

(19)



(11)

EP 2 813 887 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
06.02.2019 Bulletin 2019/06

(51) Int Cl.:
G02F 1/1343 (2006.01)

(21) Application number: **14182241.1**

(22) Date of filing: **06.08.2013**

(54) **Color filter substrate, liquid crystal panel and liquid crystal display device**

Farbfiltersubstrat, Flüssigkristalltafel und Flüssigkristallanzeigevorrichtung

Substrat de filtre coloré, panneau à cristaux liquides et dispositif d'affichage à cristaux liquides

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **10.08.2012 CN 201210285759**

(43) Date of publication of application:
17.12.2014 Bulletin 2014/51

(62) Document number(s) of the earlier application(s) in
accordance with Art. 76 EPC:
13179341.6 / 2 696 239

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EP 2 813 887 B1

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Description

FIELD OF THE ART

[0001] Embodiments of the invention relate to the field of liquid crystal display, more specifically, to a color filter substrate, a liquid crystal panel and a liquid crystal display (LCD) device.

BACKGROUND

[0002] LCD devices are categorized into vertical electric field (E-field) LCD devices and horizontal E-field LCD devices, based on the direction of the E-field driving the liquid crystals. The vertical E-field LCD devices generally include Twist Nematic (TN) mode and vertical alignment (VA) mode, while the horizontal E-field LCD devices generally include in-plane switching (IPS) mode, fringe field switching (FFS) mode and advanced super dimension switching (ADS) mode. In comparison with the vertical E-field LCD devices, the horizontal E-field LCD devices do not require additional optical compensation films to realize wide view angle. However, the distribution of the E-field in the liquid crystal layer of the horizontal E-field LCD device is not uniform and there are local regions not covered by the E-field and therefore non-transmissive for the light, which makes the overall light transmissivity of the liquid crystal panel low.

US 2008/129901A1 of You et al. entitled "Liquid Crystal Display Panel" filed on October 31, 2007, discloses a liquid crystal panel, including an array substrate having a first pixel electrode and a first common electrode, and an opposite substrate facing the array substrate, the opposite substrate including a second pixel electrode and a second common electrode, and the second pixel electrode receives a pixel voltage from the first pixel electrode. A similar display device is disclosed in CN 101943829 A; both substrates comprise a respective pixel and a common electrode.

SUMMARY

[0003] The present invention aims to provide a color filter substrate, a liquid crystal panel and a liquid crystal display device so as to increase light transmissivity of the liquid crystal panel.

[0004] To meet the above purpose, the invention provides the following technical solutions.

[0005] The invention provides a liquid crystal display panel as defined in claim 1, inter alia comprising an array substrate, a color filter substrate, and a liquid crystal layer formed between the array substrate and the color filter substrate, wherein a plurality of first strip-shaped pixel electrodes and first strip-shaped common electrodes are arranged alternately on the array substrate and a plurality of sets of electrode structures comprising second pixel and second common electrodes are arranged on a surface of the color filter substrate.

[0006] According to claim 2, in any two neighboring sets of electrode structure, the distance between the second pixel electrode and the second common electrode is the same.

5 **[0007]** According to claim 3, each of the second pixel electrode and the second common electrode has a width of 2~3 μ m;

[0008] the distance between the second pixel electrode and the second common electrode is 2~5 μ m.

10 **[0009]** In the above liquid crystal panel, in any two neighboring sets of electrode structure on the color filter substrate, the second pixel electrode and the second common electrode are disposed in opposite order.

15 **[0010]** In the above liquid crystal panel, a distance between the second pixel electrode and the neighboring second common electrode of the electrode structure is smaller than a distance between the first pixel electrode and the neighboring first common electrode.

20 **[0011]** In the above liquid crystal panel, the first pixel electrode, each of the second pixel electrode, the first common electrode and the second common electrode has a width of 2~3 μ m;

25 **[0012]** the distance between the second pixel electrode and the neighboring second common electrode of the electrode structure is 2~5 μ m;

[0013] the distance between the first pixel electrode and the neighboring first common electrode is 5~10 μ m.

30 **[0014]** According to a third aspect it is described a liquid crystal display device comprising the above liquid crystal panel.

BRIEF DESCRIPTION OF THE DRAWINGS

35 **[0015]** In order to clearly illustrate the technical solution of the embodiments of the invention, the drawings of the embodiments will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the invention and thus are not limitative of the invention.

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Fig. 1 schematically illustrates a configuration of a liquid crystal panel comprising a color filter substrate, in accordance with an embodiment of the invention; Fig. 2 schematically illustrates a light transmissivity distribution of the liquid crystal panel in accordance with the liquid crystal panel shown in Figure 1 when electric field is formed therein;

Fig. 3 schematically illustrates a light transmissivity distribution of the conventional liquid crystal panel.

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DETAILED DESCRIPTION

55 **[0016]** In order to make objects, technical details and advantages of the embodiments of the invention apparent, the technical solutions of the embodiment will be described in a clearly and fully understandable way in connection with the drawings related to the embodiments of the invention. It is obvious that the described embod-

iments are just a part but not all of the embodiments of the invention. Based on the described embodiments herein, those skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the invention.

[0017] Unless otherwise defined, all the technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which the present invention belongs. The terms "first," "second," etc., which are used in the description and the claims of the present application for invention, are not intended to indicate any sequence, amount or importance, but distinguish various components. Also, the terms such as "a," "an," etc., are not intended to limit the amount, but indicate the existence of at least one. The terms "comprises," "comprising," "includes," "including," etc., are intended to specify that the elements or the objects stated before these terms encompass the elements or the objects and equivalents thereof listed after these terms, but do not preclude the other elements or objects. The phrases "connect," "connected", etc., are not intended to define a physical connection or mechanical connection, but may include an electrical connection, directly or indirectly. "On," "under," "right," "left" and the like are only used to indicate relative position relationship, and when the position of the object which is described is changed, the relative position relationship may be changed accordingly.

[0018] With reference to Fig. 3, a configuration of a conventional horizontal electric field (E-field) liquid crystal panel has a pixel electrode a and a common electrode b formed on an array substrate 1 and no electrode is formed on a color filter substrate 2. It is seen from Fig. 3 that a horizontal E-field 4 is formed between the pixel electrode a and the common electrode b when a voltage is applied, while no E-field is formed in regions direct over the pixel electrode a and the common electrode b. As a result, liquid crystal molecules in the regions are not rotated and no phase delay is generated when light passes through the regions. Under the effect of the upper and lower polarizers of the liquid crystal panel, light in these regions can not transmit through the liquid crystal panel, which makes the overall light transmissivity of the liquid crystal panel low. Generally, the liquid crystal panel having such a configuration has a maximum light transmissivity of about 70%.

[0019] To solve the above problem, an embodiment of the invention provides a liquid crystal panel, which further has a pixel electrode and a common electrode formed on the color filter substrate other than the pixel electrode and the common electrode formed on the array substrate. The liquid crystal layer not only has a primary E-field generated by the pixel and common electrodes on the array substrate but also an auxiliary E-field generated by the pixel and common electrodes on the color filter substrate. The auxiliary E-field compensates and enhances the horizontal E-field in the liquid crystal layer, thereby forming a uniform E-field distribution in the liquid crystal layer. A

liquid crystal panel with such a configuration has a minimum light transmissivity of over 70% and a maximum light transmissivity of up to 90%.

[0020] With reference to Fig. 1, a liquid crystal panel comprising a color filter substrate 2 in accordance with the embodiment of the invention comprises an array substrate 1, the color filter substrate 2 and a liquid crystal layer (not shown) formed between the array substrate 1 and the color filter substrate 2, in which:

[0021] a plurality of first pixel electrodes "a" and a plurality of first common electrodes "b" are alternatively disposed on a side of the array substrate 1 facing the color filter substrate 2;

[0022] a plurality of sets of electrode structure 3 are formed on a side of the color filter substrate 2 facing the array substrate 1, each set of electrode structure 3 comprises a second pixel electrode "c" and a second common electrode "d", the second pixel electrode c and the second common electrode d in each set of electrode structure 3 are symmetrically disposed on both sides of an orthographic projection of the first pixel electrode a or the first common electrode b on the color filter substrate 2.

[0023] Preferably, in the above liquid crystal panel, the second pixel electrode c and the second common electrode d of two neighboring sets of electrode structure 3 are disposed in opposite order. As an example, in a first set of electrode structure 3, the second pixel electrode c is disposed on the left side of the second common electrode d, while in a second (i.e., neighboring) set of electrode structure 3, the second pixel electrode c is disposed on the right side of the second common electrode d. By this means, the auxiliary E-field is distributed only in the regions direct over the first pixel electrode a and the first common electrode b.

[0024] Preferably, a distance y between the second pixel electrode c and the neighboring second common electrode d of the electrode structure 3 is smaller than a distance x between the first pixel electrode a and a neighboring first common electrode b.

[0025] As an example, each of the first pixel electrode a, the second pixel electrode c, the first common electrode b and the second common electrode d has a width of 2~3 μ m, the distance between the second pixel electrode c and the neighboring second common electrode d of the electrode structure 3 is 2~5 μ m, and the distance between the first pixel electrode a and the neighboring first common electrode b is 5~10 μ m. The auxiliary E-field generated by the second pixel electrode c and the second common electrode d on the color filter substrate is located right above the first pixel electrode or the first common electrode on the array substrate and may enhance the primary horizontal E-field on the array substrate. Here, a voltage for the first and second common electrodes a and c may be constant, while a voltage for the first and second pixel electrodes b and d may be adjusted based on the displayed gray level value, for example, it may be 0~20V.

[0026] With reference to Fig. 2, in the afore-mentioned

liquid crystal panel as shown by Figure 1, when display is required, voltages are applied to the first pixel electrode a, the first common electrode b, the second pixel electrode c and the second common electrode d, a primary horizontal E-field 4 is formed between the first pixel electrode a and the first common electrode b, an auxiliary horizontal E-field 5 is formed between the second pixel electrode c and the second common electrode d, and the auxiliary horizontal E-field 5 is in the regions direct over the first pixel electrode a and the first common electrode b. In such a way, a uniform E-field distribution is formed in the liquid crystal layer. The uniform E-field may substantially rotate all the liquid crystal molecules in the pixel region, thereby, phase delay of the light transmitted through the liquid crystal layer is increased and the light transmissivity of the liquid crystal panel is accordingly increased.

[0027] The advantages effect of the embodiment of the invention may be seen by comparing Figs.2 and 3. It is seen from Fig. 3 that no E-field exists direct over the first pixel electrode a and the first common electrode b, which makes the light transmissivity low, while the auxiliary horizontal E-field 5 is formed right above the first pixel electrode a and the first common electrode in Fig. 2, thereby increasing the light transmissivity.

[0028] Moreover, an embodiment of the invention provides a display device which comprises the liquid crystal panel of the above embodiment. The display device may be a liquid crystal panel, an E-paper, a liquid crystal television, a liquid crystal display, a digital photo-frame, a mobile phone, a tablet PC and any other product or device having a display function.

[0029] What are described above is related to the illustrative embodiments of the disclosure only and not limitative to the scope of the disclosure; the scopes of the disclosure are defined by the accompanying claims.

Claims

1. A liquid crystal panel comprising an array substrate (1), a color filter substrate (2), and a liquid crystal layer formed between the array substrate (1) and the color filter substrate (2), wherein a plurality of first pixel electrodes (a) and a plurality of first common electrodes (b) are disposed on a surface of the array substrate (1) facing the color filter substrate (2), each of the first pixel electrodes (a) and each of the first common electrodes (b) are in a strip shape and extend along a first direction, the first pixel electrodes (a) and the first common electrodes (b) are arranged alternately along a second direction perpendicular to the first direction in the same horizontal plane, the panel being configured to form a primary horizontal electrical field (4) between each of the first pixel electrodes (a) and the neighboring first common electrode (b); a plurality of sets of electrode structure (3) are formed

on a surface of the color filter substrate (2) facing the array substrate (1), each set of electrode structure (3) comprises a second pixel electrode (c) and a second common electrode (d), the second pixel electrode (c) and the second common electrode (d) are in a strip shape and extend along the same first direction, the panel being further configured to form an auxiliary horizontal electrical field (5) between the second pixel electrode (c) and the second common electrode (d);

characterized in that in any two neighboring sets of electrode structure (3), any two second pixel electrodes (c) of the two neighboring sets of electrode structures are adjacent to each other, or any two second common electrodes (d) of the two neighboring sets of electrode structure are adjacent to each other, and the two second pixel electrodes (c) and the two second common electrodes (d) of the two neighboring sets of the electrode structures (3) on the color filter substrate are respectively located between the first pixel electrode (a) and the first common electrode (b) of the opposite array substrate in a plan view.

2. The liquid crystal panel of claim 1, wherein:

in any two neighboring sets of electrode structure (3), the distance between the second pixel electrode (c) and the second common electrode (d) is the same.

3. The liquid crystal panel of claim 1 or claim 2, wherein:

each of the second pixel electrode (c) and the second common electrode (d) has a width of 2~3 μ m; and the distance between the second pixel electrode (c) and the second common electrode (d) is 2~5 μ m.

Patentansprüche

1. Flüssigkristalltafel, umfassend ein Array-Substrat (1), ein Farbfiltersubstrat (2) und eine Flüssigkristallschicht, die zwischen dem Array-Substrat (1) und dem Farbfiltersubstrat (2) gebildet ist, wobei eine Mehrzahl von erste-Pixel-Elektroden (a) und eine Mehrzahl von erste-gemeinsame-Elektroden (b) auf einer Oberfläche des Array-Substrats (1), dem Farbfiltersubstrat (2) zugewandt, vorgesehen sind, wobei jede der erste-Pixel-Elektroden (a) und jede der erste-gemeinsame-Elektroden (b) eine Streifengestalt hat und sich entlang einer ersten Richtung erstreckt, wobei die erste-Pixel-Elektroden (a) und die erste-gemeinsame-Elektroden (b) alternierend entlang einer zweiten Richtung, senkrecht zu der ersten Richtung in der gleichen horizontalen Ebene, angeordnet sind, wobei die Tafel konfiguriert ist, um ein primäres

horizontales elektrisches Feld (4) zwischen jeder der erste-Pixel-Elektroden (a) und der benachbarten erste-gemeinsame-Elektrode (b) zu bilden;

wobei eine Mehrzahl von Sets aus Elektrodenstruktur (3) auf einer Oberfläche des Farbfiltersubstrats (2), dem Array-Substrat (1) zugewandt, gebildet ist, wobei jedes Set aus Elektrodenstruktur (3) eine zweite-Pixel-Elektrode (c) und eine zweite-gemeinsame-Elektrode (d) umfasst, wobei die zweite-Pixel-Elektrode (c) und die zweite-gemeinsame-Elektrode (d) eine Streifengestalt aufweisen und sich entlang der gleichen ersten Richtung erstrecken, wobei die Tafel außerdem konfiguriert ist, um ein zusätzliches horizontales elektrisches Feld (5) zwischen der zweiten-Pixel-Elektrode (c) und der zweiten-gemeinsamen-Elektrode (d) zu bilden;

dadurch gekennzeichnet, dass in beliebigen zwei benachbarten Sets aus Elektrodenstruktur (3) beliebige zwei zweite-Pixel-Elektroden (c) der beiden benachbarten Sets aus Elektrodenstrukturen zueinander benachbart sind, oder dass beliebige zwei zweite-gemeinsame-Elektroden (d) der zwei benachbarten Sets aus Elektrodenstruktur benachbart zueinander sind, und wobei die zwei zweite-Pixel-Elektroden (c) und die zwei zweite-gemeinsamen-Elektroden (d) der zwei benachbarten Sets aus den Elektrodenstrukturen (3) auf dem Farbfiltersubstrat in einer Draufsicht jeweils zwischen der ersten-Pixel-Elektrode (a) und der ersten-gemeinsamen-Elektrode (b) des gegenüber liegenden Array-Substrats lokalisiert sind.

2. Flüssigkristalltafel gemäß Anspruch (1), wobei:

in beliebigen zwei benachbarten Sets aus Elektrodenstruktur (3) der Abstand zwischen der zweiten-Pixel-Elektrode (c) und der zweiten-gemeinsamen-Elektrode (d) der gleiche ist.

3. Flüssigkristalltafel gemäß Anspruch 1 oder Anspruch 2, wobei:

jede von der zweiten-Pixel-Elektrode (c) und der zweiten-gemeinsamen-Elektrode (d) eine Breite von 2-3 μm aufweist;
und wobei der Abstand zwischen der zweiten-Pixel-Elektrode (c) und der zweiten-gemeinsamen-Elektrode (d) 2-5 μm beträgt.

Revendications

1. Un panneau à cristaux liquides comprenant un substrat de réseau (1), un substrat de filtre de couleur (2) et une couche de cristaux liquides formée entre le

substrat de réseau (1) et le substrat de filtre de couleur (2), dans lequel une pluralité de premières électrodes de pixel (a) et une pluralité de premières électrodes communes (b) sont disposées sur une surface du substrat de réseau (1) faisant face au substrat de filtre de couleur (2), chacune des premières électrodes de pixel (a) et chacune des premières électrodes communes (b) sont sous la forme d'une bande et s'étendent le long d'une première direction, les premières électrodes de pixel (a) et les premières électrodes communes (b) sont agencées alternativement le long d'une deuxième direction perpendiculaire à la première direction dans le même plan horizontal, le panneau étant configuré pour former un champ électrique horizontal primaire (4) entre chacune des premières électrodes de pixel (a) et la première électrode commune voisine (b) ;

une pluralité d'ensembles de structure d'électrodes (3) sont formés sur une surface du substrat de filtre de couleur (2) faisant face au substrat de réseau (1), chaque ensemble de structure d'électrodes (3) comprend une deuxième électrode de pixel (c) et une deuxième électrode commune (d), la deuxième électrode de pixel (c) et la deuxième électrode commune (d) sont sous la forme d'une bande et s'étendent le long de la même première direction, le panneau étant en outre configuré pour former un champ électrique horizontal auxiliaire (5) entre la deuxième électrode de pixel (c) et la deuxième électrode commune (d) ;

caractérisé en ce que dans deux ensembles voisins quelconques de structure d'électrodes (3), deux deuxièmes électrodes de pixel (c) quelconques des deux ensembles voisins de structures d'électrode sont adjacentes l'une avec l'autre, ou deux deuxièmes électrodes communes (d) quelconques des deux ensembles voisins de structure d'électrodes sont adjacentes l'une avec l'autre, et les deux deuxièmes électrodes de pixels (c) et les deux deuxièmes électrodes communes (d) des deux ensembles voisins de structures d'électrode (3) sur le substrat de filtre de couleur sont respectivement situées entre la première électrode de pixel (a) et la première électrode commune (b) du substrat de réseau opposé dans une vue en plan.

2. Le panneau à cristaux liquides de la revendication 1, dans lequel :

dans deux ensembles voisins de structure d'électrodes (3) quelconques, la distance entre la deuxième électrode de pixel (c) et la deuxième électrode commune (d) est la même.

3. Le panneau à cristaux liquides de la revendication

1 ou de la revendication 2, dans lequel :

chacune de la deuxième électrode de pixel (c)
et la deuxième électrode de pixel (d) a une lar-
geur de 2~3 μm ;
et la distance entre la deuxième électrode de
pixel (c) et la deuxième électrode commune (d)
est de 2~5 μm .

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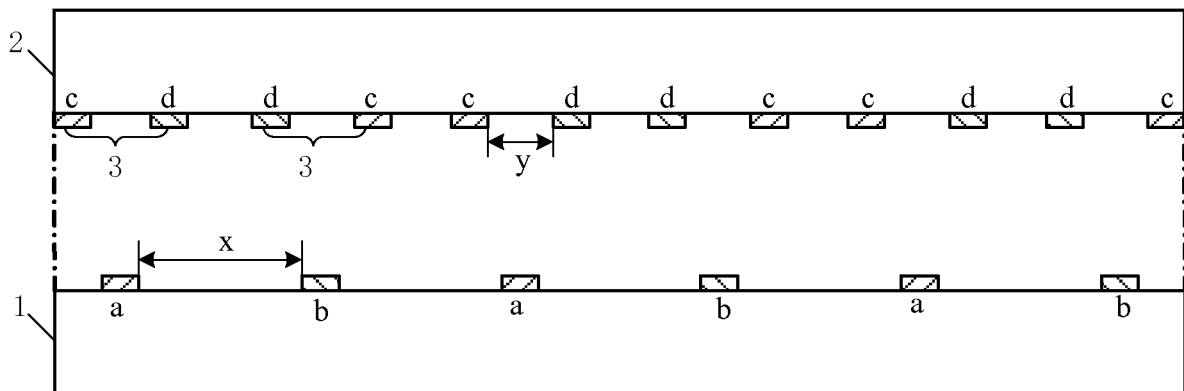
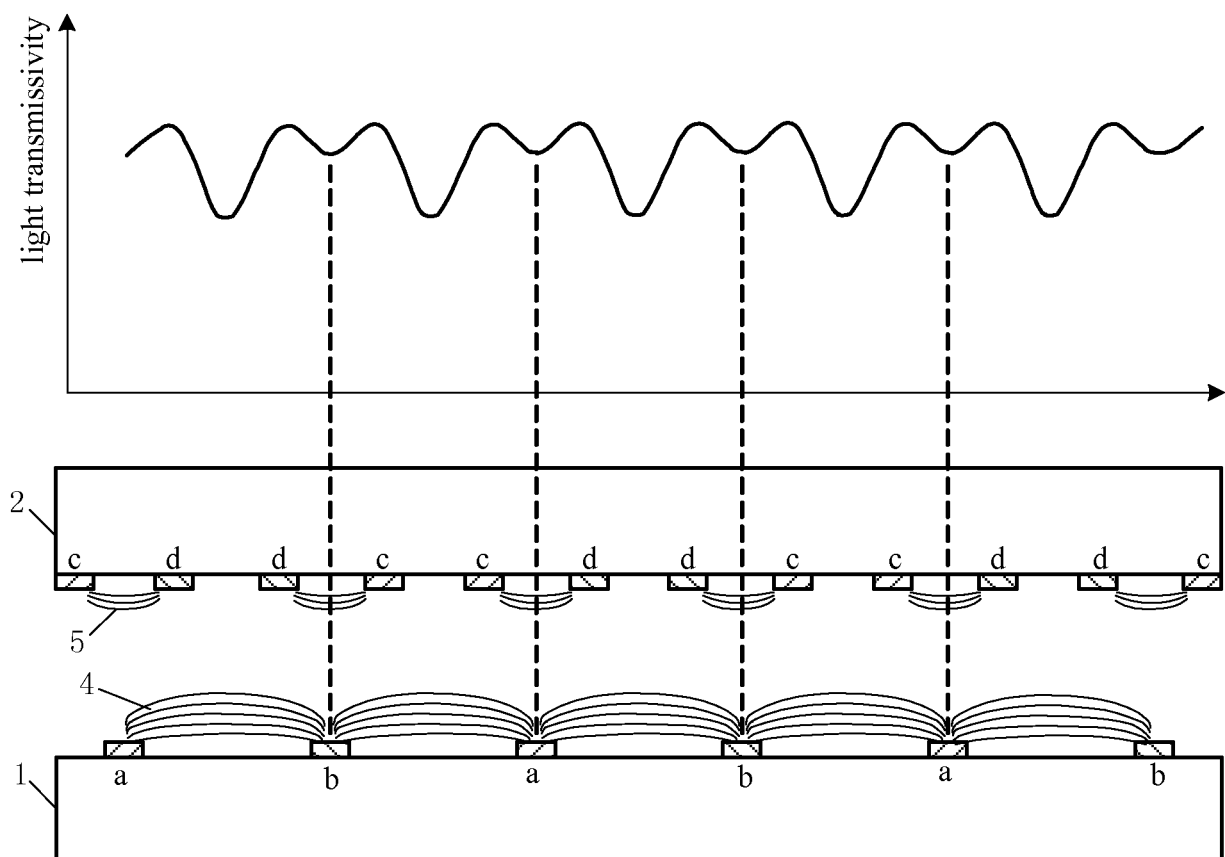


Fig. 1



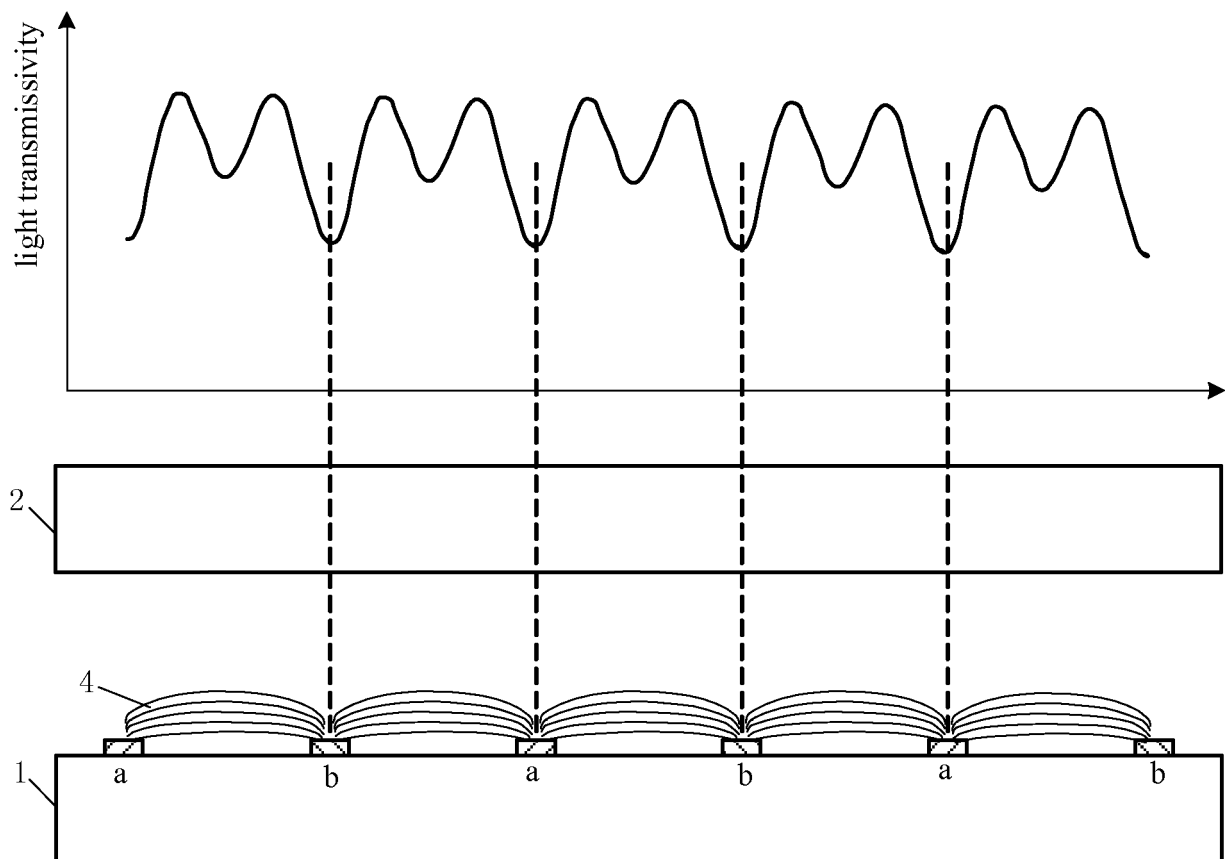


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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- CN 101943829 A [0002]

专利名称(译)	滤色器基板，液晶面板和液晶显示装置		
公开(公告)号	EP2813887B1	公开(公告)日	2019-02-06
申请号	EP2014182241	申请日	2013-08-06
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IPC分类号	G02F1/1343		
CPC分类号	G02F1/134309 G02F1/134363 G02F2001/134318 G02F2201/121 G02F2201/122 G02F2201/123 G02B5/22 G02B30/27 G02F1/1343 G02F1/133514		
优先权	201210285759.X 2012-08-10 CN		
其他公开文献	EP2813887A3 EP2813887A2		
外部链接	Espacenet		

摘要(译)

本发明实施例提供一种彩色滤光基板，液晶面板和液晶显示装置。滤色器基板包括基板；形成在基板一侧的多组电极结构，每组电极结构包括像素电极和公共电极，用于通过施加电压在像素电极和公共电极之间产生水平电场。

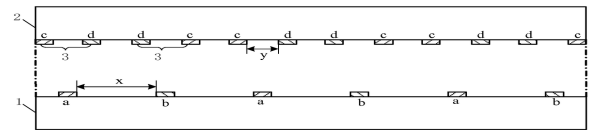


Fig. 1

