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(54) **Transparent display**

(57) The present invention provides a transparent display comprising a light source (170); a first liquid crystal layer (140) for transmitting a first part of the light emitted from the light source having a first polarisation state and reflecting a second part of the light emitted from the light source having a second polarisation state; a light-transmissive image display device including a second liquid crystal layer (130) arranged so that the second part of the light is incident on the second liquid crystal layer (130); wherein when the light-transmissive image display device is in a first state, the second part of the light is

transmitted through the second liquid crystal layer (130); and when the light-transmissive image display device is in a second state, the second part of the light is reflected by the second liquid crystal layer (130), so that an image can be generated in the first state and the light-transmissive image display device appears transmissive in the second state. Since the transparent display can realize the function of a transparent display without the use of a sheet polarizer or a light guide plate, the light transmittance can be improved.

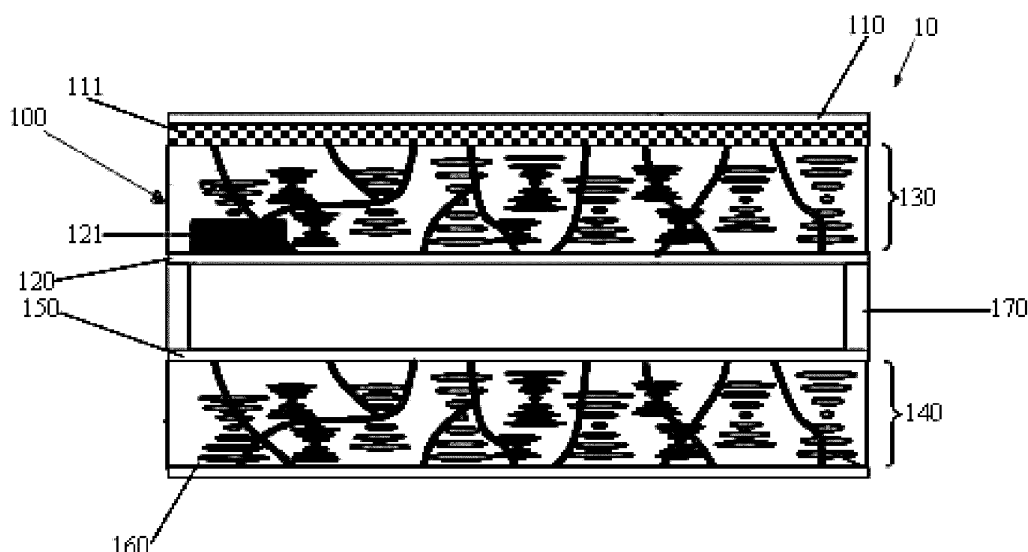


Fig. 1

Description**FIELD OF THE INVENTION**

5 **[0001]** The present invention relates to the technical field of liquid crystal display, and in particular, to a transparent display.

DESCRIPTION OF THE PRIOR ART

10 **[0002]** Recently, with the development of information technology, transparent display technology gains more and more attention. A transparent display has a certain degree of penetrability, wherein when a voltage is applied, information may be displayed on the display screen, and when no voltage is applied, the background image behind the displayed image may be seen through the display screen, thus it is suitable for the windows of a building and a vehicle, as well as the shop windows. In addition to the inherent display function, it further has the features of a future display which provides
15 information, thus it gains the attention of the market. And in the further, it is likely to replace a part of the market that uses a display, including buildings, advertisings and public utilities.

20 **[0003]** In the basic construction of an existing transparent display, a back light source is installed on a side edge of a transparent light guide plate, then the transparent light guide plate is combined with a liquid crystal panel; a light transmitted to the liquid crystal layer is rotated and delayed via an upper sheet polarizer and a lower sheet polarizer; and by controlling the light rotation direction of the upper sheet polarizer and the lower sheet polarizer, the state of a light is made different after it transmits through vertically-arranged liquid crystal molecules or rotatory liquid crystal molecules, and the display panel can realize a normal black mode or a normal white mode, for displaying an image information or being transparent. However, for a transparent display device with such structure in the prior art, due to the employing of a sheet polarizer and a light guide plate, the light transmittance cannot meet the requirement sometimes, that is, the transparent display
25 state of the display screen is not good.

SUMMARY OF THE INVENTION

30 **[0004]** The object of the technical solutions of the invention is to provide a transparent display, which can solve the problem of low light transmittance of an existing transparent display due to the employing of a sheet polarizer and a light guide plate.

35 **[0005]** One aspect of the invention provides a transparent display, wherein the transparent display includes:

40 **[0006]** a light source;

45 **[0007]** a first liquid crystal layer, for transmitting a first part of the light emitted from the light source and reflecting a second part of the light emitted from the light source;

50 **[0008]** a light-transmittable image display device including a second liquid crystal layer, wherein the first part of the light is emitted to the second liquid crystal layer, when the image display device is in a first state, the first part of the light is transmitted through the second liquid crystal layer, and the image display device displays an image; when the image display device is in a second state, the first part of the light is reflected by the second liquid crystal layer, and the image display device becomes transparent.

55 **[0009]** Preferably, in the above transparent display, the light source is set between the first liquid crystal layer and the image display device, and one such light source is individually set on both side edges of the region between the first liquid crystal layer and the image display device.

60 **[0010]** Preferably, in the above transparent display, a cholesteric-phase liquid crystal with a first screw pitch is formed on the first liquid crystal layer and the second liquid crystal layer, respectively.

65 **[0011]** Preferably, in the above transparent display, the first liquid crystal layer and the second liquid crystal layer individually include a cholesteric-phase liquid crystal with a left-hand screw pitch structure, the first part of the light is a right-handed light, and the second part of the light is a left-handed light.

70 **[0012]** Preferably, in the above transparent display, the image display device further comprises:

75 **[0013]** a first substrate with a first light transmittance including a color film layer; and

80 **[0014]** a second substrate with a second light transmittance including a thin-film transistor layer, wherein the second substrate and the first substrate is set opposite to each other;

85 **[0015]** wherein, the second liquid crystal layer is set between the first substrate and the second substrate.

90 **[0016]** Preferably, in the above transparent display, when a voltage is applied to the second liquid crystal layer, the image display device will be in the first state; when no voltage is applied to the second liquid crystal layer, the image display device will be in the second state.

95 **[0017]** Preferably, in the above transparent display, the first liquid crystal layer is set via a third substrate with a third light transmittance and a fourth substrate with a fourth light transmittance, and the third substrate is opposite to the fourth

substrate.

[0018] Preferably, in the above transparent display, the first liquid crystal layer and the second liquid crystal layer individually include a cholesteric-phase liquid crystal with a right-hand screw pitch structure, the first part of the light is a left-handed light, and the second part of the light is a right-handed light.

[0019] At least one of the above technical solutions of the specific embodiments of the invention has the following beneficial effects:

[0020] The transparent display according to one specific embodiment of the invention can realize the function of a transparent display without using a sheet polarizer or a light guide plate, and thus in comparison with the transparent display of the prior art, the transparent display according to the invention has a greatly-improved light transmittance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Fig.1 shows a structural representation of the transparent display according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] To make the objects, the technical solutions and the advantages of the invention more apparent, the invention will be described in detail below in conjunction with the drawings and specific embodiments.

[0023] The transparent display according to one specific embodiment of the invention includes:

[0024] a light source;

[0025] a first liquid crystal layer, for transmitting a first part of the light emitted from the light source and reflecting a second part of the light emitted from the light source; and

[0026] a light-transmittable image display device, which includes a second liquid crystal layer, wherein the first part of the light is emitted to the second liquid crystal layer, when the image display device is in a first state, the first part of the light is transmitted through the second liquid crystal layer, and the image display device displays an image; when the image display device is in a second state, the first part of the light is reflected by the second liquid crystal layer, and the image display device becomes transparent.

[0027] Preferably, a cholesteric-phase liquid crystal can be formed on the first liquid crystal layer and the second liquid crystal layer respectively. By utilizing the features of the cholesteric-phase liquid crystal (light transmission and light scattering are mainly determined by the screw pitch, and only a light beam with a screw direction different from that of the cholesteric-phase liquid crystal can pass through a macromolecular liquid crystal (of which the reflectivity and the transmissivity are both approximately 50%), for example, for a cholesteric-phase liquid crystal with a right-hand screw pitch structure that has a screw pitch approximate to the wavelength of an incident light, when a left-handed light enters, light transmission occurs; when a right-handed light enters, a light scattering the same as Bragg (Fiber Bragg Grating) reflection occurs), after the first liquid crystal layer receives an incident light emitted from the light source, a first part of the light is transmitted, a second part of the light is reflected, and after the second liquid crystal layer receives the first part of the light, the light can be made to be transmitted, and the image display device displays an image, or the light can be made to be reflected, and the image display device becomes transparent, thereby the function of a transparent display can be realized.

[0028] For the transparent display according to an embodiment of the invention, neither a sheet polarizer nor a light guide plate needs to be used in the realization theory thereof. Therefore, in comparison with the prior art, the light transmittance can be improved greatly.

[0029] The structure of the transparent display according to an embodiment of the invention will be described in detail below.

[0030] Fig.1 is a structural representation of a transparent display according to an embodiment of the invention. As shown in Fig.1, the transparent display 10 includes an image display device 100, wherein the image display device 100 includes:

[0031] a first substrate 110 with a first light transmittance, which can make the first substrate 110 to meet a light transmission requirement, wherein a color film layer 111 is formed on the first substrate 110;

[0032] a second substrate 120 with a second light transmittance, which can make the second substrate 120 to meet a light transmission requirement, wherein a thin-film transistor (TFT) layer 121 is formed on the second substrate 120, and the first substrate 110 is set opposite to the second substrate 120; similarly, in order to meet the light transmission requirement, both of the color film layer 111 and the TFT layer 121 has a transparent electrode; and

[0033] a second liquid crystal layer 130, which is set between the first substrate 110 and the second substrate 120.

[0034] The first substrate 110, the second substrate 120 and the second liquid crystal layer 130 construct an ordinary image display device, wherein, when a light beam passes through the second liquid crystal layer 130, by applying a voltage control, the liquid crystal molecules on the second liquid crystal layer 130 are arranged along the direction of an electric field, and an image is generated.

[0035] As shown in Fig.1, the transparent display 10 further includes:

[0036] a third substrate 150 with a third light transmittance and a fourth substrate 160 with a fourth light transmittance, wherein the third substrate 150 and the fourth substrate 160 are opposite to and parallel with each other; similarly, the third light transmittance makes the third substrate 150 to meet a light transmission requirement, and the fourth light transmittance makes the fourth substrate 160 to meet a light transmission requirement;

[0037] a first liquid crystal layer 140, which is set between the third substrate 150 and the fourth substrate 160, and liquid crystal molecules are enveloped by the third substrate 150 and the fourth substrate 160 to form the first liquid crystal layer 140; and

[0038] a light source 170, which is set between the image display device 100 and the first liquid crystal layer 140, and one such light source 170 is individually set on both side edges the region between the image display device 100 and the first liquid crystal layer 140.

[0039] In the embodiment of the invention, a left-hand cholesteric-phase liquid crystal with a first screw pitch is formed on the first liquid crystal layer 140 and the second liquid crystal layer 130 respectively.

[0040] By utilizing the features of the left-hand cholesteric-phase liquid crystal, when a light emitted from the light source 170 is transmitted to the first liquid crystal layer 140, only a light beam with a screw direction different from that of the cholesteric-phase liquid crystal can pass through the macromolecular liquid crystal, thus when a left-handed light from the light source 170 irradiates on the first liquid crystal layer 140, a reflection occurs; and when a right-handed light from the light source 170 irradiates on the first liquid crystal layer 140, a transmission occurs.

[0041] Based on the structure shown in Fig.1, the left-handed light reflected by the first liquid crystal layer 140 can be transmitted to the second liquid crystal layer 130, wherein, when no voltage is applied to the second liquid crystal layer 130, the second liquid crystal layer 130 reflects the left-handed light but transmits the right-handed light, that is, the left-handed light reflected by the first liquid crystal layer 140 is reflected by the second liquid crystal layer 130, the second liquid crystal layer 130 is in a dark state, and the image display device 100 becomes transparent; when a voltage is applied to the second liquid crystal layer 130, the second liquid crystal layer 130 transmits both the left-handed light and the right-handed light, that is, the left-handed light reflected by the first liquid crystal layer 140 can be transmitted through the second liquid crystal layer 130, the second liquid crystal layer 130 is in a bright state, and the image display device 100 displays an image.

[0042] Table 1 shows the relationship between the states of the image display device 100 when a voltage is applied or not and its display states.

Table 1

	A voltage is applied		No voltage is applied	
Light Source	Left-handed light	Right-handed light	Left-handed light	Right-handed light
First liquid crystal layer	Reflected	Transmitted	Reflected	Transmitted
Second liquid crystal layer	Transmitted	-	Reflected	-
Display State	Bright State (An image is displayed)		Dark State (No image is displayed, being transparent)	

[0043] It may be understood by a person skilled in the art that, the first liquid crystal layer 140 and the second liquid crystal layer 130 are not limited to a cholesteric-phase liquid crystal with a left-hand screw pitch; instead, they may be a cholesteric-phase liquid crystal with a right-hand screw pitch. The operation theory thereof will be the same as the above cholesteric-phase liquid crystal with a left-hand screw pitch, so it will not be described again here.

[0044] The transparent display with the structure shown in Fig.1 according to an embodiment of the invention may be manufactured by the following steps:

[0045] Step 1: A transparent first substrate 110 is prepared, and a color film layer 111 is formed on the first substrate 110;

[0046] Step 2: A transparent second substrate 120 is prepared, and a TFT layer 121 is formed on the second substrate 120;

[0047] Step 3: A nematic-phase liquid crystal in the form of a chiral ionic liquid, a polymerisable monomer and an initiator are added to the region between the first substrate 110 and the second substrate 120, an ultraviolet light irradiation is carried out at a temperature 10 degrees above the cholesteric-phase and smectic A phase transition temperature of the liquid crystal, and a second liquid crystal layer 130 with a left-hand screw pitch is obtained;

[0048] Step 4: A third substrate 150 and a fourth substrate 160 that are both transparent are set opposite to each other, and a Polyimide (PI) liquid is coated on the third substrate 150 and the fourth substrate 160; after the PI is solidified, the surface of the PI film is polished, so that it forms a parallel alignment on the substrate;

[0049] Step 5: A polymerisable liquid crystalline monomer and a photoinitiator are added to the region between the third substrate 150 and the fourth substrate 160, and ultraviolet light irradiation is carried out at a temperature 10 degrees above the cholesteric-phase and smectic A phase transition temperature, so that a first liquid crystal layer 140 with a left-hand screw pitch is obtained; and

[0050] Step 6: A light source 170 is set between the third substrate 150 and the second substrate 120.

[0051] For the transparent display according to an embodiment of the invention, the function of a transparent display can be realized without the use of a sheet polarizer or a light guide plate. Therefore, in comparison with the transparent display of the prior art, the light transmittance can be improved greatly.

[0052] The above only describes some preferred embodiments of the invention. It should be pointed out that, for a person skilled in the art, various variations and modifications may also be made without departing from the principles of the invention, and all these variations and modifications should be considered to fall within the protection scope of the invention.

Claims

1. A transparent display, comprising:

a light source;

a first liquid crystal layer, for transmitting a first part of the light emitted from the light source and reflecting a second part of the light emitted from the light source; and

a light-transmittable image display device including a second liquid crystal layer, wherein the first part of the light is emitted to the second liquid crystal layer, when the image display device is in a first state, the first part of the light is transmitted through the second liquid crystal layer, and the image display device displays an image; when the image display device is in a second state, the first part of the light is reflected by the second liquid crystal layer, and the image display device becomes transparent.

2. The transparent display according to claim 1, wherein the light source is set between the first liquid crystal layer and the image display device, and one such light source is individually set on both side edges of the region between the first liquid crystal layer and the image display device.

3. The transparent display according to claim 1, wherein a cholesteric-phase liquid crystal with a first screw pitch is formed on the first liquid crystal layer and the second liquid crystal layer, respectively.

4. The transparent display according to claim 3, wherein the first liquid crystal layer and the second liquid crystal layer individually include a cholesteric-phase liquid crystal with a left-hand screw pitch structure, the first part of the light is a right-handed light, and the second part of the light is a left-handed light.

5. The transparent display according to claim 1, wherein the image display device further comprises:

a first substrate with a first light transmittance including a color film layer; and

a second substrate with a second light transmittance including a thin-film transistor layer, wherein both the second substrate and the first substrate are set opposite to each other;

wherein the second liquid crystal layer is set between the first substrate and the second substrate.

6. The transparent display according to claim 1, wherein when a voltage is applied to the second liquid crystal layer, the image display device will be in the first state; when no voltage is applied to the second liquid crystal layer, the image display device will be in the second state.

7. The transparent display according to claim 1, wherein the first liquid crystal layer is set via a third substrate with a third light transmittance and a fourth substrate with a fourth light transmittance, and both the third substrate and the fourth substrate are opposite to each other.

8. The transparent display according to claim 3, wherein the first liquid crystal layer and the second liquid crystal layer individually include a cholesteric-phase liquid crystal with a right-hand screw pitch structure, the first part of the light is a left-handed light, and the second part of the light is a right-handed light.

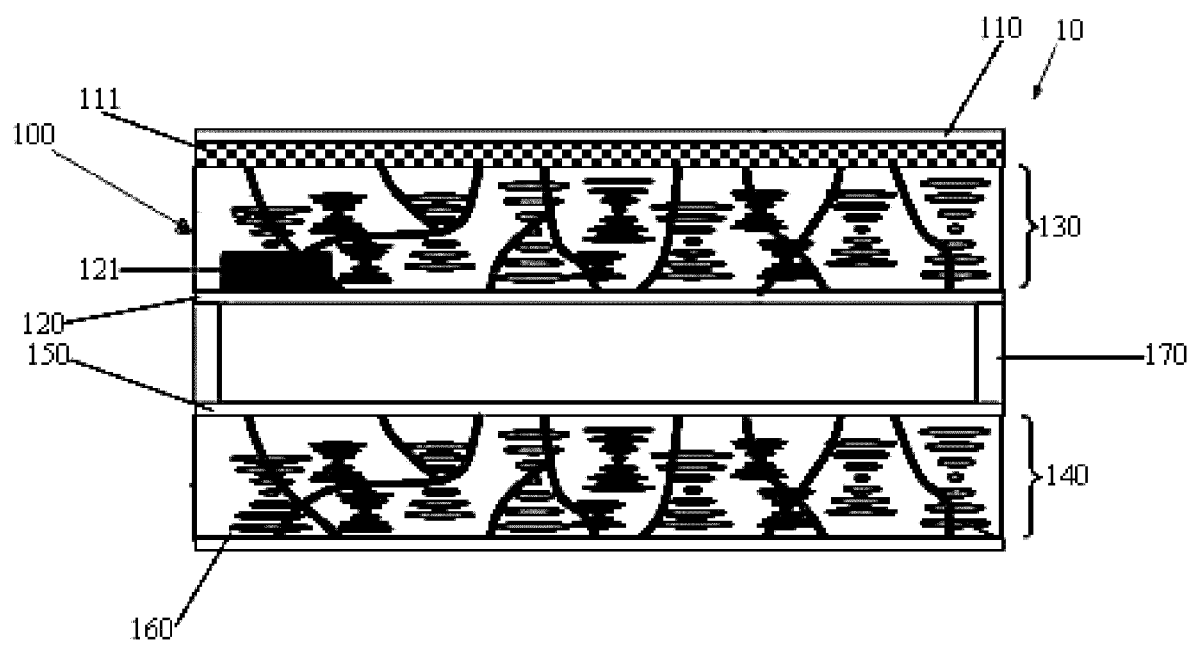


Fig. 1



EUROPEAN SEARCH REPORT

Application Number
EP 13 19 3653

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 97/05520 A1 (SCREEN TECH LTD [GB]; CROSSLAND WILLIAM ALDEN [GB]; DAVEY ANTHONY BERN) 13 February 1997 (1997-02-13)	1	INV. G02F1/1335 G02F1/137 A47F11/06
A	* abstract * * page 7, line 3 - page 8, line 5 * * figure 2 *	2-8	ADD. G02F1/13
A	WO 2012/154236 A1 (ANTHONY INC [US]; ARTWOHL PAUL J [US]; SANDNES MARK [US]; ROCHE JOHN M) 15 November 2012 (2012-11-15) * abstract * * paragraph [0026] * * figures 1,4 *	1-8	
A	US 6 671 008 B1 (LI LE [US] ET AL) 30 December 2003 (2003-12-30) * abstract * * column 13, line 9 - line 23 * * column 23, line 56 - column 24, line 19 * * figures 2,13,14 *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			G02F A47F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 March 2014	Examiner Hauser, Markus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 19 3653

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9705520 A1	13-02-1997	AU 6627096 A	26-02-1997
		EP 0842454 A1	20-05-1998
		JP H11510267 A	07-09-1999
		WO 9705520 A1	13-02-1997

WO 2012154236 A1	15-11-2012	CA 2835424 A1	15-11-2012
		EP 2707661 A1	19-03-2014
		US 2012285089 A1	15-11-2012
		WO 2012154236 A1	15-11-2012

US 6671008 B1	30-12-2003	NONE	

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摘要(译)

本发明提供一种透明显示器，包括光源（170）；第一液晶层（140），用于透射从具有第一偏振态的光源发出的光的第一部分，并反射从具有第二偏振态的光源发出的光的第二部分；一种透光图像显示装置，包括第二液晶层，所述第二液晶层设置成使得第二部分光入射在第二液晶层上。其中，当透光图像显示装置处于第一状态时，第二部分光透过第二液晶层（130）；当透光图像显示装置处于第二状态时，第二部分光被第二液晶层（130）反射，从而可以在第一状态和透光图像中产生图像显示设备在第二状态下具有传输性。由于透明显示器可以在不使用片状偏振器或导光板的情况下实现透明显示器的功能，因此可以提高透光率。

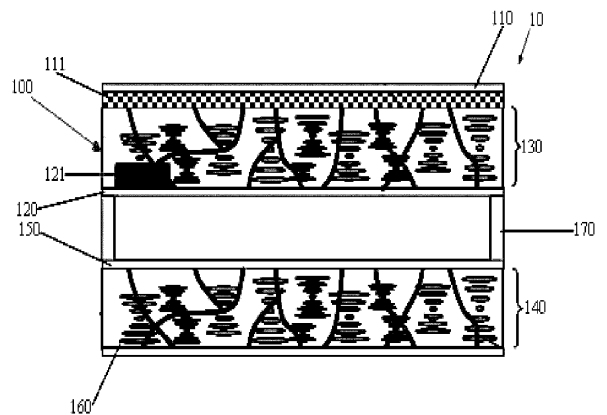


Fig. 1