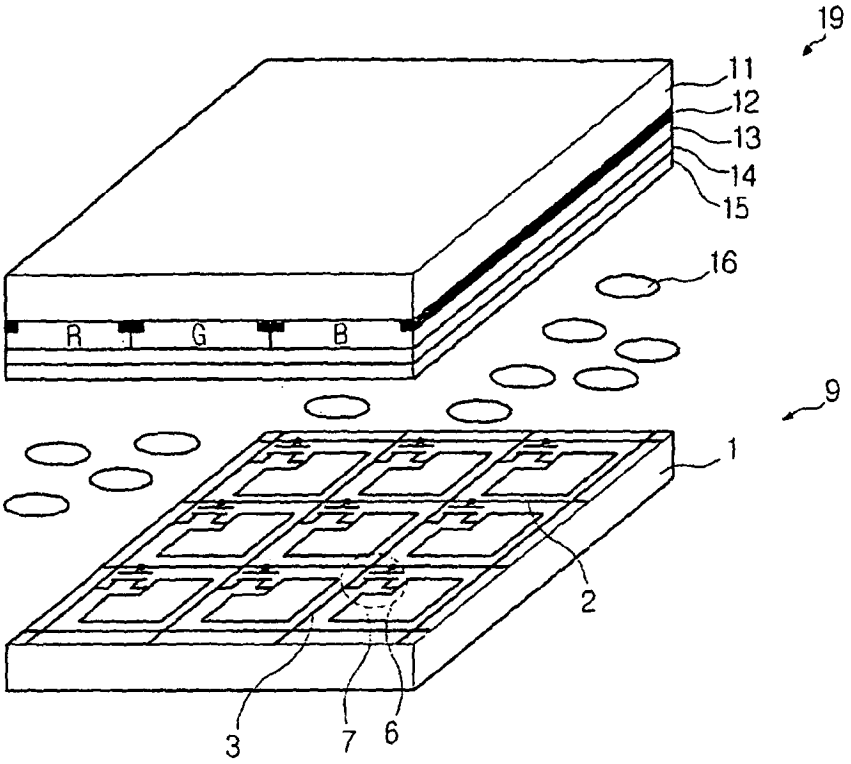


Fig.2

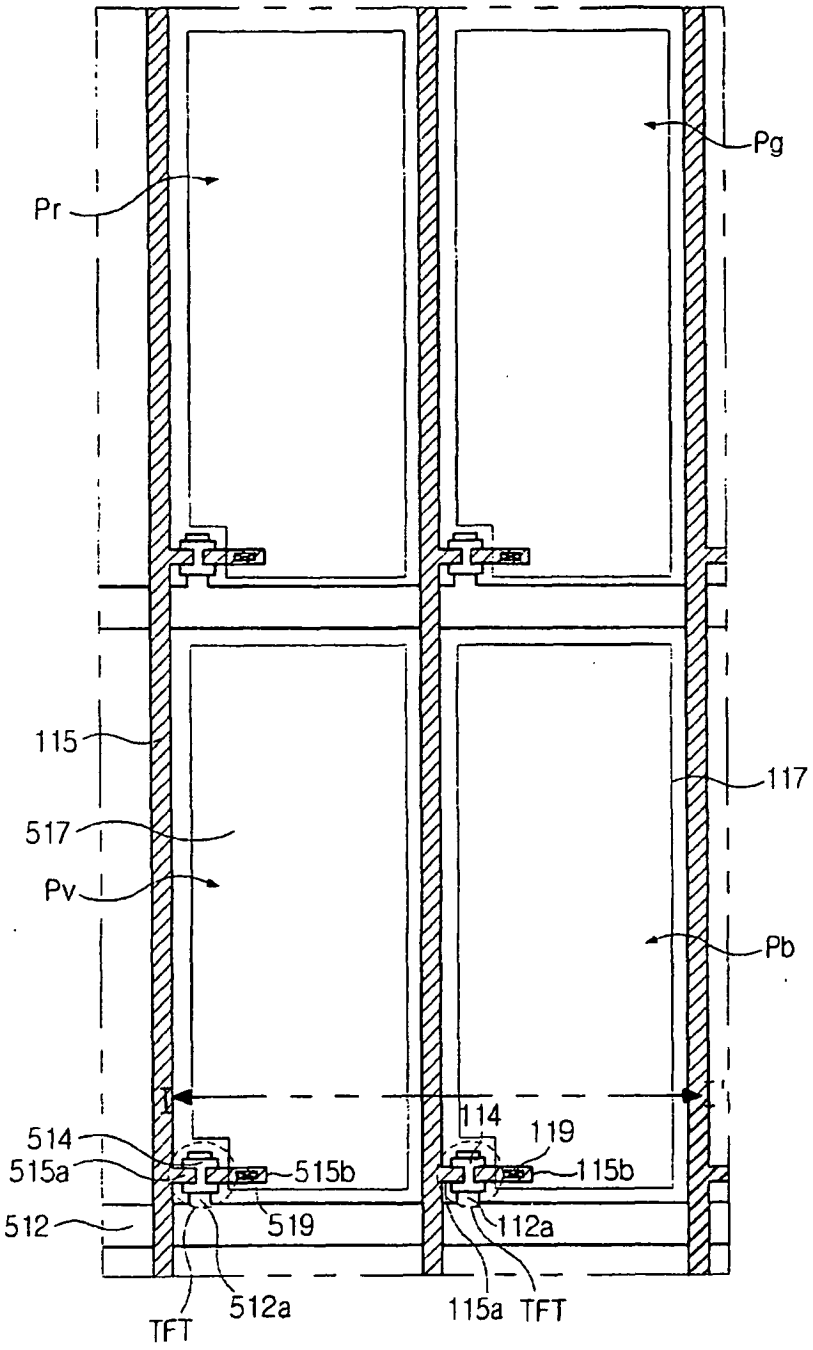

Pg
Pr
115
117
517
Pv
Pb
I
I
114
119
514
515a
515b
115b
512
519
112a
TFT
512a
115a
TFT

Fig.3

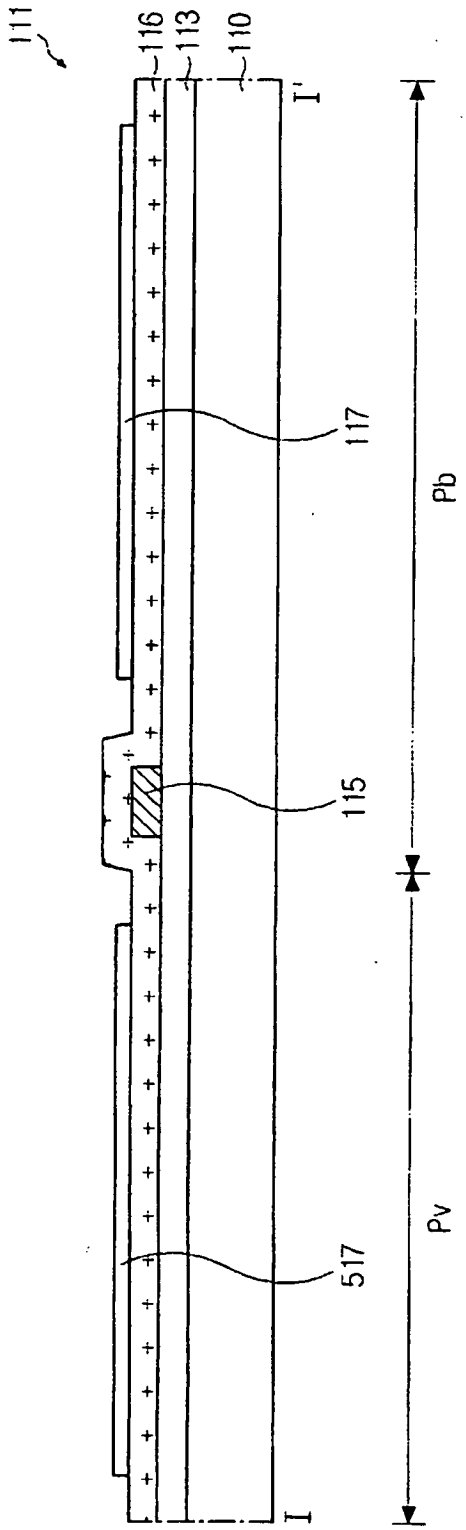


Fig. 4

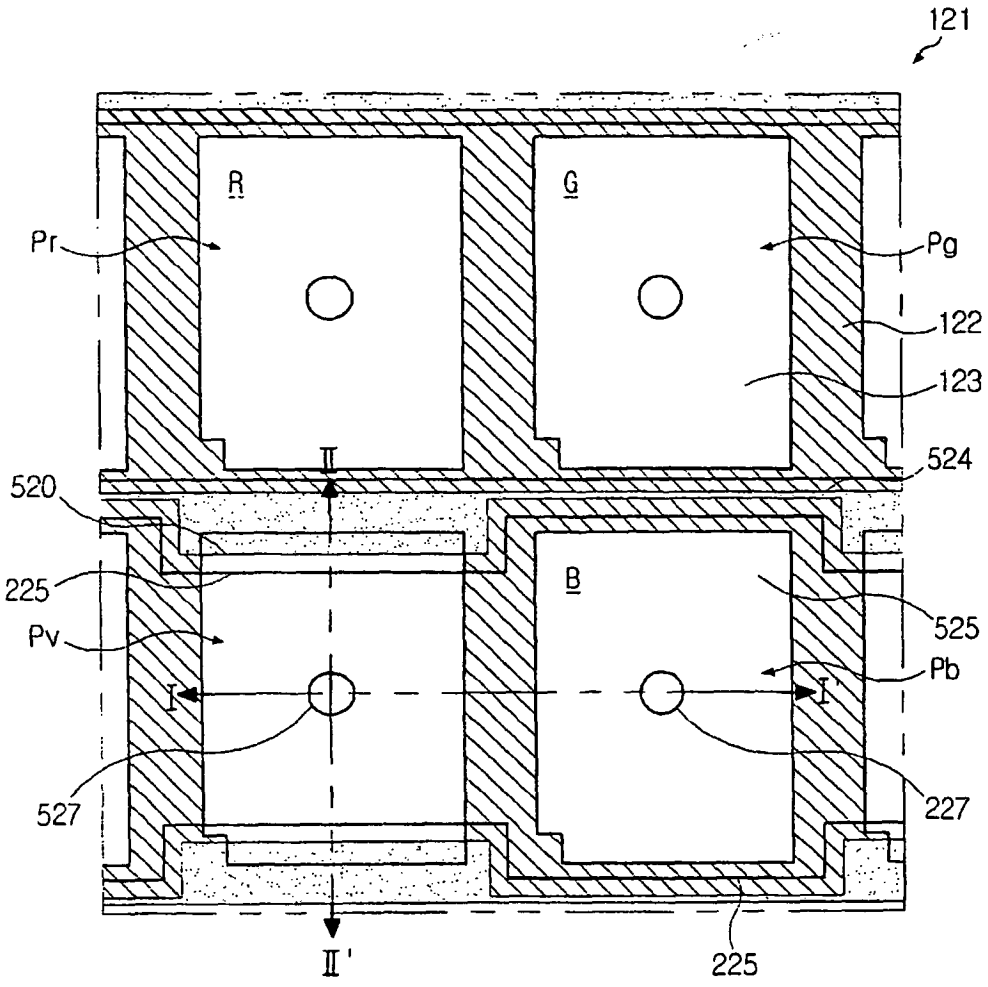


Fig.5

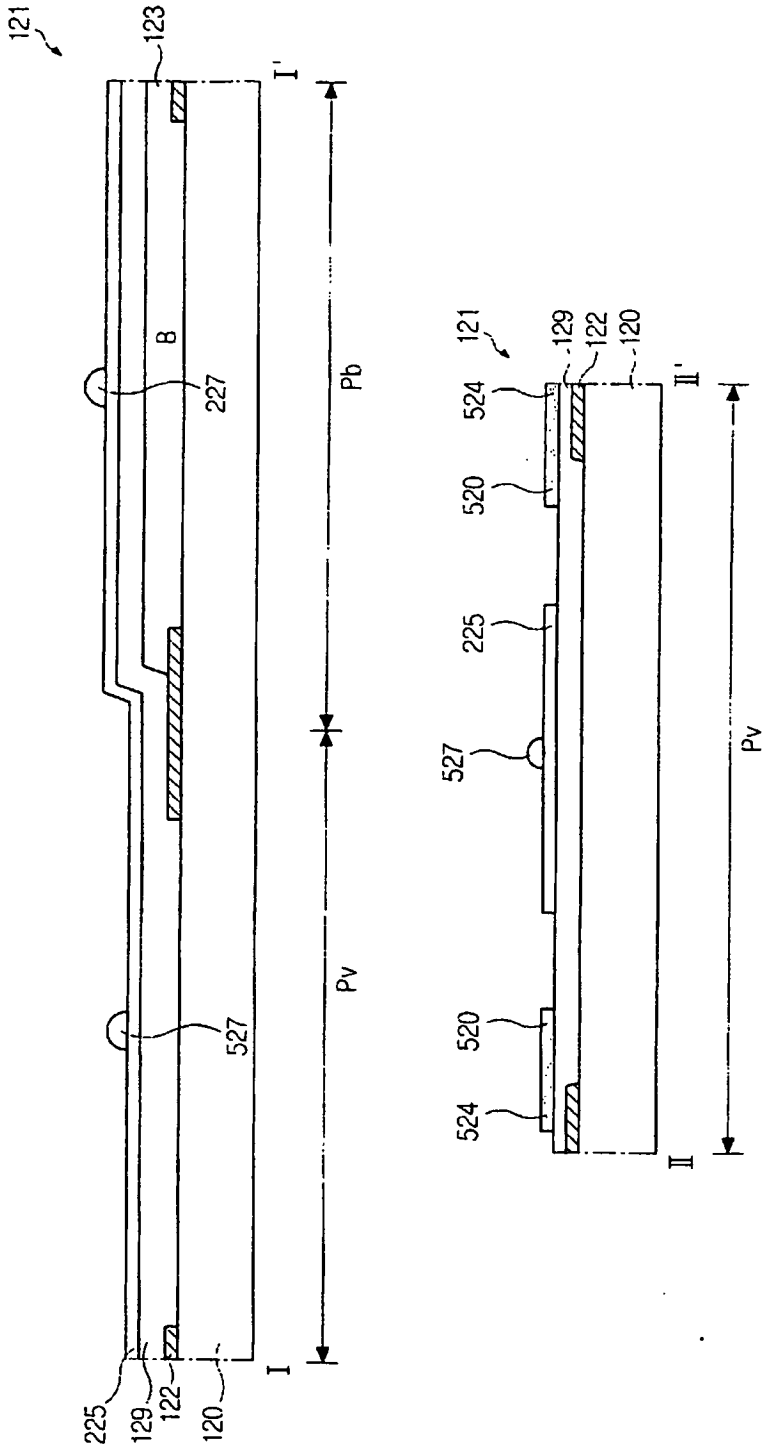

121
123
I'
B
227
Pb
Pv
527
225
129
122
120
I
121
129
122
120
524
520
225
527
520
524
II'
II
Pv

Fig. 6

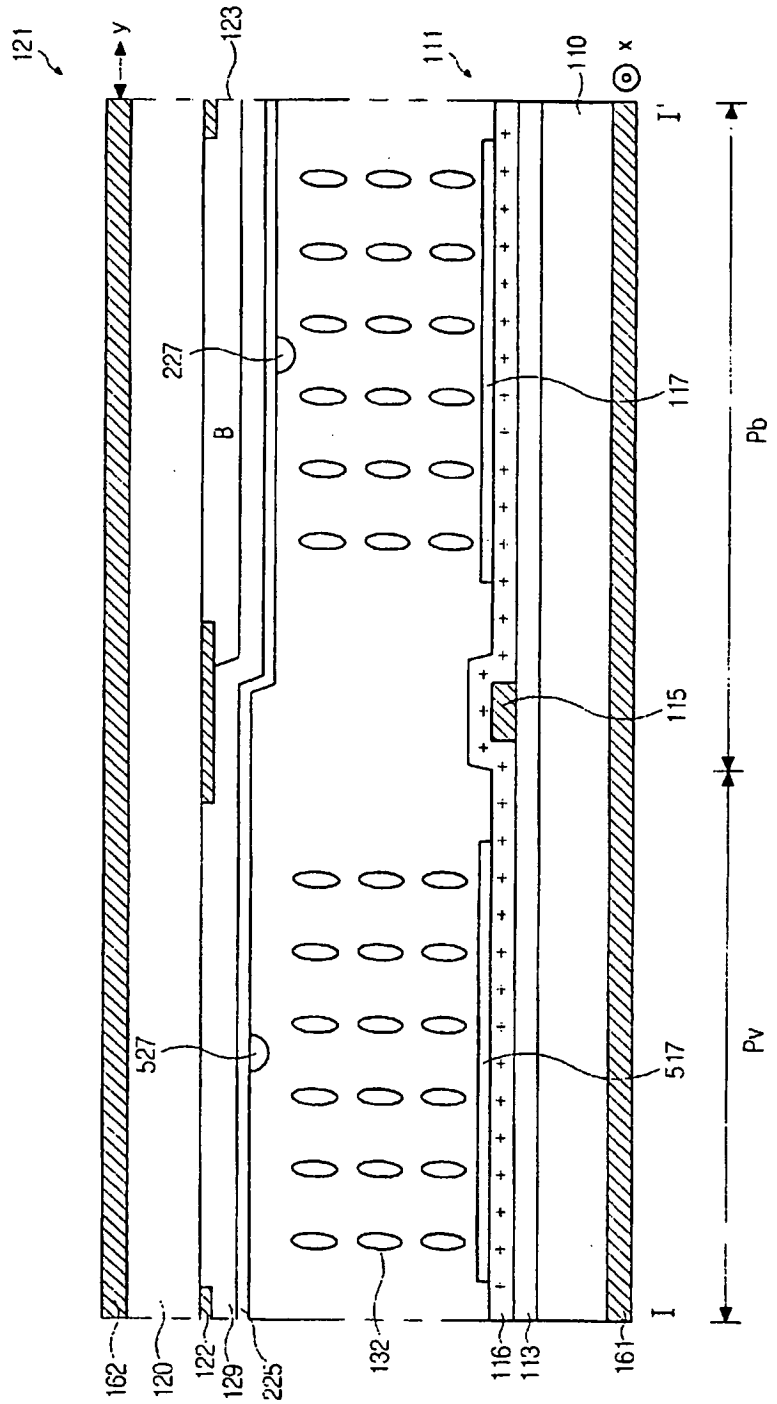

121
y
123
111
110
x
I'
227
B
117
Pb
115
527
517
Pv
I
162
120
122
129
225
132
116
113
161

Fig.7A

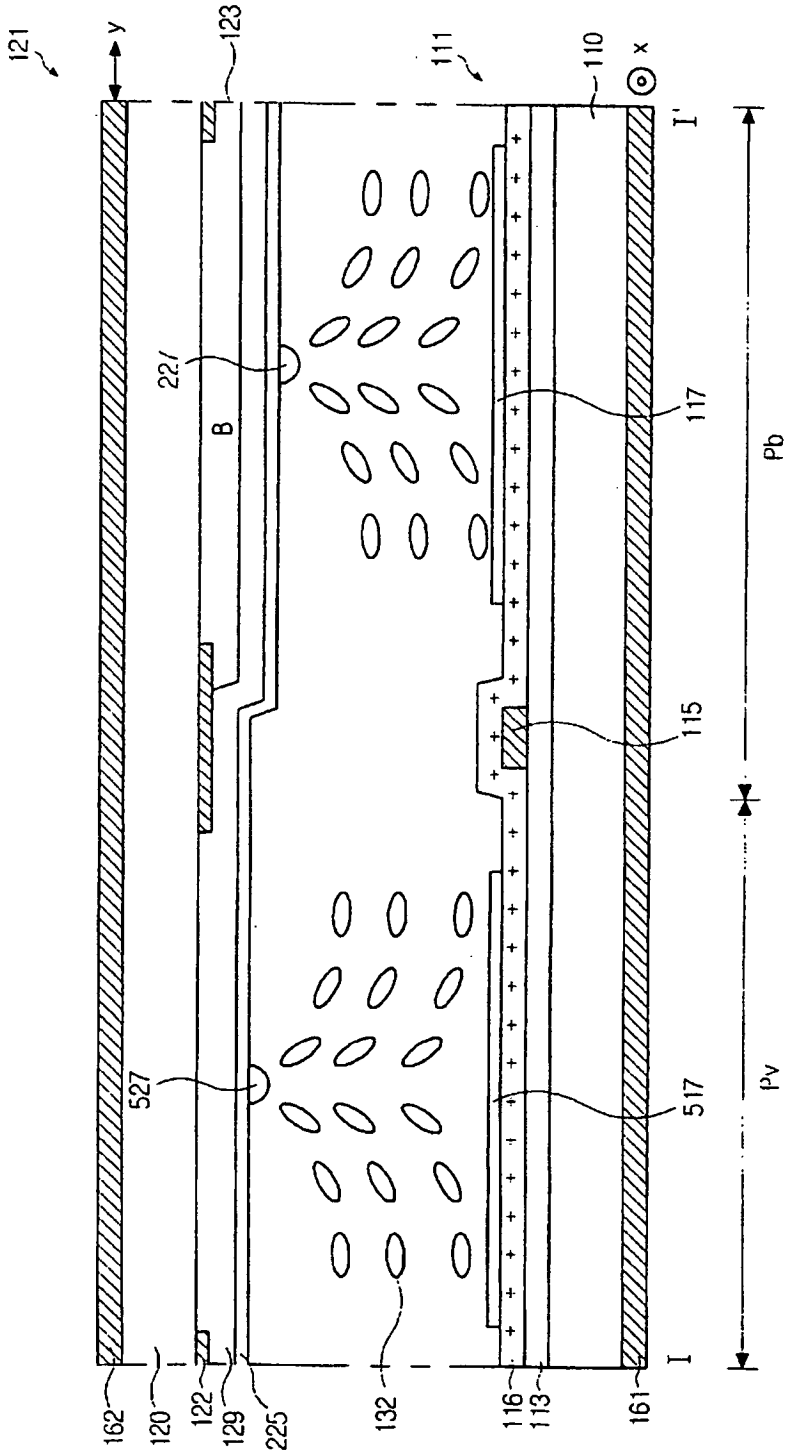

121
y
123
111
110
x
I'
221
B
117
Pb
115
527
517
Pv
I
162
120
122
129
225
132
116
113
161

Fig. 7B

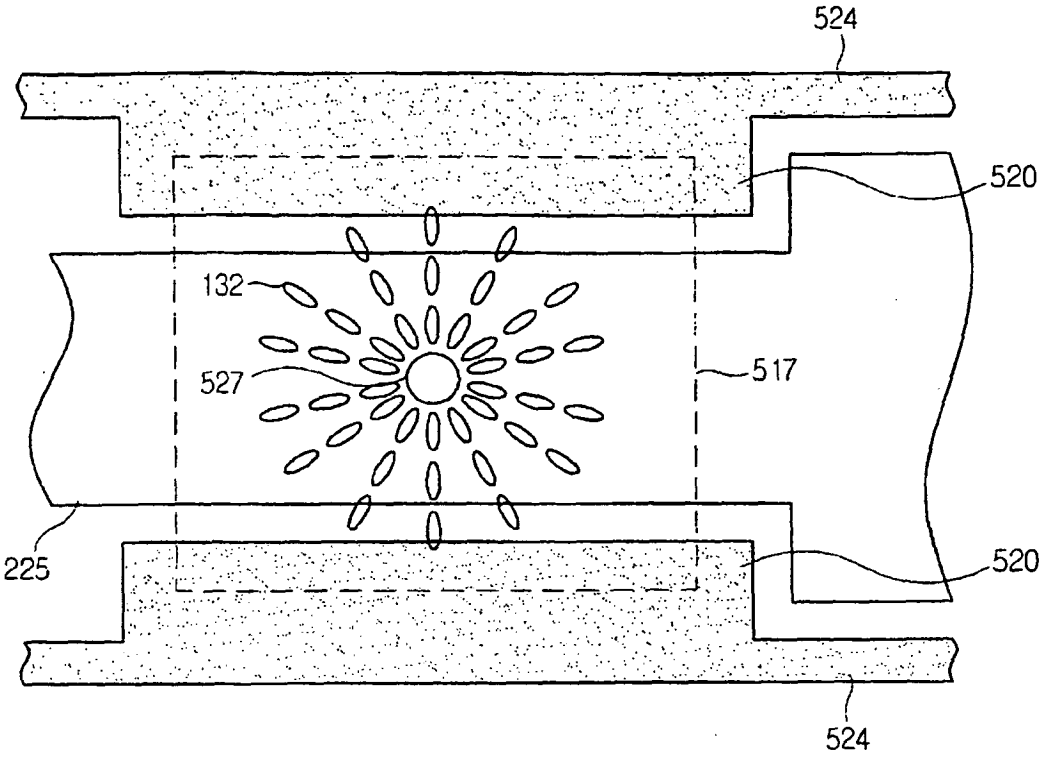


Fig.8A

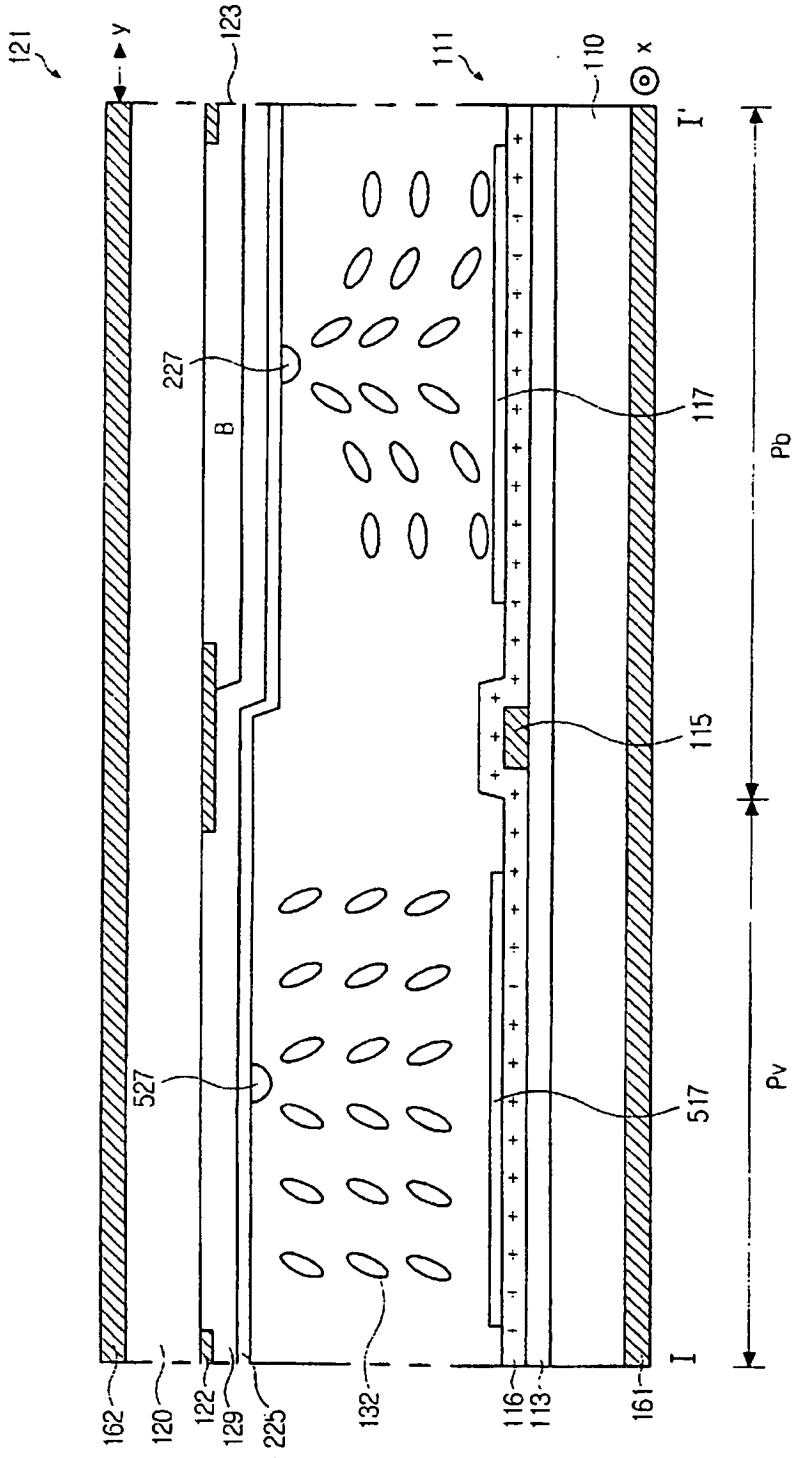
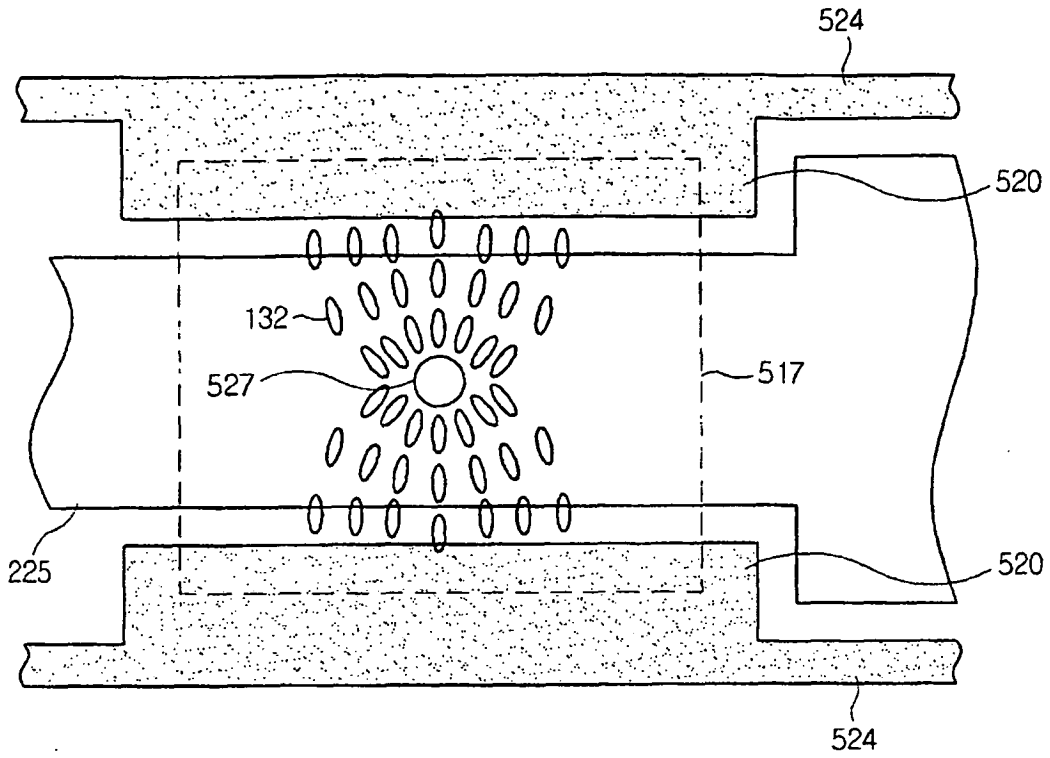

121
y
123
111
110
x
I'
227
B
117
Pb
115
527
517
Pv
I
162
120
122
129
225
132
116
113
161

Fig.8B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20070040780 A **[0010]**

专利名称(译)	液晶显示装置及其驱动方法		
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申请号	EP2007150401	申请日	2007-12-21
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	JIN HYUN SUK		
发明人	JIN, HYUN SUK		
IPC分类号	G02F1/1333 G02F1/139 G02F1/1343		
CPC分类号	G02F1/134309 G02F1/1323 G02F1/133707 G02F1/1393 G02F2001/134345 G02F2001/134381		
代理机构(译)	庆祝活动，JENTSCHURA＆PARTNER		
优先权	1020070037940 2007-04-18 KR		
其他公开文献	EP1986039A2 EP1986039A3		
外部链接	Espacenet		

摘要(译)

提供一种LCD装置。 LCD装置包括显示子像素的数据和视角控制子像素。使用负LC的VA模式的LC层插入在施加红色，绿色和蓝色数据电压的第一像素电极与施加有公共电压的公共电极之间。视角控制子像素包括响应于施加到公共电极的电压而驱动的垂直配向模式的液晶层，与公共电极分离的侧电极，以及第二像素电极。每个子像素包括肋，该肋扭曲施加到液晶层的电场。视角控制子像素在宽视角模式期间基本上直接传递来自数据显示子像素的光，并且在窄视角模式期间延迟来自数据显示子像素的光的相位。