



US 20030112391A1

(19) **United States**

(12) **Patent Application Publication**

Jang et al.

(10) **Pub. No.: US 2003/0112391 A1**

(43) **Pub. Date: Jun. 19, 2003**

(54) **TRANSMISSIVE AND REFLECTIVE TYPE  
LIQUID CRYSTAL DISPLAY**

(30) **Foreign Application Priority Data**

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Dec. 18, 2001 (KR) ..... 2001-80714  
Jul. 8, 2002 (KR) ..... 2002-39499

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**Publication Classification**

(51) **Int. Cl.<sup>7</sup>** ..... G02F 1/1335  
(52) **U.S. Cl.** ..... 349/114

(57) **ABSTRACT**

Disclosed is a transmissive and reflective type LCD. In the LCD, a second substrate faces a first substrate. Liquid crystal layer is formed between the first and second substrate. A first polarizing plate is formed on outer surface of the first substrate. A second polarizing plate is formed on outer surface of the second substrate. A backlight is arranged at a rear side of the first polarizing plate. A transparent transflective film is arranged between the first polarizing plate and the backlight and has a plurality of layers where a first and a second layer each having different refractivity indexes are alternatively stacked. The transparent transflective film partially reflects and transmits incident light. By a restoring process occurring between the transflective film and the backlight, a predetermined amount of the incident light is transmitted through the transflective film repeatedly, so that transmissivity and light efficiency are enhanced.

(73) Assignee: **SAMSUNG ELECTRONICS, CO., LTD**

(21) Appl. No.: **10/322,812**

(22) Filed: **Dec. 18, 2002**

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 10/183,143, filed on Jun. 26, 2002.

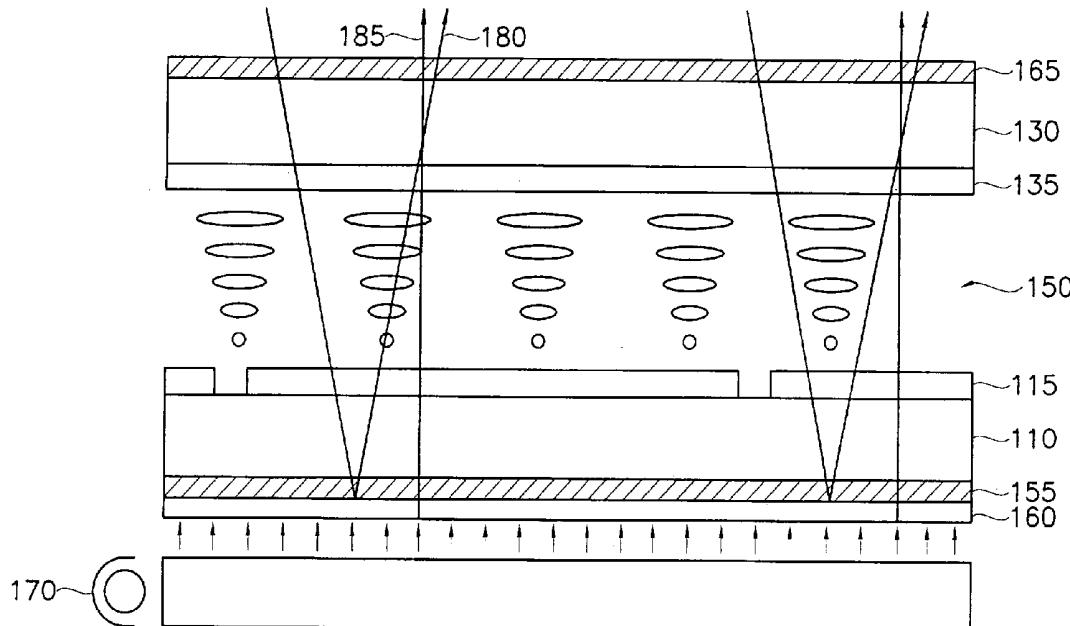


FIG. 1  
(PRIOR ART)

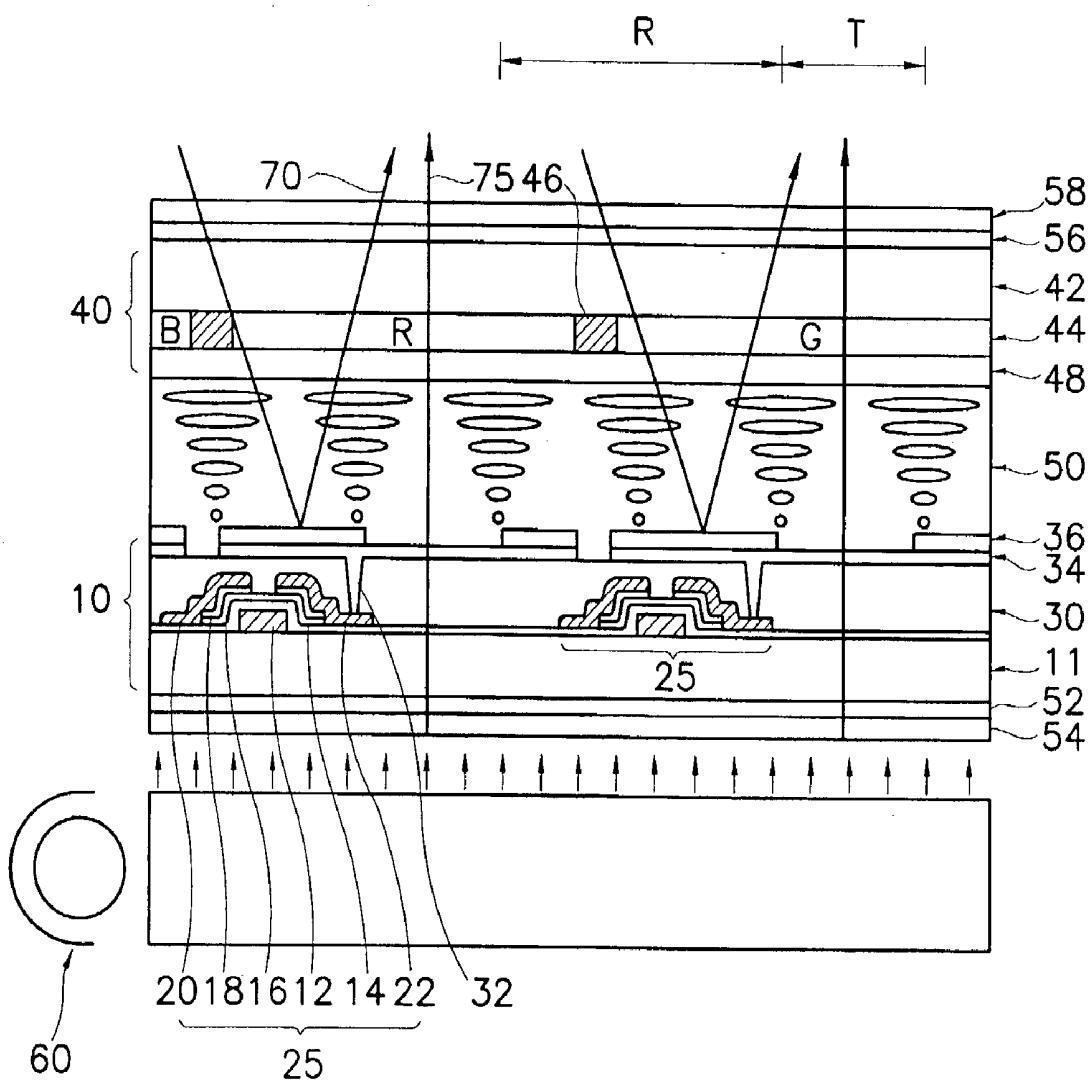


FIG.2A  
(PRIOR ART)

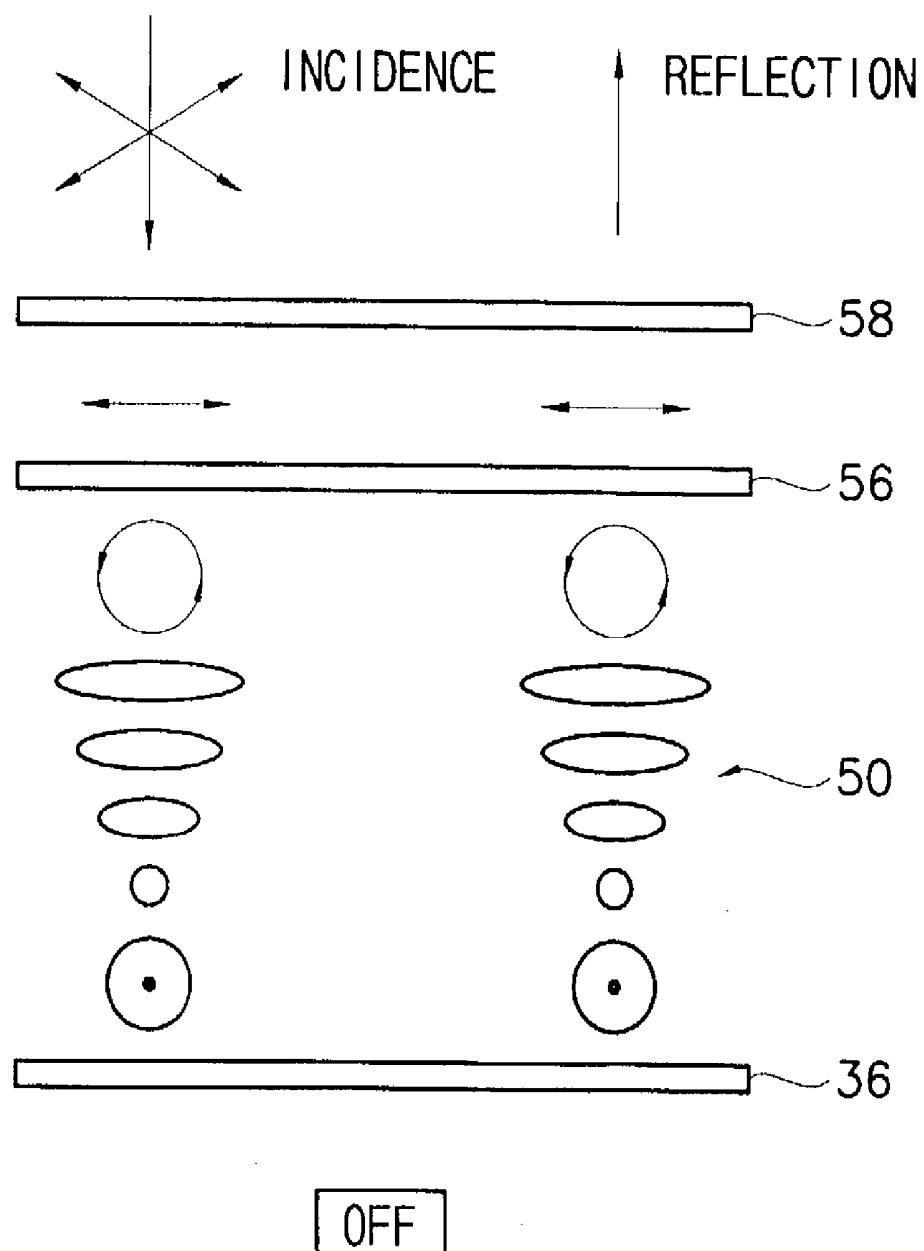


FIG.2B  
(PRIOR ART)

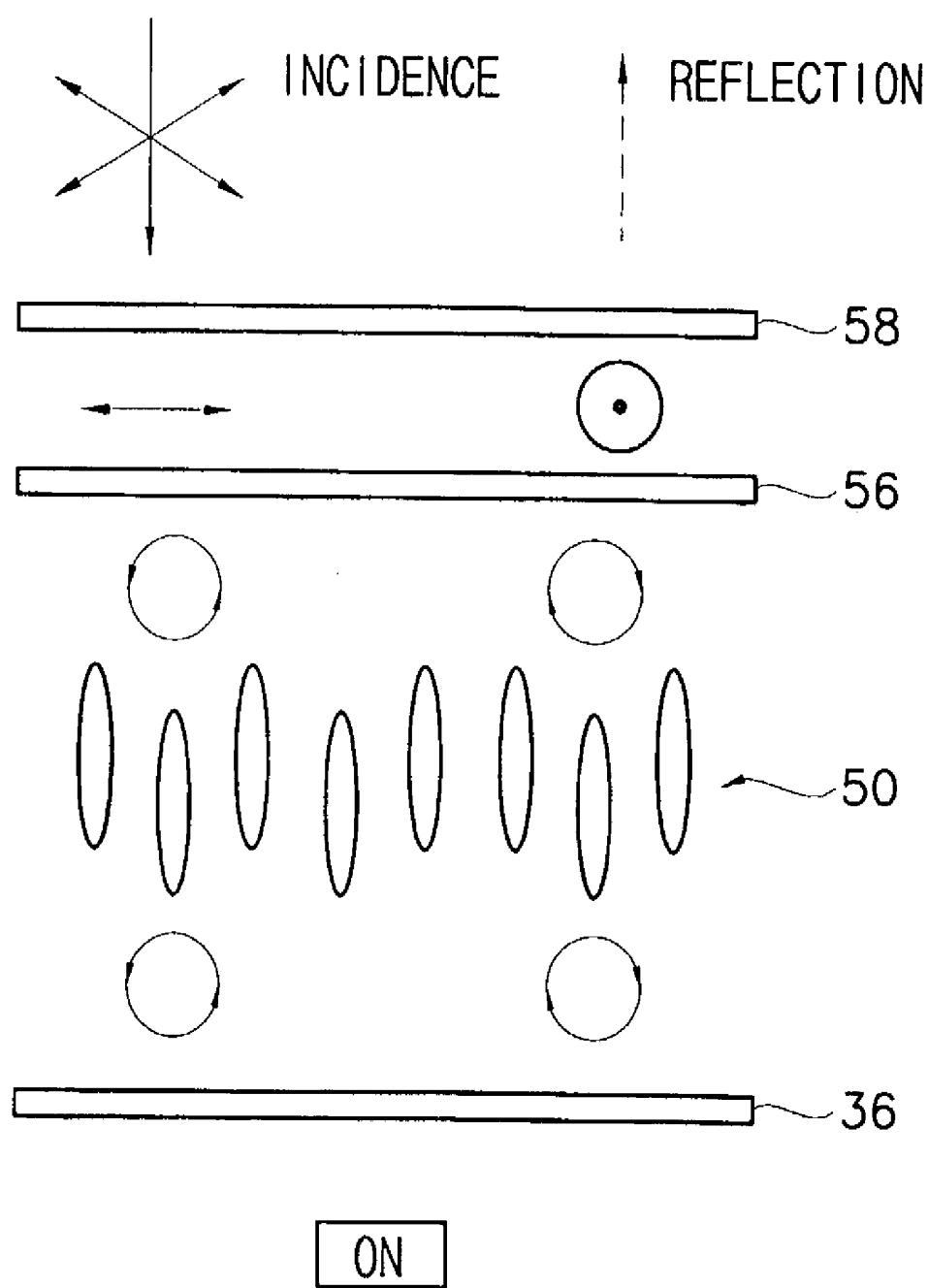


FIG.3A  
(PRIOR ART)

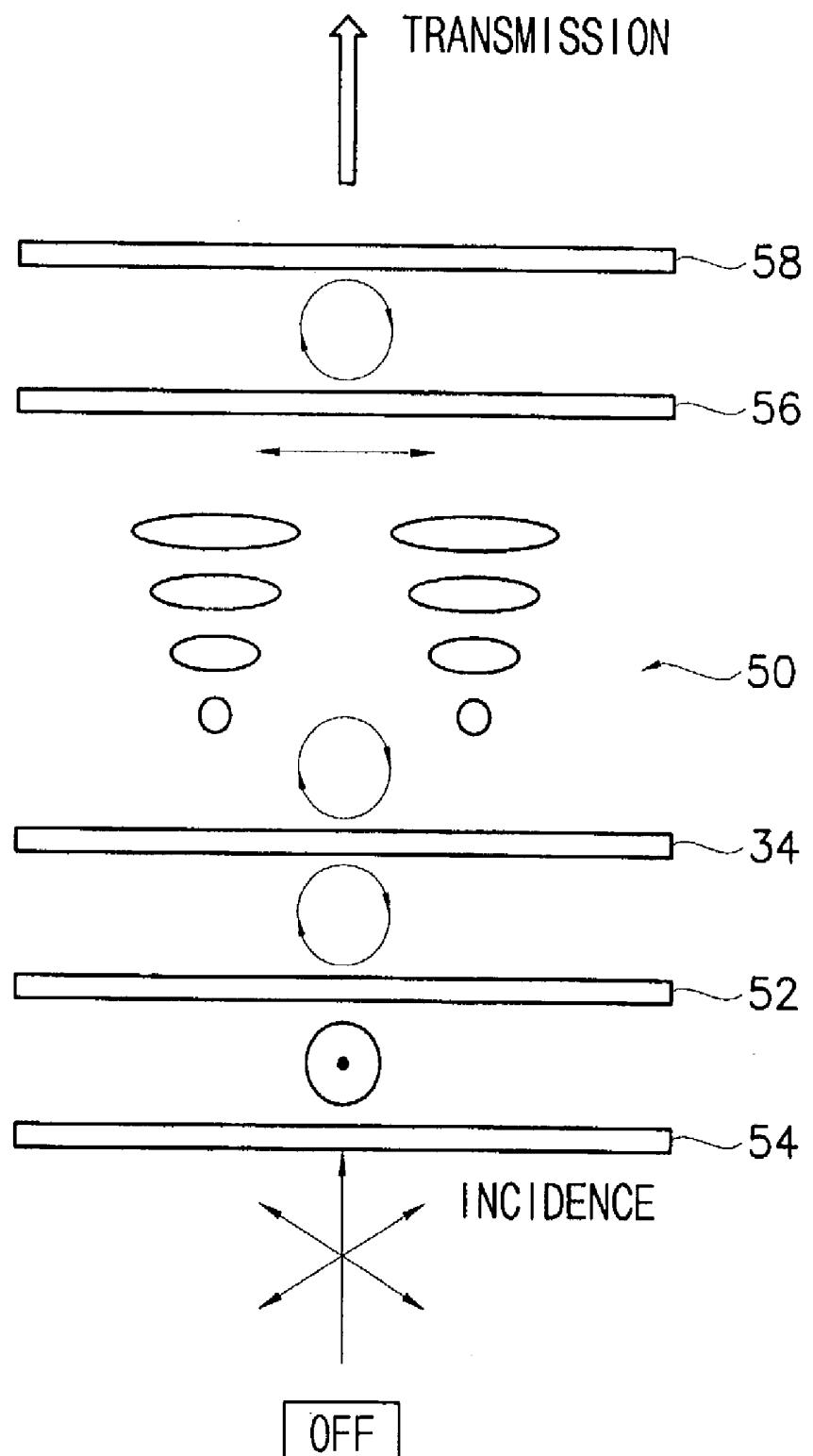


FIG. 3B  
(PRIOR ART)

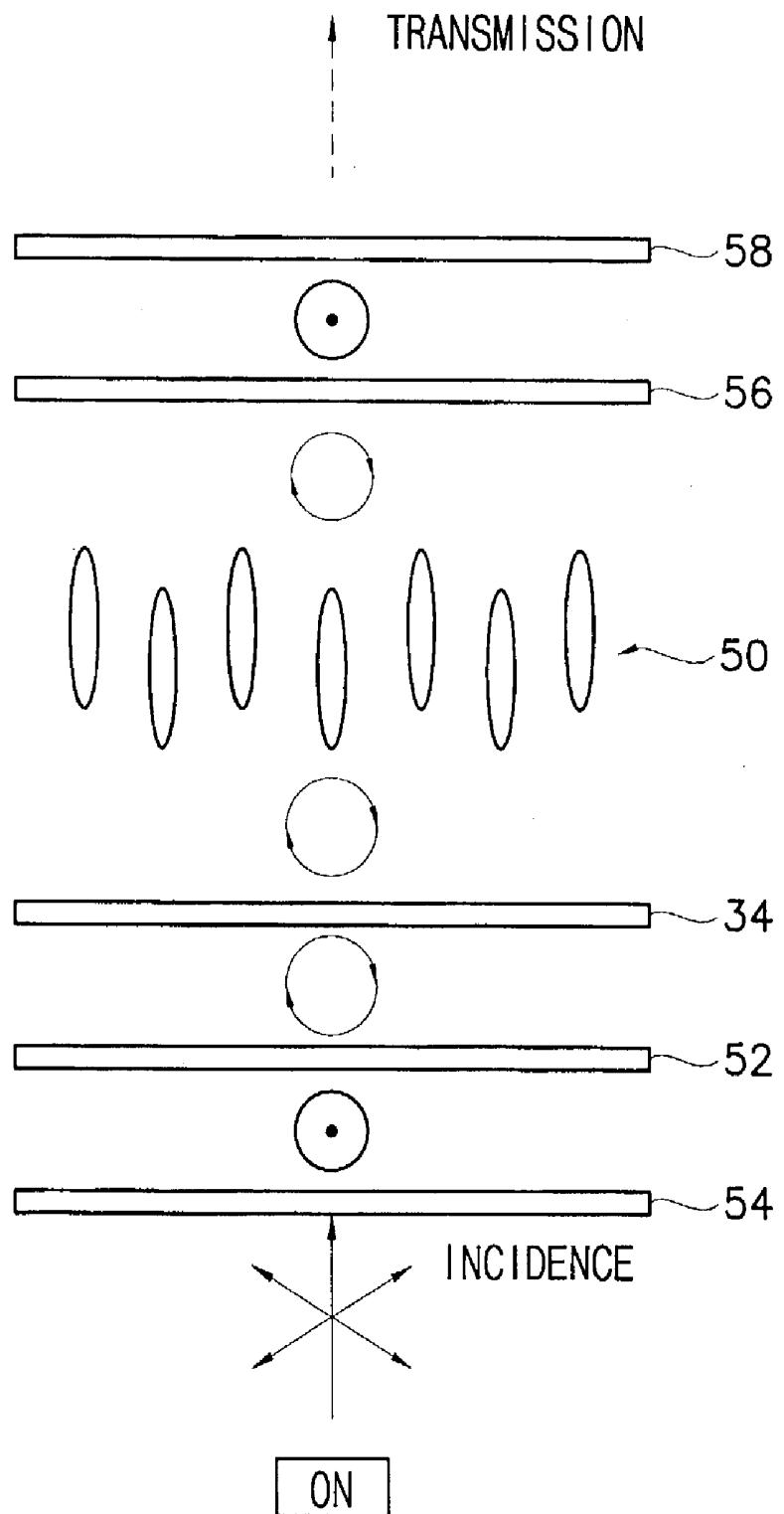


FIG. 4

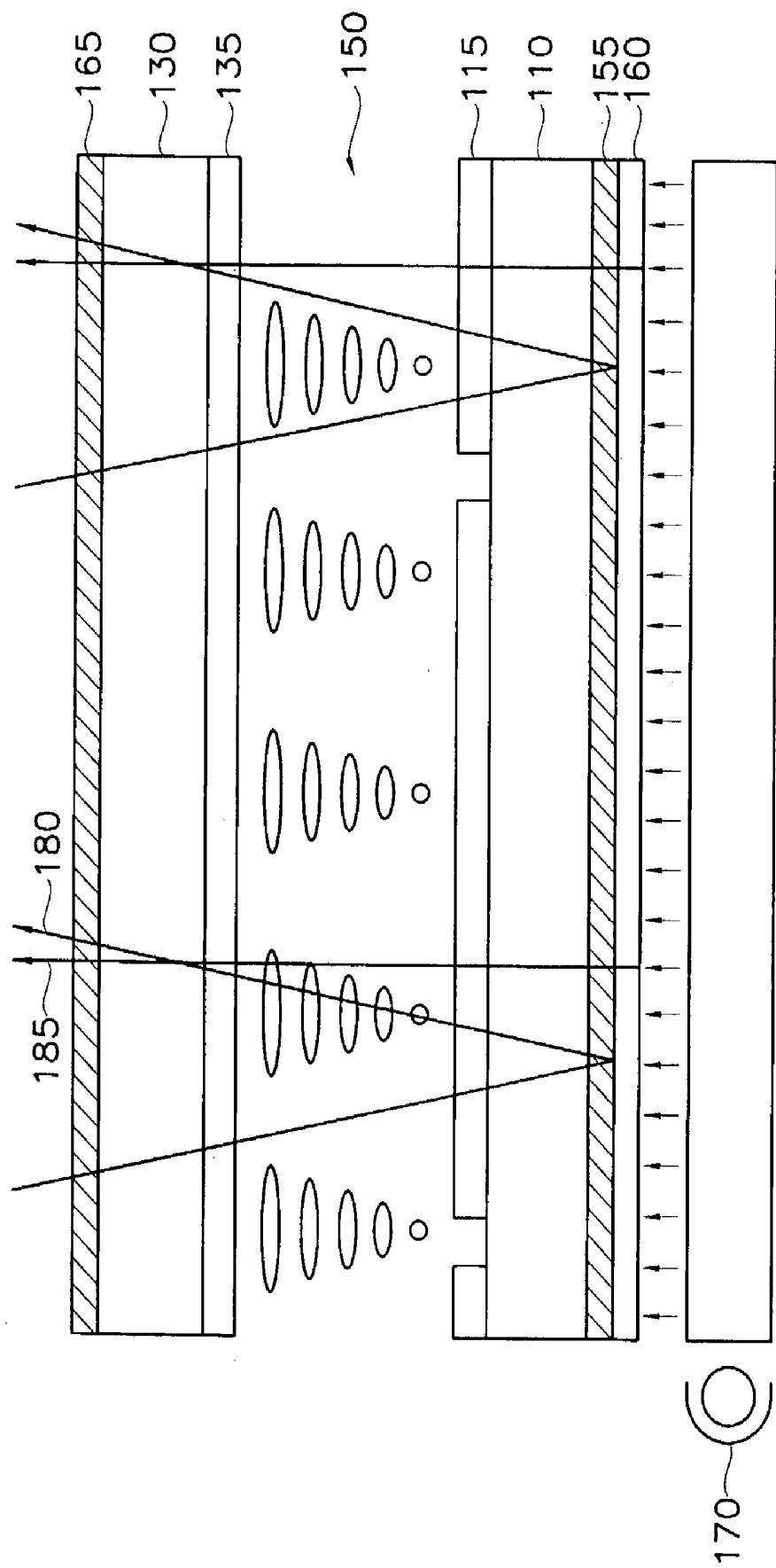


FIG. 5

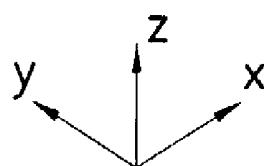
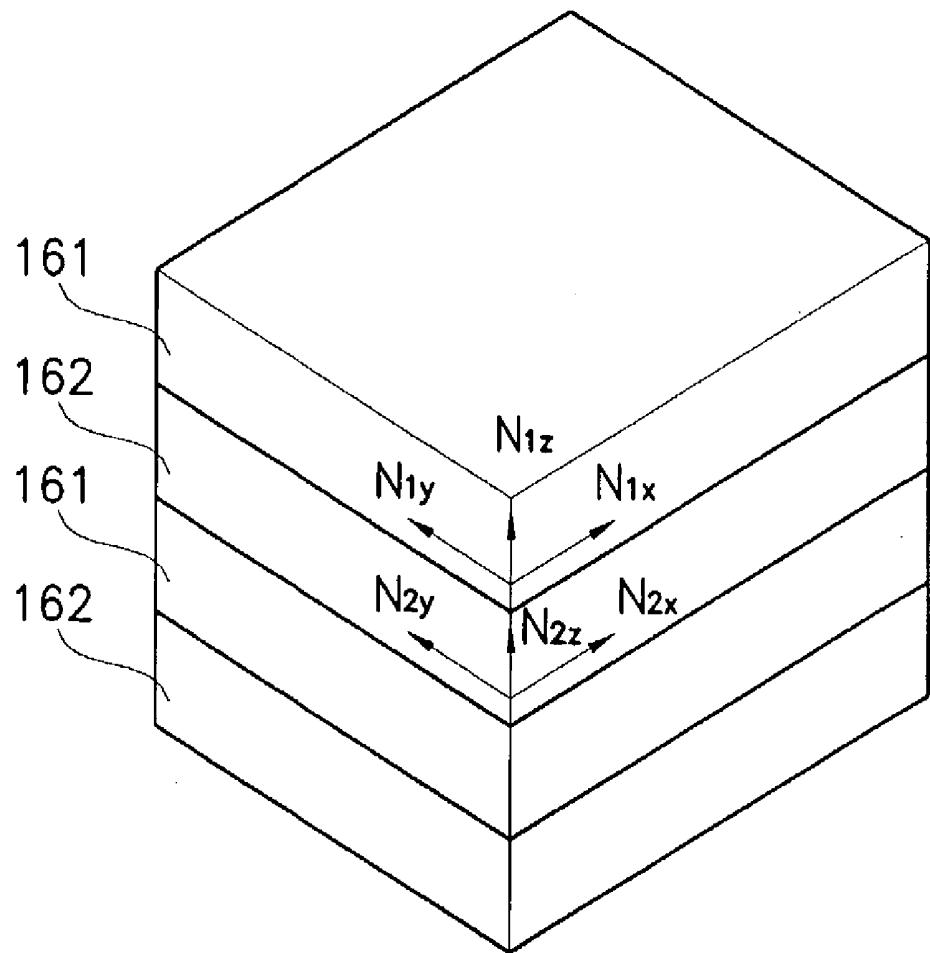


FIG.6A

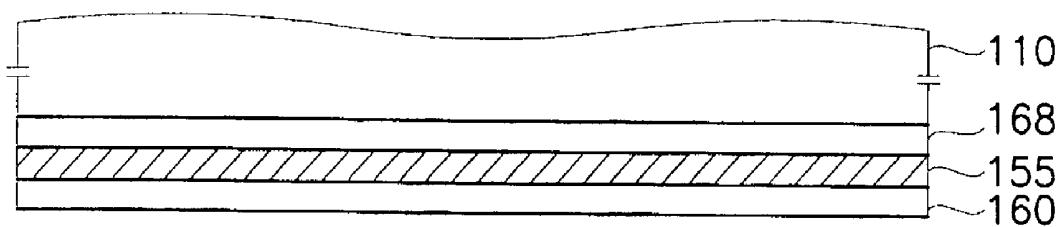


FIG.6B

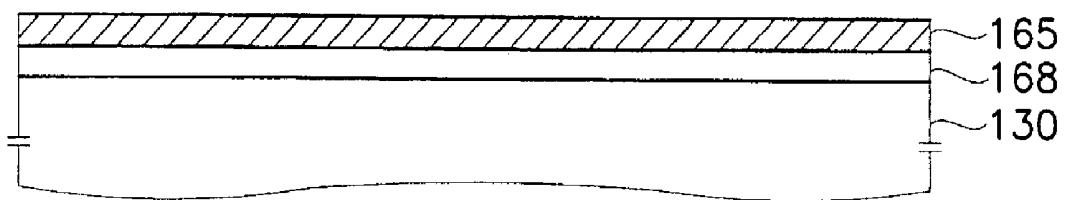
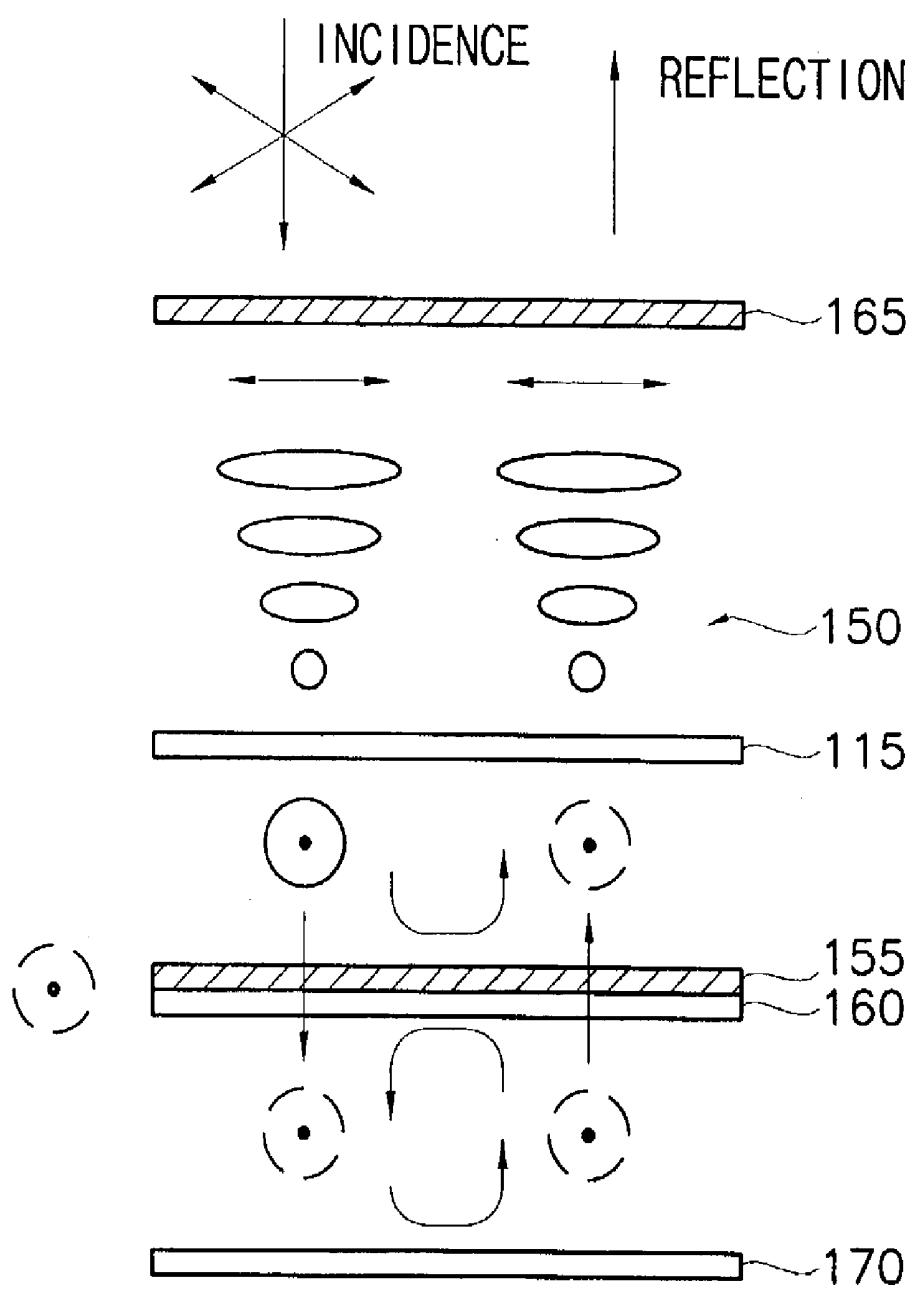


FIG. 7A



OFF

FIG. 7B

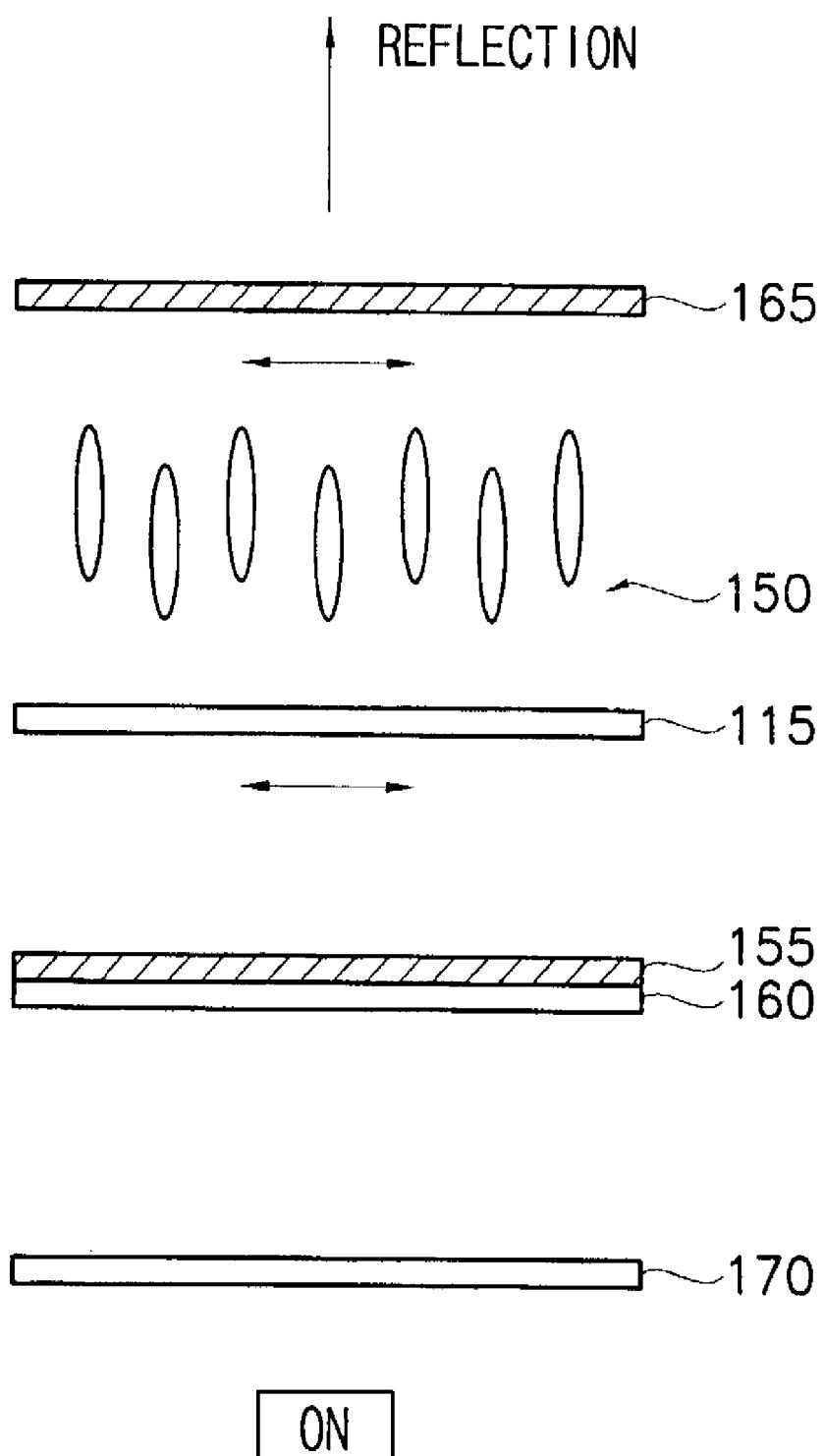


FIG.8A

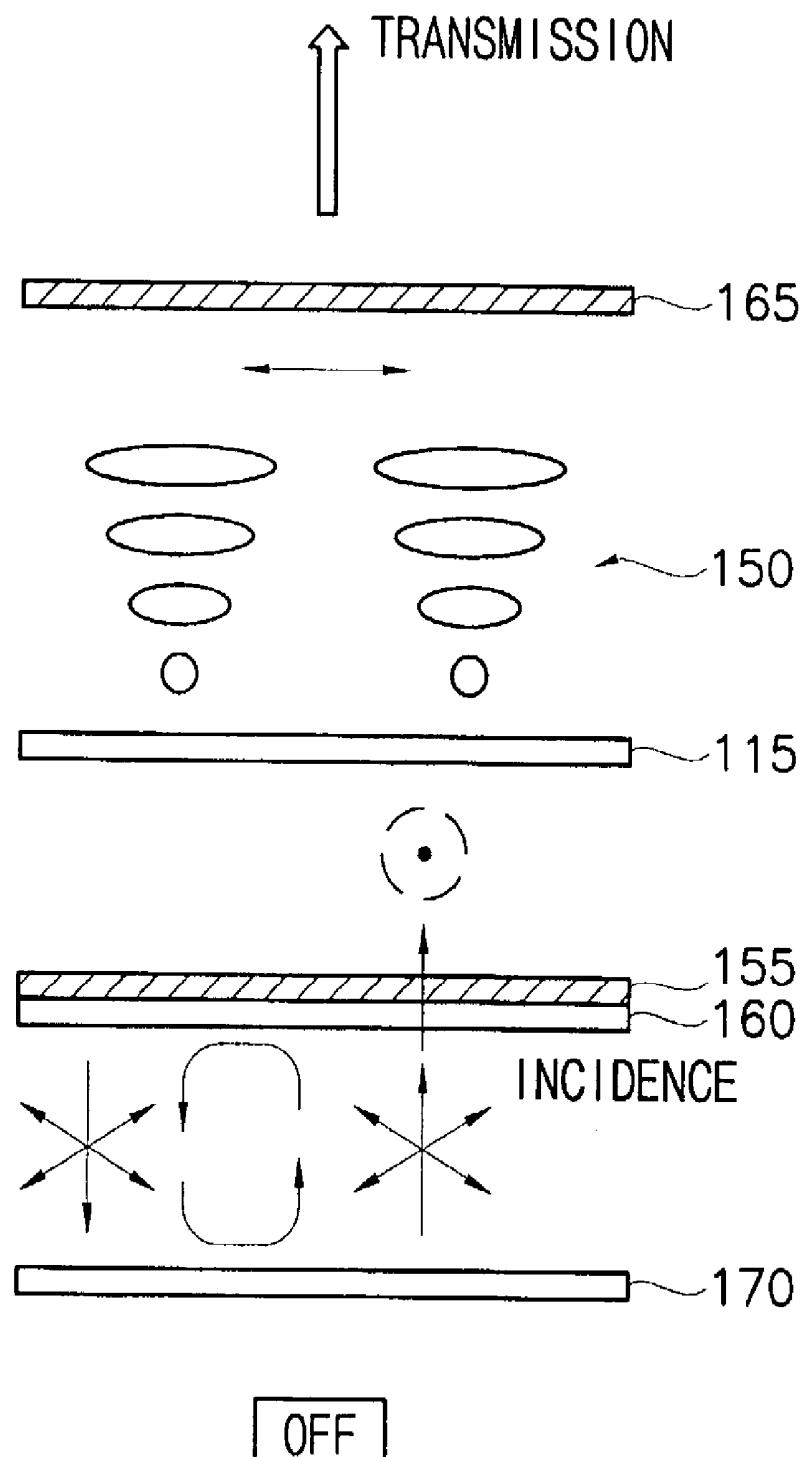
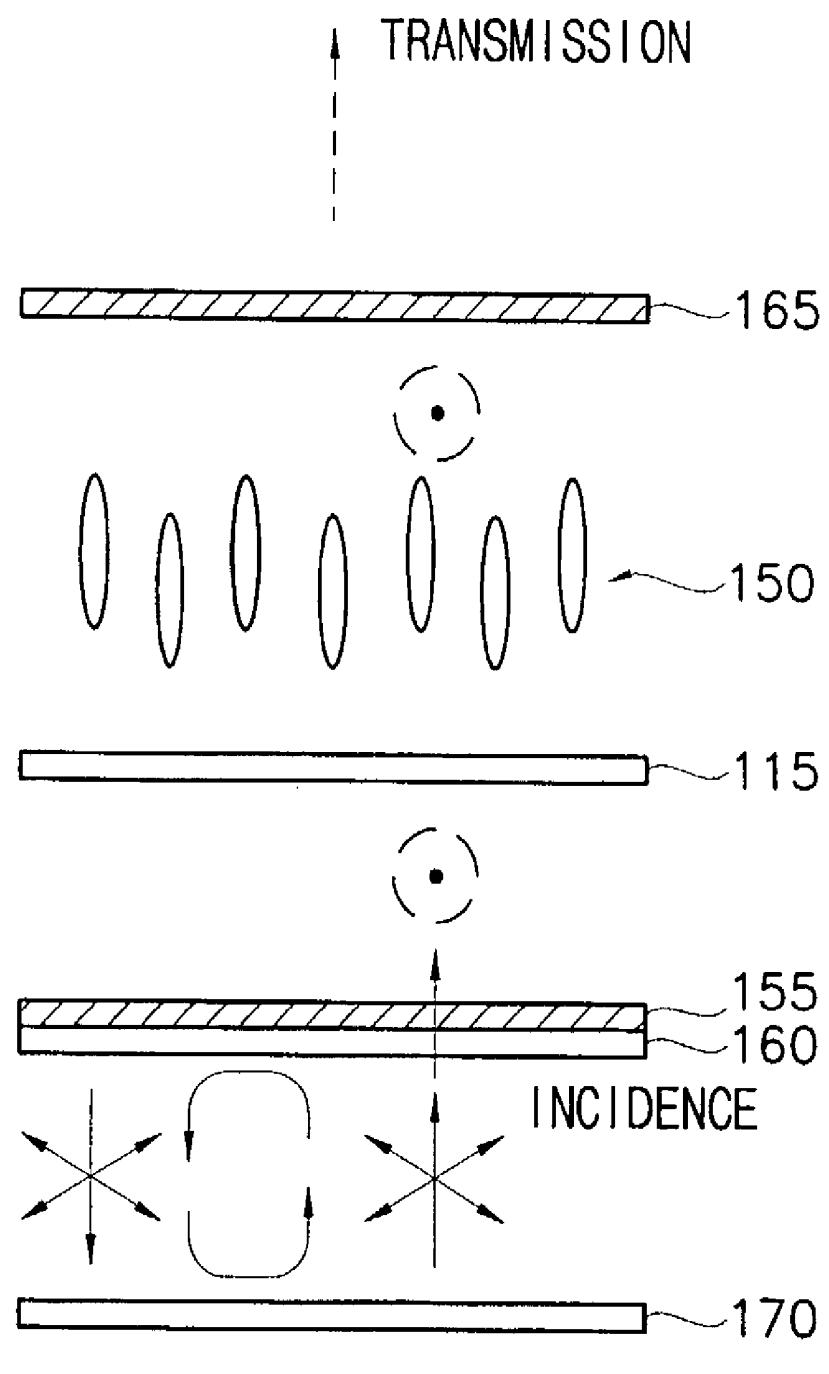


FIG. 8B



ON

FIG.9A

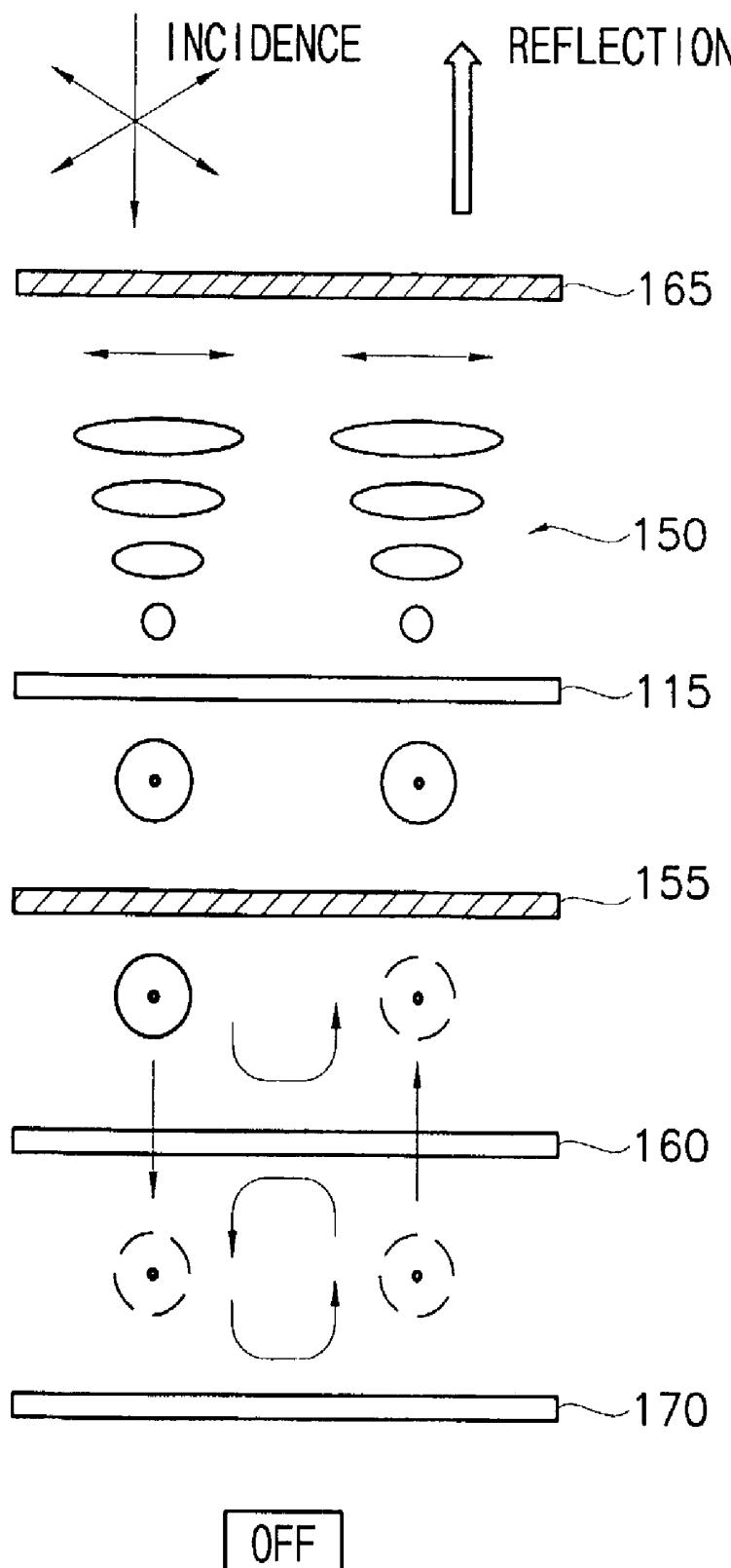


FIG. 9B

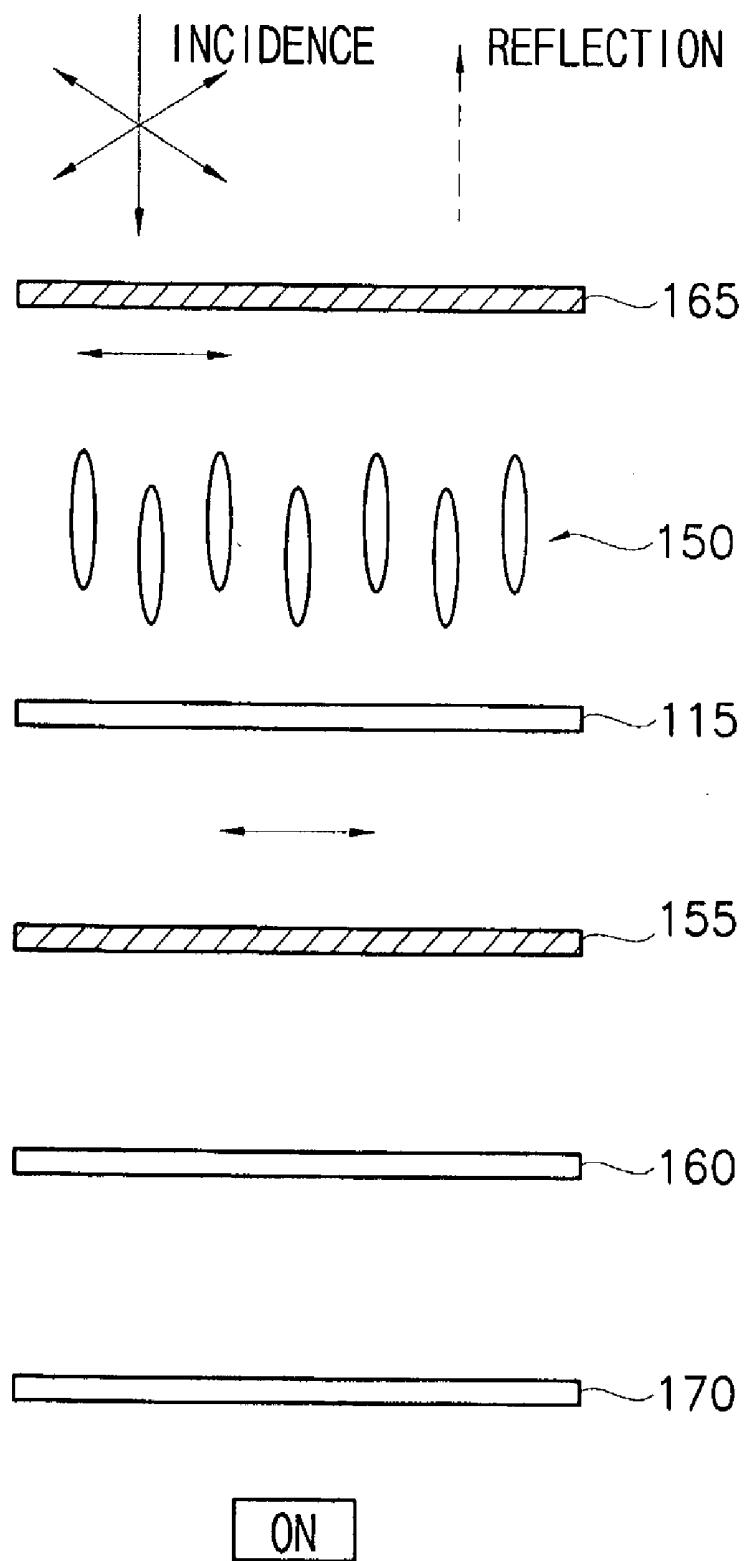


FIG. 10A

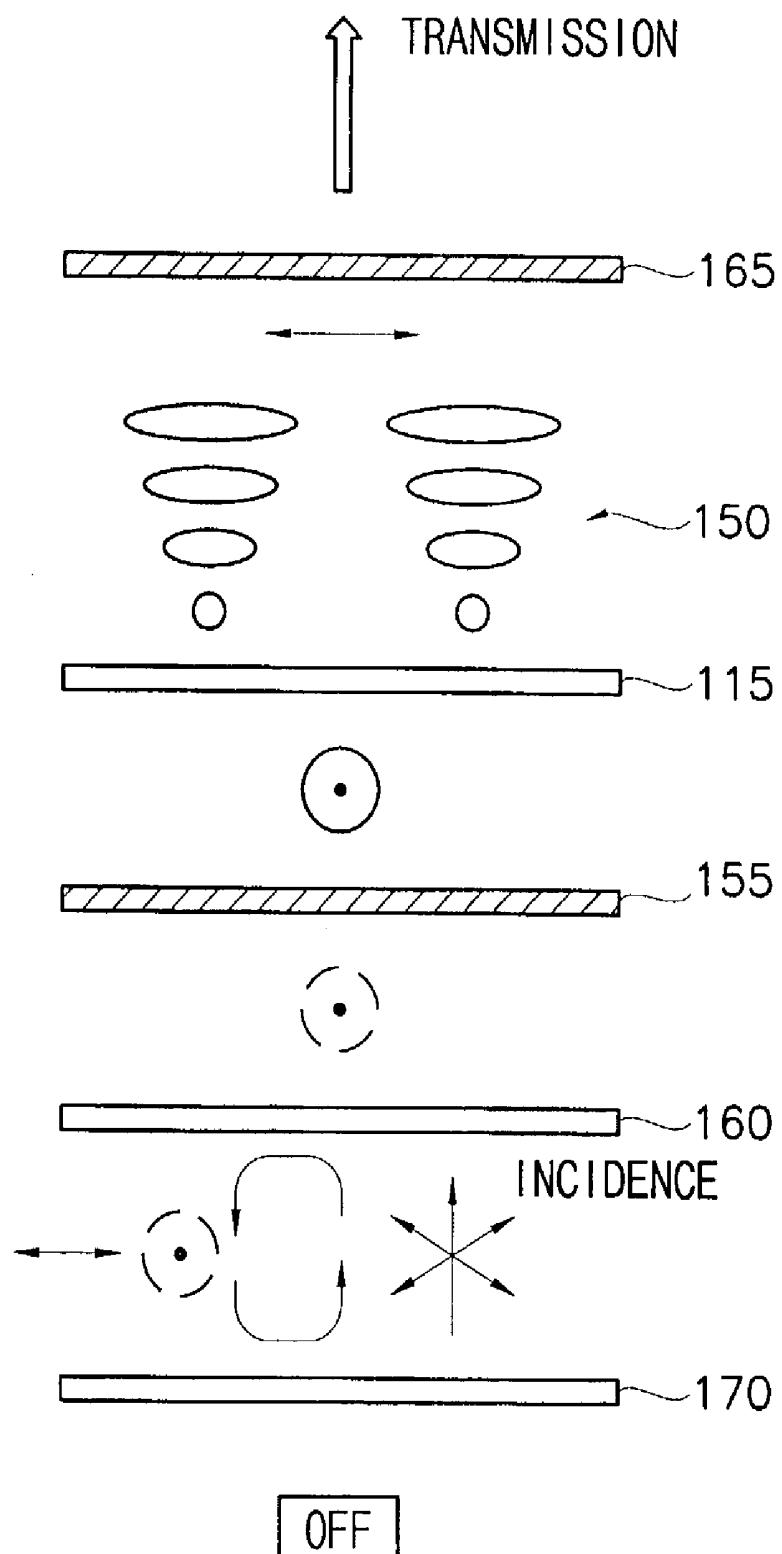


FIG.10B

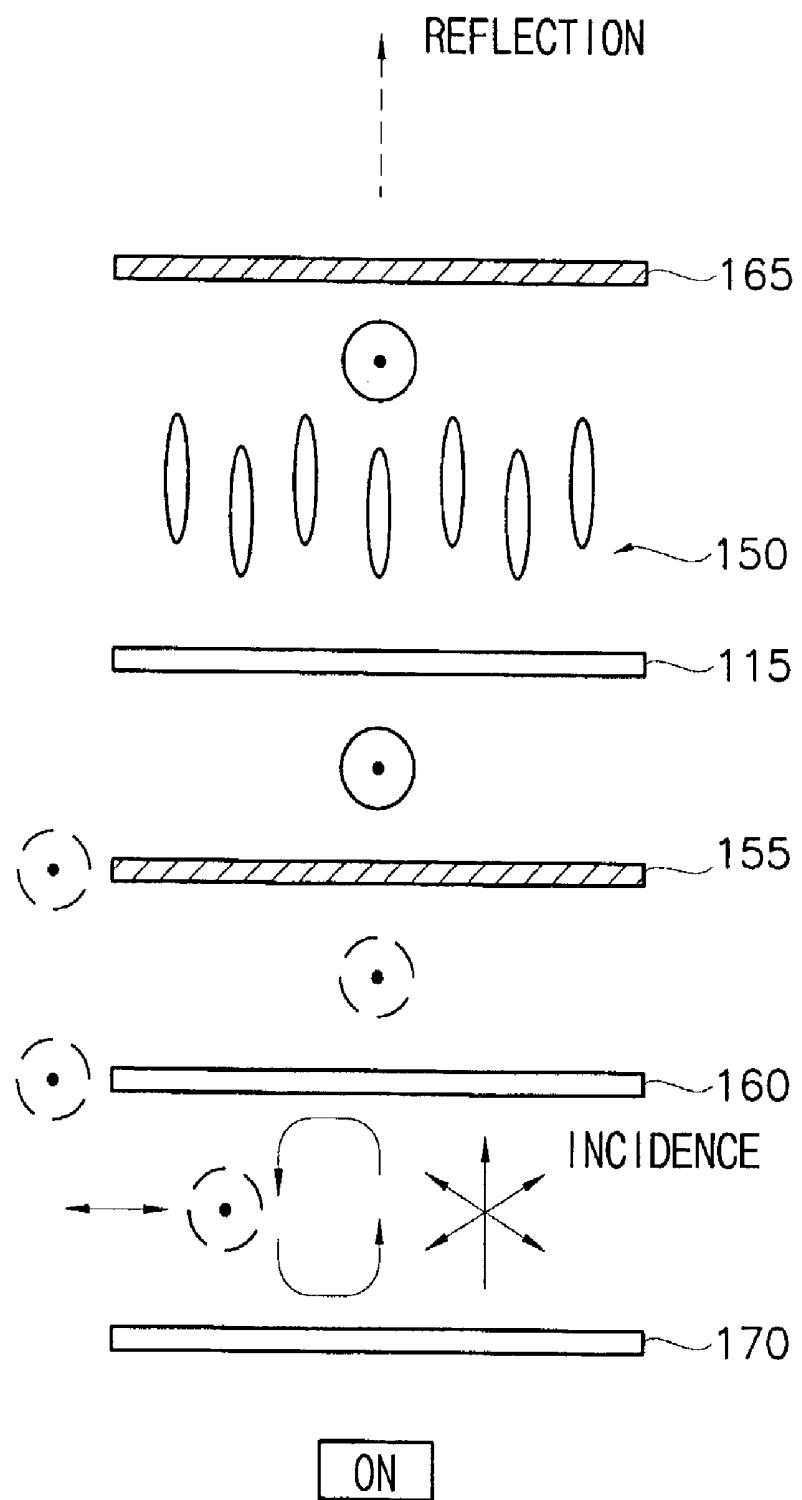


FIG. 11

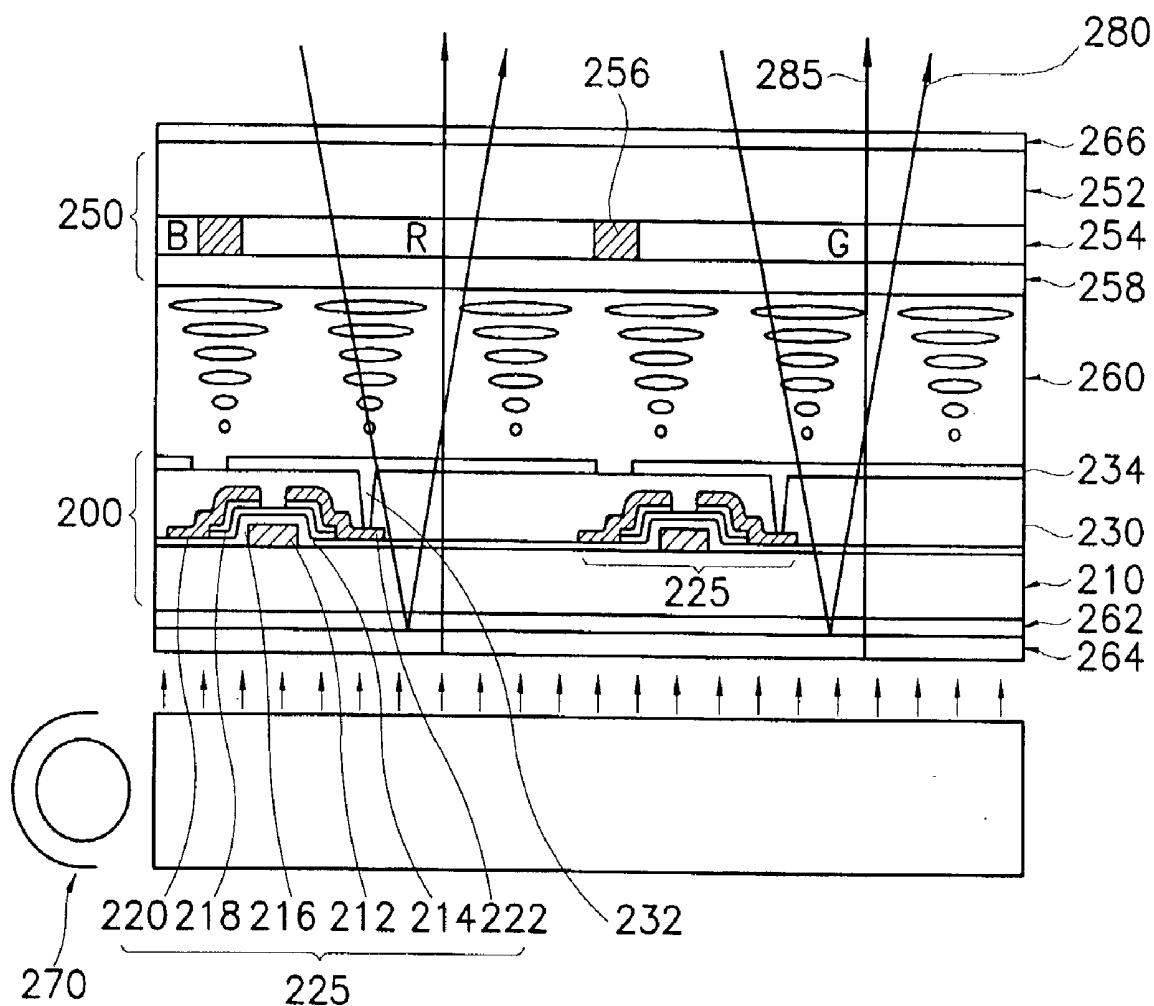


FIG.12

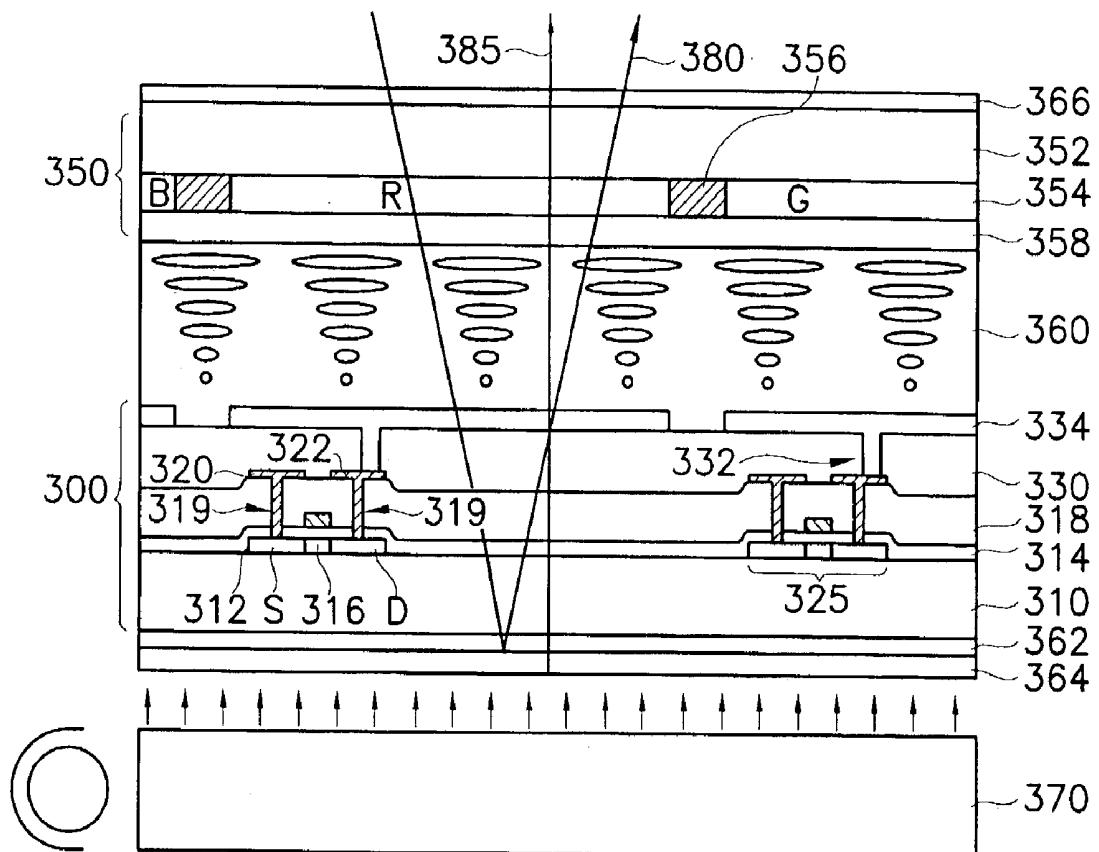


FIG.13

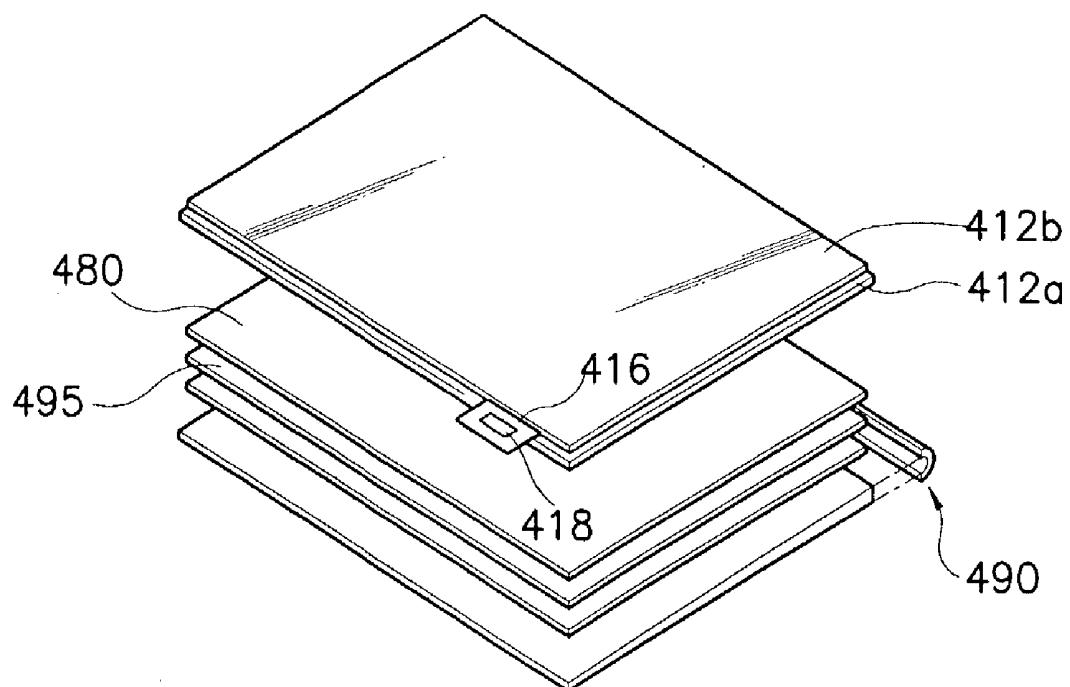
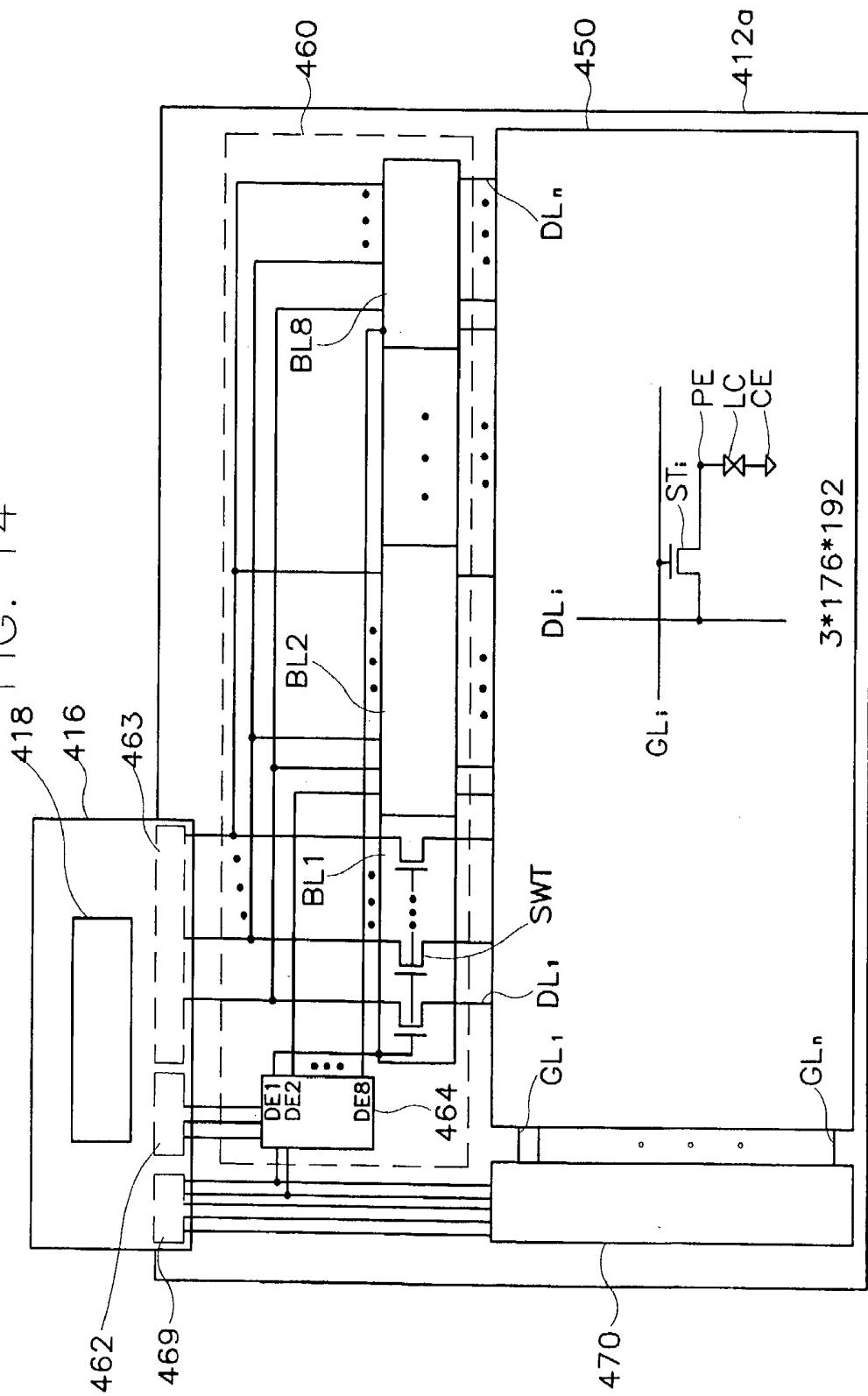


FIG. 14



## TRANSMISSIVE AND REFLECTIVE TYPE LIQUID CRYSTAL DISPLAY

### CROSS-REFERENCE OF RELATED APPLICATIONS

[0001] This application is a Continuation-in-part application of "TRANSMISSIVE AND REFLECTIVE TYPE LIQUID CRYSTAL DISPLAY", by the present inventor, Serial No. 10/183,143, filed on Jun. 26, 2002, the contents of which are herein incorporated by reference in their entirety. The application also relies for priority upon Korean Patent Application No.2001-80714 filed on Dec. 18, 2001 and Korean Patent Application No.2002-39499 filed on Jul. 8, 2002, the contents of which are herein incorporated by reference in their entirety.

### BACKGROUND OF THE INVENTION

#### [0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display, and more particularly, to a transmissive and reflective type liquid crystal display in which the display operation is carried out in a reflection mode of a low power consumption at a bright place where a light amount is abundant and the display operation is also carried out in a transmission mode of a high luminance at a dark place where a light amount is deficient.

#### [0004] 2. Description of the Related Art

[0005] In an information-oriented society these days, the role of an electronic display is getting more important. All kinds of electronic displays are widely used in various industrial fields.

[0006] Generally, the electronic display is an apparatus for visually providing a variety of information to a person. In other words, an electrical information signal output from various electronic devices is converted into a visually recognizable optical information signal at the electronic display. Therefore, the electronic display serves as a bridge for connecting the person and the electronic devices.

[0007] Electronic display is classified into an emissive display in which the optical information signal is displayed by a light-emitting way, and a non-emissive display in which the optical information signal is displayed by an optical modulation way such as light-reflecting, dispersing and interfering phenomenon, etc. As the emissive display called an active display, for example, there are a CRT (Cathode Ray Tube), a PDP (Plasma Display Panel), an LED (Light Emitting Diode) and an ELD (Electroluminescent Display), etc. As the non-emissive display as a passive display, there are an LCD (Liquid Crystal Display), an ECD (Electrochemical Display) and an EPID (Electrophoretic Image Display), etc.

[0008] The CRT used in an image display such as a television receiver and a monitor, etc., has the highest market share in an aspect of displaying quality and economical efficiency, but also has many disadvantages such as heavy weight, large volume and high power consumption.

[0009] Meanwhile, due to rapid development of a semiconductor technology, various kinds of electronic devices are driven by lower voltage and lower power, and thus the electronic equipments became much slimmer and lighter.

Therefore, a flat panel type display having the slimmer and lighter characteristic as well as the lower driving voltage and lower power consumption characteristic is required according to the new environment.

[0010] The LCD among the various developed flat panel type displays is much slimmer and lighter than any other displays, and has the lower driving voltage and the lower power consumption, and also has the displaying quality similar to that of the CRT. Therefore, the LCD is widely used in various electronic equipments.

[0011] The LCD is classified into a transmission type LCD for displaying an image using an external light source such as a backlight assembly, a reflection type LCD for displaying an image using natural light, and a transmissive and reflective type LCD in which the display operates in a transmission mode using an internal light source provided in the display itself at indoors or a dark place where an external light source does not exist and the display operates in a reflection mode to display an image by reflecting an external incident light at a high brightness environment of outdoors.

[0012] Also, the LCD controls to align liquid crystal molecules using a voltage applied to the liquid crystal layer, and can be classified depending on the driving way thereof into a passive matrix type and an active matrix type. In the passive matrix type, pixels are driven using a root-mean-square (rms) of a difference between voltages applied to signal lines and scanning lines while a line addressing in which a signal voltage is applied to all of the pixels at the same time is carried out. In the active matrix type, pixels are driven by a switching element such as a **MIN** (Metal-insulator-metal) device or a thin film transistor.

[0013] FIG. 1 is a sectional view of a conventional transmissive and reflective type LCD, and shows an active matrix type LCD using the thin film transistor.

[0014] Referring to FIG. 1, a conventional transmissive and reflective type LCD includes a first substrate **10**, a second substrate **40** arranged facing the first substrate **10**, a liquid crystal layer **50** formed between the first substrate **10** and the second substrate **40**, and a light source, i.e., a backlight assembly disposed at a rear side of the first substrate **10**.

[0015] The first substrate **10** comprises a first insulating substrate **11**, a thin film transistor **25** formed on the first insulating substrate **11**, a passivation film **30** having a contact hole **32** for exposing a part of the thin film transistor **25**, a transparent electrode **34**, and a reflection electrode **36**. The thin film transistor **25** comprises a gate electrode **12**, a gate insulating film **14**, an active pattern **16**, an ohmic contact pattern **18**, a source electrode **20** and a drain electrode **22**. The transparent electrode **34** functions as a pixel electrode for transmitting a light that is generated from the backlight **60** and is then incident through the first substrate **10**. The transparent electrode **34** is connected to the thin film transistor **25** formed on every unit pixel region on the first substrate **10**. The reflection electrode **36** reflects the light that is incident through the second substrate **40** and at the same time functions as the pixel electrode. In other words, regions where the transparent electrodes **34** exist are a transmission part (T), portions other than the transmission part (T) are a reflection part (R) for reflecting an external light that is incident through the second substrate **40**.

[0016] The second substrate **40** comprises a second insulating substrate **42**, a color filter **44** comprised of RGB pixels for displaying colors while a light is transmitted therethrough, a black matrix **46** for preventing a light from being leaked between the pixels, and a transparent common electrode **48**.

[0017] The liquid crystal layer **50** is made of 90° twisted nematic liquid crystal, and has an approximately 0.24 of  $\Delta n d$  which is a product of anisotropy  $\Delta n$  in refractive index and thickness  $d$  of the liquid crystal layer.

[0018] Also, according to an alignment direction of the liquid crystal molecules, a first polarizing plate **54** and a second polarizing plate **58** are respectively attached to external surfaces of the first and second substrates **10** and **40** so as to transmit only a light vibrating in a specific direction. The first and second polarizing plates **54** and **58** are all linear polarizer in which each polarizing axe of the first and second polarizing plates **54** and **58** are normal to each other.

[0019] Between the first substrate **10** and the first polarizing plate **54**, and between the second substrate **40** and the second polarizing plate **58**, there are respectively arranged a first  $\frac{1}{4}$  wavelength phase difference plate **52** and a second  $\frac{1}{4}$  wavelength phase difference plate **56**. Each of the  $\frac{1}{4}$  wavelength phase difference plates **52** and **56** functions to convert a linearly polarized light to a circularly polarized light, or vice versa by causing a phase difference of  $\frac{1}{4}$  wavelength between two polarization components that are normal to each other and are parallel to optical axes of the  $\frac{1}{4}$  wavelength phase difference plates **52** and **56**.

[0020] Hereinafter, there are respectively described operation principles in the reflection mode and the transmission mode in the conventional transmissive and reflective type LCD shown in FIG. 1.

[0021] FIGS. 2A and 2B are schematic views for illustrating an operation principle of the conventional LCD in the reflection mode.

[0022] First, when a pixel voltage is not applied (OFF), as shown in FIG. 2A, a light that is incident from an outside is transmitted through the second polarizing plate **58**, so that the light is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate **58**. The linearly polarized light is transmitted through the second  $\frac{1}{4}$  wavelength phase difference plate **56**, so that the linearly polarized light is converted into a left-handed circularly polarized light. The left-handed circularly polarized light is transmitted through the liquid crystal layer **50**, so that the left-handed circularly polarized light is linearly polarized in a direction vertical to the polarizing axis of the second polarizing plate **58**, and is then incident into the reflection electrode **36**. The linearly polarized light, which is reflected by the reflection electrode **36**, is transmitted through the liquid crystal layer **50**, so that the linearly polarized light is converted into the left-handed circularly polarized light. The left-handed circularly polarized light is transmitted through the second  $\frac{1}{4}$  wavelength phase difference plate **56**, so that the left-handed circularly polarized light is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate **58**. And then, the linearly polarized light is transmitted through the second polarizing plate **58**, so that a white image is displayed.

[0023] When a maximum pixel voltage is applied (ON), as shown in FIG. 2B, a light that is incident from an outside is

transmitted through the second polarizing plate **58**, so that it is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate **58**. The linearly polarized light is transmitted through the second  $\frac{1}{4}$  wavelength phase difference plate **56**, so that it is converted into a left-handed circularly polarized light. The left-handed circularly polarized light is transmitted through the liquid crystal layer **50** without a variation in the polarization state, and is then incident into the reflection electrode **36**. The light, which is incident into the reflection electrode **36**, is reflected by the reflection electrode **36**, so that it is converted into a right-handed circularly polarized light and the converted right-handed circularly polarized light is transmitted through the liquid crystal layer **50**. Thus, the right-handed circularly polarized light, which has been passed through the liquid crystal layer **50**, is transmitted through the second  $\frac{1}{4}$  wavelength phase difference plate **56**, so that it is linearly polarized in a direction perpendicular to the polarizing axis of the second polarizing plate **58**. The linearly polarized light is shielded by the second polarizing plate **58**, so that a black image is displayed.

[0024] FIGS. 3A and 3B are schematic views for illustrating an operation mechanism of the transmission mode.

[0025] When a pixel voltage is not applied (OFF), as shown in FIG. 3A, a light that is irradiated from a backlight disposed below the first polarizing plate **54** is incident into the first polarizing plate **54**, and only a light vibrating in a direction parallel to the polarizing axis of the first polarizing plate **54** is transmitted through the first polarizing plate **54**. At this time, since the polarizing axis of the first polarizing plate **54** is perpendicular to that of the second polarizing plate **58**, the light that has been passed through the first polarizing plate **54** is converted into a light linearly polarized in a direction perpendicular to the polarizing axis of the second polarizing plate **58**. The linearly polarized light is converted into a right-handed circularly polarized light by a first  $\frac{1}{4}$ -wavelength phase difference plate **52**. The right-handed circularly polarized light is transmitted through a transparent electrode **34**, and is then incident into a liquid crystal layer **50**. The right-handed circularly polarized light is transmitted through the liquid crystal layer **50**, so that it is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate **58**. The linearly polarized light is transmitted through a second  $\frac{1}{4}$ -wavelength phase difference plate **56**, so that it is converted into the right-handed circularly polarized light. At this time, since only a component vibrating in a direction parallel to the polarizing axis of the second polarizing plate **58** can be transmitted through the second polarizing plate **58**, only 50% of the right-handed circularly polarized light is transmitted through the second polarizing plate **58**. Accordingly, a light loss of 50% is generated, so that an image having a middle brightness is displayed.

[0026] Meanwhile, although not shown in the drawings, an optical path of the incident light becomes different at a region where a metal layer, such as the gate line, the data line, or the reflection electrode exists in the transmission mode. In other words, a light that is incident from the backlight is transmitted through the first polarizing plate **54**, so that it is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **54**. The linearly polarized light is transmitted through the first  $\frac{1}{4}$  wavelength phase difference plate **52**, so that it is right-handed circularly

polarized. The right-handed circularly polarized light is reflected by above illustrated metal layers, so that it is left-handed circularly polarized. Then, the left-handed circularly polarized light is transmitted through the first  $\frac{1}{4}$  wavelength phase difference plate 52, so that it is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate 54. Accordingly, the linearly polarized light is absorbed in the first polarizing plate 54, and does not return to the backlight. Thus, the light reflected by the metal layers is not reproduced and disappears, so that an overall light efficiency is lowered.

[0027] When a maximum pixel voltage is applied (ON), as shown in FIG. 3B, a light that is irradiated from a backlight disposed below the first polarizing plate 54 is incident into the first polarizing plate 54, so that only a light vibrating in a direction parallel to the polarizing axis of the first polarizing plate 54 is transmitted through the first polarizing plate 54. The light linearly polarized by the first polarizing plate 54 is converted into a right-handed circularly polarized light after being transmitted through the first  $\frac{1}{4}$  wavelength phase difference plate 52. The right-handed circularly polarized light is transmitted through the transparent electrode 34, and is then incident into the liquid crystal layer 50. The right-handed circularly polarized light is transmitted through the liquid crystal layer 50 without a variation in the polarization state, and is linearly polarized in a direction normal to the polarizing axis of the second polarizing plate 58 after being transmitted through the second  $\frac{1}{4}$  wavelength phase difference plate 56. Afterwards, the light linearly polarized in the direction normal to the polarizing axis of the second polarizing plate 58 is not transmitted the second polarizing plate 58, so that a dark image is displayed.

[0028] As described above, since the conventional transmissive and reflective type LCD has to be provided with the wide band  $\frac{1}{4}$  wavelength phase difference plates 52 and 56 covering an overall frequency band of the visible ray, as well as the first and second polarizing plates 54 and 58 with respect to each of the first and second substrates 10 and 40, a manufacturing cost is elevated compared with the transmission type LCD. Also, since the polarization characteristic in the transmission mode causes a light loss of 50%, there are drawbacks in that a light transmissivity decreases by 50% and a contrast ratio (C/R) is lowered.

[0029] Further, since  $\Delta n$  of the liquid crystal layer 50 is only  $0.24 \mu\text{m}$  which is a half of  $\Delta n$  ( $0.48 \mu\text{m}$ ) of the conventional transmission type LCD, the cell gap of the liquid crystal cell should be decreased to a level of  $3 \mu\text{m}$ , and the refractive anisotropy  $\Delta n$  of the liquid crystal also should be decreased. Accordingly, there are problems in that the manufacturing process becomes difficult and degeneration in the reliability of the liquid crystal is caused.

#### SUMMARY OF THE INVENTION

[0030] Accordingly, the present invention is to solve the aforementioned problems of the conventional art, and it is an object of the present invention to provide a transmissive and reflective type LCD capable of simplifying a structure of a liquid crystal cell and decreasing light loss in the transmission mode.

[0031] In one aspect, there is provided a transmissive and reflective type LCD comprising a first substrate, a second substrate, a liquid crystal layer, a first polarizing plate, a

second polarizing plate, a backlight, and a transparent transreflective film. In the transmissive and reflective type LCD, the second substrate has an inner surface that is arranged so as to face the first substrate, and the liquid crystal layer is formed between the first substrate and the second substrate. The first polarizing plate is formed on an outer surface of the first substrate. The second polarizing plate is formed on an outer surface of the second substrate, the outer surface being opposite to the inner surface of the second substrate. The backlight is arranged at a rear side of the first polarizing plate. The transparent transreflective film is arranged between the first polarizing plate and the backlight, the transparent transreflective film has a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, and the transparent transreflective film partially reflects and partially transmits incident lights.

[0032] According to another aspect of the invention, there is provided a transmissive and reflective type LCD comprising an LC cell, a first polarizing plate, a second polarizing plate, a backlight and a transparent transreflective film. The LC cell includes a first substrate, a second substrate having an inner surface that is arranged to face the first substrate, and a liquid crystal layer formed between the first substrate and the second substrate. The first polarizing plate is formed on an outer surface of the first substrate. The second polarizing plate is formed on an outer surface of the second substrate that oppositely faces the inner surface of the second substrate. The backlight is arranged at a rear side of the first polarizing plate. The transparent transreflective film is arranged between the first polarizing plate and the backlight, and has a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked. The transmissive and reflective type LCD has a reflection light path along which a first incident light beam is incident into the LC cell from a front side of the LC cell, is reflected by the transreflective film, and is outputted through the front side of the LC cell. And, The transmissive and reflective type LCD has a transmission light path along which a second incident light beam is incident into the LC cell from a rear side of the LC cell, is transmitted through the transreflective film, and is outputted through the front side of the LC cell.

[0033] According to another aspect of the invention, there is provided a transmissive and reflective type LCD comprising: a first substrate including a gate line formed on an insulating substrate, a data line insulated from the gate line and arranged to intersect the gate line, and a pixel electrode electrically connected to the data line; a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon; a liquid crystal layer formed between the first substrate and the second substrate; a first polarizing plate formed on an outer surface of the first substrate; a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate; a backlight arranged at a rear side of the first polarizing plate; and a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**[0034]** According to another aspect of the invention, there is provided a transmissive and reflective type LCD comprising: a first substrate including i) a thin film transistor having a gate electrode formed on an insulating substrate, a gate insulating layer formed on the gate electrode and on the insulating substrate, an active pattern formed on the gate insulating layer to be disposed above the gate electrode, and a source electrode and a drain electrode separately formed on the active pattern each other, and ii) a pixel electrode electrically connected to one of the source electrode and the drain electrode; a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon; a liquid crystal layer formed between the first substrate and the second substrate; a first polarizing plate formed on an outer surface of the first substrate; a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate; a backlight arranged at a rear side of the first polarizing plate; and a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**[0035]** According to another aspect of the invention, there is provided a transmissive and reflective type LCD comprising: a first substrate including i) a thin film transistor having an active pattern formed on an insulating substrate, a gate insulating layer formed on the active pattern and on the insulating substrate, a gate electrode formed on the gate insulating layer to be disposed above the active pattern, an interinsulation layer formed on the gate electrode and the gate insulating layer, and a source electrode and a drain electrode separately formed on the interinsulation layer each other, and ii) a pixel electrode electrically connected to one of the source electrode and the drain electrode; a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon; a liquid crystal layer formed between the first substrate and the second substrate; a first polarizing plate formed on an outer surface of the first substrate; a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate; a backlight arranged at a rear side of the first polarizing plate; and a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**[0036]** According to another aspect of the invention, there is provided a transmissive and reflective type LCD comprising: a first substrate including i) a display cell array circuit formed on an insulating substrate, a plurality of data lines and a plurality of gate lines arranged in a matrix shape to intersect each other on the display cell array circuit, and ii) a gate driver circuit, formed adjacent to a first portion of the display cell array circuit, for driving the gate lines; a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second

substrate having a transparent common electrode thereon; a liquid crystal layer formed between the first substrate and the second substrate; a first polarizing plate formed on an outer surface of the first substrate; a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate, a backlight arranged at a rear side of the first polarizing plate; and a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**[0037]** The transmissive and reflective type LCD of the invention has no reflection electrode within LC cell and no  $\frac{1}{4}$ -wavelength phase difference plate on each of the upper substrate (second substrate) and the lower substrate (first substrate). Hence, compared with the conventional transmissive and reflective type LCD, the transmissive and reflective type LCD of the present invention can be made in a more simple structure.

**[0038]** Further, it is possible that the transreflective film of partially being transmitted and reflecting incident light performs both functions of the reflection electrode and the transparent electrode at the same time, and a recycling process of light is lastingly generated, so that light loss is not generated in the transmission mode. Accordingly, compared with the conventional transmissive and reflective type LCD, the transmissive and reflective type LCD of the invention has an enhanced transmissivity. Also, since the transmissive and reflective type LCD of the invention does not utilize the  $\frac{1}{4}$  wavelength phase difference plate, the light that is incident from the backlight and is then reflected by metal regions of LC cell is recycled and again used, so that it becomes possible to enhance an overall light efficiency.

**[0039]** Furthermore, since the optical conditions applied to the liquid crystal of the conventional transmissive and reflective type LCD can be identically applied to that of the transmissive and reflective type LCD of the present invention, degeneration in the reliability of the liquid crystal can be prevented.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0040]** The above objects and other advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

**[0041]** FIG. 1 is a sectional view of a conventional transmissive and reflective type LCD;

**[0042]** FIGS. 2A and 2B are schematic views for illustrating an operation mechanism of the conventional transmissive and reflective type LCD of FIG. 1 in the reflection mode;

**[0043]** FIGS. 3A and 3B are schematic views for illustrating an operation mechanism of the conventional transmissive and reflective type LCD of FIG. 1 in the transmission mode;

**[0044]** FIG. 4 is a sectional view of a transmissive and reflective type LCD in accordance with a first embodiment of the present invention;

[0045] FIG. 5 is a schematic view showing a structure of the transreflective film shown in FIG. 4;

[0046] FIGS. 6A and 6B are sectional views for illustrating a position of a light scattering layer that is applicable to the transmissive and reflective type LCD of FIG. 4;

[0047] FIGS. 7A and 7B are schematic views for illustrating an operation mechanism of the transmissive and reflective type LCD of FIG. 4 to which a integrally formed transreflective film is applied in the reflection mode;

[0048] FIGS. 8A and 8B are schematic views for illustrating an operation mechanism of the transmissive and reflective type LCD of FIG. 4 to which a integrally formed transreflective film is applied in the transmission mode;

[0049] FIGS. 9A and 9B are schematic views for illustrating an operation mechanism of the transmissive and reflective type LCD of FIG. 4 to which a separation type transreflective film is applied in the reflection mode;

[0050] FIGS. 10A and 10B are schematic views for illustrating an operation mechanism of the transmissive and reflective type LCD of FIG. 4 to which a separation type transreflective film is applied in the transmission mode; and

[0051] FIG. 11 is a sectional view of a transmissive and reflective type LCD in accordance with a second embodiment of the present invention.

[0052] FIG. 12 is a sectional view of a transmissive and reflective type LCD in accordance with a third embodiment of the present invention.

[0053] FIG. 13 is a sectional view of a transmissive and reflective type LCD in accordance with a fourth embodiment of the present invention.

[0054] FIG. 14 is a plane view of a first substrate of FIG. 13.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0055] Now, exemplary embodiments of the present invention will be described in detail with reference to the annexed drawings.

[0056] FIG. 4 is a sectional view of a transmissive and reflective type LCD in accordance with one embodiment of the present invention.

[0057] Referring to FIG. 4, a transmissive and reflective type LCD in accordance with one embodiment of the present invention includes a first substrate 110, a second substrate 130 of which an inner surface is arranged facing the first substrate 110, and a liquid crystal layer 150 formed between the first substrate 110 and the second substrate 130.

[0058] The first and second substrates 110 and 130 are preferably manufactured using a glass substrate.

[0059] On the inner surface of the first substrate 110 is formed a first transparent electrode 115 made of conductive oxide film such as indium tin oxide (ITO). Preferably, the first transparent electrode 115 is elongated in a first direction, and serves as a signal electrode that is repeatedly arranged in a second direction normal to the first direction.

[0060] On the outer surface of the first substrate 110 is disposed a first polarizing plate 155. A second polarizing

plate 165 is formed on an outer surface of the second substrate 130 oppositely facing the inner surface of the second substrate 130. The first and second polarizing plates 155 and 165 function to absorb a predetermined polarization component and to transmit other polarization component, thereby allowing an incident light to be transmitted in a specific direction. The first and second polarizing plates 155 and 165 are linear polarizers of which polarizing axes are arranged to be normal to each other.

[0061] At a rear side of the first polarizing plate 155 is installed a backlight 170.

[0062] On the inner surface of the second substrate 130 facing the first substrate 110 is formed a second transparent electrode 135 made of conductive oxide film such as ITO. Preferably, the second transparent electrode 135 serves as a scanning electrode that is repeatedly arranged in the second direction and is elongated in the first direction. In other words, in a passive matrix type LCD, the first transparent electrode 115 of the first substrate 110 and the second transparent electrode 135 of the second substrate 130 are arranged to be normal to each other such that they are used as the signal electrode and scanning electrode, respectively.

[0063] The liquid crystal layer 150 is made of 270° twisted STN liquid crystal composition. Selectively, the liquid crystal layer 150 can be made of 90° twisted nematic liquid crystal composition. It is well known that the passive matrix type LCD uses STN liquid crystal while the active matrix type LCD uses TN liquid crystal. According to the present embodiment, the liquid crystal layer 150 has an  $\Delta n$  of 0.2-0.6  $\mu m$  that is a product of a refractive anisotropy  $\Delta n$  and a thickness  $d$  of the liquid crystal layer 150, preferably 0.48  $\mu m$ . The value of 0.48  $\mu m$  allows the LCD of the present invention to identically use the LC optical condition of the conventional transmission type LCD without a variation, thereby preventing the reliability of the liquid crystal from being degenerated.

[0064] Between the first polarizing plate 155 and the backlight 170 is disposed a transreflective film 160 including at least two transparent layers having different refractivity index values from each other, i.e., a first layer 161 and a second layer 162 alternatively stacked as shown in FIG. 5. The transparent transreflective film 160 functions to partially reflect and transmit an incident light. Accordingly, the transmissive and reflective type LCD in accordance with the present embodiment of the invention has a reflection light path 180 and a transmission light path 185. In the reflection light path, an incident light is incident toward the second substrate 130, is transmitted through the first substrate 110, is reflected by the transreflective film 160, and is outputted through the second substrate 130. In the transmission light path 185, the incident light is incident from the backlight into the first substrate 110, is transmitted through the transreflective film 160, and is outputted through the second substrate 130.

[0065] Hereinafter, structure and operation of the transreflective film 160 are in detail described.

[0066] As shown in FIG. 5, when it is assumed that the transreflective film 160 has a film thickness direction of z-axis and a film plane of x-y plane, the transreflective film 160 according to one aspect of the invention is characterized in that the first layer 161 thereof has a refractive anisotropy

within the film plane, i.e., x-y plane, and the second layer **162** does not have a refractive anisotropy within the film plane.

[0067] The transflective film **160** has various transmissivity and reflectivity characteristics depending on a polarizing state and a direction of the incident light. For instance, when it is assumed that a direction parallel to an elongated direction of the transflective film **160** is x-direction and a direction perpendicular to the elongated direction is y-direction, each of the first layer **161** having a high refractivity and refractive anisotropy within the film plane and the second layer **162** not having refractive anisotropy have three main refractive indexes of  $n_x$ ,  $n_y$  and  $n_z$ , that satisfy the following relationships (1):

$$\begin{aligned} n_{1x} &= n_{1z} \neq n_{1y}; \\ n_{2x} &= n_{2y} = n_{2z}; \\ n_{1x} &\neq n_{2x}; \\ n_{1y} &\neq n_{2y}; \text{ and} \\ |n_{1x} - n_{2x}| &< |n_{1y} - n_{2y}| \end{aligned} \quad (1)$$

[0068] ( $n_{1x}$ ,  $n_{1y}$ ,  $n_{1z}$  denotes a main refractive index of the first layer in an x-axis, y-axis, z-axis, respectively, and  $n_{2x}$ ,  $n_{2y}$ ,  $n_{2z}$  denotes a main refractive index of the second layer in an x-axis, y-axis, z-axis, respectively)

[0069] Thus, if a refractivity difference in the x-direction between the first layer **161** and the second layer **162** is less than a refractivity difference in the y-direction between the first layer **161** and the second layer **162**, when a non-polarized light is incident in the direction perpendicular to the film plane, i.e., z-direction, a polarization component polarized parallel to the y-direction is mostly reflected due to a high difference in the refractivity based on Fresnel's equation, but a polarization component polarized parallel to the x-direction partially is transmitted and reflected due to a low difference in the refractivity.

[0070] There are disclosed methods for enhancing the display brightness by using a reflection type polarizing plate made of dielectric multilayered film having birefringence in Japanese Patent Laid Open Publication No. 9-506985 and International Patent Publication No. WO 97/01788. The dielectric multilayered film having birefringence has a structure in which two kinds of polymer layers are alternatively stacked. One of the two kinds of polymer layers is selected from a polymer group having a high refractivity and the other is selected from a polymer group having a low refractivity.

[0071] Hereinafter, the structure of the dielectric multilayered film is reviewed in an aspect of optical property.

[0072] For instance, when it is assumed that there is the following relationship between the first layer in which a material having a high refractivity is elongated, and a second layer in which a material having a low refractivity is elongated:

[0073]  $n_{1x} = n_{1z} = 1.57$ ,  $n_{1y} = 1.86$ ; and

[0074]  $n_{2x} = n_{2y} = n_{2z} = 1.57$ .

[0075] Thus, in case that refractivity values of the first and second layers in the x-direction and the z-direction are identical each other and refractivity values of the first and second layers in the y-direction are different from each other, when a non-polarized light is incident in the direction

perpendicular to the film plane, i.e., z-direction, polarization components in the x-direction are all transmitted, polarization components in the y-direction are all reflected based on Fresnel's equation. A representative example of birefringence dielectric multilayered films having the above characteristics is DBEF (Dual brightness enhancement film) made by 3M company. The DBEF has a multilayered structure in which two kinds of films made of different material are a few hundred layers stacked. In other words, polyethylene naphthalate layer having a high birefringence and polymethyl methacrylate (PMMA) layer are alternatively stacked to form the DBEF layer. Since naphthalene radical has a flat plane structure, when these radicals are adjacently placed to each other, it is easy to stack the polyethylene naphthalate layer and the DBEF layer, so that the refractivity in the stacking direction becomes considerably different from those in other directions. On the contrary, since the PMMA is an amorphous polymer and is isotropically aligned, the PMMA has an identical refractivity in all directions.

[0076] The DBEF made by 3M company transmits all x-directional polarization components and reflects all y-directional polarization components, while the transflective film **160** according to one aspect of the invention mostly reflects a specific-directional (for instance, y-directional) polarization component, but partially reflects and transmits polarization component, which is polarized in a direction (for instance, x-direction) normal to the specific direction. The transflective film may be made by vertically attaching two anisotropic transflective films having various transmissivity and reflectivity depending on polarizing state and direction of an incident light. Selectively, the transflective film may be made by attaching an anisotropic transflective film having various transmissivity and reflectivity depending on polarizing state and direction of an incident light and a transflective film having isotropic reflection and transmission characteristics regardless of polarizing state and direction of incident light. The two transflective films can be made in an integrally formed structure, or made in a separately formed film structure.

[0077] Also, according to another preferred aspect of the invention, the transflective film **160** has isotropic reflection and transmission characteristics regardless of polarizing state and direction of an incident light. For instance, if it is assumed that a direction parallel to an elongated direction of the film is x-direction and a direction perpendicular to the elongated direction of the film is y-direction, the first layer **161** having a high refractivity and the second layer **162** having a low refractivity both have a refractive isotropy within x-y plane of the film, and each of the first and second layers **161** and **162** have three main refractive indexes of  $n_x$ ,  $n_y$  and  $n_z$  that satisfy the following relationships:

$$\begin{aligned} n_{1x} &= n_{1y} = n_{1z}; \text{ and} \\ n_{2x} &= n_{2y} = n_{2z} \neq n_{1z} \end{aligned} \quad (2)$$

[0078] Thus, in case that the first and second layers **161** and **162** have different refractivity index values in the z-direction, when a non-polarized light is incident in the direction (i.e., z-direction) perpendicular to the film, polarization components in the x-direction are partially transmitted and reflected according to Fresnel's equation, and polarization components in the y-direction are partially transmitted and reflected. At this time, the reflectivity of a

reflected light can be adjusted to match with characteristics of the transmissive and reflective type LCD by controlling the thickness or the refractivity of the first layer 161 or the second layer 162. In other words, a reflection characteristic-enhanced transmissive and reflective type LCD enhances the reflectivity, whereas a transmissive and reflective type LCD in which transmission characteristic is considered to be an important issue, lowers the reflectivity to thereby enhance the transmissivity.

[0079] As described above, the transflective film 160 of the invention can be formed to have an anisotropy characteristic in which transmissivity and reflectivity of the film 160 varies with polarizing state and direction of incident light, or can be formed to have an isotropy characteristic in which transmissivity and reflectivity of the film 160 do not depend on polarizing state and direction of the incident light. In any case, it is desirous that the transflective film 160 has a reflectivity of no less than about 4% with respect to polarization component in all directions when light is incident in a direction perpendicular to the film plane.

[0080] The transflective film 160 of the invention can be made in an integrally formed structure together with the first polarizing plate 155, or made in a separately formed film structure separated from the first polarizing plate 155. In case that the transflective film 160 is made in an integrally formed structure together with the first polarizing plate 155, it is possible to decrease the thickness of the LC cell, and the LCD has an advantage in an aspect of manufacturing cost.

[0081] In the above, there is explained a method of forming the transflective film 160 by depositing or coating the polymer multilayered film on a surface of the first polarizing plate 155, which is an contrary concept to an anti-reflection treatment in the polarizing plate. In other words, in the anti-reflection treatment, two kinds of transparent films having different refractivity are repeatedly deposited or coated in a constant thickness such that destructive interference occurs by multi-reflection within the polymer multilayered film. However, in order to form a transflective film capable of partially transmitting and partially reflecting an incident light, the film thickness should be adjusted such that constructive interference occurs.

[0082] Further, as shown in FIGS. 6A and 6B, the transmissive and reflective type LCD in accordance with the current embodiment may further include a light scattering layer 168 formed on the first substrate 110 or the second substrate 130 in order to prevent specular reflection and to properly diffuse a reflected light in various angles. For instance, it is possible to form the light scattering layer 168 between the first substrate 110 and the first polarizing plate 155, between the second substrate 130 and the second polarizing plate 165, or between the first polarizing plate 155 and the transflective film 160. The light scattering layer 168 can be made in an integrally formed structure together with the first polarizing plate 155 or the second polarizing plate 165, or made in a separate film structure separated from the polarizing plates. Further, the light scattering layer 168 can be made in the form of a plastic film in which transparent biz is dispersed. Moreover, the light scattering layer 168 can be made in a state in which biz is added to adhesive, which makes it possible to directly attach the first substrate 110 to the first polarizing plate 155.

[0083] Furthermore, in order to optimize light efficiency in the transmissive and reflective type LCD in accordance with

the current embodiment of the invention, it is possible to form a phase difference plate (not shown) on the first substrate 110 or the second substrate 130. For instance, the phase difference plate is formed in an integrally formed structure together with polarizing plate or a separate film structure separated from the polarizing plate between the first substrate 110 and the first polarizing plate 155, or between the second substrate 130 and the second polarizing plate 165.

[0084] Hereinafter, there is described in detail an operation mechanism of the transmissive and reflective type LCD having the above structure.

[0085] FIG. 7A through FIG. 8B are schematic views for illustrating operation mechanisms of reflection mode and transmission mode in the transmissive and reflective type LCD in which the transflective film 160 is made an integrally formed structure together with the first polarizing plate 155. Here, polarization directions of the light are represented on the basis of a polarizing axis of the second polarizing plate 165, and a partially reflected light and a partially transmitted light by a dotted line.

[0086] First, when a pixel voltage is not applied (OFF) in the reflection mode, as shown in FIG. 7A, a light that is incident from an outside is transmitted through the second polarizing plate 165, so that the light is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate 165. The linearly polarized light is transmitted through the liquid crystal layer 150 and the first transparent electrode 115, so that the linearly polarized light is linearly polarized in a direction perpendicular to the polarizing axis of the second polarizing plate 165 and is then incident into the transflective film 160 made an integrally formed structure together with the first polarizing plate 155. At this time, since the polarizing axis of the first polarizing plate 155 is normal to that of the second polarizing plate 165, the light that is incident into the first polarizing plate 155 comes to have the direction parallel to the polarizing axis of the first polarizing plate 155. Accordingly, the light linearly polarized in the direction parallel to the polarizing axis of the first polarizing plate 155 partially is transmitted through the transflective film 160 and is partially reflected by the transflective film 160. In other words, in case that the transflective film 160 has the refractivity characteristic of the relationship (1), a polarization component, which is polarized in the x-direction parallel to the elongated direction of the transflective film 160, in the lights that are incident into the transflective film 160 is partially transmitted and reflected, whereas a polarization component which is polarized in the direction perpendicular to the elongated direction is mostly reflected. Further, in case that the transflective film 160 has the refractive characteristic of the relationship (2), in the lights that are incident into the transflective film 160, the polarization components which is polarized in the x- and y-directions are partially transmitted and partially reflected.

[0087] Thus, the linearly polarized light reflected by the transflective film 160 is transmitted through the first transparent electrode 115 and the liquid crystal layer 150, so that it is linearly polarized in the direction parallel to the polarizing axis of the second polarizing plate 165. Afterwards, the light is transmitted through the second polarizing plate 165, so that a white image is displayed. Also, the lights that have been transmitted through the transflective film 160 are

restored between the transreflective film 160 and the backlight 170, and the restored lights repeatedly carry out a procedure of a partial reflection and a partial transmission. As a consequence, light loss is eliminated and reflectivity and light efficiency are enhanced.

[0088] When a maximum pixel voltage is applied (ON) in the reflection mode, as shown in **FIG. 7B**, a light that is incident from an outside is transmitted through the second polarizing plate 165, so that the light is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate 165. Afterwards, the linearly polarized light is transmitted through the liquid crystal layer 150 without a variation in the polarizing state, and is then incident into the transreflective film 160 integrally formed with the first polarizing plate 155. At this time, since the linearly polarized light is perpendicular to the polarizing axis of the first polarizing plate 155, the light is all absorbed in the first polarizing plate 155. Thus, the linearly polarized light is not reflected by the transreflective film 160, so that a black image is displayed.

[0089] When a pixel voltage is not applied (OFF) in the transmission mode, as shown in **FIG. 8A**, a light that is irradiated from the backlight 170 is incident into the transreflective film 160 integrally formed with the first polarizing plate 155. In case that the transreflective film 160 has the refractive characteristic of the relationship (1), a polarization component, which is polarized parallel to the x-direction in the lights that are parallel to the polarizing axis of the first polarizing plate 155, is partially transmitted and reflected, whereas a polarization component which is polarized parallel to the y-direction is mostly reflected. Also, in case that the transreflective film 160 has the refractive characteristic of the relationship (2), the lights, which are parallel to the polarizing axis of the first polarizing plate 155, are partially transmitted and partially reflected because all polarization components which are polarized in the x-direction and y-direction is partially transmitted and reflected.

[0090] Thus, the light that has been transmitted through the transreflective film 160 and the first polarizing plate 155 becomes a linearly polarized light having a vibrating direction parallel to the polarizing axis of the first polarizing plate 155. The linearly polarized light is transmitted through the first transparent electrode 115 and the liquid crystal 150, so that it is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate 165. Accordingly, the light linearly polarized in the direction parallel to the polarizing axis of the second polarizing plate 165 is transmitted through the second polarizing plate 165, so that a white image is displayed. Also, a light reflected by the transreflective film 160 is restored between the backlight 170 and the transreflective film 160, and then repeats to carry out the above steps. Thus, polarization components parallel to the x-direction or polarization components parallel to the x- and y-directions continuously is transmitted through the transreflective film 160 and are used, so that light loss is eliminated and transmissivity and light efficiency are enhanced.

[0091] When a maximum pixel voltage is applied (ON) in the transmission mode, as shown in **FIG. 8B**, a light that is irradiated from the backlight 170 is incident into the transreflective film 160 integrally formed with the first polarizing plate 155, so that the light parallel to the polarizing axis of the first polarizing plate 155 is partially transmitted and

reflected. The light that has been transmitted through the transreflective film 160 and the first polarizing plate 155, is converted into a light linearly polarized in the direction parallel to the polarizing axis of the first polarizing plate 155, i.e., in the direction perpendicular to the polarizing axis of the second polarizing plate 165. The linearly polarized light is transmitted through the first transparent electrode 115 and the liquid crystal layer 150 without a variation in the polarizing state. Accordingly, the light linearly polarized in the direction perpendicular to the polarizing axis of the second polarizing plate 165 is not transmitted through the second polarizing plate 165, so that a black image is displayed.

[0092] **FIG. 9A** through **FIG. 10B** are schematic views for illustrating an operation mechanism in the transmission mode and the reflection mode of a transmissive and reflective type LCD in which the transreflective film 160 is separated from the first polarizing plate 155 and is made in a film structure. Here, polarization directions of the light are represented on the basis of a polarizing axis of the second polarizing plate 165, and a partially reflected light and a partially transmitted light by a dotted line.

[0093] First, when a pixel voltage is not applied (OFF) in the reflection mode, as shown in **FIG. 9A**, a light that is incident from an outside is transmitted through the second polarizing plate 165, so that the light is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate 165. The linearly polarized light is transmitted through the liquid crystal layer 150 and the first transparent electrode 115, so that the linearly polarized light is linearly polarized in a direction perpendicular to the polarizing axis of the second polarizing plate 165 and is then incident into the first polarizing plate 155. At this time, since the polarizing axis of the first polarizing plate 155 is normal to that of the second polarizing plate 165, the light that has been linearly polarized in a direction perpendicular to the polarizing axis of the second polarizing plate 165 is transmitted through the first polarizing plate 155 and is then incident into the transreflective film 160. In case that the transreflective film 160 has the refractivity characteristic of the relationship (1), a polarization component, which is polarized in the x-direction parallel to the elongated direction of the transreflective film 160, in the lights that are incident into the transreflective film 160 is partially transmitted and reflected, whereas a polarization component, which is polarized in the y-direction perpendicular to the elongated direction, is mostly reflected. Further, in case that the transreflective film 160 has the refractive characteristic of the relationship (2), in the lights that are incident into the transreflective film 160, the polarization components polarized in the x- and y-directions are partially transmitted and partially reflected.

[0094] Thus, since the linearly polarized light reflected by the transreflective film 160 is parallel to the polarizing axis of the first polarizing plate 155, it is transmitted through the first polarizing plate 155, and is incident into the liquid crystal layer 150 via the transparent electrode 115. The linearly polarized light is transmitted through the liquid crystal layer 150, whereby it is linearly polarized in the direction parallel to the polarizing axis of the second polarizing plate 165. Afterwards, the light is transmitted through the second polarizing plate 165, so that a white image is displayed. Also, the lights that have been transmitted through the transreflective film 160 are restored between the

transflective film 160 and the backlight 170, and the restored lights repeatedly carry out a procedure of a partial reflection and a partial transmission. As a consequence, light loss is eliminated and reflectivity and light efficiency are enhanced.

[0095] When a maximum pixel voltage is applied (ON) in the reflection mode as shown in FIG. 9B, a light that is incident from an outside is transmitted through the second polarizing plate 165, so that the light is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate 165. Afterwards, the linearly polarized light is transmitted through the liquid crystal layer 150 without a variation in the polarizing state, and is then incident into the first polarizing plate 155. At this time, since the linearly polarized light is perpendicular to the polarizing axis of the first polarizing plate 155, the light is all absorbed in the first polarizing plate 155. Thus, since the linearly polarized light is not reflected by the transflective film 160, a black image is displayed.

[0096] When a pixel voltage is not applied (OFF) in the transmission mode, as shown in FIG. 10A, a light that is irradiated from the backlight 170 is incident into the transflective film 160, so that the light is partially transmitted and reflected. In case that the transflective film 160 has the refractive characteristic of the relationship (1), polarization components, which is polarized in the x-direction parallel to the elongated direction of the transflective film 160, in the lights that have been incident into the transflective film 160 is partially transmitted and reflected, whereas polarization components, which is polarized in the y-direction perpendicular to the elongated direction, are mostly reflected. Also, in case that the transflective film 160 has the refractive characteristic of the relationship (2), polarization components, which is polarized in the x- and y-directions, in the lights that have been incident into the transflective film 160 are partially transmitted and reflected.

[0097] Thus, the light that has been transmitted through the transflective film 160 and the first polarizing plate 155 is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate 155. Afterwards, the linearly polarized light is transmitted through the first transparent electrode 115 and the liquid crystal 150, so that it is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate 165. Accordingly, the light linearly polarized in the direction parallel to the polarizing axis of the second polarizing plate 165 is transmitted through the second polarizing plate 165, so that a white image is displayed. Also, a light reflected by the transflective film 160 is restored between the backlight 170 and the transflective film 160, and then repeats to carry out the above steps. Thus, polarization components polarized parallel to the x-direction or polarization components polarized parallel to the x- and y-directions continuously is transmitted through the transflective film 160 and are used, so that light loss is eliminated and transmissivity and light efficiency are enhanced.

[0098] When a maximum pixel voltage is applied (ON) in the transmission mode, as shown in FIG. 10B, a light that is irradiated from the backlight 170 is incident into the transflective film 160, so that the incident light is partially transmitted through the transflective film 160 and is partially reflected by the transflective film 160. The light that has been transmitted through the transflective film 160 is transmitted through the first polarizing plate 155, so that it is converted

into a light linearly polarized parallel to the polarizing axis of the first polarizing plate 155, i.e., a direction perpendicular to the polarizing axis of the second polarizing plate 165. Afterwards, the linearly polarized light is transmitted through the first transparent electrode 115 and the liquid crystal layer 150 without a variation in the polarizing state. Accordingly, the light linearly polarized in the direction perpendicular to the polarizing axis of the second polarizing plate 165 cannot be transmitted through the second polarizing plate 165, so that a black image is displayed.

[0099] FIG. 11 is a sectional view of a transmissive and reflective type LCD in accordance with another embodiment of the present invention.

[0100] Referring to FIG. 11, a transmissive and reflective type LCD includes a first substrate 200, a second substrate 250 arranged facing the first substrate 200, a liquid crystal layer 260 formed between the first substrate 200 and the second substrate 250, and a backlight 270 arranged at a rear side of the first substrate 200.

[0101] The first substrate 200 includes a first insulating substrate 210. On the first insulating substrate 210 is formed a plurality of gate lines (not shown) and a plurality of data lines (not shown) in a matrix configuration. A pixel electrode 234 and a thin film transistor 225 are formed at a region defined by a pair of gate line and a pair of data lines. The second substrate 250 includes a second insulating substrate 252, a color filter 254 of RGB pixels, for displaying colors while a light is transmitted therethrough, a black matrix 256 for preventing a light from being leaked between pixels, and a transparent common electrode 258.

[0102] A thin film transistor 225 comprises a gate electrode 212 formed on the first insulating substrate 210, a gate insulating film 214 formed on the gate electrode 212 and the first insulating substrate 210, an active pattern 216 and an ohmic contact pattern 218 both formed on the gate insulating film 214 on the gate electrode 212, and source and drain electrodes 220 and 222 formed apart from each other on the ohmic contact pattern 218. On the first insulating substrate 210 including the thin film transistor 225 is formed a passivation film 230 made of organic or inorganic substance. A contact hole 232 of penetrating the passivation film 230 is formed in the passivation film 230 to expose the drain electrode 222. The pixel electrode 234 is made of transparent conductive oxide such as ITO (Indium tin oxide).

[0103] The liquid crystal layer 260 is made of 900 twisted nematic (TN) liquid crystal, and has a  $\Delta n$  of  $0.2\text{--}0.6 \mu\text{m}$  that is a product of a refractive anisotropy  $\Delta n$  and a thickness  $d$  of the liquid crystal layer 150, preferably  $0.48 \mu\text{m}$ . Thus, the value on the refractivity anisotropy allows the LCD of the present invention to use the LC optical condition of the conventional transmission type LCD without any variation, thereby preventing the reliability of the liquid crystal from being degenerated.

[0104] Depending on alignment direction of the liquid crystal layer 260, first and second polarizing plates 262 and 266 for transmitting only a light vibrating in a specific direction are respectively attached on outer surfaces of the first and second substrates 210 and 252. Preferably, the first and second polarizing plates 262 and 266 are linear polarizers of which polarizing axes are arranged perpendicular to each other.

[0105] The gate electrode 212 of the thin film transistor 225 is connected to the gate line, the source electrode 220 is connected to the data line, and the drain electrode 222 is connected to the pixel electrode 234 through the contact hole 232. Accordingly, as a scanning voltage is applied to the gate electrode 212, a signal voltage flowing through the data line is applied to the drain electrode 222 through the active pattern 216 from the source electrode 220. If the signal voltage is applied to the drain electrode 222, there is generated a voltage difference between the pixel electrode 234 connected to the drain electrode 222 and the common electrode 258 of the second substrate 252. As a consequence, molecular arrangement of the liquid crystal layer 260 injected between the pixel electrode 234 and the common electrode 258 varies, and thereby light transmissivity through the liquid crystal layer 260 varies. Thus, the thin film transistor 225 performs the role as switching element for turning on or turning off pixels of the LC cell.

[0106] Between the first polarizing plate 262 and the backlight 270 is arranged the transflective film 264 of a plurality of transparent layers in which first and second layers having different refractivity are alternatively stacked. As described in the above embodiment, the transflective film 264 functions to partially transmit and reflect the incident light. In other words, the transflective film 264 can be formed in a structure having anisotropy characteristic in which degrees of the transmissivity and the reflectivity vary with polarizing state and direction of the incident light, or in a structure having isotropy characteristic in which degrees of the transmissivity and the reflectivity do not vary with polarizing state and direction of the incident light. In any cases, it is desirous that the transflective film 264 is formed to have 4% or more in the reflectivity with respect to polarization components in all directions. The transflective film 264 is formed in an integrally formed structure with the first polarizing plate 262 or in a structure separated from the first polarizing plate 262.

[0107] Further, in order to prevent specular reflection and properly diffuse reflected lights in several directions, the transmissive and reflective type LCD in accordance with the present embodiment may further include a light scattering layer (not shown) on either the first substrate 200 or the second substrate 250. For instance, the light scattering layer can be formed between the first substrate 200 and the first polarizing plate 262, between the second substrate 250 and the second polarizing plate 266, or between the first polarizing plate 262 and the transflective film 264. The light scattering layer is formed in an integrally formed structure with the first polarizing plate 262 or the second polarizing plate 266, or in a structure separated from the first polarizing plate 262 or the second polarizing plate 266. Also, the light scattering layer can be made by mixing adhesive and biz.

[0108] Moreover, in order to optimize light efficiency in the transmissive and reflective type LCD of the present embodiment, a phase difference plate (not shown) can be formed on either the first substrate 200 or the second substrate 250. For instance, the phase difference plate is formed between the first substrate 200 and the first polarizing plate 262 or between the second substrate 250 and the second polarizing plate 266. Also, the phase difference plate is formed in an integrally formed structure with the first

polarizing plate 262 or the second polarizing plate 266, or in a structure separated from the first polarizing plate 262 or the second polarizing plate 266.

[0109] According to the transmissive and reflective type LCD of the present embodiment, a reflection electrode is not formed within the LC cell, but the transflective film 264 substitutes for the reflection electrode, and performs the role of the reflection electrode. Accordingly, a light that is incident toward the second substrate 252 from an outside has a reflection light path 280 in which the light is transmitted through the first substrate 210, is reflected by the transflective film 264, and is outputted through the second substrate 252. Also, a light that is incident toward the first substrate 200 from the backlight 270 has a transmission light path 285 in which the light is transmitted through the transflective film 264 and then is outputted through the second substrate 250.

[0110] The transmissive and reflective type LCD shown in FIG. 11 has the same operation mechanism in the reflection mode and the transmission mode as those described with reference to FIG. 7A through FIG. 10B. In other words, by using the transflective film which partially transmits and reflects the incident light, light loss is not generated in the reflection mode and the transmission mode, so that it is possible to enhance both of the reflectivity and transmissivity. Also, compared with the conventional transmissive and reflective type LCD of FIG. 1, the transmissive and reflective type LCD is not provided with a  $\frac{1}{4}$ -wavelength phase difference plate on the lower substrate, i.e., the first substrate 210. To this end, lights that are incident from the backlight 270 and are reflected from regions where a metal layer, such as the gate line or data line, exists within the LC cell, are restored between the transflective film 264 and the backlight 270 and the restored lights are used, so that it increases an overall light efficiency.

[0111] FIG. 12 is a sectional view of a transmissive and reflective type LCD in accordance with a third embodiment of the present invention, especially shows a thin film transistor (TFT) LCD having top-gate structure.

[0112] Referring to FIG. 12, a transmissive and reflective type LCD includes a first substrate 300, a second substrate 350 facing the first substrate 300, a liquid crystal layer 360 disposed between the first substrate 300 and the second substrate 350, and a backlight assembly disposed below the first substrate 300.

[0113] The first substrate 300 includes a plurality of gate lines (not shown) and a plurality of data lines (not shown), pixel electrodes 334 and thin film transistors (TFTs) 325 on a first insulating substrate 310. The data lines and gate lines are arranged in a matrix shape on the first insulating substrate 310. Each pixel electrode and each TFT 325 are disposed on a intersection of the data and gate lines. The second substrate 350 includes a second insulating substrate 352, color filters 354 having RGB pixels for representing predetermined colors, black matrix (light blocking layer) 356 for preventing light from being leaked from the pixels, and a transparent common electrode 358.

[0114] The TFT includes an active pattern 312 formed on a first insulating substrate 310, a gate insulating layer 314 formed on the active pattern 312 and on the first insulating substrate 310, a gate electrode 316 formed on the gate

insulating layer 314 to be disposed above the active pattern 312, an interinsulation layer 318 formed on the gate electrode 316 and the gate insulating layer 314, and a source electrode and a drain electrode separately formed on the interinsulation layer each other. The source and drain electrodes (320, 322) are connected to a source region (S) and a drain region (D) of the active pattern 312, respectively, through first contact holes 319 that penetrate the interinsulation layer 318 and the gate insulating layer 314. The active pattern 312 is comprised of one of polycrystalline silicon and amorphous silicon.

[0115] A passivation film 330 comprised of organic or inorganic substance is formed on the first insulating substrate 310 having the TFTs 325. A second contact hole 332 penetrates the passivation film 330 and exposes the drain electrode 322. The pixel electrode is a transparent electrode 334 comprised of a conductive oxide film, such as indium tin oxide (ITO).

[0116] The liquid crystal layer 360 is made of 90° twisted nematic liquid crystal, and has an approximately 0.2-0.6  $\mu\text{m}$ , preferably 0.48  $\mu\text{m}$ , of  $\Delta n$  which is a product of anisotropy ( $\Delta n$ ) of refractive index and thickness (d) of the liquid crystal layer. Accordingly, optical condition of the conventional transmissive LCD device can be applied to the present invention, to thereby prevent reliability of the liquid crystal from being deteriorated.

[0117] Also, according to an alignment direction of the liquid crystal molecules in the liquid crystal layer 360, a first polarizing plate 362 and a second polarizing plate 366 are respectively attached to external surfaces of the first and second substrates 300 and 350 so as to transmit only a light vibrating in a specific direction. The first and second polarizing plates 362 and 366 are all linear polarizer in which each polarizing axe of the first and second polarizing plates 362 and 366 are normal to each other.

[0118] Between the first polarizing plate 362 and the backlight 370 is disposed a transparent transreflective film 364 including at least two transparent layers having different refractivity index values from each other, i.e. a first layer and a second layer alternatively stacked. The transparent transreflective film 364 partially reflects and transmit incident light. The transparent transreflective film 364 serves as a reflection electrode.

[0119] Accordingly, the transmissive and reflective type LCD in accordance with the present invention has a reflection light path 380 and a transmission light path 385. In the reflection light path 380, incident light is incident toward the second substrate 350, is transmitted through the first substrate 300, is reflected by the transparent transreflective film 364, and is exited toward the second substrate 130. In the transmission light path 385, the incident light is incident from the backlight 370 into the first substrate 300, is transmitted through the transreflective film 364, and is exited toward the second substrate 350.

[0120] FIG. 13 is a sectional view of a transmissive and reflective type LCD in accordance with a fourth embodiment of the present invention, and FIG. 14 is a plane view of a first substrate of FIG. 13.

[0121] Referring to FIG. 13 and FIG. 14, the transmissive and reflective type LCD includes a first substrate 412a, a second substrate 412b facing the first substrate 412a, a liquid

crystal layer (LC, not shown) disposed between the first substrate 412a and the second substrate 412b, and a backlight assembly 490 disposed below the first substrate 412a.

[0122] A display cell array circuit 450, a data driver circuit 460, a gate driver circuit 470, a first external terminal 463 for connecting the data driver circuit 460 and a second external terminal 472 for connecting the gate driver circuit 470. The liquid crystal layer (LC) is disposed between the first substrate 412a having color filters and the second substrate 412b having transparent common electrode (CE). According to an alignment direction of the liquid crystal molecules in the liquid crystal layer (LC), a first polarizing plate 480 and a second polarizing plate (not shown) are respectively attached to external surfaces of the first and second substrates 300 and 350 so as to transmit only a light vibrating in a specific direction.

[0123] An integrated control and data driver chip 418 and circuits on a first substrate 412a is electrically connected each other by a flexible circuit board 416. The integrated control and data driver chip 418 is installed on the flexible circuit board 416. The flexible circuit board 416 provides a data signal, a data timing signal, a gate timing signal and a gate driving voltage signal to the data driver circuit 460 and the gate driver circuit 470 of the first substrate 412a.

[0124] The display cell array circuit 450 includes m data lines (DL1~DLm) extended in a column direction and n gate lines (GL1~GLn) extended in a low direction. Switching transistors (ST) are disposed at intersections between the gate lines and the data lines. A drain of the switching transistor (ST) is connected to the data line (DLi), and a gate of the switching transistor (ST) is connected to the gate lines (GLi). A source of the switching transistor (ST) is connected to transparent pixel electrode (PE).

[0125] The gate driver circuit 470 includes a shift resistor. The shift resistor has a plurality of stages, each stage is connected in cascade. An starting signal is inputted to input terminal of a first stage. The gate lines (GL1~GLn) is selected sequentially by output signal of each stage.

[0126] The data driver circuit 460 includes a shift resistor 464 and a plurality of switching transistors—for example, 528(176\*3) switching transistors. The 528 switching transistors are divided into 8 data line blocks (BL1~BL8), and each data line block includes 66 switching transistors. 66 input terminals of each data line block (BLi) is commonly connected to the external input terminal 463 having 66 data input terminals. 66 output terminal s of the shift resistor 464 are connected to corresponding 66 data lines. The shift resistor 464 is provided clock signals (CK, CKB) and a block-selection starting signal (STH) through the external connecting terminal 462 having 3 terminals. Also, a block selection terminal is connected to one corresponding output terminal of 8 output terminal s of the shift resistor 464. Each source of the 528 switching transistors is connected to corresponding data line, each drain of the 528 switching transistors is connected to corresponding input terminal of 66 data input terminals, and each gate of the 528 switching transistors is connected to the block selection terminal. The switching transistors is an amorphous silicon (a-Si) thin film transistors. 528 data lines is divided to 8 blocks, each block has 66 data lines, and each block is selected sequentially by 8 block selection signals of the shift resistor 464.

[0127] In the reflective and transmissive type LCD device according to the fourth preferred embodiment of the present

invention, the gate driver circuit 470 and the data driver circuit 460 is integrated with the display cell array circuit 450 on the first substrate 412a.

[0128] Between the first polarizing plate 480 and the backlight 490 is disposed a transparent transflective film 495 including at least two transparent layers having different refractivity index values from each other, i.e. a first layer and a second layer alternatively stacked. The transparent transflective film 495 can be formed on the first polarizing plate 480 in one-piece, i.e. in an integral structure.

[0129] The transparent transflective film 495 partially reflects and transmit incident light. The transparent transflective film 495 can have an anisotropy characteristic having various transmissivity and reflectivity depending on a polarizing state and a direction of incident light, or can have an isotropic transmission and reflection characteristics regardless of a polarizing state and a direction of the incident light. In all cases, preferably, the transparent transflective film 495 has reflectivity (reflection ratio) more than 4% for all polarized component polarized in all directions when light is incident perpendicular to the transparent transflective film 495.

[0130] According to the fourth preferred embodiment of the present invention, both the data driver circuit and the gate driver circuit employ shift resistor(s). However, the shift resistor(s) can be employed only at the data driver circuit, or only at the gate driver circuit.

[0131] As described above, according to the present invention, between the first polarizing plate attached on the outer surface of the lower substrate (i.e., first substrate) and the backlight is formed an anisotropy transflective film having an optical characteristic in which light components in a specific direction are strongly reflected and polarization components in a direction perpendicular to the specific direction are partially transmitted and reflected depending on polarizing state and direction of an incident light, or an isotropy transflective film having an optical characteristic in which light components are partially transmitted and reflected regardless of polarizing state and direction of the incident light. As a result, by a restoring process of a light occurring between the transflective film and the backlight, the restored light is transmitted through the transflective film repeatedly, so that transmissivity and light efficiency are enhanced.

[0132] Further, the transmissive and reflective type LCD has no reflection electrode within LC cell and no  $\frac{1}{4}$ -wave-length phase difference plate on each of the upper substrate (second substrate) and the lower substrate (first substrate). Accordingly, compared with the conventional transmissive and reflective type LCD, the transmissive and reflective type LCD of the present invention can be made in more simple structure.

[0133] Furthermore, since the optical conditions applied to the liquid crystal of the conventional transmissive and reflective type LCD can be identically applied to that of the transmissive and reflective type LCD of the present invention, degeneration in the reliability of the liquid crystal can be prevented.

[0134] While the present invention has been described in detail, it should be understood that various changes, substi-

tutions and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A transmissive and reflective type LCD comprising:
  - a first substrate;
  - a second substrate having an inner surface that is arranged so as to face the first substrate;
  - a liquid crystal layer formed between the first substrate and the second substrate;
  - a first polarizing plate formed on an outer surface of the first substrate;
  - a second polarizing plate formed on an outer surface of the second substrate, the outer surface being opposite to the inner surface of the second substrate;
  - a backlight arranged at a rear side of the first polarizing plate; and
  - a transparent transflective film arranged between the first polarizing plate and the backlight, said transparent transflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transflective film partially reflecting and partially transmitting incident lights.

2. The transmissive and reflective type LCD of claim 1, wherein the transflective film is integrally formed with the first polarizing plate.

3. The transmissive and reflective type LCD of claim 1, wherein the transflective film is separately formed from the first polarizing plate.

4. The transmissive and reflective type LCD of claim 1, wherein the first layer of the transflective film has a refractive anisotropy and the second layer of the transflective film does not have the refractive anisotropy within a plane thereof.

5. The transmissive and reflective type LCD of claim 1, wherein the transflective film has an anisotropy characteristic having various transmissivity and reflectivity depending on a polarizing state and a direction of the incident light.

6. The transmissive and reflective type LCD of claim 5, when it is assumed that the transflective film has a thickness direction of z-axis and a film plane of x-y plane, wherein each of the first layer and the second layer has three main refractive indexes of  $n_x$ ,  $n_y$  and  $n_z$  that satisfy the following relationships:

$$\begin{aligned} n1_x &= n1_z \neq n1_y; \\ n2_x &= n2_y = n2_z; \\ n1_x &\neq n2_x; \\ n1_y &\neq n2_y; \text{ and} \\ |n1_x - n2_x| &< |n1_y - n2_y| \end{aligned}$$

wherein  $n1_x$ ,  $n1_y$ ,  $n1_z$  denotes a main refractive index of the first layer in an x-axis, y-axis, z-axis, respectively, and  $n2_x$ ,  $n2_y$ ,  $n2_z$  denotes a main refractive index of the second layer in an x-axis, y-axis, z-axis, respectively.

7. The transmissive and reflective type LCD of claim 1, wherein the transflective film has isotropic transmission and reflection characteristics regardless of a polarizing state and a direction of the incident light.

**8.** The transmissive and reflective type LCD of claim 7, when it is assumed that the transflective film has a thickness direction of z-axis and a film plane of x-y plane, wherein each of the first layer and the second layer has three main refractive indexes of  $n_x$ ,  $n_y$  and  $n_z$  that satisfy the following relationships:

$$n_{1x}=n_{1y}=n_{1z}; \text{ and}$$

$$n_{2x}=n_{2y}=n_{2z}\neq n_{1z},$$

wherein  $n_{1x}$ ,  $n_{1y}$ ,  $n_{1z}$  denotes a main refractive index of the first layer in an x-axis, y-axis, z-axis, respectively, and  $n_{2x}$ ,  $n_{2y}$ ,  $n_{2z}$  denotes a main refractive index of the second layer in an x-axis, y-axis, z-axis, respectively.

**9.** The transmissive and reflective type LCD of claim 1, wherein the transflective film comprises two transflective films having various transmissivity and reflectivity depending on a polarizing state and a direction of the incident light, the two transflective films being vertically attached to each other.

**10.** The transmissive and reflective type LCD of claim 1, wherein the transflective film comprises a first transflective film and a second transflective film attached to each other, the first transflective film having a transmissivity and a reflectivity that vary according to a polarizing state and a direction of the incident light, and the second transflective film having isotropic transmission and reflection characteristics regardless of the polarizing state and the direction of the incident light.

**11.** The transmissive and reflective type LCD of claim 1, when the incident light is incident into the transflective film with an angle perpendicular to a surface thereof, wherein the transflective film has a reflectivity of no less than about 4% with respect to all directions of polarization components.

**12.** The transmissive and reflective type LCD of claim 1, further comprising a light scattering layer formed on the first substrate or the second substrate.

**13.** The transmissive and reflective type LCD of claim 12, wherein the light scattering layer is formed between the first substrate and the first polarizing plate, between the second substrate and the second polarizing plate, or between the first polarizing plate and the transflective film.

**14.** The transmissive and reflective type LCD of claim 1, further comprising a phase difference plate formed on the first substrate or the second substrate.

**15.** The transmissive and reflective type LCD of claim 14, wherein the phase difference plate is formed between the first substrate and the first polarizing plate, or between the second substrate and the second polarizing plate.

**16.** The transmissive and reflective type LCD of claim 1, wherein the liquid crystal layer has a  $\Delta n$  of about 0.2-0.6  $\mu m$  that is a product of a refractive anisotropy  $\Delta n$  and a thickness  $d$  of the liquid crystal layer.

**17.** A transmissive and reflective type LCD comprising:

an LC cell including a first substrate, a second substrate having an inner surface that is arranged to face the first substrate, and a liquid crystal layer formed between the first substrate and the second substrate;

a first polarizing plate formed on an outer surface of the first substrate;

a second polarizing plate formed on an outer surface of the second substrate that oppositely faces the inner surface of the second substrate;

a backlight arranged at a rear side of the first polarizing plate; and

a transparent transflective film arranged between the first polarizing plate and the backlight and having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked,

wherein the transmissive and reflective type LCD has a reflection light path along which a first incident light beam is incident into the LC cell from a front side of the LC cell, is reflected by the transflective film, and is outputted through the front side of the LC cell,

and a transmission light path along which a second incident light beam is incident into the LC cell from a rear side of the LC cell, is transmitted through the transflective film, and is outputted through the front side of the LC cell.

**18.** The transmissive and reflective type LCD of claim 17, wherein the first layer of the transflective film has a refractive anisotropy and the second layer of the transflective film does not have the refractive anisotropy.

**19.** The transmissive and reflective type LCD of claim 17, wherein the transflective film has an anisotropy characteristic of various transmissivity and reflectivity depending on a polarizing state and a direction of the incident light.

**20.** The transmissive and reflective type LCD of claim 19, when it is assumed that the transflective film has a thickness direction of z-axis and a film plane of x-y plane, wherein each of the first layer and the second layer has three main refractive indexes of  $n_x$ ,  $n_y$  and  $n_z$  that satisfy the following relationships:

$$n_{1x}=n_{1z}\neq n_{1y};$$

$$n_{2x}=n_{2y}=n_{2z};$$

$$n_{1x}\neq n_{2x};$$

$$n_{1y}\neq n_{2y}; \text{ and}$$

$$|n_{1x}-n_{2x}|<|n_{1y}-n_{2y}|.$$

wherein  $n_{1x}$ ,  $n_{1y}$ ,  $n_{1z}$  denotes a main refractive index of the first layer in an x-axis, y-axis, z-axis, respectively, and  $n_{2x}$ ,  $n_{2y}$ ,  $n_{2z}$  denotes a main refractive index of the second layer in an x-axis, y-axis, z-axis, respectively.

**21.** The transmissive and reflective type LCD of claim 17, wherein the transflective film has isotropic transmission and reflection characteristics regardless of a polarizing state and a direction of the incident light.

**22.** The transmissive and reflective type LCD of claim 21, when it is assumed that the transflective film has a thickness direction of z-axis and a film plane of x-y plane, wherein each of the first layer and the second layer has three main refractive indexes of  $n_x$ ,  $n_y$  and  $n_z$  that satisfy the following relationships:

$$n_{1x}=n_{1y}=n_{1z}; \text{ and}$$

$$n_{2x}=n_{2y}=n_{2z}\neq n_{1z}.$$

wherein  $n_{1x}$ ,  $n_{1y}$ ,  $n_{1z}$  denotes a main refractive index of the first layer in an x-axis, y-axis, z-axis, respectively, and  $n_{2x}$ ,  $n_{2y}$ ,  $n_{2z}$  denotes a main refractive index of the second layer in an x-axis, y-axis, z-axis, respectively.

**23.** The transmissive and reflective type LCD of claim 17, wherein the transflective film comprises two transflective films having various transmissivity and reflectivity depend-

ing on a polarizing state and a direction of the incident light, the two transflective films being vertically attached to each other.

**24.** The transmissive and reflective type LCD of claim 17, wherein the transflective film comprises a first transflective film and a second transflective film attached to each other, the first transflective film having a transmissivity and a reflectivity that varying with a polarizing state and a direction of the incident light, and the second transflective film having isotropic transmission and reflection characteristics regardless of the polarizing state and the direction of the incident light.

**25.** The transmissive and reflective type LCD of claim 17, when the incident light is incident into the transflective film with an angle perpendicular to a plane thereof, wherein the transflective film has a reflectivity of no less than about 4% with respect to all directions of polarization components.

**26.** The transmissive and reflective type LCD of claim 17, further comprising a light scattering layer formed on the first substrate or the second substrate.

**27.** A transmissive and reflective type LCD comprising:

- a first substrate on which a first transparent electrode is formed;
- a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a second transparent electrode thereon;
- a liquid crystal layer formed between the first substrate and the second substrate;
- a first polarizing plate formed on an outer surface of the first substrate;
- a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate;
- a backlight arranged at a rear side of the first polarizing plate; and
- a transparent transflective film arranged between the first polarizing plate and the backlight, said transparent transflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transflective film partially reflecting and partially transmitting incident lights.

**28.** The transmissive and reflective type LCD of claim 27, wherein the first transparent electrode is a signal electrode and the second transparent electrode is a scanning electrode.

**29.** A transmissive and reflective type LCD comprising:

- a first substrate on which a switching element and a transparent pixel electrode connected to the switching element are formed;
- a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon;
- a liquid crystal layer formed between the first substrate and the second substrate;
- a first polarizing plate formed on an outer surface of the first substrate;

a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate;

a backlight arranged at a rear side of the first polarizing plate; and

a transparent transflective film arranged between the first polarizing plate and the backlight, said transparent transflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transflective film partially reflecting and partially transmitting incident lights.

**30.** The transmissive and reflective type LCD of claim 29, wherein the switching element is a thin film transistor.

**31.** A transmissive and reflective type LCD comprising:

a first substrate including a gate line formed on an insulating substrate, a data line insulated from the gate line and arranged to intersect the gate line, and a pixel electrode electrically connected to the data line;

a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon;

a liquid crystal layer formed between the first substrate and the second substrate;

a first polarizing plate formed on an outer surface of the first substrate;

a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate;

a backlight arranged at a rear side of the first polarizing plate; and

a transparent transflective film arranged between the first polarizing plate and the backlight, said transparent transflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transflective film partially reflecting and partially transmitting incident lights.

**32.** The transmissive and reflective type LCD of claim 31, wherein the transparent transflective film has an anisotropy characteristic having various transmissivity and reflectivity depending on a polarizing state and a direction of the incident light.

**33.** The transmissive and reflective type LCD of claim 31, wherein the transparent transflective film has isotropic transmission and reflection characteristics regardless of a polarizing state and a direction of the incident light.

**34.** The transmissive and reflective type LCD of claim 31, wherein the transflective film comprises two transflective films having various transmissivity and reflectivity depending on a polarizing state and a direction of the incident light, the two transflective films being vertically attached to each other.

**35.** The transmissive and reflective type LCD of claim 31, wherein the transflective film comprises a first transflective film and a second transflective film attached to each other, the first transflective film having a transmissivity and a reflectivity that vary according to a polarizing state and a direction of the incident light, and the second transflective

film having isotropic transmission and reflection characteristics regardless of the polarizing state and the direction of the incident light.

**36.** The transmissive and reflective type LCD of claim 31, when the incident light is incident into the transreflective film with an angle perpendicular to a surface thereof, wherein the transreflective film has a reflectivity of no less than about 4% with respect to all directions of polarization components.

**37.** A transmissive and reflective type LCD comprising:

a first substrate including i) a thin film transistor having a gate electrode formed on an insulating substrate, a gate insulating layer formed on the gate electrode and on the insulating substrate, an active pattern formed on the gate insulating layer to be disposed above the gate electrode, and a source electrode and a drain electrode separately formed on the active pattern each other, and ii) a pixel electrode electrically connected to one of the source electrode and the drain electrode;

a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon;

a liquid crystal layer formed between the first substrate and the second substrate;

a first polarizing plate formed on an outer surface of the first substrate;

a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate;

a backlight arranged at a rear side of the first polarizing plate; and

a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**38.** The transmissive and reflective type LCD of claim 37, wherein the active pattern is comprised of polycrystalline silicon.

**39.** The transmissive and reflective type LCD of claim 37, wherein the active pattern is comprised of amorphous silicon.

**40.** A transmissive and reflective type LCD comprising:

a first substrate including i) a thin film transistor having an active pattern formed on an insulating substrate, a gate insulating layer formed on the active pattern and on the insulating substrate, a gate electrode formed on the gate insulating layer to be disposed above the active pattern, an interinsulation layer formed on the gate electrode and the gate insulating layer, and a source electrode and a drain electrode separately formed on the interinsulation layer each other, and ii) a pixel electrode electrically connected to one of the source electrode and the drain electrode;

a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon;

a liquid crystal layer formed between the first substrate and the second substrate;

a first polarizing plate formed on an outer surface of the first substrate;

a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate;

a backlight arranged at a rear side of the first polarizing plate; and

a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**41.** The transmissive and reflective type LCD of claim 40, wherein the active pattern is comprised of polycrystalline silicon.

**42.** The transmissive and reflective type LCD of claim 40, wherein the active pattern is comprised of amorphous silicon.

**43.** A transmissive and reflective type LCD comprising:

a first substrate including i) a display cell array circuit formed on an insulating substrate, a plurality of data lines and a plurality of gate lines arranged in a matrix shape to intersect each other on the display cell array circuit, and ii) a gate driver circuit, formed adjacent to a first portion of the display cell array circuit, for driving the gate lines;

a second substrate of which an inner surface is arranged so as to face the first substrate, the inner surface of the second substrate having a transparent common electrode thereon;

a liquid crystal layer formed between the first substrate and the second substrate;

a first polarizing plate formed on an outer surface of the first substrate;

a second polarizing plate formed on an outer surface of the second substrate oppositely facing the inner surface of the second substrate;

a backlight arranged at a rear side of the first polarizing plate; and

a transparent transreflective film arranged between the first polarizing plate and the backlight, said transparent transreflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternatively stacked, the transparent transreflective film partially reflecting and partially transmitting incident lights.

**44.** The transmissive and reflective type LCD of claim 43, further comprising a data driver circuit, formed adjacent to a second portion of the display cell array circuit, for driving the data lines.

专利名称(译)	透射和反射型液晶显示器		
公开(公告)号	<a href="#">US20030112391A1</a>	公开(公告)日	2003-06-19
申请号	US10/322812	申请日	2002-12-18
[标]申请(专利权)人(译)	三星电子株式会社		
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IPC分类号	G02F1/1335 G02F1/13357		
CPC分类号	G02F1/133555 G02F2001/133567 G02F1/133615		
优先权	1020010080714 2001-12-18 KR 1020020039499 2002-07-08 KR		
其他公开文献	US6937303		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

### 摘要(译)

公开了一种透射和反射型LCD。在LCD中，第二基板面向第一基板。在第一和第二基板之间形成液晶层。第一偏振板形成在第一基板的外表面上。在第二基板的外表面上形成第二偏振板。背光设置在第一偏振板的后侧。透明半透半反膜设置在第一偏振板和背光之间，并且具有多个层，其中交替堆叠各自具有不同折射率的第一层和第二层。透明半透半反膜部分地反射并透射入射光。通过在透射反射膜和背光之间发生的恢复过程，预定量的入射光反复透射穿过透反射膜，从而提高透射率和光效率。

