



US 20040125286A1

(19) **United States**(12) **Patent Application Publication**
Moon et al.(10) **Pub. No.: US 2004/0125286 A1**(43) **Pub. Date: Jul. 1, 2004**(54) **REFLECTIVE LIQUID CRYSTAL DISPLAY
DEVICE**(76) Inventors: **Jong-Weon Moon**, Anyang-si (KR);
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MCKENNA LONG & ALDRIDGE LLP**Song K. Jung****1900 K Street, N.W.****Washington, DC 20006 (US)**(21) Appl. No.: **10/667,460**(22) Filed: **Sep. 23, 2003**(30) **Foreign Application Priority Data**

Dec. 27, 2002 (KR) 2002-85360

Publication Classification(51) **Int. Cl.⁷ G02F 1/1335**(52) **U.S. Cl. 349/113**(57) **ABSTRACT**

A reflective liquid crystal display device includes first and second substrates spaced apart and facing each other, a gate line and a data line on an inner surface of the first substrate and crossing each other to define a pixel area, a thin film transistor electrically connected to the gate and data lines, a passivation layer covering the thin film transistor, a blocking layer on the passivation layer and corresponding to the thin film transistor, a pixel electrode on the passivation layer and connected to the thin film transistor, a retardation film on an outer surface of the first substrate, a polarizer on the retardation film, an absorption layer on an inner surface of the second substrate, a cholesteric liquid crystal color filter layer on the absorption layer, a common electrode on the cholesteric liquid crystal color filter layer, and a liquid crystal layer between the common electrode and the pixel electrode, wherein the data line overlaps adjacent pixel electrodes and a overlapping width is over 50% of a width of the data line.

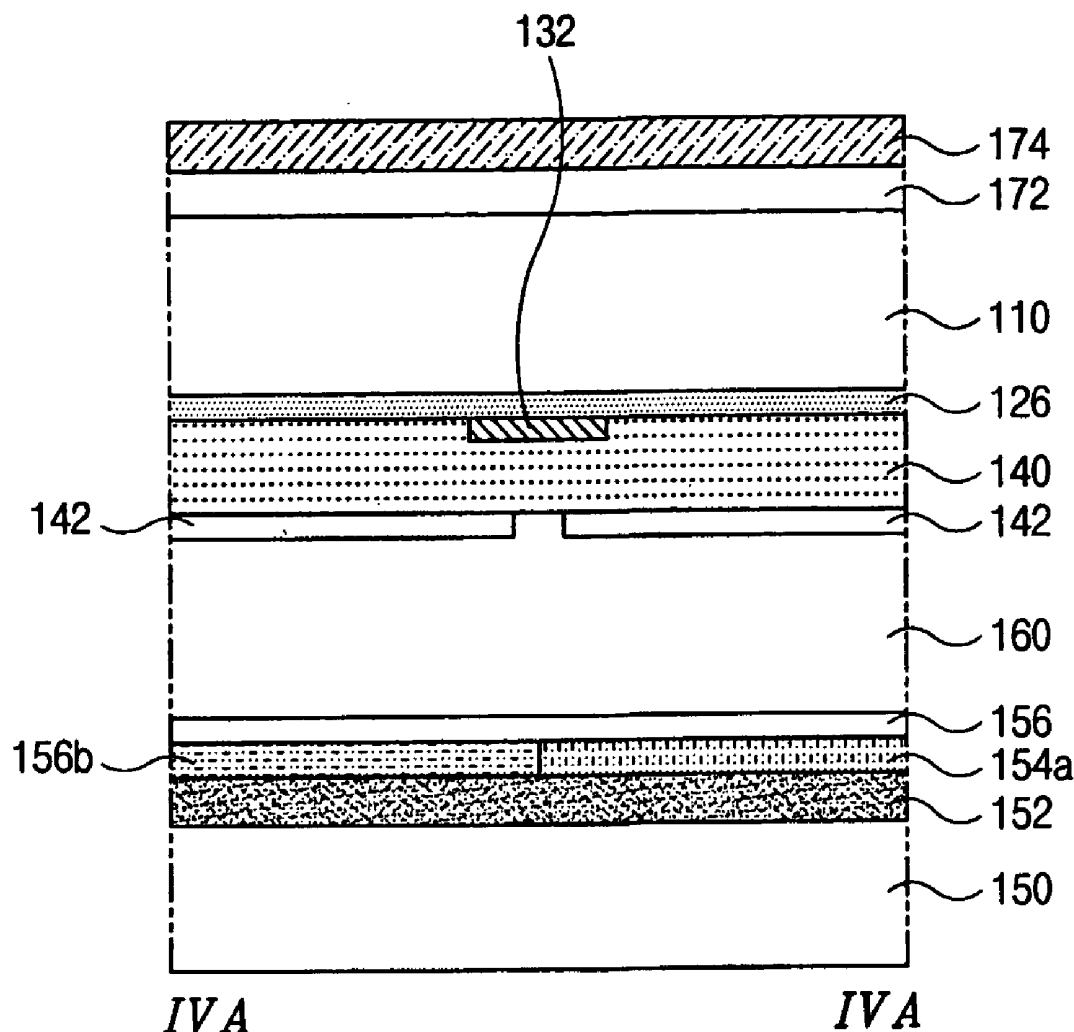


FIG. 1
RELATED ART

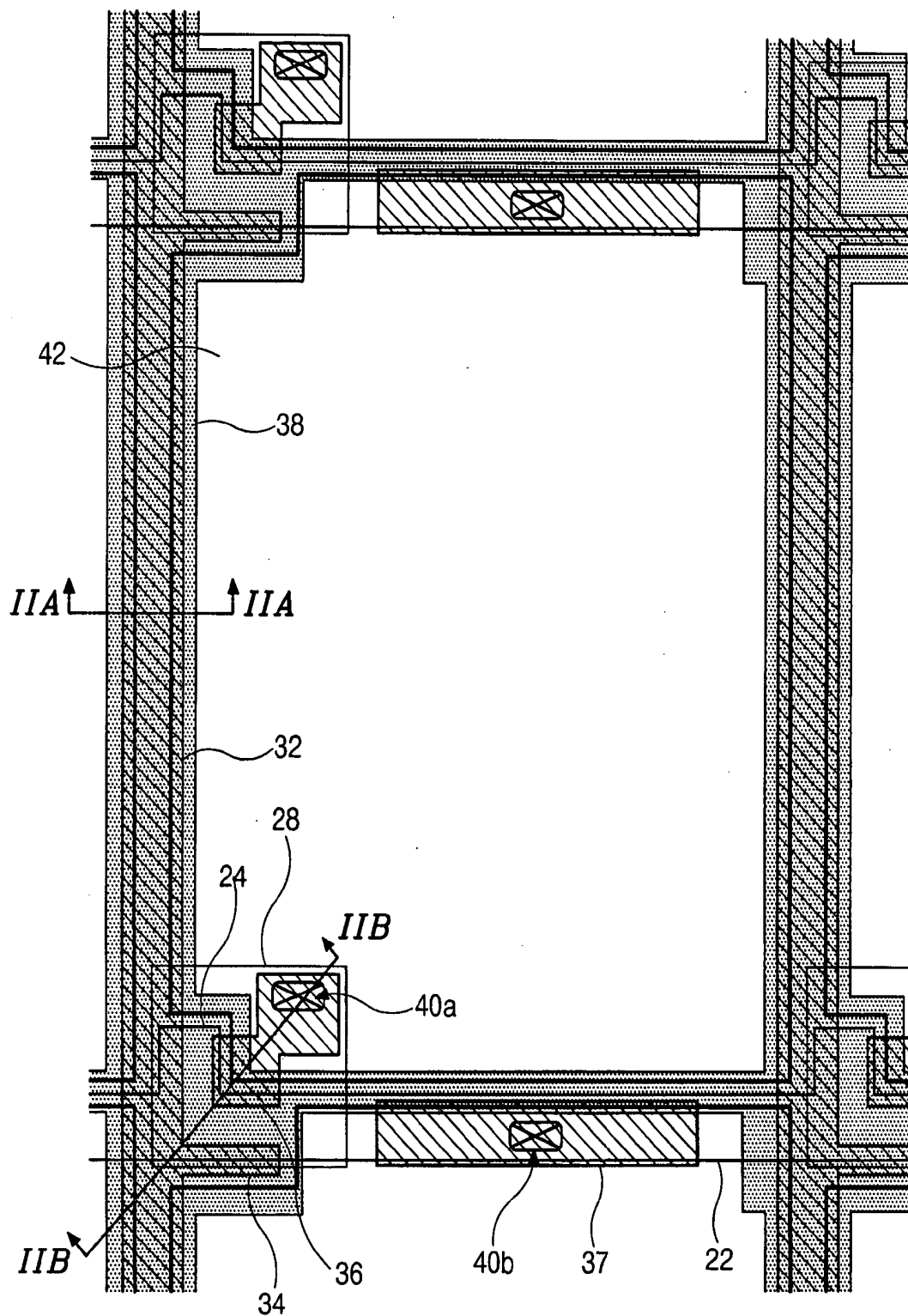


FIG. 2A
RELATED ART

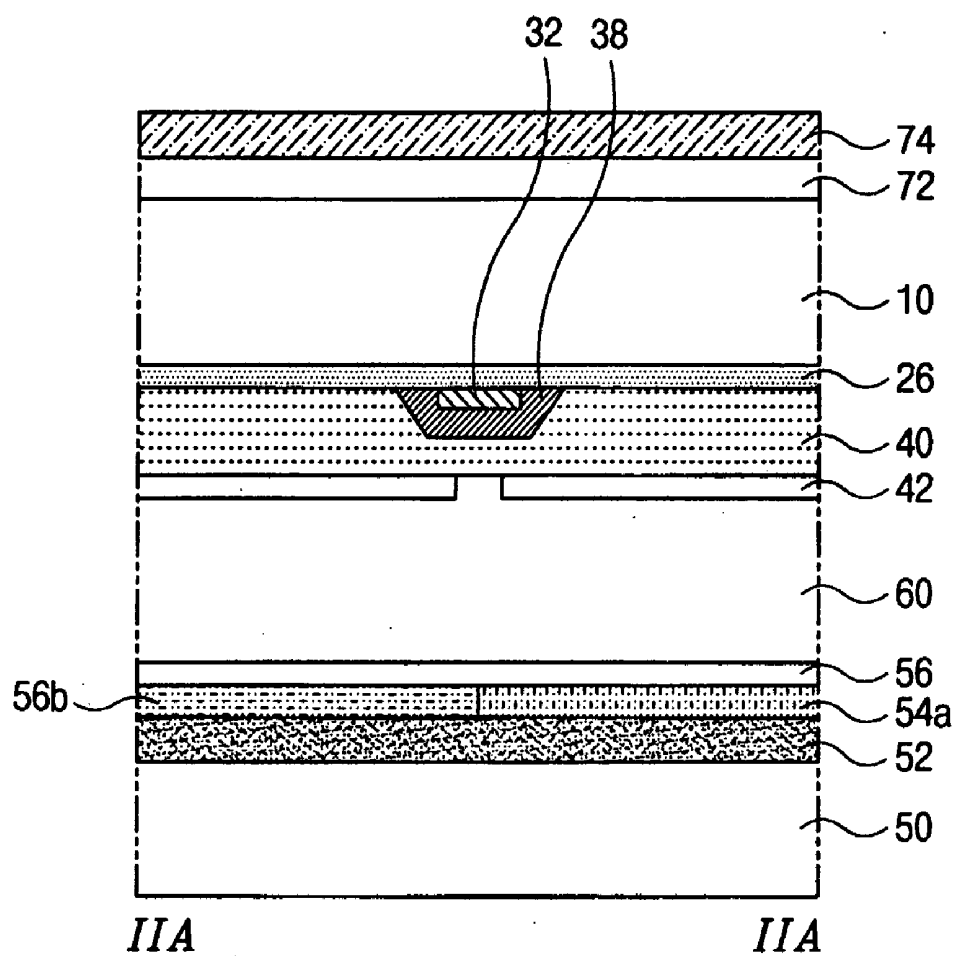


FIG. 2B
RELATED ART

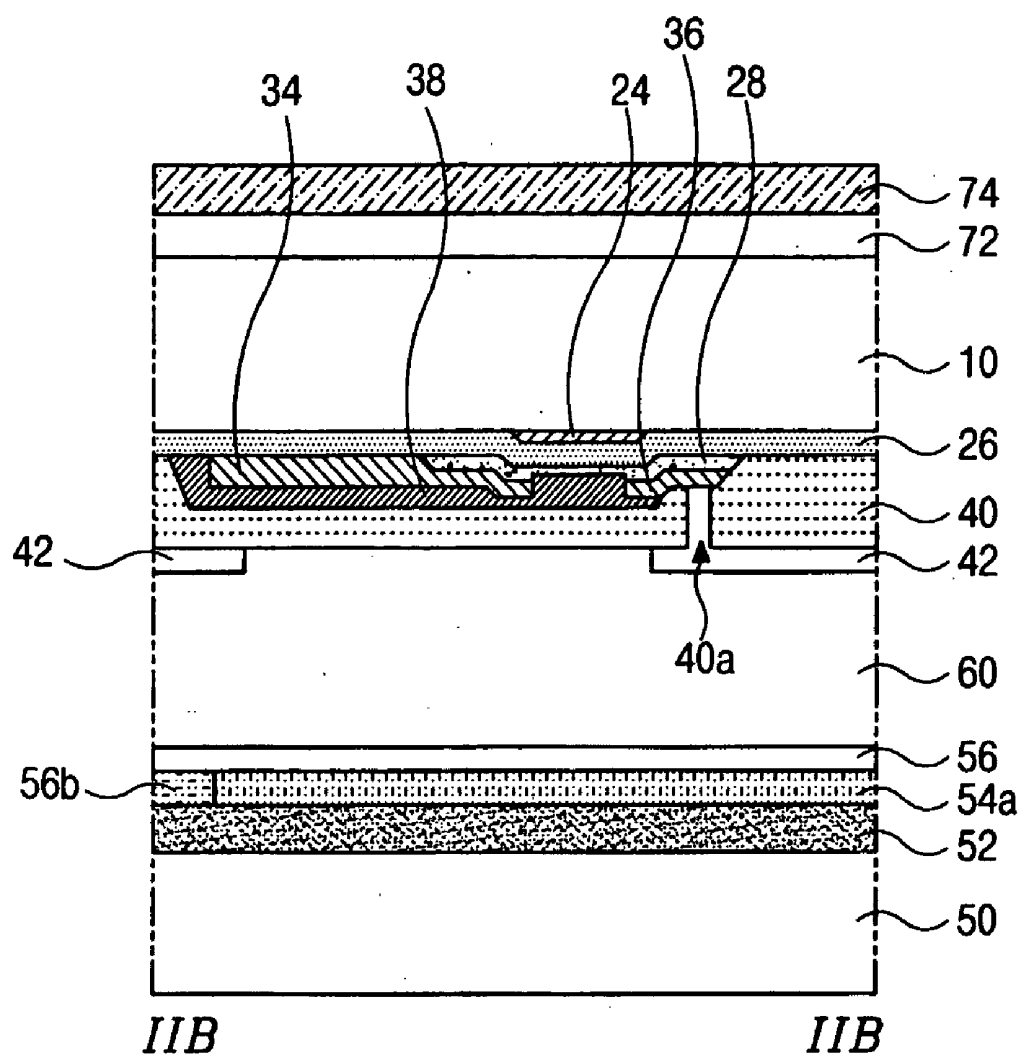


FIG. 3

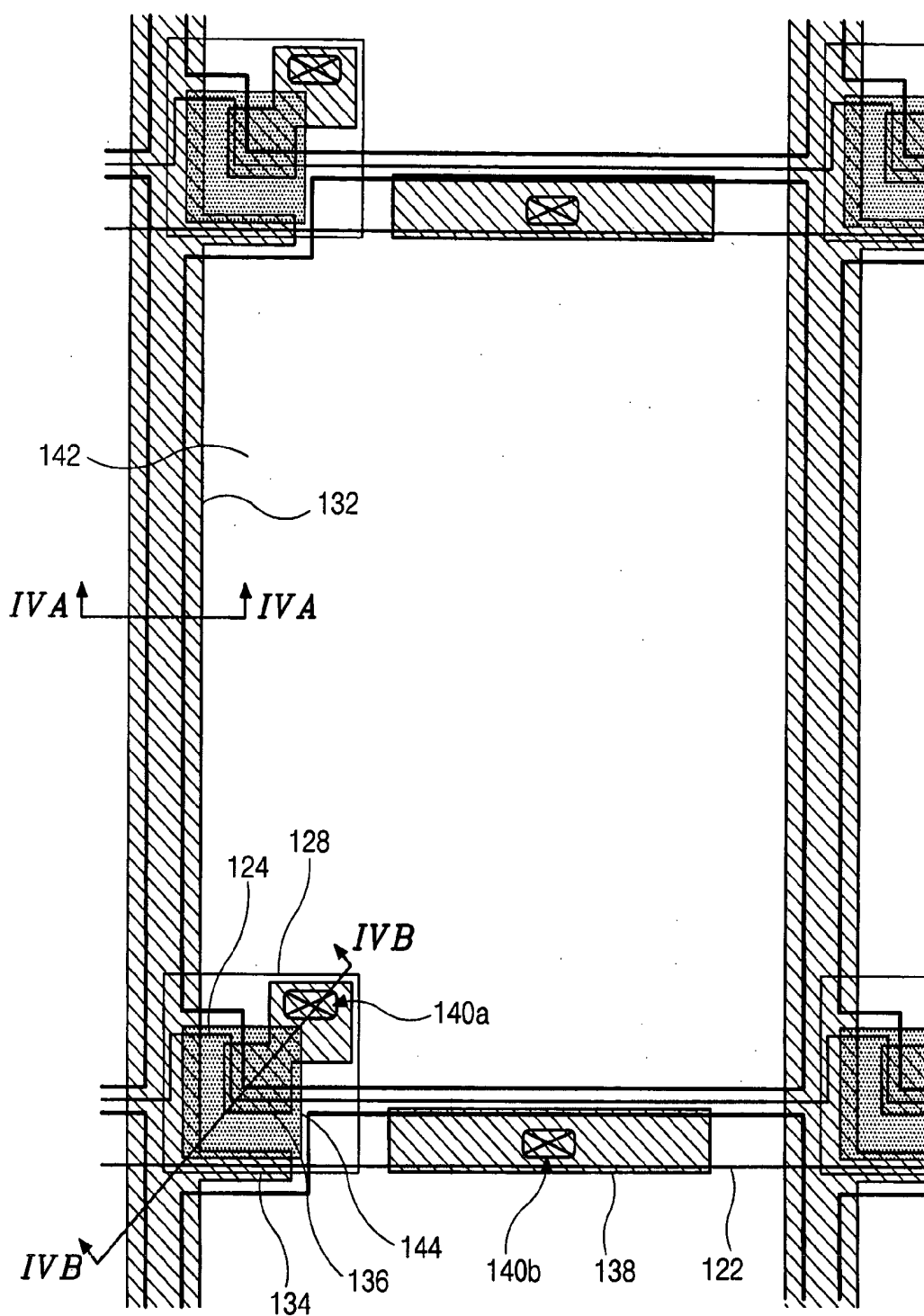


FIG. 4A

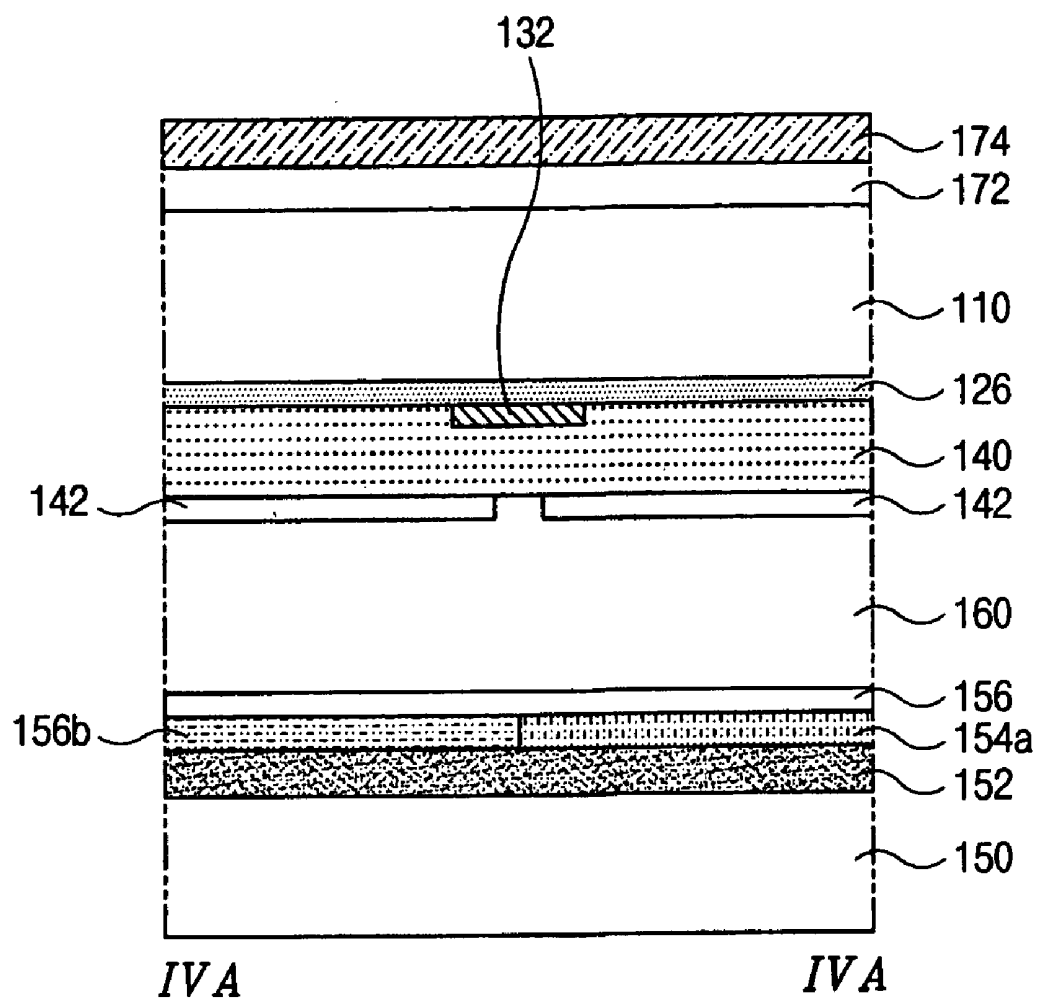


FIG. 4B

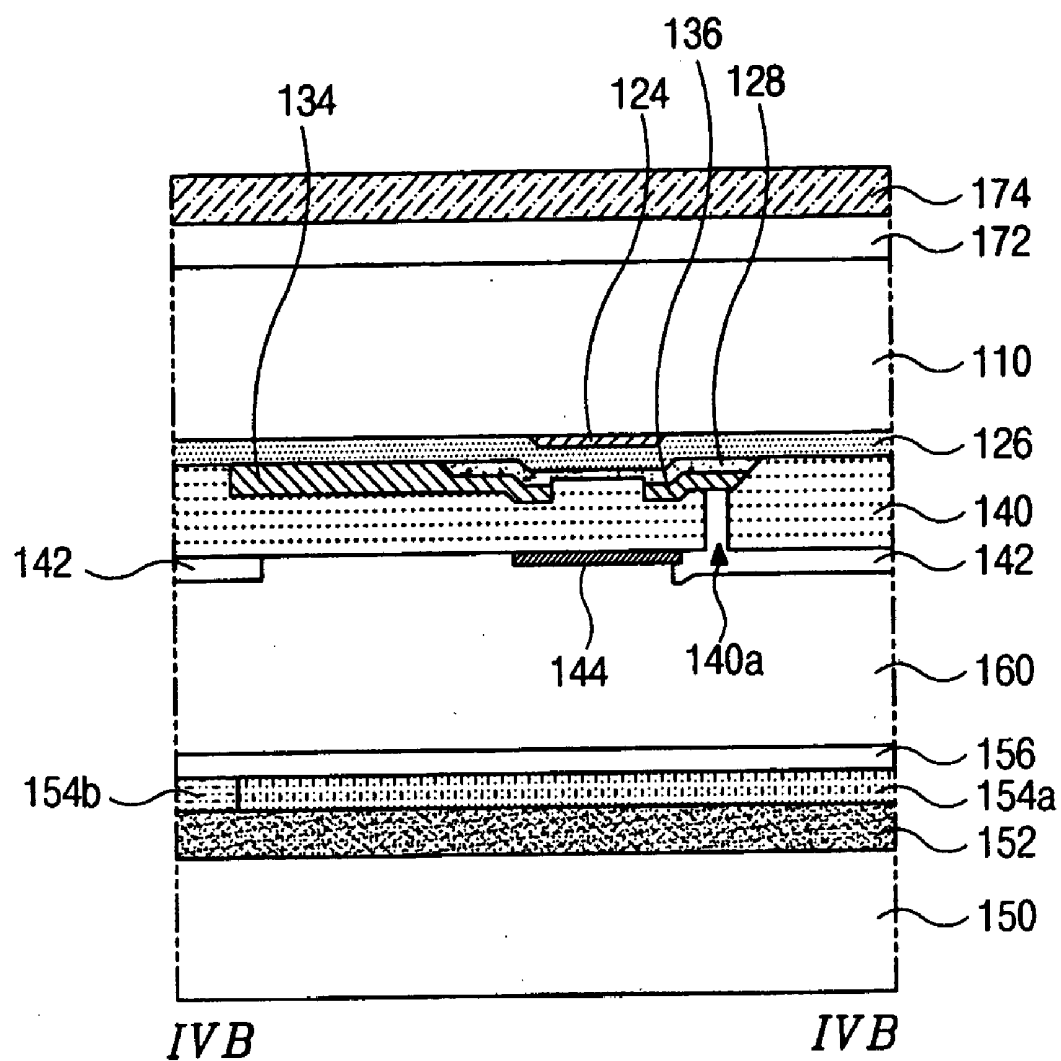


FIG. 4C

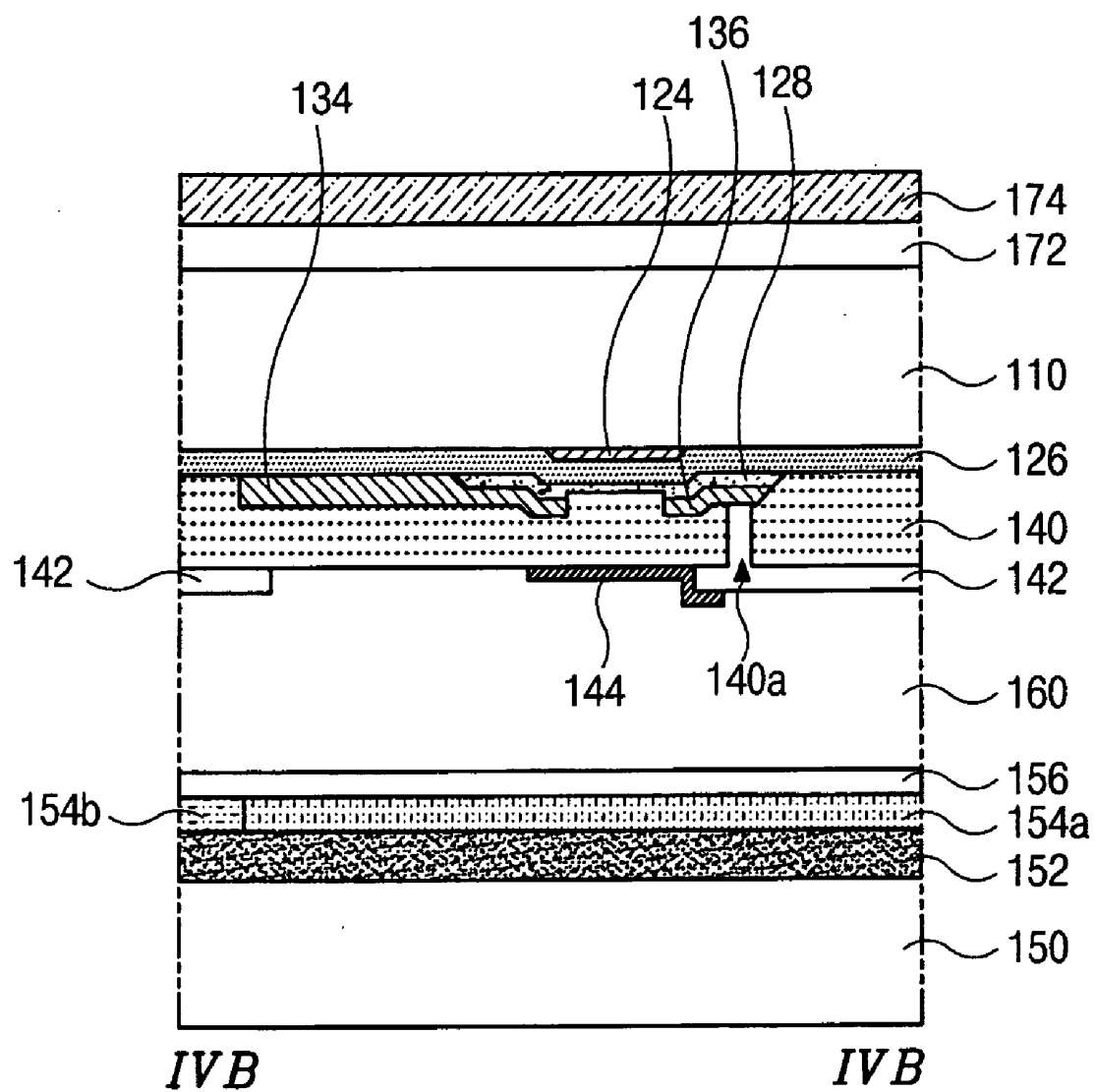


FIG. 5

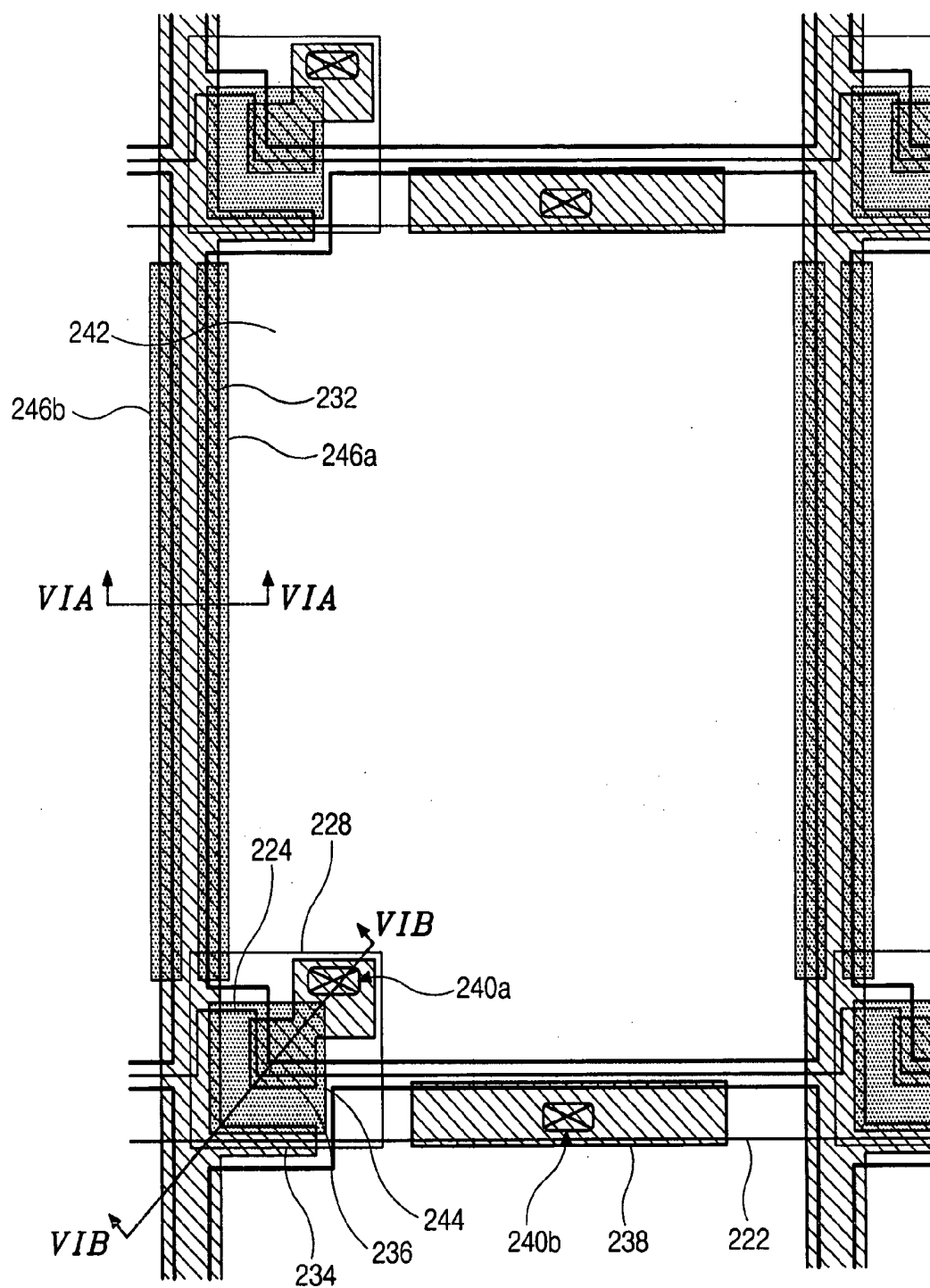


FIG. 6A

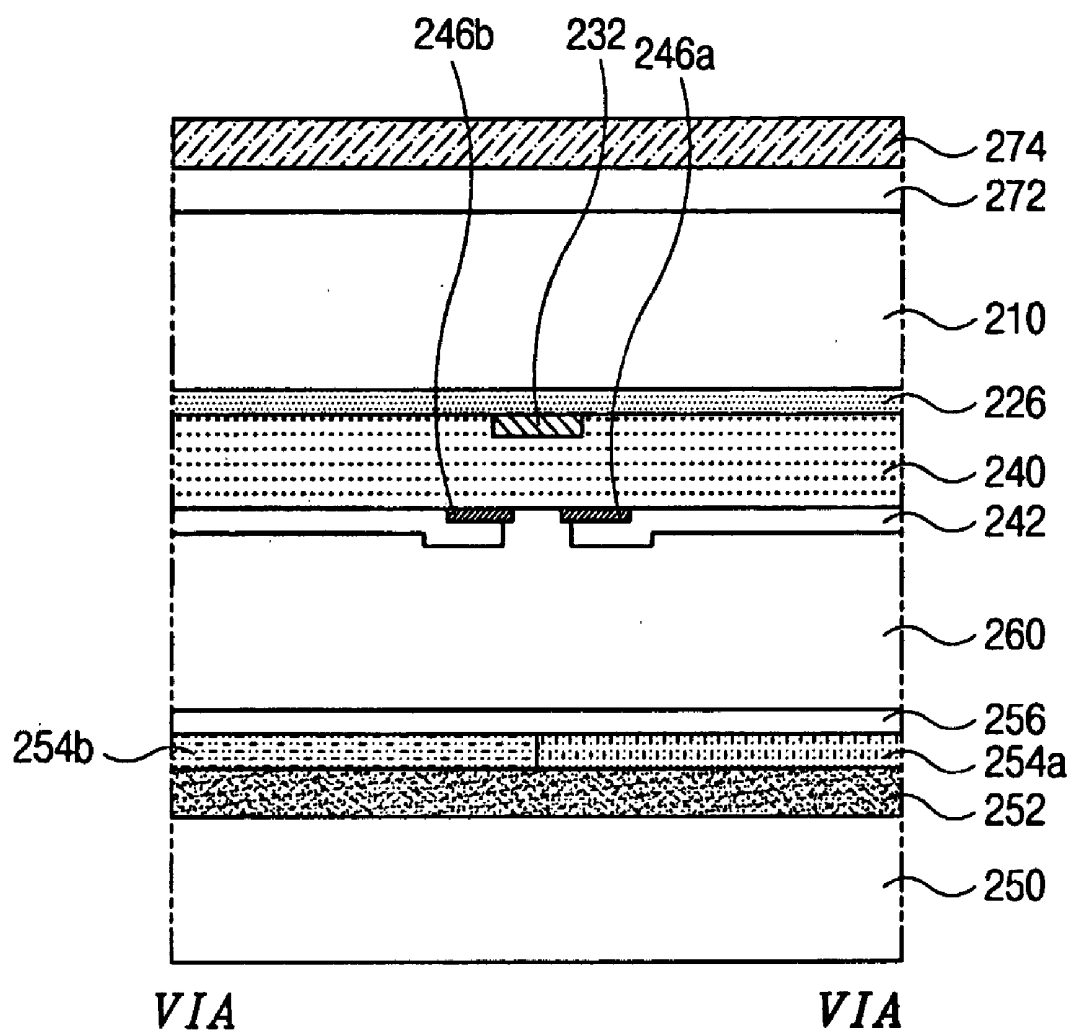


FIG. 6B

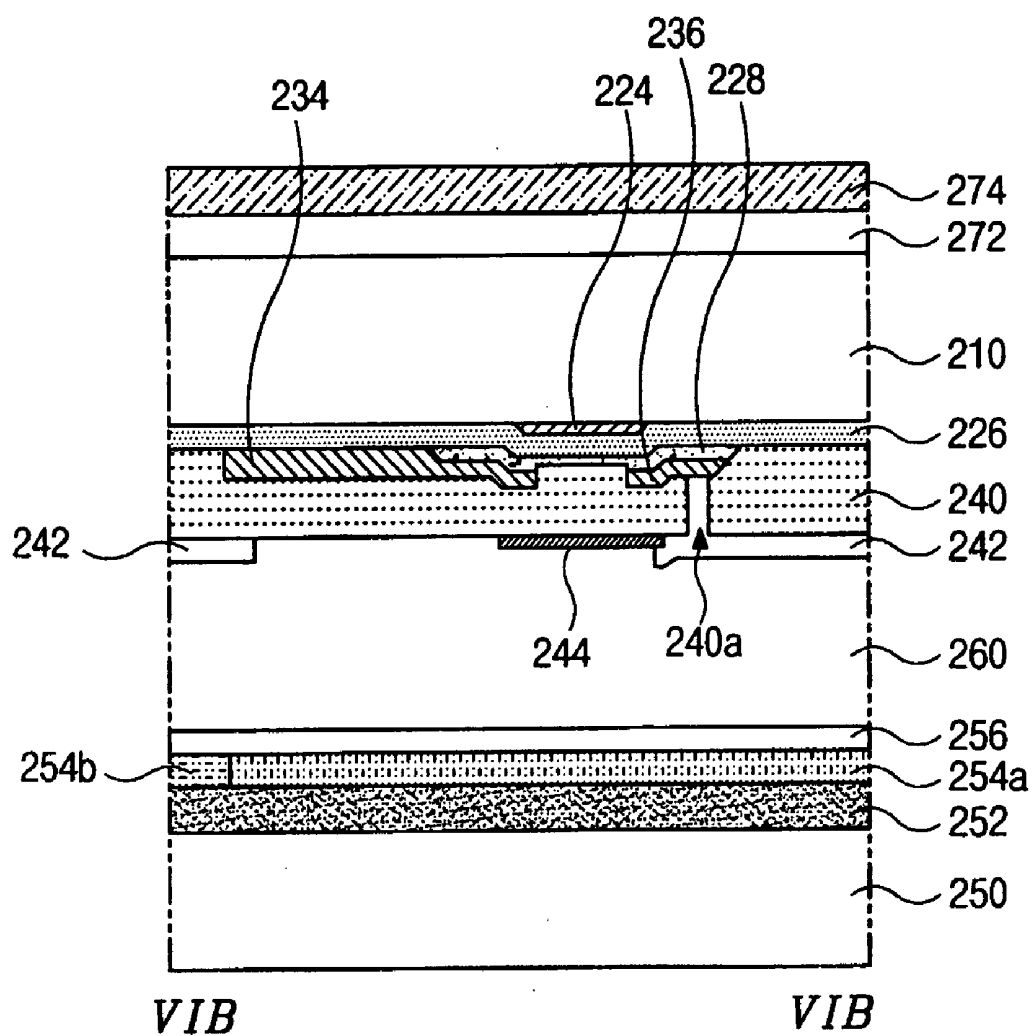


FIG. 6C

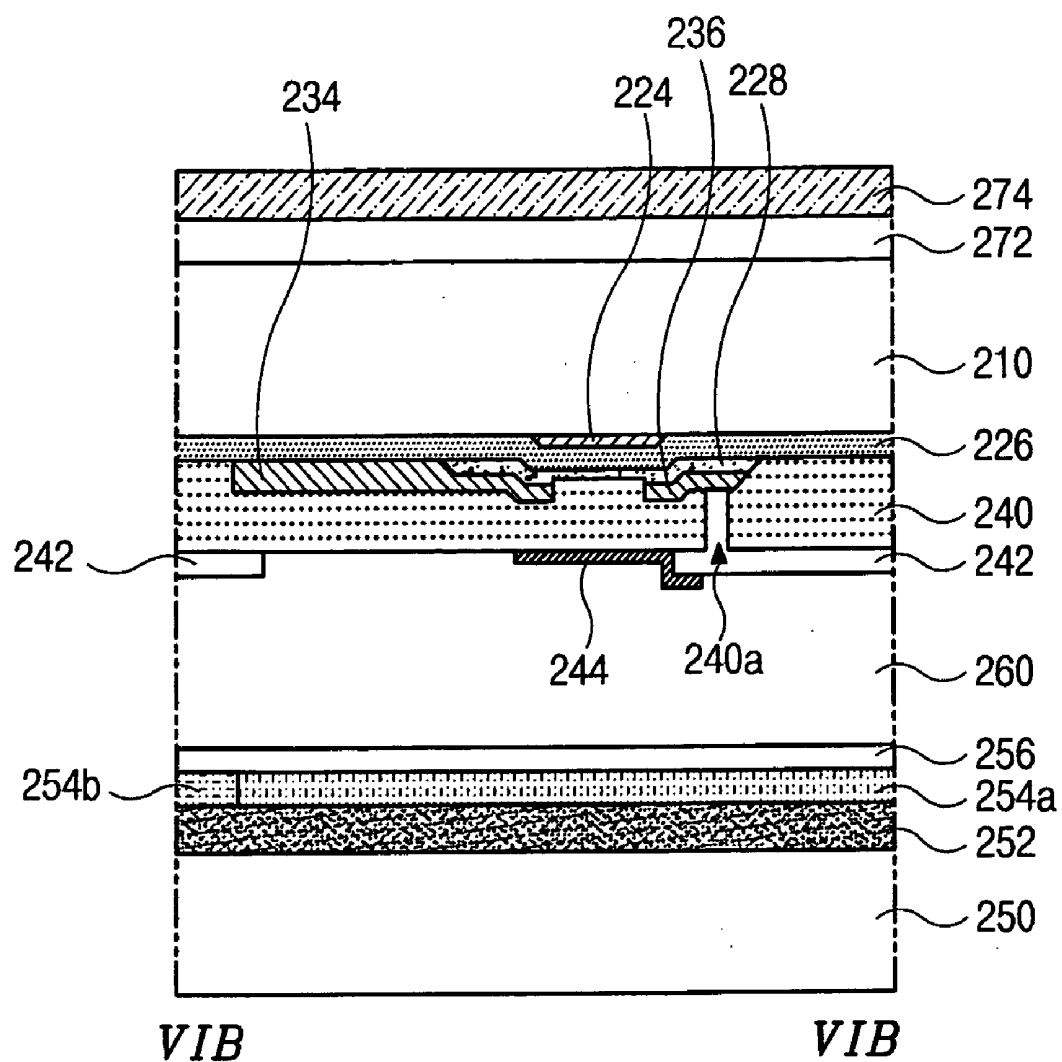


FIG. 7

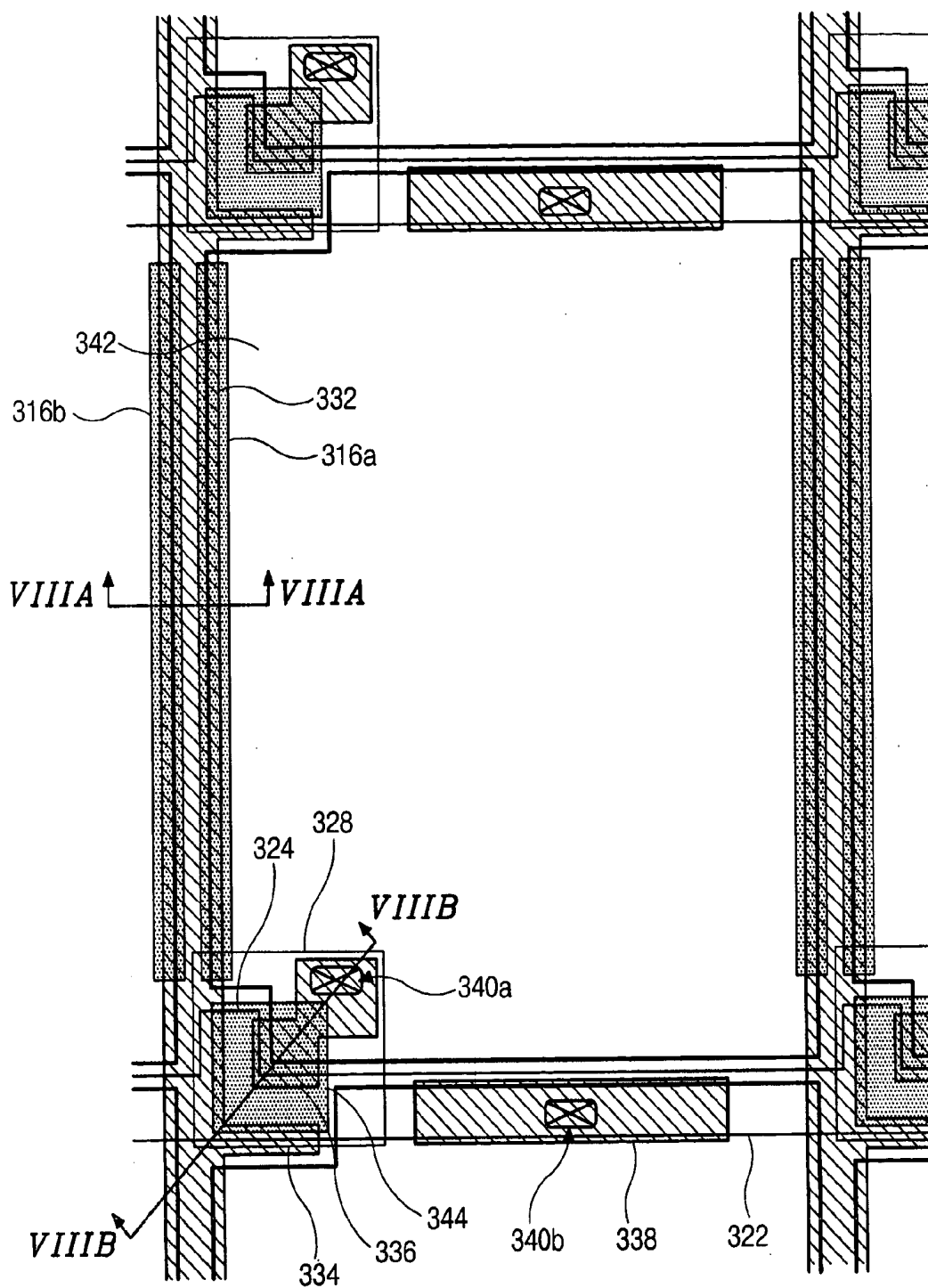


FIG. 8A

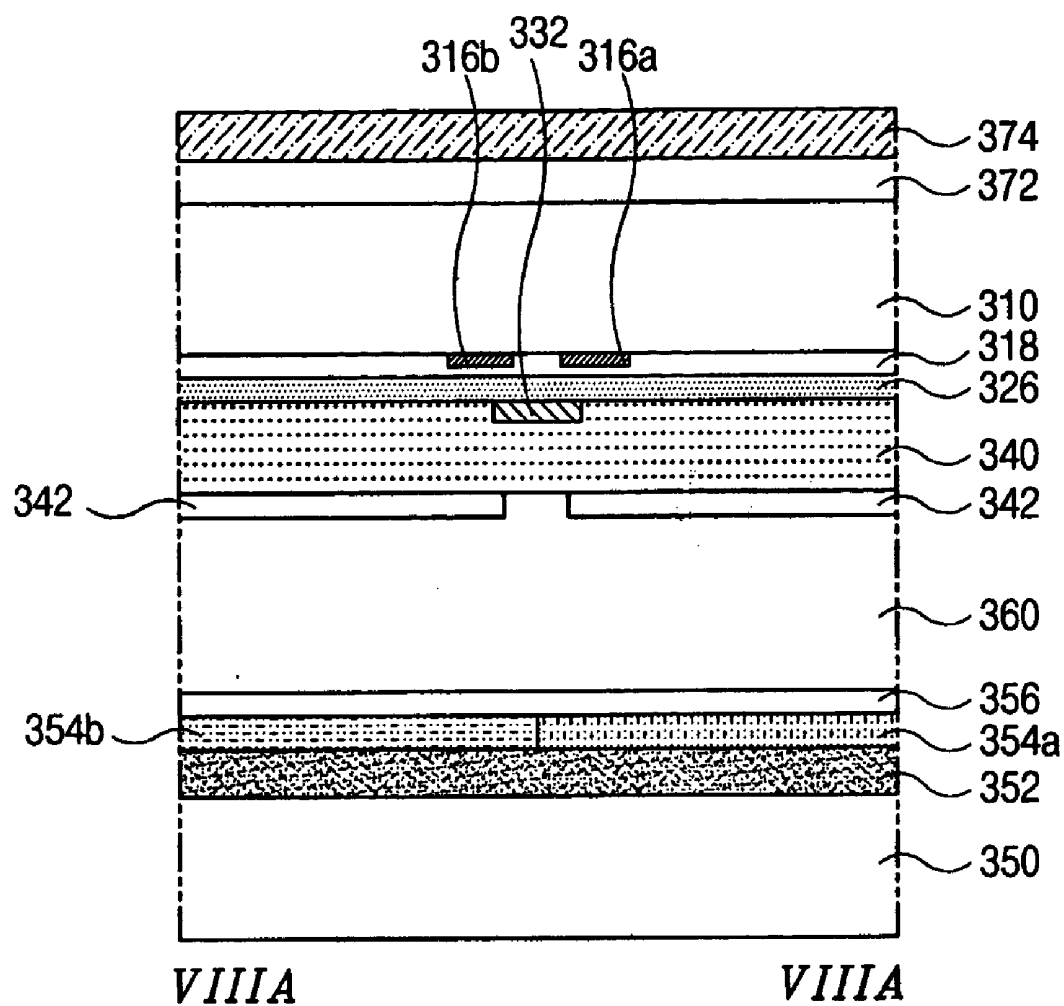


FIG. 8B

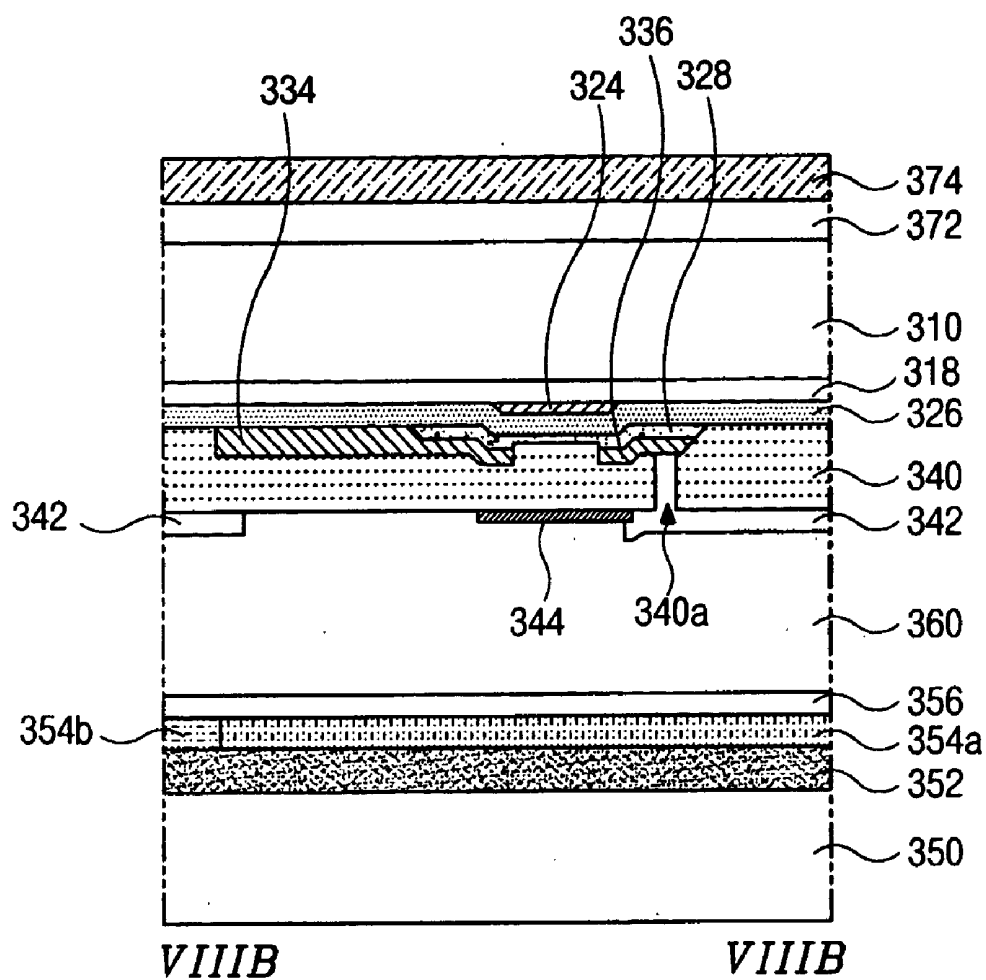


FIG. 8C

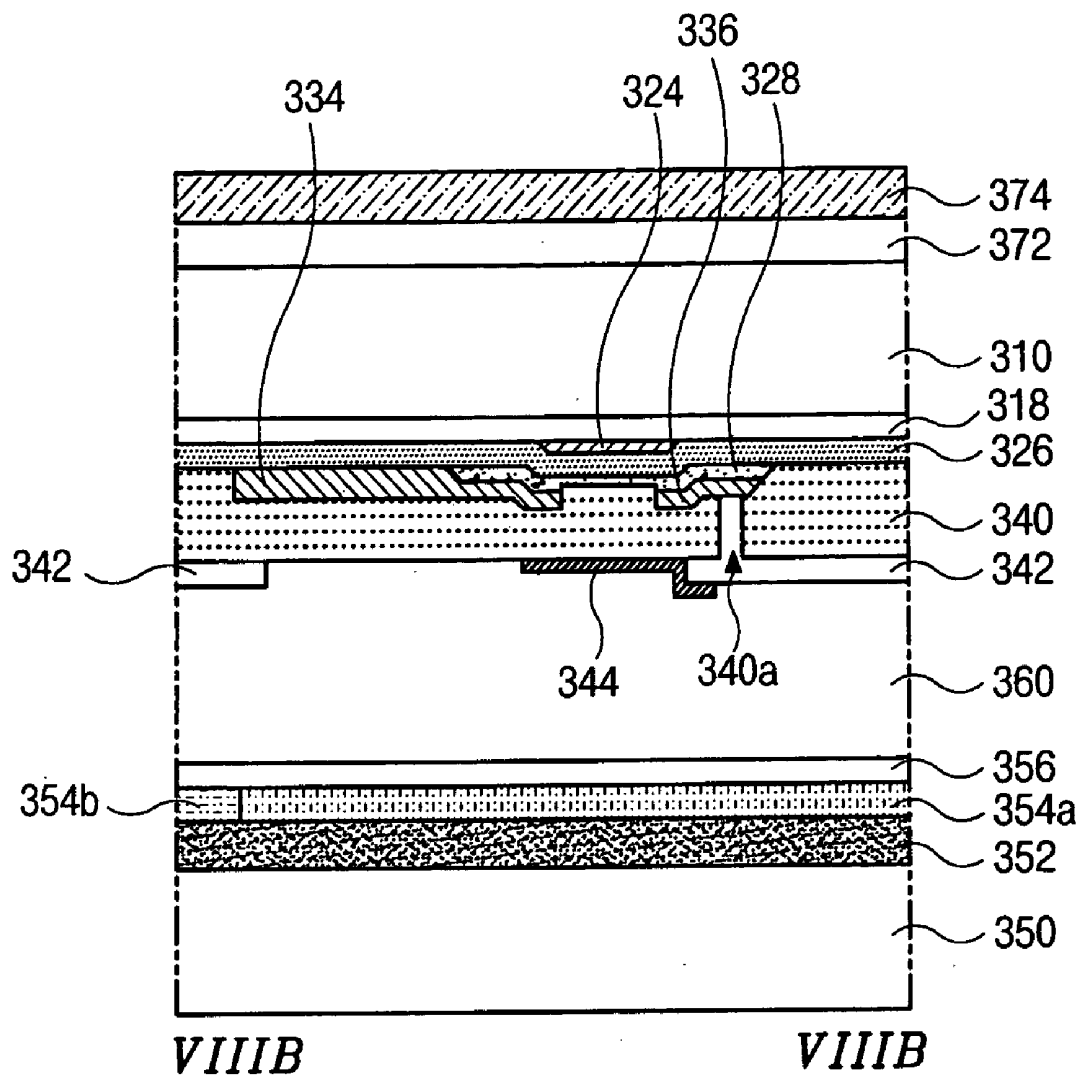


FIG. 9

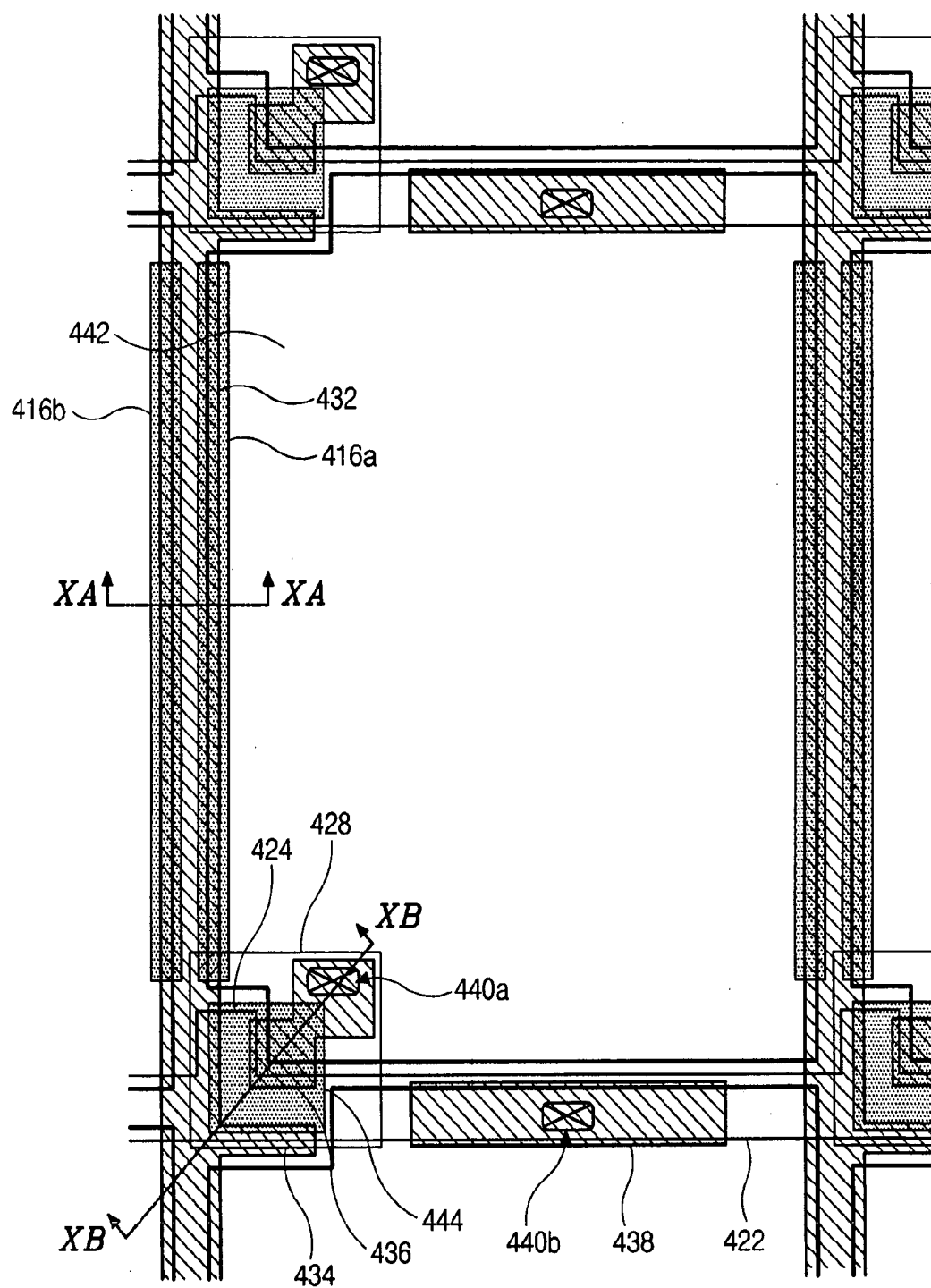


FIG. 10A

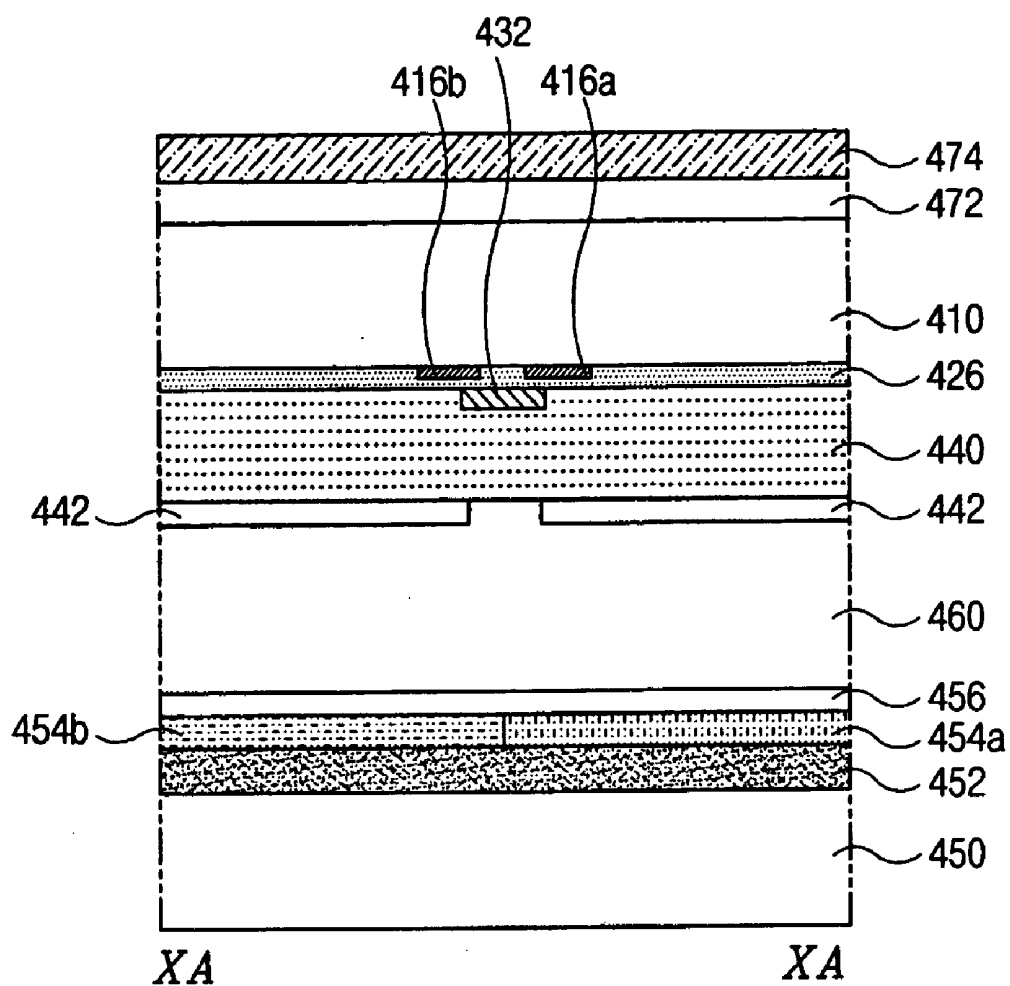


FIG. 10B

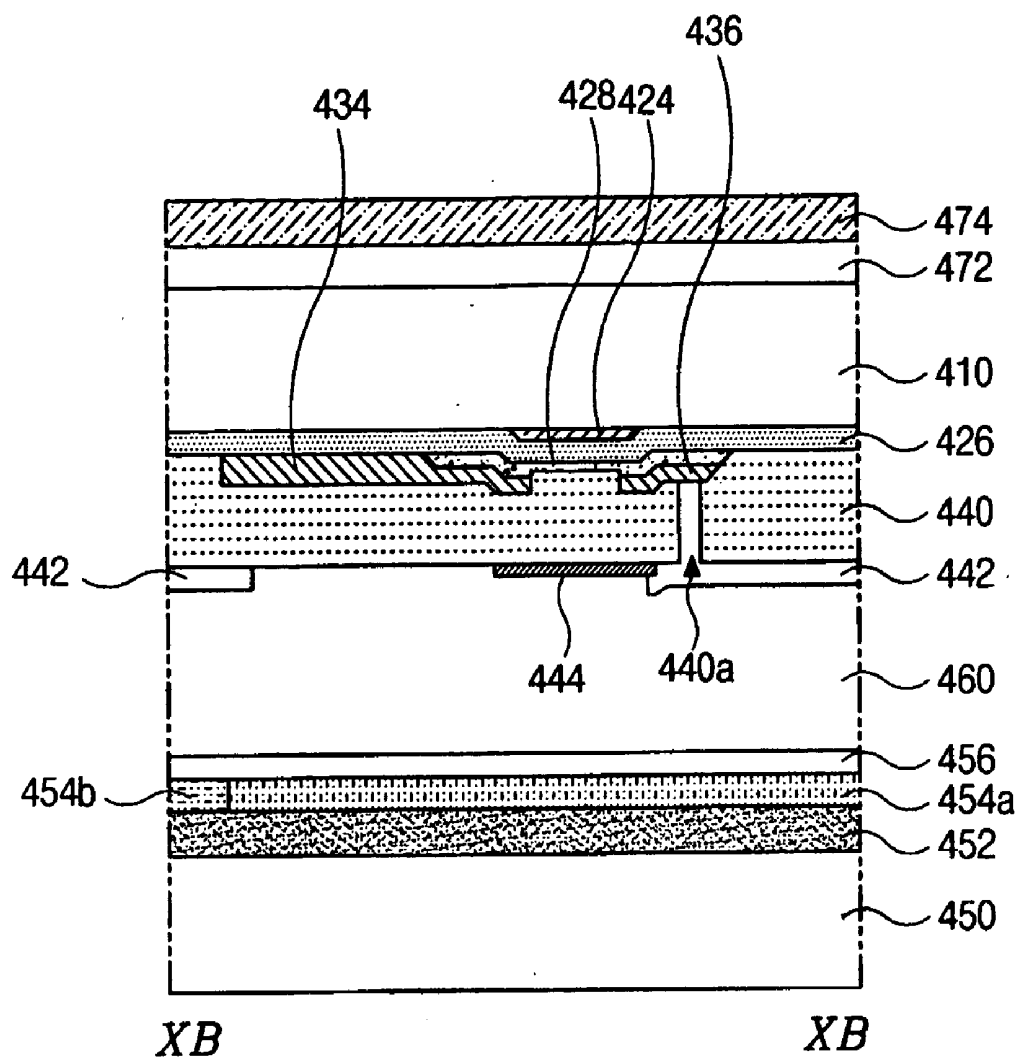
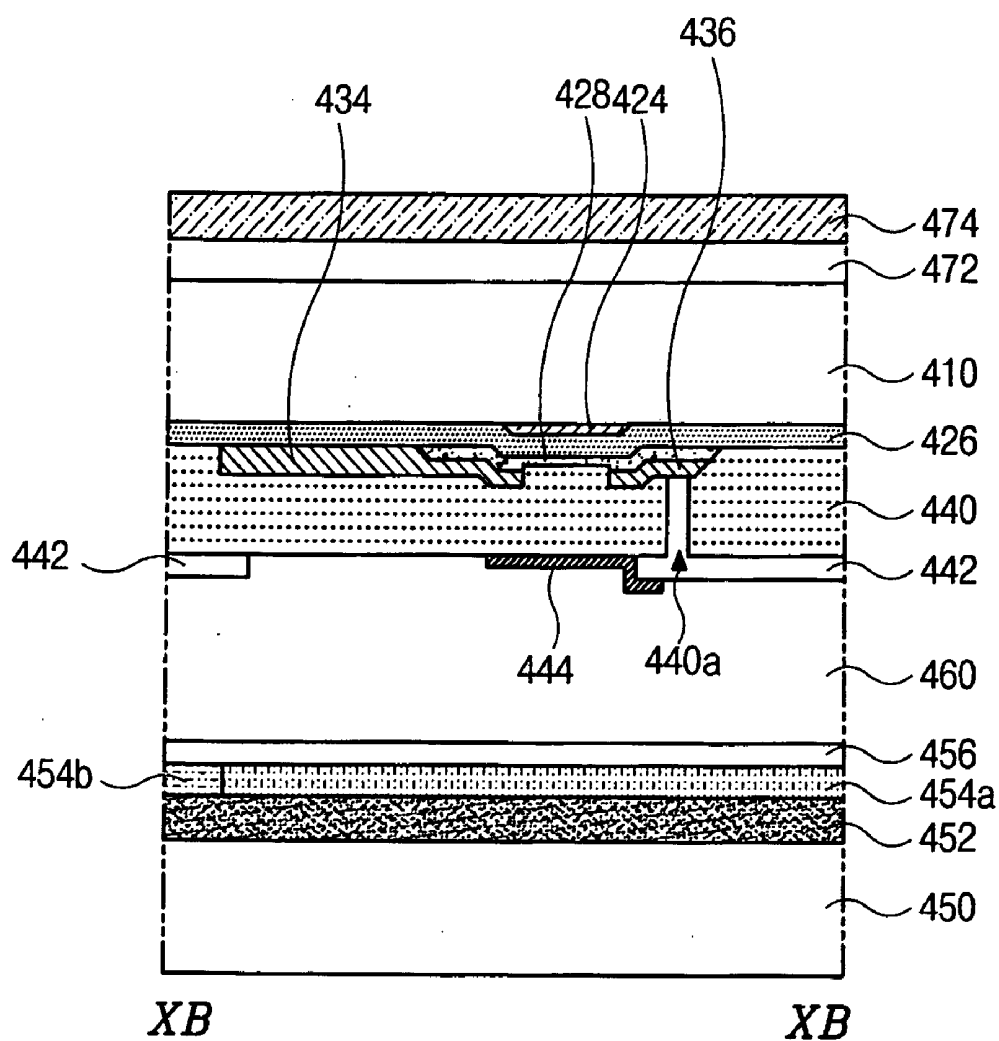


FIG. 10C



REFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE

[0001] The present invention claims the benefit of Korean Patent Application No. 2002-85360, filed in Korea on Dec. 27, 2002, which is hereby incorporated by reference for all purposes as of fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display (LCD) device and more particularly, to a reflective liquid crystal display device having a cholesteric color filter layer.

[0004] 2. Discussion of the Related Art

[0005] A liquid crystal display (LCD) device has been in the spotlight as a next generation display device having high value added because of its low power consumption and good portability.

[0006] An active matrix liquid crystal display (AMLCD) device, which includes thin film transistors as a switching device for a plurality of pixels, has been widely used due to its high resolution and fast moving images.

[0007] Because the LCD device is not luminescent, it needs an additional light source in order to display images. In general, the LCD device has a backlight behind a liquid crystal panel as a light source, and such a LCD is usually referred to as a transmissive LCD device. In the transmissive type, light incident from the backlight penetrates the liquid crystal panel, and the amount of the transmitted light is controlled according to the alignment of liquid crystal molecules. Because the transmissive LCD device uses the backlight as a light source, it can display a bright image in dark surroundings. However, the amount of the transmitted light is very small for the amount of light incident from the backlight. That is, because only 7% of the light incident from the backlight is transmitted through the liquid crystal panel, the brightness of the backlight should be increased in order to increase the brightness of the LCD device. Consequently, the transmissive LCD device has high power consumption due to the backlight.

[0008] To solve the problems in the transmissive LCD device, a reflective LCD device has been proposed. In the reflective LCD device, sunlight or artificial light is used as a light source of the LCD device. The light incident from the outside is reflected at a reflective plate of the LCD device according to the arrangement of the liquid crystal molecules. Since there is no backlight, the reflective LCD device has much lower power consumption than the transmissive LCD device. By the way, the reflective LCD device, generally, includes an absorptive color filter layer, which is made of pigments or dyes, the same as the transmissive LCD device. The reflective LCD device also has a disadvantage of low light transmittance due to the absorptive color filter layer.

[0009] To improve the light transmittance in the reflective LCD device, a cholesteric liquid crystal (CLC) color filter has been researched and developed. As the CLC color filter selectively reflects and transmits light, the CLC color filter can emit light of high purity in color. Additionally, the CLC color filter functions both as a color filter layer and as a reflector. Therefore, since the reflective LCD device includ-

ing the CLC color filter does not require an additional reflector, manufacturing processes are decreased and image quality is improved.

[0010] Liquid crystal molecules of the CLC are arranged in a helical structure. The helical structure is characterized by a helical direction and a pitch, which is a cycle of the helical structure. A color tone of light reflected by the CLC depends on the pitch. That is, an average wavelength of the reflected light is the pitch times an average reflective index of the CLC, and is represented by the following formula.

$$\lambda = n(\text{avg}) \cdot \text{pitch},$$

[0011] wherein the $n(\text{avg})$ is the average reflective index of the CLC.

[0012] For example, if the CLC has the average reflective index of about 1.5 and the pitch of the CLC is about 430 nm, the light reflected by the CLC has the average wavelength of about 650 nm, and is reddish. Greenish or bluish light may be reflected by changing the pitch of the CLC.

[0013] A reflective LCD device including a CLC color filter will be explained in detail with reference to the following figures.

[0014] **FIG. 1** is a plan view of a reflective LCD device including a cholesteric liquid crystal (CLC) color filter according to the related art. As shown in the figure, a gate line **22** of a horizontal direction and a data line **32** of a vertical direction in the context of the figure cross each other to define a pixel area. A thin film transistor, which includes a gate electrode **24**, a source electrode **34** and a drain electrode **36**, is formed at the crossing of the gate line **22** and the data line **32** to function as a switching element. The gate electrode **24** is connected to the gate line **22**; the source electrode **34** is connected to the data line **32**; and the drain electrode **36** is spaced apart from the source electrode **34**. The thin film transistor further includes an active layer **28**, and the active layer **28** between the source electrode **34** and the drain electrode **36** becomes a channel of the thin film transistor. A passivation layer **40** is formed over the thin film transistor.

[0015] A capacitor electrode **37** overlaps the gate line **22** to form a storage capacitor. The capacitor electrode **37** may be made of the same material as the data line **32**.

[0016] In the pixel area, a pixel electrode **42** is formed. The pixel electrode **42** is connected to the drain electrode **36** through a drain contact hole **40a** through the passivation layer **40** and is connected to the capacitor electrode **37** through a capacitor contact hole **40b** through the passivation layer **40**. The pixel electrode **42** overlaps the data line **32**.

[0017] To prevent light leakage in a region except for the pixel area, a black matrix **38** is formed corresponding to edges of the pixel electrode **42**. The black matrix **38** also covers a part of the gate line **22**, the data line **32** and the channel of the thin film transistor.

[0018] Although not shown in the figure, a CLC color filter layer is formed, and the CLC color filter layer reflects light of wavelengths corresponding to one of red, green and blue colors by pixel areas.

[0019] **FIGS. 2A and 2B** are cross sectional views along the line IIA-IIA and the line IIB-IIB of **FIG. 1**, respectively.

[0020] In FIGS. 2A and 2B, a first substrate 10 and a second substrate 50 are spaced apart and facing each other. The first substrate 10 may be made of a transparent substrate. A gate electrode 24 is formed on an inner surface of the first substrate 10, and a gate insulating layer 26 covers the gate electrode 24. An active layer 28 is formed on the gate insulating layer 26 over the gate electrode 24, and a source electrode 34 and a drain electrode 36 are formed on the active layer 28. As state above, the gate electrode 24, the active layer 28, the source electrode 34 and the drain electrode 36 form a thin film transistor, and the active layer 28 exposed between the source electrode 34 and the drain electrode 36 becomes a channel of a thin film transistor. Additionally, a data line 32, which is made of the same material as the source electrode 34 and the drain electrode 36, is formed on the gate insulating layer 26.

[0021] A black matrix 38 is formed on the data line 32, the source electrode 34 and the drain electrode 36, and covers the data line 32 and the channel of the thin film transistor. The black matrix 38 may be made of a black resin. The black matrix 38 blocks light leakage in edge portions of a pixel area, that is, close by the data line 32, and prevents light from reaching the channel of the thin film transistor.

[0022] A passivation layer 40 is formed on the black matrix 38, and the passivation layer 40 is made of an organic material having a relatively low dielectric constant. The passivation layer 40 includes a drain contact hole 40a exposing the drain electrode 36.

[0023] A pixel electrode 42 is formed on the passivation layer 40, and the pixel electrode 42 is connected to the drain electrode 36 through the drain contact hole 40a. The pixel electrode 42 may overlap the data line 32 to increase an aperture ratio of the LCD device.

[0024] On the other hand, an absorption layer 52 is formed on an inner surface of the second substrate 50, and a CLC color filter layer, which includes sub color filters 54a and 54b, is formed on the absorption layer 52. Each sub color filter of the CLC color filter layer 54a and 54b corresponds to one pixel area and reflects light of wavelengths corresponding to one of red, green and blue colors. A common electrode 56 is formed on the CLC color filter layer 54a and 54b. The common electrode 56 is made of a transparent conducting material.

[0025] A liquid crystal layer 60 is disposed between the common electrode 56 and the pixel electrode 42.

[0026] A retardation film 72 and a polarizer 74 are subsequently arranged on an outer surface of the first substrate 10. The retardation film 72 may be a quarter wave plate (QWP) having a retardation of $\lambda/4$, and the polarizer 74 may be a linear polarizer that transmits only linearly polarized light parallel to its transmission axis.

[0027] Like this, the black matrix is formed to prevent photocurrent from being generated in the thin film transistor due to light and to block light leakage nearby the data line. However, since the black matrix of the related art is made of a resin that has relatively a low resistivity and a high dielectric constant, leakage current may be generated in the thin film transistor.

SUMMARY OF THE INVENTION

[0028] Accordingly, the present invention is directed to a reflective liquid crystal display device that substantially

obviates one or more of problems due to limitations and disadvantages of the related art.

[0029] An advantage of the present invention is to provide a reflective liquid crystal display device that prevents leakage current from being generated.

[0030] Another advantage of the present invention is to provide a reflective liquid crystal display device that blocks light leakage.

[0031] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0032] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, a reflective liquid crystal display device includes first and second substrates spaced apart and facing each other, a gate line and a data line on an inner surface of the first substrate and crossing each other to define a pixel area, a thin film transistor electrically connected to the gate and data lines, a passivation layer covering the thin film transistor, a blocking layer on the passivation layer and corresponding to the thin film transistor, a pixel electrode on the passivation layer and connected to the thin film transistor, a retardation film on an outer surface of the first substrate, a polarizer on the retardation film, an absorption layer on an inner surface of the second substrate, a cholesteric liquid crystal color filter layer on the absorption layer, a common electrode on the cholesteric liquid crystal color filter layer, and a liquid crystal layer between the common electrode and the pixel electrode, wherein the data line overlaps adjacent pixel electrodes and a overlapping width is over 50% of a width of the data line.

[0033] In another aspect, a reflective liquid crystal display device includes first and second substrates spaced apart and facing each other, a gate line and a data line on an inner surface of the first substrate and crossing each other to define a pixel area, a thin film transistor electrically connected to the gate and data lines, a passivation layer covering the thin film transistor, a blocking layer on the passivation layer and corresponding to the thin film transistor, first and second black matrices on the passivation layer and overlapping respective sides of the data line, a pixel electrode on the passivation layer, the pixel electrode connected to the thin film transistor and overlapping the first and second black matrices, a retardation film on an outer surface of the first substrate, a polarizer on the retardation film, an absorption layer on an inner surface of the second substrate, a cholesteric liquid crystal color filter layer on the absorption layer, a common electrode on the cholesteric liquid crystal color filter layer, and a liquid crystal layer between the common electrode and the pixel electrode.

[0034] In another aspect, a reflective liquid crystal display device includes first and second substrates spaced apart and facing each other, first and second black matrices on an inner surface of the first substrate, a gate line on the inner surface of the first substrate, a data line crossing the gate line to define a pixel area and overlapping the first and second black

matrices, a thin film transistor electrically connected to the gate and data lines, a passivation layer covering the thin film transistor, a blocking layer on the passivation layer and corresponding to the thin film transistor, a pixel electrode on the passivation layer, the pixel electrode connected to the thin film transistor and overlapping the first and second black matrices, a retardation film on an outer surface of the first substrate, a polarizer on the retardation film, an absorption layer on an inner surface of the second substrate, a cholesteric liquid crystal color filter layer on the absorption layer, a common electrode on the cholesteric liquid crystal color filter layer, and a liquid crystal layer between the common electrode and the pixel electrode.

[0035] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0037] In the drawings:

[0038] **FIG. 1** is a plan view of a reflective liquid crystal display (LCD) device including a cholesteric liquid crystal (CLC) color filter according to the related art;

[0039] **FIGS. 2A and 2B** are cross sectional views along the line IIA-IIA and the line IIB-IIB of **FIG. 1**, respectively;

[0040] **FIG. 3** is a plan view of a reflective LCD device including a CLC color filter according to a first embodiment of the present invention;

[0041] **FIGS. 4A and 4B** are cross sectional views along the line IVA-IVA and the line IVB-IVB of **FIG. 3**, respectively;

[0042] **FIG. 4C** illustrates another aspect of the present invention along line IVB-IVB of **FIG. 3**;

[0043] **FIG. 5** is a plan view of a reflective LCD device including a CLC color filter according to a second embodiment of the present invention;

[0044] **FIGS. 6A and 6B** are cross sectional views along the line VIA-VIA and the line VIB-VIB of **FIG. 5**, respectively;

[0045] **FIG. 6C** illustrates another aspect of the present invention along line VIB-VIB of **FIG. 5**;

[0046] **FIG. 7** is a plan view of a reflective LCD device including a CLC color filter according to a third embodiment of the present invention;

[0047] **FIGS. 8A and 8B** are cross sectional views along the line VIIIA-VIIIA and the line VIIIB-VIIIB of **FIG. 7**, respectively;

[0048] **FIG. 8C** illustrates another aspect of the present invention along line VIIIB-VIIIB of **FIG. 7**;

[0049] **FIG. 9** is a plan view of a reflective LCD device including a CLC color filter according to a fourth embodiment of the present invention; and

[0050] **FIGS. 10A and 10B** are cross sectional views along the line XA-XA and the line XB-XB of **FIG. 9**, respectively;

[0051] **FIG. 10C** illustrates another aspect of the present invention along line XB-XB of **FIG. 9**.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0052] Reference will now be made in detail to the illustrated embodiments of the present invention, which are illustrated in the accompanying drawings.

[0053] **FIG. 3** is a plan view of a reflective liquid crystal display (LCD) device including a cholesteric liquid crystal (CLC) color filter according to a first embodiment of the present invention. As shown in **FIG. 3**, a gate line **122** of a horizontal direction and a data line **132** of a vertical direction in the context of the figure cross each other to define a pixel area. A gate electrode **124**, a source electrode **134** and a drain electrode **136** are formed at the crossing of the gate line **122** and the data line **132**. The gate electrode **124** is connected to the gate line **122**; the source electrode **134** is connected to the data line **132**; and the drain electrode **136** is spaced apart from the source electrode **134**. The gate electrode **124**, the source electrode **134** and the drain electrode **136** form a thin film transistor that functions as a switching element. The thin film transistor further includes an active layer **128**, and the active layer **128** between the source electrode **134** and the drain electrode **136** becomes a channel of the thin film transistor. A passivation layer **140** is formed over the thin film transistor.

[0054] Also, a channel blocking layer **144** is formed at the crossing of the gate line **122** and the data line **132** and covers the channel of the thin film transistor.

[0055] A capacitor electrode **138** overlaps the gate line **122** to form a storage capacitor. The capacitor electrode **138** may be made of the same material as the data line **132**.

[0056] In the pixel area, a pixel electrode **142** is formed. The pixel electrode **142** overlaps the drain electrode **136**, and a drain contact hole **140a** is formed through the passivation layer **140** at the overlapping portion of the pixel electrode **142** and the drain electrode **136**. The pixel electrode **142** is connected to the drain electrode **136** through the drain contact hole **140a** and is connected to the capacitor electrode **138** through a capacitor contact hole **140b** through the passivation layer **140**. The pixel electrode **142** also overlaps the data line **132**. Thus, the pixel electrode **142** gets larger and the data line **132** functions as a black matrix, so that the aperture ratio of the LCD device increases.

[0057] Although not shown in the figure, a CLC color filter layer is formed, and the CLC color filter layer reflects light of wavelengths corresponding to one of red, green and blue colors by pixel areas.

[0058] **FIGS. 4A and 4B** are cross sectional views along the line IVA-IVA and the line IVB-IVB of **FIG. 3**, respectively.

[0059] As shown in the figures, a first substrate **110** and a second substrate **150** are spaced apart and facing each other.

The first substrate **110** may be made of a transparent substrate, and the second substrate **150** may be made of either a transparent substrate or an opaque substrate. A gate electrode **124** is formed on an inner surface of the first substrate **110**, and a gate insulating layer **126** covers the gate electrode **124**. Although not shown in the figures, a gate line **122** of **FIG. 2** that is connected to the gate electrode **124** also is formed on the inner surface of the first substrate **110**. An active layer **128** is formed on the gate insulating layer **126** over the gate electrode **124**, and a source electrode **134** and a drain electrode **136** are formed on the active layer **128**. As stated above, the gate electrode **124**, the active layer **128**, the source electrode **134** and the drain electrode **136** form a thin film transistor, and the active layer **128** exposed between the source electrode **134** and the drain electrode **136** becomes a channel of the thin film transistor. Additionally, a data line **132** and a capacitor electrode **138** of **FIG. 3**, which may be made of the same material as the source electrode **134** and the drain electrode **136**, are formed on the gate insulating layer **126**. The data line **132** is connected to the source electrode **134**, and crosses the gate line to define a pixel area. The capacitor electrode overlaps the gate line. Here, the data line **132** has a width of over about $8\ \mu\text{m}$. Although not shown in the figures, an ohmic contact layer may be formed between the active layer **128** and the source electrode **134** and between the active layer **128** and the drain electrode **136** to lower the contact resistance.

[0060] The passivation layer **140** is formed on the data line **132**, the source electrode **134** and the drain electrode **136**. The passivation layer **140** may be made of an organic material having a relatively low dielectric constant, such as benzocyclobutene (BCB) or acrylic resin. The passivation layer **140** includes a drain contact hole **140a** exposing the drain electrode **136** and a capacitor contact hole **140b** of **FIG. 3** exposing the capacitor electrode **138** of **FIG. 3**.

[0061] Next, a blocking layer **144** is formed on the passivation layer **140** to cover the channel of the thin film transistor. The blocking layer **144** may be made of an opaque metal material, such as chromium (Cr). The blocking layer **144** blocks light incident to the channel, and thus prevents leakage current from generating.

[0062] As illustrated in **FIG. 4B**, a pixel electrode **142**, which may be made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), may be formed on at least a portion of the blocking layer **144** and on the passivation layer **140**. The pixel electrode **142** is connected to the drain electrode **136** through the drain contact hole **140a** and to the capacitor electrode through the capacitor contact hole. The pixel electrode **142** may overlap the data line **132** to increase an aperture ratio of the LCD device. As shown in the figures, the pixel electrode **142** may contact and overlap the blocking layer **144**, such that a portion of the blocking layer **144** is between the passivation layer **140** and the pixel electrode **142**.

[0063] In another aspect of the present invention, the blocking layer **144** may overlap the pixel electrode **142** such that a portion of the pixel electrode **142** is between the blocking layer **144** and the passivation layer **140**, as illustrated in **FIG. 4C**.

[0064] On the other hand, an absorption layer **152** is formed on an inner surface of the second substrate **150**, and a CLC color filter layer, which includes sub color filters

154a and **154b**, is formed on the absorption layer **152**. Each sub color filter of the CLC color filter layer **154a** and **154b** corresponds to one pixel area and reflects light of wavelengths corresponding to one of red, green and blue colors. A common electrode **156** is formed on the CLC color filter layer **154a** and **154b**. The common electrode **156** is made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO).

[0065] A liquid crystal layer **160** is disposed between the common electrode **156** and the pixel electrode **142**.

[0066] A retardation film **172** and a polarizer **174** are subsequently arranged on an outer surface of the first substrate **110**. The retardation film **172** may be a quarter wave plate (QWP) having a retardation of $\lambda/4$, and the polarizer **174** may be a linear polarizer that transmits only linearly polarized light parallel to its transmission axis.

[0067] In the first embodiment of the present invention, the blocking layer **144** corresponding to the channel of the thin film transistor is formed, and the data line **132** has a wider width than the related art. Thus, the data line **132** and the pixel electrode **142** are wider overlapped than the related art. That is, over about 50% of the width of the data line **132** overlaps the pixel electrodes **142**. For example, if the data line has a width of over $8\ \mu\text{m}$, the data line **132** overlaps each of the adjacent pixel electrodes **142** by over $2\ \mu\text{m}$, respectively, because the formable minimum width of a fine pattern, presently, is about $4\ \mu\text{m}$ and the distance between the adjacent pixel electrodes **142** is about $4\ \mu\text{m}$. Therefore, since the data line **132** functions as a black matrix and light leakage is blocked around the data line **132**, the black matrix can be omitted. Additionally, leakage current in the thin film transistor may be prevented due to the blocking layer **144**.

[0068] In the first embodiment, the blocking layer **144** is formed between the passivation layer **140** and the pixel electrode **142**, and the blocking layer **144** may be formed on the pixel electrode **142**.

[0069] **FIG. 5** is a plan view of a reflective liquid crystal display (LCD) device including a cholesteric liquid crystal (CLC) color filter according to a second embodiment of the present invention. As shown in **FIG. 5**, a gate line **222** of a horizontal direction and a data line **232** of a vertical direction in the context of the figure cross each other to define a pixel area. At the crossing of the gate line **222** and the data line **232**, a thin film transistor, which includes a gate electrode **224**, a source electrode **234** and a drain electrode **236**, is formed. The gate electrode **224** is connected to the gate line **222**; the source electrode **234** is connected to the data line **232**; and the drain electrode **236** is spaced apart from the source electrode **234**. The thin film transistor further includes an active layer **228**, and the active layer **228** between the source electrode **234** and the drain electrode **236** becomes a channel of the thin film transistor. A passivation layer **240** is formed over the thin film transistor.

[0070] A capacitor electrode **238** overlaps the gate line **222** to form a storage capacitor. The capacitor electrode **238** may be made of the same material as the data line **232**.

[0071] A blocking layer **244** is formed at the crossing of the gate line **222** and the data line **232**, and covers the channel of the thin film transistor. Next, a first black matrix **246a** and a second black matrix **246b** are formed overlapping both sides of the data line **232**, respectively.

[0072] In the pixel area, a pixel electrode 242 is formed. The pixel electrode 242 is connected to the drain electrode 236 through a drain contact hole 240a through the passivation layer 240 and is connected to the capacitor electrode 238 through a capacitor contact hole 240b through the passivation layer 240. The pixel electrode 242 also overlaps the data line 232, so that the aperture ratio of the LCD device increases.

[0073] Although not shown in the figure, a CLC color filter layer is formed, and the CLC color filter layer reflects light of wavelengths corresponding to one of red, green and blue colors by pixel areas.

[0074] FIGS. 6A and 6B are cross sectional views along the line VIA-VIA and the line VIB-VIB of FIG. 5, respectively.

[0075] As shown in the figures, a first substrate 210 and a second substrate 250 are spaced apart and facing each other. The first substrate 210 may be made of a transparent substrate, and the second substrate 250 may be made of either a transparent substrate or an opaque substrate. A gate electrode 224 is formed on an inner surface of the first substrate 210, and a gate insulating layer 226 covers the gate electrode 224. Although not shown in the figures, a gate line 222 of FIG. 5 that is connected to the gate electrode 224 also is formed on the inner surface of the first substrate 210. An active layer 228 is formed on the gate insulating layer 226 over the gate electrode 224, and a source electrode 234 and a drain electrode 236 are formed on the active layer 228. As stated above, the gate electrode 224, the active layer 228, the source electrode 234 and the drain electrode 236 form a thin film transistor, and the active layer 228 exposed between the source electrode 234 and the drain electrode 236 becomes a channel of the thin film transistor. Additionally, a data line 232 and a capacitor electrode 238 of FIG. 5, which may be made of the same material as the source electrode 234 and the drain electrode 236, are formed on the gate insulating layer 226. The data line 232 is connected to the source electrode 234, and crosses the gate line to define a pixel area. The capacitor electrode overlaps the gate line. Although not shown in the figures, an ohmic contact layer may be formed between the active layer 228 and the source electrode 234 and between the active layer 228 and the drain electrode 236 to lower the contact resistance.

[0076] A passivation layer 240 is formed on the data line 232, the source electrode 234 and the drain electrode 236. The passivation layer 240 may be made of an organic material having a relatively low dielectric constant, such as benzocyclobutene (BCB) or acrylic resin. The passivation layer 240 includes a drain contact hole 240a exposing the drain electrode 236 and a capacitor contact hole 240b of FIG. 5 exposing the capacitor electrode 238 of FIG. 5.

[0077] Next, a blocking layer 244, a first black matrix 246a and a second black matrix 246b are formed on the passivation layer 240. The blocking layer 244 covers the channel of the thin film transistor. The first and second black matrices 246a and 246b extend vertically in the context of figure and overlap both sides of the data line 232, respectively. The blocking layer 244, the first black matrix 246a and the second black matrix 246b may be made of an opaque metal material, such as chromium (Cr).

[0078] As illustrated in FIG. 6B, a pixel electrode 242, which may be made of a transparent conducting material,

such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), may be formed on at least a portion of the blocking layer 244, the first black matrix 246a, the second black matrix 246b, and on the passivation layer 240. The pixel electrode 242 is connected to the drain electrode 236 through the drain contact hole 240a, and overlaps not only the data line 232 but also the first and second black matrices 246a and 246b to increase an aperture ratio of the LCD device. As shown in the figures, the pixel electrode 242 may contact and overlap the blocking layer 244 such that a portion of the blocking layer 244 is between the passivation layer 240 and the pixel electrode 242.

[0079] In another aspect of the present invention, the blocking layer 244 may overlap the pixel electrode 242 such that a portion of the pixel electrode 242 is between the blocking layer 244 and the passivation layer 240, as illustrated in FIG. 6C.

[0080] On the other hand, an absorption layer 252 is formed on an inner surface of the second substrate 250, and a CLC color filter layer, which includes sub color filters 254a and 254b, is formed on the absorption layer 252. Each sub color filter of the CLC color filter layer 254a and 254b corresponds to one pixel area, and reflects light of wavelengths corresponding to one of red, green and blue colors. A common electrode 256 is formed on the CLC color filter layer 254a and 254b. The common electrode 256 is made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO).

[0081] A liquid crystal layer 260 is disposed between the common electrode 256 and the pixel electrode 242.

[0082] A retardation film 272 and a polarizer 274 are subsequently arranged on an outer surface of the first substrate 210. The retardation film 272 may be a quarter wave plate (QWP) having a retardation of $\lambda/4$, and the polarizer 274 may be a linear polarizer that transmits only linearly polarized light parallel to its transmission axis.

[0083] In the second embodiment of the present invention, the blocking layer 244 corresponding to the channel of the thin film transistor is formed, and the first and second black matrices 246a and 246b overlap each side of the data line 232. Therefore, leakage current in the thin film transistor is prevented, and light leakage is blocked around the data line 232. Here, the data line 232 may have the same width as the related art, that is, a width of about 8 μm . Although the blocking layer 244 is formed between the passivation layer 240 and the pixel electrode 242 in the second embodiment, the blocking layer 244 may be formed on the pixel electrode 242.

[0084] Meanwhile, the first and second black matrices may be formed under the data line. Such a third embodiment of the present invention will be explained with reference to the following figures.

[0085] FIG. 7 is a plan view of a reflective liquid crystal display (LCD) device including a cholesteric liquid crystal (CLC) color filter according to a third embodiment of the present invention, and FIGS. 8A and 8B are cross sectional views along the line VIIIA-VIIIA and the line VIIB-VIIB of FIG. 7, respectively.

[0086] In FIG. 7, the reflective LCD device of the third embodiment has the same plan structure as the second

embodiment, although the cross-sectional views differ. Thus, similar reference numbers will be used throughout the drawing to refer to the same or like parts, and thus the explanation about these will be omitted.

[0087] Next, as shown in **FIGS. 8A and 8B**, a first substrate **310** and a second substrate **350** are spaced apart and facing each other. The first substrate **310** may be made of a transparent substrate, and the second substrate **350** may be made of either a transparent substrate or an opaque substrate. A first black matrix **316a** and a second black matrix **316b** are formed on an inner surface of the first substrate **310**, and an overcoat layer **318** covers the first and second black matrices **316a** and **316b**. The first and second black matrices **316a** and **316b** may be made of an opaque metal material. A gate electrode **324** is formed on the overcoat layer **318**, and a gate insulating layer **326** covers the gate electrode **324**. Although not shown in the figures, a gate line **322** of **FIG. 7** that is connected to the gate electrode **324** also is formed on the overcoat layer **318**. An active layer **328** is formed on the gate insulating layer **326** over the gate electrode **324**, and a source electrode **334** and a drain electrode **336** are formed on the active layer **328**. As stated above, the gate electrode **324**, the active layer **328**, the source electrode **334** and the drain electrode **336** form a thin film transistor, and the active layer **328** exposed between the source electrode **334** and the drain electrode **336** becomes a channel of the thin film transistor. Moreover, a data line **332**, which may be made of the same material as the source electrode **334** and the drain electrode **336**, is formed on the gate insulating layer **326**. The data line **332** is connected to the source electrode **334** and crosses the gate line to define a pixel area. The data line **332** overlaps the first and second black matrices **316a** and **316b**. Although not shown in the figures, an ohmic contact layer may be formed between the active layer **328** and the source electrode **334** and between the active layer **328** and the drain electrode **336** to lower the contact resistance.

[0088] A passivation layer **340** is formed on the data line **332**, the source electrode **334** and the drain electrode **336**. The passivation layer **340** may be made of an organic material having a relatively low dielectric constant, such as benzocyclobutene (BCB) or acrylic resin. The passivation layer **340** includes a drain contact hole **340a** exposing the drain electrode **336**.

[0089] Next, a blocking layer **344** is formed on the passivation layer **340**, and covers the channel of the thin film transistor. The blocking layer **344** may be made of an opaque metal material, such as chromium (Cr).

[0090] As illustrated in **FIG. 8B**, a pixel electrode **342**, which may be made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), may be formed on at least a portion of the blocking layer **344** and on the passivation layer **340**. The pixel electrode **342** is connected to the drain electrode **336** through the drain contact hole **340a**, and overlaps not only the data line **332** but also the first and second black matrices **316a** and **316b** to increase an aperture ratio of the LCD device. As shown in the figures, the pixel electrode **342** may contact and overlap the blocking layer **344** such that a portion of the blocking layer **344** is between the passivation layer **340** and the pixel electrode **342**.

[0091] In another aspect of the present invention, the blocking layer **344** may overlap the pixel electrode **342** such

that a portion of the pixel electrode **342** is between the blocking layer **344** and the passivation layer **340**, as illustrated in **FIG. 6C**.

[0092] On the other hand, an absorption layer **352** is formed on an inner surface of the second substrate **350**, and a CLC color filter layer, which includes sub color filters **354a** and **354b**, is formed on the absorption layer **352**. Each sub color filter of the CLC color filter layer **354a** and **354b** corresponds to one pixel area, and reflects light of wavelengths corresponding to one of red, green and blue colors. A common electrode **356** is formed on the CLC color filter layer **354a** and **354b**. The common electrode **356** is made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO).

[0093] A liquid crystal layer **360** is disposed between the common electrode **356** and the pixel electrode **342**.

[0094] A retardation film **372** and a polarizer **374** are subsequently arranged on an outer surface of the first substrate **310**. The retardation film **372** may be a quarter wave plate (QWP) having a retardation of $\lambda/4$, and the polarizer **374** may be a linear polarizer that transmits only linearly polarized light parallel to its transmission axis.

[0095] In the third embodiment of the present invention, the blocking layer **344** corresponding to the channel of the thin film transistor is formed, and the first and second black matrices **316a** and **316b** overlapping each side of the data line **332** are formed under the data line **332**. Therefore, leakage current in the thin film transistor is prevented and light leakage is blocked around the data line **332**. Here, the data line **332** may have a width of about $8\ \mu\text{m}$. Although the blocking layer **344** is formed between the passivation layer **340** and the pixel electrode **342** in the third embodiment, the blocking layer **344** may be formed on the pixel electrode **342**.

[0096] In the third embodiment, the overcoat layer may be omitted, and such a fourth embodiment of the present invention will be explained with reference to the following figures.

[0097] **FIG. 9** is a plan view of a reflective liquid crystal display (LCD) device including a cholesteric liquid crystal (CLC) color filter according to a fourth embodiment of the present invention, and **FIGS. 10A and 10B** are cross sectional views along the line XA-XA and the line XB-XB of **FIG. 9**, respectively.

[0098] In **FIG. 9**, the reflective LCD device of the fourth embodiment has the same plan structure as the third embodiment. Thus, similar reference numbers will be used throughout the drawing to refer to the same or like parts, and thus the explanation about these will be omitted.

[0099] Next, as shown in **FIGS. 10A and 10B**, a first substrate **410** and a second substrate **450** are spaced apart and facing each other. The first substrate **410** may be made of a transparent substrate, and the second substrate **450** may be made of either a transparent substrate or an opaque substrate. A first black matrix **416a** and a second black matrix **416b** are formed on an inner surface of the first substrate **410**. Also, a gate electrode **424** and a gate line (not shown) are formed on the inner surface of the first substrate **410**, and a gate insulating layer **426** covers the gate electrode **424** and the gate line. The first and second black matrices

416a and **416b** may be formed of the same material as the gate electrode **424**. An active layer **428** is formed on the gate insulating layer **426** over the gate electrode **424**, and a source electrode **434** and a drain electrode **436** are formed on the active layer **428**. As stated above, the gate electrode **424**, the active layer **428**, the source electrode **434** and the drain electrode **436** form a thin film transistor, and the active layer **428** exposed between the source electrode **434** and the drain electrode **436** becomes a channel of the thin film transistor. Moreover, a data line **432**, which may be made of the same material as the source electrode **434** and the drain electrode **436**, is formed on the gate insulating layer **426**. The data line **432** is connected to the source electrode **434** and crosses the gate line to define a pixel area. The data line **432** overlaps the first and second black matrices **416a** and **416b**. Although not shown in the figures, an ohmic contact layer may be formed between the active layer **428** and the source electrode **434** and between the active layer **428** and the drain electrode **436** to lower the contact resistance.

[0100] A passivation layer **440** is formed on the data line **432**, the source electrode **434** and the drain electrode **436**. The passivation layer **440** may be made of an organic material having a relatively low dielectric constant, such as benzocyclobutene (BCB) or acrylic resin. The passivation layer **440** includes a drain contact hole **440a** exposing the drain electrode **436**.

[0101] Next, a blocking layer **444** is formed on the passivation layer **440** and covers the channel of the thin film transistor. The blocking layer **444** may be made of an opaque metal material, such as chromium (Cr).

[0102] As illustrated in FIG. 10B, a pixel electrode **442**, which may be made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO), may be formed on at least a portion of the blocking layer **444** and on the passivation layer **440**. The pixel electrode **442** is connected to the drain electrode **436** through the drain contact hole **440a** and overlaps not only the data line **432**, but also the first and second black matrices **416a** and **416b** to increase an aperture ratio of the LCD device. As shown in the figures, the pixel electrode **442** may contact and overlap the blocking layer **444** such that a portion of the blocking layer **444** is between the passivation layer **440** and the pixel electrode **442**.

[0103] In another aspect of the present invention, the blocking layer **444** may overlap the pixel electrode **442** such that a portion of the pixel electrode **442** is between the blocking layer **444** and the passivation layer **440**, as illustrated in FIG. 10C.

[0104] On the other hand, an absorption layer **452** is formed on an inner surface of the second substrate **450**, and a CLC color filter layer, which includes sub color filters **454a** and **454b**, is formed on the absorption layer **452**. Each sub color filter of the CLC color filter layer **454a** and **454b** corresponds to one pixel area and reflects light of wavelengths corresponding to one of red, green and blue colors. A common electrode **456** is formed on the CLC color filter layer **454a** and **454b**. The common electrode **456** is made of a transparent conducting material, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO).

[0105] A liquid crystal layer **460** is disposed between the common electrode **456** and the pixel electrode **442**.

[0106] A retardation film **472** and a polarizer **474** are subsequently arranged on an outer surface of the first substrate **410**. The retardation film **472** may be a quarter wave plate (QWP) having a retardation of $\lambda/4$, and the polarizer **474** may be a linear polarizer that transmits only linearly polarized light parallel to its transmission axis.

[0107] In the fourth embodiment of the present invention, the blocking layer **444** corresponding to the channel of the thin film transistor is formed, and the first and second black matrices **416a** and **416b** overlapping each side of the data line **432** are formed under the data line **432**. Therefore, leakage current in the thin film transistor is prevented and light leakage is blocked around the data line **432**. Here, the data line **432** may have a width of about 8 μm . Although the blocking layer **444** is formed between the passivation layer **440** and the pixel electrode **442** in the second embodiment, the blocking layer **444** may be formed on the pixel electrode **442**.

[0108] It will be apparent to those skilled in the art that various modifications and variations can be made in the fabrication and application of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A reflective liquid crystal display device, comprising:
first and second substrates spaced apart and facing each other;
a gate line and a data line on an inner surface of the first substrate and crossing each other to define a pixel area;
a thin film transistor corresponding to each pixel area electrically connected to the gate and data lines;
a passivation layer covering the thin film transistor;
a blocking layer on the passivation layer and corresponding to the thin film transistor;
a pixel electrode corresponding to each pixel area on the passivation layer and connected to the thin film transistor;
a retardation film on an outer surface of the first substrate;
a polarizer on the retardation film;
a color filter layer on the second substrate;
a common electrode on the color filter layer; and
a liquid crystal layer between the common electrode and the pixel electrode,

wherein the blocking layer is made of a metal material.

2. The device according to claim 1, wherein the data line overlaps adjacent pixel electrodes and an overlapping width is between about 50% and about 100% of a width of the data line.

3. The device according to claim 1, wherein a portion of the width of the data not overlapped by the adjacent pixel electrodes is less than about 50%.

4. The device according to claim 1, further comprising an absorption layer on an inner surface of the second substrate, wherein the color filter layer is a cholesteric liquid crystal color filter layer.

5. The device according to claim 1, further comprising an reflective layer on an inner surface of the second substrate, wherein the color filter layer is a absorption type color filter layer.

6. The device according to claim 1, wherein the blocking layer includes chromium.

7. The device according to claim 1, wherein at least a portion of the blocking layer is disposed between the passivation layer and the pixel electrode.

8. The device according to claim 1, wherein the blocking layer is disposed on the pixel electrode.

9. The device according to claim 1, wherein the passivation layer includes one of benzocyclobutene and acrylic resin.

10. A reflective liquid crystal display device, comprising:
first and second substrates spaced apart and facing each other;

a gate line and a data line on an inner surface of the first substrate and crossing each other to define a pixel area;

a thin film transistor electrically connected to the gate and data lines;

a passivation layer covering the thin film transistor;

a blocking layer on the passivation layer and corresponding to the thin film transistor;

first and second black matrices on the passivation layer and overlapping respective sides of the data line;

a pixel electrode on the passivation layer, the pixel electrode connected to the thin film transistor and overlapping the first and second black matrices;

a retardation film on an outer surface of the first substrate;

a polarizer on the retardation film;

a color filter layer on the second substrate;

a common electrode on the color filter layer; and

a liquid crystal layer between the common electrode and the pixel electrode.

11. The device according to claim 10, further comprising an absorption layer on an inner surface of the second substrate, wherein the color filter layer is a cholesteric liquid crystal color filter layer.

12. The device according to claim 10, further comprising an reflective layer on an inner surface of the second substrate, wherein the color filter layer is a absorption type color filter layer.

13. The device according to claim 10, wherein the pixel electrode overlaps adjacent data lines.

14. The device according to claim 10, wherein the first and second black matrices are made of the same material as the blocking layer.

15. The device according to claim 10, wherein the blocking layer is made of a metal material.

16. The device according to claim 15, wherein the blocking layer includes chromium.

17. The device according to claim 10, wherein the blocking layer is disposed between the passivation layer and the pixel electrode.

18. The device according to claim 10, wherein the blocking layer is disposed on the pixel electrode.

19. A reflective liquid crystal display device, comprising:
first and second substrates spaced apart and facing each other;

first and second black matrices on an inner surface of the first substrate;

a plurality of gate lines on the inner surface of the first substrate;

a plurality of data lines crossing the gate lines to define pixel areas and overlapping the first and second black matrices;

a thin film transistor electrically connected to the gate and data lines;

a passivation layer covering the thin film transistor;

a blocking layer on the passivation layer and corresponding to the thin film transistor;

a pixel electrode on the passivation layer, the pixel electrode connected to the thin film transistor and overlapping the first and second black matrices;

a retardation film on an outer surface of the first substrate;

a polarizer on the retardation film;

a color filter layer on the second substrate;

a common electrode on the color filter layer; and

a liquid crystal layer between the common electrode and the pixel electrode.

20. The device according to claim 19, further comprising an absorption layer on an inner surface of the second substrate, wherein the color filter layer is a cholesteric liquid crystal color filter layer.

21. The device according to claim 19, further comprising an reflective layer on an inner surface of the second substrate, wherein the color filter layer is a absorption type color filter layer.

22. The device according to claim 19, wherein the pixel electrode overlaps adjacent data lines.

23. The device according to claim 19, wherein the first and second black matrices are made of the same material as the gate lines.

24. The device according to claim 19, further comprising an overcoat layer between the first and second black matrices and the gate lines.

25. The device according to claim 19, wherein the blocking layer is made of a metal material.

26. The device according to claim 19, wherein the blocking layer is disposed between the passivation layer and the pixel electrode.

27. The device according to claim 19, wherein the blocking layer is disposed on the pixel electrode.

* * * * *

专利名称(译)	反射式液晶显示装置		
公开(公告)号	US20040125286A1	公开(公告)日	2004-07-01
申请号	US10/667460	申请日	2003-09-23
[标]申请(专利权)人(译)	MOON JONG WEON 金文CHUL		
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IPC分类号	G02F1/1335 G02F1/13363 G02F1/1362 G02F1/1368		
CPC分类号	G02F1/133553 G02F2001/133543 G02F2001/133521 G02F1/136209		
优先权	1020020085360 2002-12-27 KR		
其他公开文献	US7030947		
外部链接	Espacenet USPTO		

摘要(译)

一种反射型液晶显示装置，包括彼此隔开并面对的第一和第二基板，在第一基板的内表面上的栅极线和数据线，并且彼此交叉以限定像素区域，电连接到的薄膜晶体管栅极和数据线，覆盖薄膜晶体管的钝化层，钝化层上的阻挡层并对应于薄膜晶体管，钝化层上的像素电极并连接到薄膜晶体管，延迟膜上的延迟膜第一基板的外表面，延迟膜上的偏振器，第二基板的内表面上的吸收层，吸收层上的胆甾型液晶滤色器层，胆甾型液晶滤色器层上的公共电极，公共电极和像素电极之间的液晶层，其中数据线与相邻的像素电极重叠并重叠ping宽度超过数据线宽度的50%。

