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(54) LIQUID CRYSTAL DISPLAY DEVICE

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(57) ABSTRACT

The present invention discloses a liquid crystal display device having a retardation film. The retardation film is formed in such a way that one of a UV curable polymer and a UV curable liquid crystal is coated.

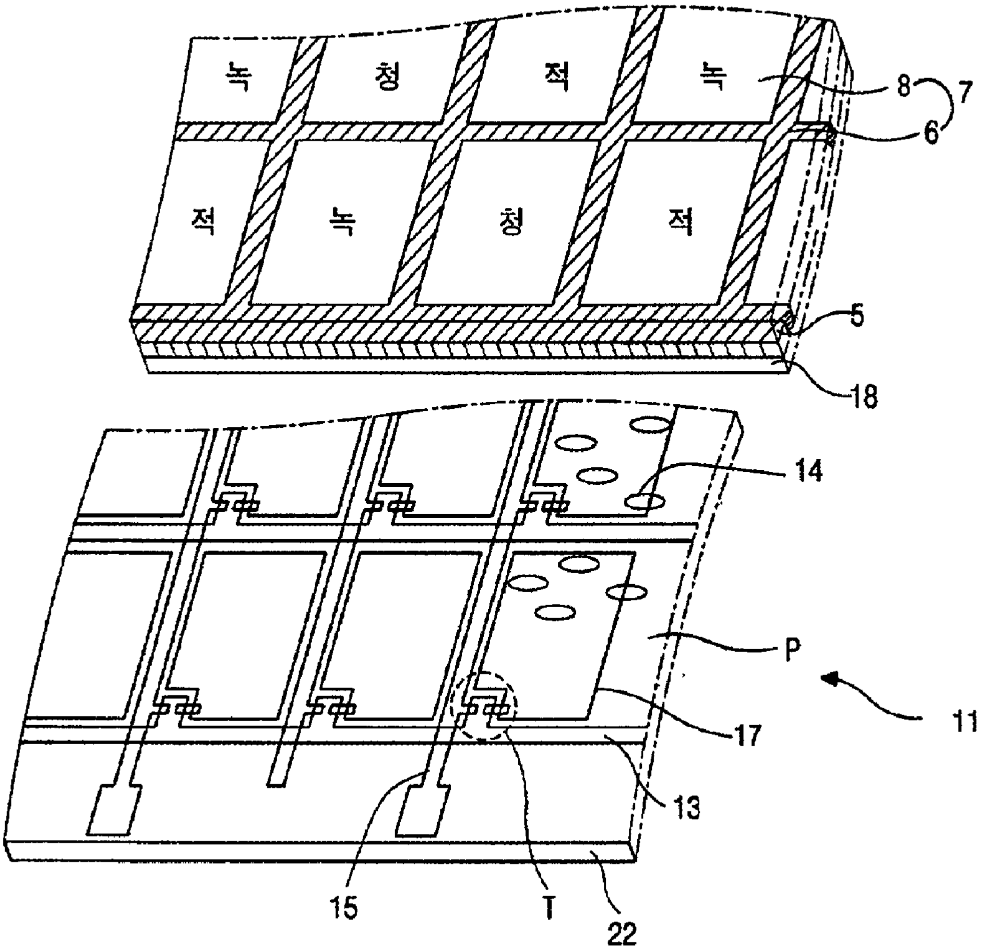


Fig.1
(Related Art)

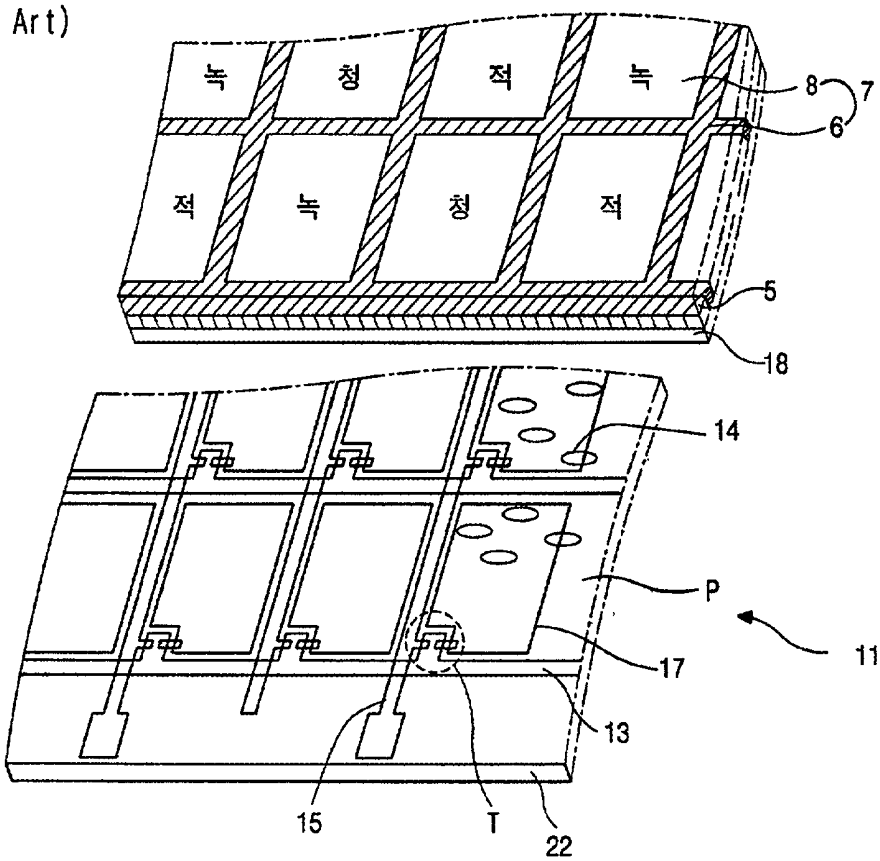


Fig.2
(Related Art)

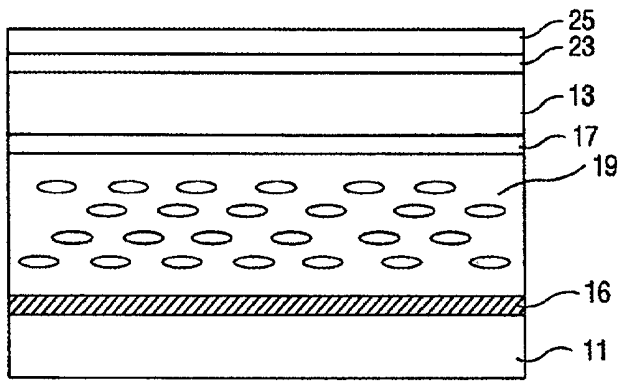


Fig.3A
(Related Art)

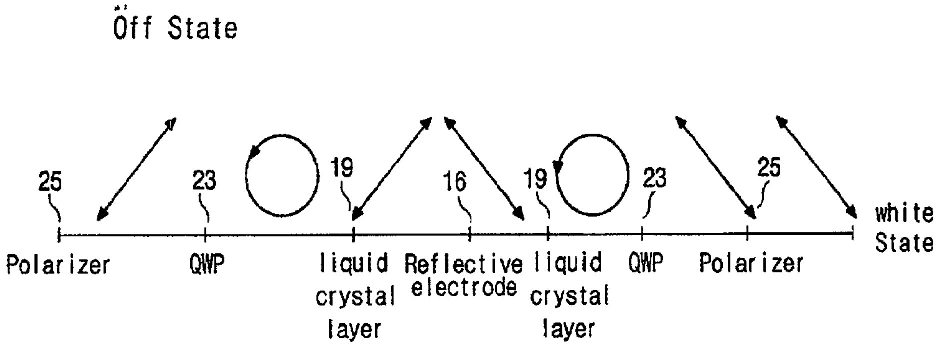


Fig.3B
(Related Art)

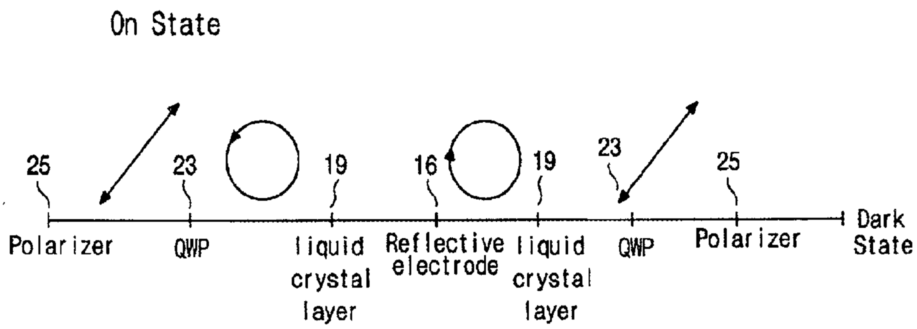


Fig.4
(Related Art)

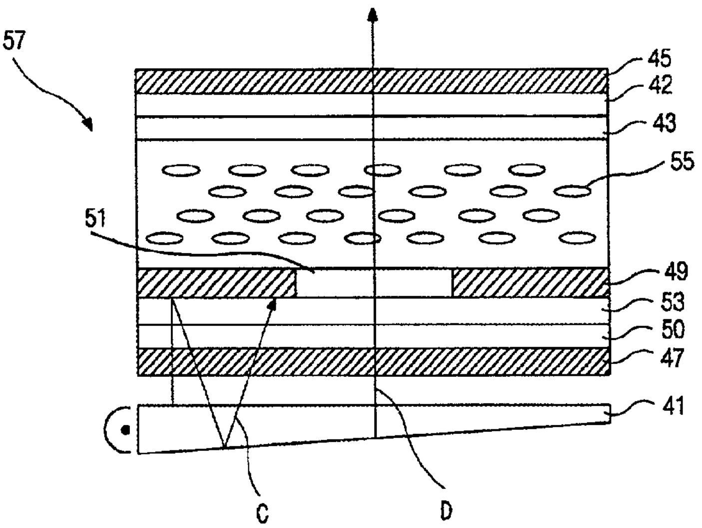


Fig.5A
(Related Art)

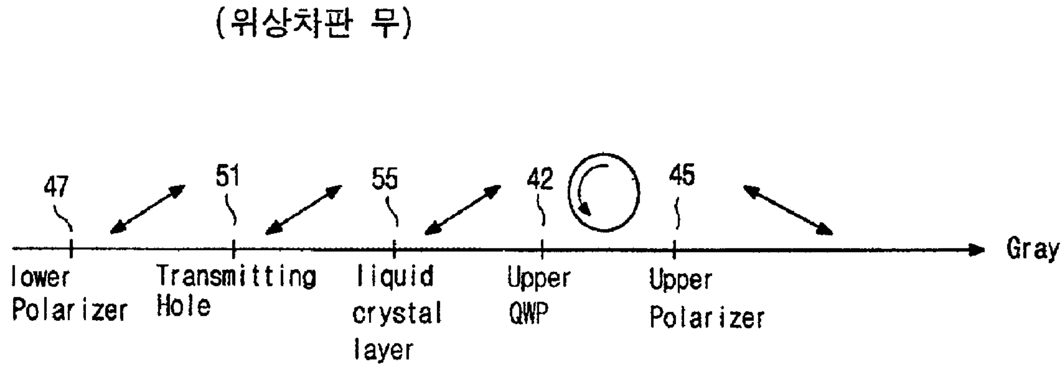


Fig.5B
(Related Art)

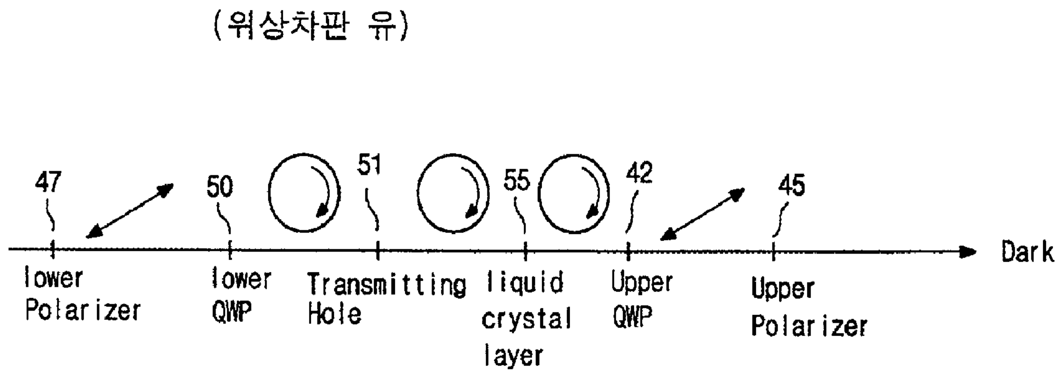


Fig.6
(Related Art)

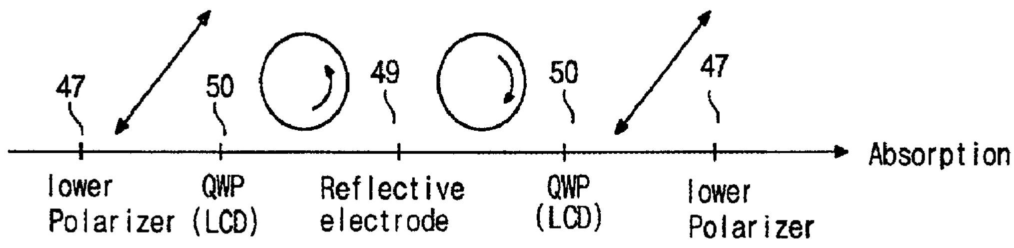


Fig.7

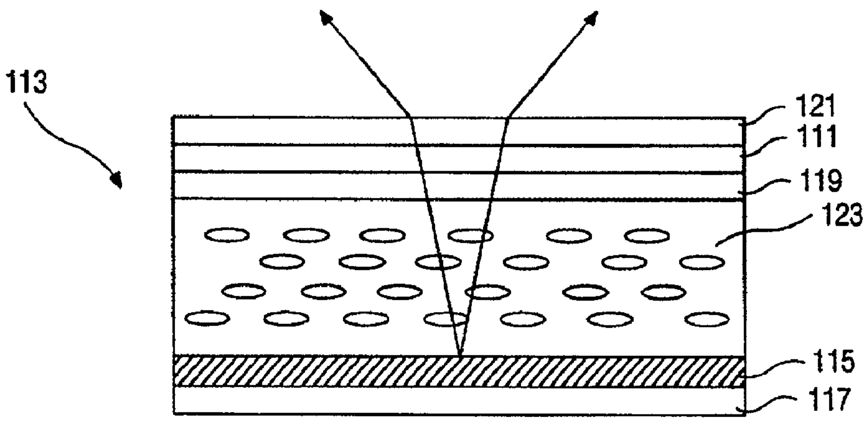


Fig.8

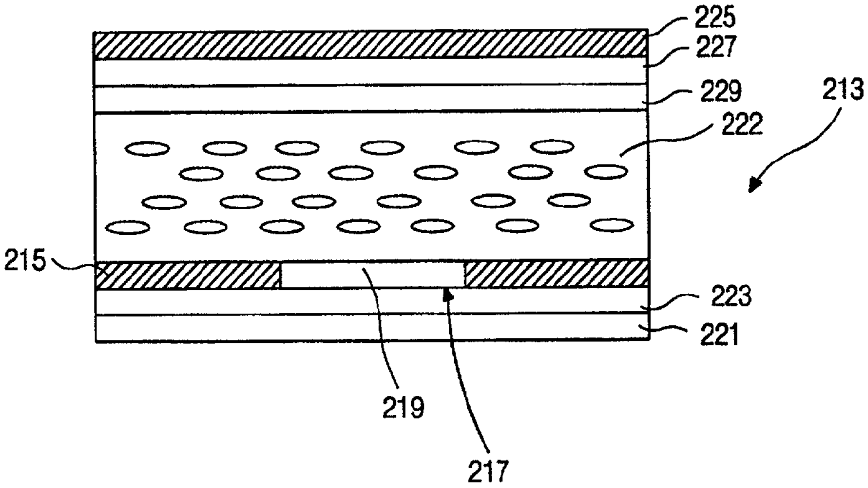
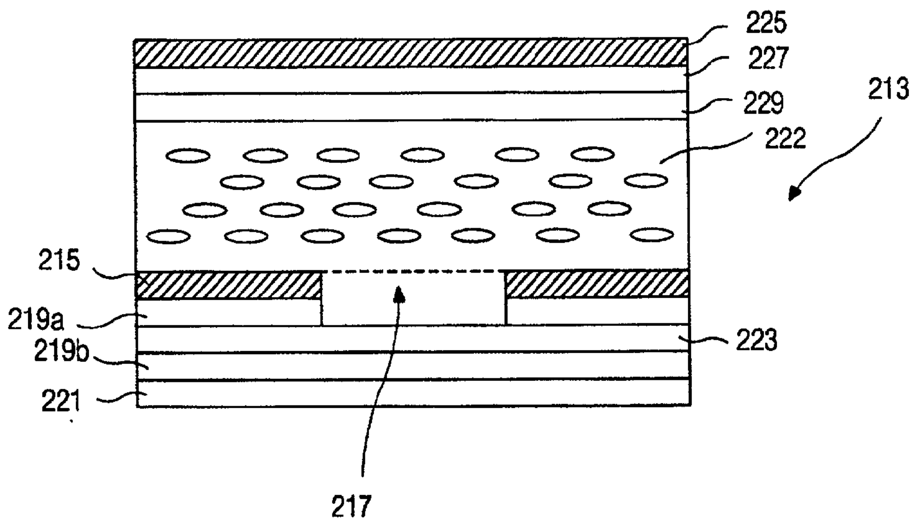

225
227
229
213
222
215
223
221
219
217

Fig.9


225
227
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222
215
219a
219b
221
223
217

LIQUID CRYSTAL DISPLAY DEVICE

CROSS REFERENCE

[0001] This application claims the benefit of Korean Patent Application No. 1999-67847, filed on Dec. 31, 2000, under 35 U.S.C. § 119, the entirety of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display (LCD) device having a retardation film.

[0004] 2. Description of Related Art

[0005] LCD devices are divided into three types: a transmissive LCD device; a reflective LCD device; and a transflective LCD device. The transmissive LCD device has a back light device as a light source, and the reflective LCD device uses ambient light instead of the back light device. The transflective LCD device has a transmissive mode and a reflective mode.

[0006] **FIG. 1** is an exploded view illustrating a typical transflective LCD device. As shown in **FIG. 1**, the transflective LCD device **1** includes upper and lower substrates **7** and **22** with a liquid crystal layer **15** interposed therebetween. The upper substrate **7** includes a black matrix **3**, a color filter **5**, and a common electrode **9**. The lower substrate **22** is called an array substrate and includes gate lines **21** arranged in a transverse direction and data lines **26** arranged in a longitudinal direction perpendicular to the gate line **21**. A pixel region P is defined by the gate and data lines **21** and **26**. A pixel electrode **18** is formed on the pixel region P. As a switching element, thin film transistors (TFTs) T are formed at a crossing point of the gate and data lines **21** and **26**. The pixel electrode **18** is made of indium tin oxide (ITO) or indium zinc oxide (IZO).

[0007] **FIG. 2** is a cross-sectional view illustrating a conventional reflective LCD device. As shown in **FIG. 2, a** lower substrate **11** includes a reflective electrode **16**, and an upper substrate **13** includes a transparent electrode **17**. A liquid crystal layer **19** is interposed between the lower and upper substrates **11** and **13**. As the liquid crystal layer **19**, twisted nematic (TN) liquid crystal is mainly used. The twisted nematic liquid crystal molecules have a molecule axis that is twisted in 90° and a phase difference of &lgr/. Therefore, a linearly polarized light incident to the twisted nematic liquid crystal layer is changed into a circularly polarized light. On the upper substrate **13**, a retardation film **23** (i.e., a quarter wave plate) and a polarizer **25** are arranged. Ambient light is changed into a linearly polarized light through the polarizer **25**. The retardation film **23** changes the linearly polarized light into a circularly polarized light.

[0008] **FIG. 3A** shows light state after passing through each layer when voltage is not applied to the liquid crystal layer and assuming that the observer traces light. Incident light passes through the polarizer **25** and become a linearly polarized light parallel to the light transmission axis of the polarizer **25**. The linearly polarized light is changed into a left-handed circularly polarized light after passing through the retardation film **23**. The left-handed circularly polarized light is changed into the linearly polarized light after passing the TN liquid crystal layer **19**. The linearly polarized light is reflected on the reflective electrode **16** and is changed into the left-handed circularly polarized light having a phase difference of &lgr/ after passing through the TN liquid crystal layer **19**. The left-handed circularly polarized light is changed into the linearly polarized light after passing through the retardation film **23**. The linearly polarized light is parallel to a transmission axis of the polarizer **25** and thus passes through the polarizer **25**, whereupon the LCD device becomes a white state.

[0009] Alternately, **FIG. 3B** shows light state after passing through each layer when voltage is applied to the liquid crystal layer. When the liquid crystal display device goes to an on state, the TN liquid crystal molecules that are twisted in 90° are polarized in a direction of applied electric field to have a certain direction. As shown in **FIG. 3**B, incident light passes through the polarizer **25** and become a linearly polarized light parallel to the light transmission axis of the polarizer **25**. The linearly polarized light is changed into a left-handed circularly polarized light after passing through the retardation film **23**. The left-handed circularly polarized light passes through the TN liquid crystal layer **19**"as is". The left-handed circularly polarized light is reflected on the reflective electrode **16** and is changed into the right-handed circularly polarized light. The right-handed circularly polarized light passes through the TN liquid crystal layer **19**"as is". The right-handed circularly polarized light is changed into the linearly polarized light after passing through the retardation film **23**. The linearly polarized light is parallel to a transmission axis of the polarizer **25** and thus passes through the polarizer **25**, whereupon the LCD device becomes a dark state.

[0010] The retardation film **23** serves to improve a viewing angle and a contrast ratio. Even though the thickness of the retardation film **23** is changed a little, error of the phase difference become greater. Further, when it is assembled to the substrate, assembly or attachment error may occur, leading to an assembling error of the polarizer.

[0011] **FIG. 4** is a cross-sectional view illustrating a transflective LCD device according to the conventional art. As shown in **FIG. 4**, on an upper substrate **43**, an upper retardation film **42** and an upper polarizer **45** are sequentially stacked. On a bottom surface of a lower substrate **53**, a lower polarizer **47** and a lower retardation film **50** are arranged. A liquid crystal layer **55** are interposed between the upper and lower substrates **43** and **47**. A back light device is arranged under the lower substrate **53**. A reflective electrode **49** is arranged on the lower substrate **53** and includes at least one light transmitting hole **51**. The light transmitting hole **51** serves to transmit light from the back light device **41**.

[0012] The transflective LCD device described above requires the lower polarizer **47** as well as the upper polarizer **45**. This is because light should not leak out in both a transmissive mode and a reflective mode when the transflective LCD device goes to a dark state in order to achieve a high contrast ratio.

[0013] **FIG. 5A** shows light state after passing through each layer in a transmissive mode when voltage is applied to the liquid crystal layer **55**, and assuming that the lower retardation film **50** does not exist. As shown in **FIG. 5**A, light generated from the back light device **41** passes through the lower polarizer **47** and is changed into a linearly polarized light parallel to a transmission axis of the lower polarizer **47**. The linearly polarized light passes through the light transmitting hole **51** and the liquid crystal layer **55**"as is". In other words, the linearly polarized light passing through the liquid crystal layer **55** has no phase difference. Then, the linearly polarized light passes through the upper retardation film **42** and is changed into left-handed circularly polarized light. The left-handed circularly polarized light passes through the upper polarizer **45**. At this point, of the left-handed circularly polarized light, only elements of light parallel to a transmission axis of the upper polarizer **45** are viewed by an observer. In other words, about a half of the circularly polarized light passes through the upper polarizer **45**, leading to a gray state other than a complete dark state, leading to a deterioration of contrast ratio.

[**0014**] **FIG. 5B** shows light state after passing through each layer in a transmissive mode when voltage is applied to the liquid crystal layer **55** and the lower retardation film **50** is arranged. As shown in **FIG.** 5B, light generated from the back light device **41** passes through the lower polarizer **47** and is changed into a linearly polarized light parallel to a transmission axis of the lower polarizer **47**. The linearly polarized light passes through the lower retardation film **50** and is changed into a right-handed circularly polarized light. The right-handed circularly polarized light passes through the light transmitting hole **51** and the liquid crystal layer **55**"as is". Then, the right-handed circularly polarized light passes through the upper retardation film **42** and is changed into a linearly polarized light perpendicular to a transmission axis of the upper polarizer **45**. The linearly polarized light is absorbed into the upper polarizer **45**, leading to a dark state.

[**0015**] In the transmissive mode of the transflective LCD device, light D generated from the back light device **41** passes through the light transmitting hole **51** and reaches the liquid crystal layer **55**. However, part C of light generated from the back light device **41** is reflected on the reflective electrode **49** and then is absorbed into the lower polarizer **47**. Or a small amount of light is reflected on the reflective electrode **49** and then directs toward the liquid crystal layer **55** through the light transmitting hole **51**.

[**0016**] **FIG. 6** shows a state of light C reflected on the reflective electrode in a transmissive mode. As shown in **FIG. 6**, light C from the back light device **41** passes through the lower polarizer **47** and is changed into a linearly polarized light parallel to a transmission axis of the lower polarizer **47**. The linearly polarized light is changed into a left-handed circularly polarized light through the retardation film **50** that is a &lgr/ plate. The left-handed circularly polarized light is reflected on the reflective electrode **49** and is changed into a right-handed circularly polarized light. The right-handed circularly polarized light passes through the lower retardation film **50** and is changed into the linearly polarized light perpendicular to a transmission axis of the lower polarizer **47**. The linearly polarized light is all absorbed into the lower polarizer **47**. Therefore, the lower retardation film **50** causes light lose in the transmissive mode of the transflective LCD device, whereupon a brightness may be lowered.

SUMMARY OF THE INVENTION

[**0017**] To overcome the problems described above, preferred embodiments of the present invention provide a reflective liquid crystal display (LCD) device having the assembly improvement of a retardation film.

[**0018**] It is another object of the present invention to provide a transflective LCD device having a high brightness and an excellent color purity.

[**0019**] In order to achieve the above object, the preferred embodiments of the present invention provide a reflective liquid crystal display device, including: a first substrate having a reflective electrode on a bottom surface thereof, a second substrate having a polarizer and a retardation film, the polarizer formed on a top surface of the second substrate, the retardation film formed on a bottom surface of the second substrate; and a liquid crystal layer interposed between the first and second substrates, wherein the retardation film is made of one of a polymer and a liquid crystal.

[**0020**] The preferred embodiment of the present invention further provides a transflective liquid crystal display, including: a liquid crystal panel including a) a first substrate having a first polarizer and a reflective electrode, the first polarizer formed a bottom surface thereof, the reflective electrode having at least one light transmitting hole and a first retardation film, the first retardation film formed in the light transmitting hole, the light transmitting hole transmitting light; b) a second substrate having a second retardation film and a second polarizer sequentially arranged thereon; and c) a liquid crystal layer interposed between the first and second substrates; and a back light device for generating light.

[**0021**] The preferred embodiment of the present invention further provides a liquid crystal display device, including: a liquid crystal panel including: a) an upper substrate having an upper polarizer and an upper retardation film sequentially arranged on a top surface thereof; b) a lower substrate having a reflective electrode and a first lower retardation film sequentially arranged on a top surface thereof and a second lower retardation film and a lower polarizer sequentially arranged on a bottom surface thereof, the reflective electrode and the first lower retardation film having a light transmitting hole, the light transmitting hole transmitting light; and c) a liquid crystal layer interposed between the upper and lower substrates; and a back light device providing light to the liquid crystal panel.

[**0022**] The retardation film is made of either of an UV curable polymer and an UV curable liquid crystal.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0023**] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which like reference numerals denote like parts, and in which:

[**0024**] **FIG. 1** is an exploded view illustrating a typical transflective LCD device;

[**0025**] **FIG. 2** is a cross-sectional view illustrating a conventional LCD device;

[**0026**] **FIG. 3A** shows light state after passing through each layer when voltage is not applied to a liquid crystal layer;

[**0027**] **FIG. 3B** shows light state after passing through each layer when voltage is applied to the liquid crystal layer;

[0028] **FIG. 4** is a cross-sectional view illustrating a transflective LCD device according to a conventional art;

[0029] **FIG. 5A** shows light state after passing through each layer in a transmissive mode when voltage is applied to the liquid crystal layer and a lower retardation film is not arranged;

[0030] **FIG. 5B** shows light state after passing through each layer in a transmissive mode when voltage is applied to the liquid crystal layer and the lower retardation film **50** is arranged;

[0031] **FIG. 6** shows a state of light reflected on the reflective electrode in a transmissive mode;

[0032] **FIG. 7** is a cross-sectional view illustrating a reflective liquid crystal display device according to a first preferred embodiment of the present invention;

[0033] **FIG. 8** is a transflective LCD device according to a second preferred embodiment of the present invention; and

[0034] **FIG. 9** is a transflective LCD device according to a third preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFFERED EMBODIMENTS

[0035] Reference will now be made in detail to preferred embodiments of the present invention, example of which is illustrated in the accompanying drawings.

[0036] **FIG. 7** is a cross-sectional view illustrating a reflective liquid crystal display (LCD) device according to a first preferred embodiment of the present invention. As shown in **FIG. 7**, the reflective LCD device **113** includes lower and upper substrates **117** and **111** with a liquid crystal layer **123** interposed therebetween. The lower substrate **117** includes a reflective electrode **115**, and the upper substrate **111** includes a retardation film **119** and a polarizer **121**. The retardation film **119** is formed in such a way that the UV curable polymer is coated on a bottom surface of the second substrate **111** and then is hardened by an ultraviolet ray.

[0037] The method of forming the retardation **119** according to the first preferred embodiment of the present invention is easy in coating of a uniform thickness and can reduce an assembly error. Further, the method can achieve a lightweight, thin LCD device. Furthermore, compared with the conventional method that the retardation film is attached on the top surface of the substrate, since causes to lower light utilization efficiency such as a reflection and an absorption of light can be reduced, the reflective LCD device having a high brightness can be manufactured.

[0038] **FIG. 8** is a transflective LCD device according to a second preferred embodiment of the present invention. As shown in **FIG. 8**, the transflective LCD device **213** includes lower and upper substrates **223** and **229** with a liquid crystal layer **222** interposed therebetween. The lower substrate **223** includes a lower polarizer **221** on its bottom surface and a reflective electrode **215** having a light transmitting hole **217**. At this point, a retardation film **219** is formed in the light transmitting hole **217**. The upper substrate **229** includes an upper polarizer **225** and an upper retardation film **227**, which are sequentially stacked on its top surface. The upper retardation film **227** may be formed on a bottom surface of the upper substrate **229** other than the top surface of the upper substrate **229**. Even though not shown, the transflective LCD device **213** further includes a back light device.

[0039] The retardation film **219** is formed by the following method. First, the UV curable polymer is coated on the reflective electrode **215** and then only a portion of the UV curable polymer layer corresponding to the light transmitting hole **217** is hardened by an ultraviolet ray. Then, a portion of the UV curable polymer layer that is hardened by an ultraviolet ray is removed by a solvent, an organic material or the like. At this point, the polymer is preferably a UV curable polymer.

[0040] The transflective LCD device **213** according to the second preferred embodiment of the present invention has an advantage that light that passes through the lower polarizer **221** and then is reflected on the reflective electrode **215** can return to the back light device (not shown), whereupon a brightness can be as improved as more than 25%. Further, in case that the retardation film **219** formed in the light transmitting hole **217** is employed in a color transflective LCD device, if a thickness of the retardation film **219** varies according to a color of each pixel to meet a waveband of each color or if the retardation film **219** is formed using a liquid crystal having different Δn, the retardation film can be formed that provides light having different color with the same phase difference. Furthermore, a weight and a thickness of the transflective LCD device can be as reduced as separate retardation film.

[0041] **FIG. 9** is a transflective LCD device according to a third preferred embodiment of the present invention. As shown in **FIG. 9**, the transflective LCD device **213** includes lower and upper substrates **223** and **229** with a liquid crystal layer **222** interposed therebetween.

[0042] The lower substrate **223** includes a reflective electrode **215**, first and second lower retardation films **219*a*** and **219*b***, and a lower polarizer. The reflective electrode **215** and the first lower retardation film **219*a*** are sequentially formed on a top surface of the lower substrate **223** and include a light transmitting hole **217** of the same size as each other. The second lower retardation film **219*b*** and the lower polarizer **221** are sequentially formed on a bottom surface of the lower substrate **223**. The upper substrate **229** includes an upper polarizer **225** and an upper retardation film **227**, which are sequentially stacked on its top surface. The upper retardation film **227** may be formed on a bottom surface of the upper substrate **229** other than the top surface of the upper substrate **229**. Even though not shown, the transflective LCD device **213** further includes a back light device.

[0043] The first lower retardation film **219*a*** is formed such a way that a UV curable polymer or a UV curable liquid crystal is coated on the lower substrate **223** and is patterned through a mask process.

[0044] The first lower retardation film **219*a*** has a phase opposite to the second lower retardation film **219*b***. Therefore, a phase of light reflected on the retardation film can not vary, like the second preferred embodiment of the present invention, light reflected on the reflective electrode **215** can direct toward the back light device. The transflective LCD device **213** can have high color purity and high brightness.

[0045] As described herein before, according to the preferred embodiments of the present invention, the reflective LCD having a reduced assembly error and having a high brightness can be manufactured. Further, the transflective LCD device according to the preferred embodiments of the present invention has high color purity and high brightness. Furthermore, the LCD device according to the preferred embodiments of the present invention is light in weight and thin in thickness.

[0046] While the invention has been particularly shown and described with reference to first preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A reflective liquid crystal display device, comprising:

a first substrate having a reflective electrode on a bottom surface thereof;

a second substrate having a polarizer and a retardation film, the polarizer formed on a top surface of the second substrate, the retardation film formed on a bottom surface of the second substrate; and

a liquid crystal layer interposed between the first and second substrates,

wherein the retardation film is made of one of a polymer and a liquid crystal.

2. The device of claim 1, wherein the polymer and the liquid crystal are an UV-curable polymer and an UV curable liquid crystal, respectively.

3. A transflective liquid crystal display, comprising:

a liquid crystal panel including:

a) a first substrate having a first polarizer and a reflective electrode, the first polarizer formed a bottom surface thereof, the reflective electrode having at least one light transmitting hole and a first retardation film, the first retardation film formed in the light transmitting hole, the light transmitting hole transmitting light;

b) a second substrate having a second retardation film and a second polarizer sequentially arranged theron; and

c) a liquid crystal layer interposed between the first and second substrates

a back light device for generating light.

4. A liquid crystal display device, comprising:

a liquid crystal panel including:

a) an upper substrate having an upper polarizer and an upper retardation film sequentially arranged on a top surface thereof;

b) a lower substrate having a reflective electrode and a first lower retardation film sequentially arranged on a top surface thereof and a second lower retardation film and a lower polarizer sequentially arranged on a bottom surface thereof, the reflective electrode and the first lower retardation film having a light transmitting hole, the light transmitting hole transmitting light; and

c) a liquid crystal layer interposed between the upper and lower substrates; and

a back light device providing light to the liquid crystal panel.

5. The liquid crystal display device of claim 4, wherein the first lower retardation film is made of either of a UV curable polymer and a UV curable liquid crystal.

6. A reflective LCD device, comprising:

a reflector;

a first substrate over the reflector;

a liquid crystal layer over the first substrate;

a retardation film over the liquid crystal layer, the retardation film having one of polymer and liquid crystal;

a second substrate over the second substrate; and

a polarizer over the second substrate.

7. A transflective LCD device, comprising:

a first polarizer;

a first substrate over the first polarizer;

a reflector having a transmitting portion over the first substrate;

a retardation layer contacting the reflector;

a liquid crystal layer over the reflector;

a second substrate over the liquid crystal layer;

an upper retardation film positioned over or under the second substrate; and

a second polarizer over the upper retardation film.

8. The device of claim 7, wherein the retardation layer is on the transmitting portion of the reflector.

9. The device of claim 7, wherein the retardation layer has one of UV curable polymer and UV curable liquid crystal.

* * * * *

专利名称(译)	液晶显示装置		
公开(公告)号	US20020021389A1	公开(公告)日	2002-02-21
申请号	US09/735509	申请日	2000-12-14
[标]申请(专利权)人(译)	HA KYOUNG SU MOON JONG WEON		
申请(专利权)人(译)	HA KYOUNG-SU MOON JONG-WEON		
当前申请(专利权)人(译)	HA KYOUNG-SU MOON JONG-WEON		
[标]发明人	HA KYOUNG SU MOON JONG WEON		
发明人	HA, KYOUNG-SU MOON, JONG-WEON		
IPC分类号	G02F1/1335 G02F1/13363		
CPC分类号	G02F1/133555 G02F1/13363 G02F2001/133565 G02F2001/133633 G02F2203/02 G02F2413/03 G02F2413/09		
优先权	1019990067847 1999-12-31 KR		
其他公开文献	US6704078		
外部链接	Espacenet USPTO		

摘要(译)

本发明公开了一种具有延迟膜的液晶显示装置。以这样的方式形成延迟膜，即涂覆UV可固化聚合物和UV可固化液晶中的一种。