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(54) **LIQUID CRYSTAL DISPLAY DEVICE USING NEMATIC LIQUID CRYSTAL**

FLÜSSIGKRISTALLANZEIGEBAUERELEMENT MIT EINEM NEMATISCHEN FLÜSSIGKRISTALL

DISPOSITIF D'AFFICHAGE À CRISTAUX LIQUIDES UTILISANT UN CRISTAL LIQUIDE NÉMATIQUE

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EP 1 921 495 B1

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Description

Patent document 2 : WO 02/06887.

TECHNICAL FIELD

[0001] Present invention relates to a liquid crystal display device and, in particular, to a liquid crystal display device using nematic liquid crystal material with low power consumption which provides a high resolution image.

BACKGROUND ART

[0002] Conventionally, liquid crystal display devices using nematic liquid crystals are mainly utilized as the display device for mobile terminals such as cellular phones, because of their low driving voltage as well as low power consumption characteristics, and their production increases with recent rapid propagation of mobile terminals.

[0003] At the same time, higher display functions such as the increase of the number of pixels as well as the number of characters has been required.

[0004] On the other hand, it is also important to comply not only with the requirement for advanced display functions such as higher resolution, but also with the requirement for low power consumption, because there is a strong requirement to maintain or extend the continuous operation time for the battery of mobile apparatus.

[0005] As one of technologies to fulfill such requirements, several methods intended to develop so-called display memory characteristics are proposed for liquid crystal display device wherein contents of the display is maintained even in the case that the power is shut off. Using the memory characteristics, it is possible to reduce the power consumption substantially to zero in principle when the contents of the display are not changed, and it is also possible to reduce the power consumption by changing the contents of the display on pixel basis by applying voltage only on pixels in which the contents of the display is changed.

[0006] Furthermore, as has been well known in the case of conventional passive matrix driving system by twisted nematic (TN) or super twisted nematic (STN) mode, the upper limit of the number of pixels is determined by the limitation of a duty ratio. The use of the memory characteristics removes the limit of the number of pixels and enables a display with high resolution.

[0007] As related arts realizing the display memory characteristics using nematic liquid crystals, for example, a method combining a nematic liquid crystal and a liquid crystal alignment layer subjected to a fine grating fabrication process (see patent document 1), and a method by the present inventors in which a nematic liquid crystal and domains having a plurality of in-plane liquid crystal anchoring directions on a substrate are arranged in a patterned form (see patent document 2), are proposed.

Patent document 1 : Japanese Unexamined Patent Application Publication No. 11-513809.

[0008] US 2005/0062919 discloses a bistable nematic liquid crystal device with a surface alignment grating on at least one cell wall and a surface treatment on the other wall. The surface profile of the monograting is asymmetric with its groove height to width selected to give approximately equal energy within the nematic material in its two allowed alignment arrangements. This document discloses the features of the preamble of claim 1.

[0009] EP 1 271 225 discloses a bistable nematic liquid crystal device which includes an array of holes in an alignment layer on at least one cell wall. The holes have a shape and/or orientation to induce the liquid crystal director adjacent the holes to adopt two different tilt angles in substantially the same azimuthal direction.

[0010] WO 01/40853 discloses a liquid crystal display device comprising a layer of a nematic liquid crystal material contained between two cell walls, each carrying electrode structures and an alignment surface. The alignment layer on one or both cell walls is formed of a plurality of small surface features each separately capable of providing a bistable pretilt.

DISCLOSURE OF INVENTION

[0011] The conventional method of combining a nematic liquid crystal and a liquid crystal alignment layer subjected to a fine grating fabrication process described above is based on the switching between a homeotropic (vertical) alignment and a hybrid alignment using a flexoelectric effect. However, the method has several problems such as the surface shape in the fine grating fabrication process. Further, the anchoring strength of the liquid crystal alignment on the surface should be accurately controlled in a limited range. Therefore, the practical application of this method has not been achieved yet.

[0012] Another conventional method, wherein a nematic liquid crystal and domains having a plurality of liquid crystal in-plane anchoring directions of the liquid crystal alignment on a substrate are arranged in a pattern, is based on the switching between memory states by an electric field substantially parallel to the substrate plane (transverse electric field). Therefore, the method requires more than a set of a pair of comb electrodes being used in an in-plane switching system which necessitates a complex fabrication process for the electrode.

[0013] As has been described above, it is difficult by a conventional art to easily produce a liquid crystal display device having the display memory characteristics which is favorable for low power consumption and for high resolution image with nematic liquid crystal materials with a high yield.

[0014] Considering the above described situations, the object of the present invention is to provide a liquid crystal display device using nematic liquid crystal materials, which has a display memory characteristics for low power consumption, and also can be easily fabricated with a

high yield.

[0015] In order to achieve the above described object, the present invention is characterized by;

[1] a liquid crystal display device according to claim 1. Further preferred developments are defined in the dependent claims.

[0016] Namely, a pair of simple plate-like electrodes opposing each other is used in the present invention similarly to the ordinary TN mode, in stead of comb electrode which necessitate a complex electrode formation process.

[0017] In order to realize a plurality of orientation states of liquid crystal having a memory effect, which can be switched with a vertical electric field, an alignment layer composed of alignment domains subjected to the anchoring treatment of the liquid crystal alignment in a plurality of different directions is used.

[0018] In the absence of the applied voltage and in the absence of imposed electric field across a liquid crystal layer, the total energy of liquid crystal orientation state is represented by the sum of the elastic deformation energy of the liquid crystal layer itself and the anchoring energy based on the interfacial interaction between the liquid crystal layer and the alignment layer formed on the surface of the substrate. Therefore, a plurality of orientation states in the liquid crystal layer can be made stable with respect to memory effect, using the surface of the substrate in which a plurality of alignment directions on the surface of the substrate is equally energetically stable enough.

[0019] Furthermore, in order to achieve the switching between a plurality of orientation states by the vertical electric field using the plate-like electrodes opposing each other, a plurality of the anchoring directions of the liquid crystal alignment in respective alignment domains may have a substantially vertical direction to a substrate surface and a substantially horizontal direction to the substrate surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

[Fig. 1] Fig. 1 shows a pattern of anchoring treatment on the substrate of liquid crystal display devices using nematic liquid crystal according to a first embodiment of the present invention.

[Fig.2] Fig.2 shows a schematic view of two stable liquid crystal orientation states of a liquid crystal display device using nematic liquid crystal and a view of the switching between the two stable orientation states according to the first embodiment of the present invention.

[Fig.3] Fig.3 shows a configuration diagram of a liquid crystal display device using nematic liquid crystal according to a second embodiment of the present

invention.

[Fig.4] Fig.4 shows a wave form of driving voltage and an electro-optic characteristic of the liquid crystal display device using nematic liquid crystal according to the second embodiment of the present invention.

[Fig.5] Fig.5 shows a configuration diagram of the liquid crystal display device according to a third embodiment of the present invention.

[Fig.6] Fig.6 shows a wave form of driving voltage and an electro-optic characteristic of the liquid crystal display device using nematic liquid crystal according to the third embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0021] The liquid crystal display device using nematic liquid crystal of the present invention includes a pair of substrates wherein at least one substrate is transparent, plate-like electrode layers formed on surface of the pair of substrates respectively wherein at least one layer is transparent, a liquid crystal layer interposed between the pair of substrates wherein an electric field is imposed therethrough by applying a voltage on the plate-like electrode layers, and an alignment layer arranged between the liquid crystal layer and at least one substrate of the pair of substrates. The alignment layer comprises alignment domains processed for liquid crystal anchoring treatment in a plurality of different directions including a substantially vertical and a substantially horizontal direction to the surface of the substrate.

EMBODIMENTS

[0022] The preferred embodiments of the present invention are described below in detail.

[0023] Fig. 1 is a perspective view showing the formation of an alignment layer on the substrates of a liquid crystal display device using nematic liquid crystal according to a first embodiment of the present invention, and showing that an upper substrate is opposing to a lower substrate.

[0024] In Fig.1, 1 is a substrate (lower substrate), 2 is a plate-like electrode layer formed on the substrate 1, and 3 is an alignment layer formed on the plate-like electrode layer 2. The alignment layer 3 has a plurality of alignment domains in checker-board like pattern, and each domain is subjected to liquid crystal anchoring treatment to form an alignment domain 3A having liquid crystal anchoring direction substantially vertical to the substrate surface or an alignment domain 3B having liquid crystal anchoring direction substantially horizontal to the substrate surface.

[0025] If the size of the alignment domains 3A and 3B arranged in the above described checker-board like pattern is regulated to small sizes ranging from several sub-microns to several microns, the orientation of liquid crystal molecules aligned by the alignment layer 3 does not correspond to the alignment patterns but takes a uniform

orientation state, because of an elastic character of the nematic liquid crystal itself.

[0026] Considering the case that the anchoring force of the liquid crystal alignment in substantially horizontal and substantially vertical directions are equivalent and that the shapes of the respective alignment domains 3A and 3B are the same, the substantially vertical and the substantially horizontal alignments are regarded to be energetically equivalent and equally stable in the substantially uniform surface alignments induced by the alignment layer 3.

[0027] Then another substrate having a similar alignment layer is prepared and two substrates are arranged in a manner that the surfaces of the alignment layer side of both substrates are opposed to each other. In Fig.1, 4 is a substrate (upper substrate), 5 is a plate-like electrode layer formed on the substrate 4, and 6 is an alignment layer formed on the plate-like electrode layer 5. An alignment domain 6A having liquid crystal anchoring direction substantially vertical to the substrate surface and an alignment domain 6B having liquid crystal anchoring direction substantially horizontal to the substrate surface are formed in a checker-board like pattern on the alignment layer 6. A cell is configured by providing a gap between the alignment layers 3 and 6 opposing each other. The size of the gap is, for example, about 10 microns which is larger than the sizes of the alignment domains 3A and 3B (submicrons to several microns). A nematic liquid crystal material is introduced between the substrates 1 and 4 (alignment layers 3 and 6) to form a liquid crystal device with a liquid crystal layer 7.

[0028] Plate-like electrode layers 2 and 5 including a transparent electrode material are formed on the substrate 1 and 4, and therefore it is possible to impose a vertical electric field across the liquid crystal layer 7 by applying a voltage between the plate-like electrode layers 2 and 5 provided on each substrate 1 and 4 opposing each other in the liquid crystal cell configured as above.

[0029] As shown in Fig.2, it is possible to realize the switching between the two energetically equivalent stable states, i.e., the substantially vertical state [Fig.2(a)] and the substantially horizontal state [Fig.2(b)], by using a liquid crystal material that can take positive or negative sign with respect to its dielectric anisotropy depending on a frequency of an alternating electric field.

[0030] In order to avoid the deterioration of display quality due to the generation of domains with different rotational directions for the liquid crystal alignment by the application of an electric field when switching between the two states, it is preferable to incline the substantially vertical alignment direction to the substrate surface in a particular direction, for example, by 3 degrees, and similarly to raise the substantially horizontal alignment direction to the substrate surface in a particular direction, for example, by 3 degrees from the substrate surface, that is, to carry out so-called a pretilt control.

[0031] In order to obtain such alignment layers (alignment layer 3 and alignment layer 6) with a checker board

like pattern of the vertical and the horizontal anchoring, it is preferable to use, for an example, an alignment layer material with photo reactivity.

[0032] As for such an alignment layer material, for an example, poly[2-(4-phenylazophenoxy)ethyl methacrylate] is known (see reference document 1, Ichimura et al., Appl. phys. Lett., Vol. 73, pp921-923). The spin cast thin film of this polymer on a substrate forms a vertical alignment layer. However, when the polymer is irradiated by an unpolarized light with a wavelength of 365nm from the direction inclined at 60 degrees from substrate surface with an enough irradiation energy, it has been reported that a horizontal alignment film having an anchoring direction in this inclined direction (that is, having a pretilt angle with a few degrees) is obtained (see the above reference document 1) .

[0033] After a thin film of the photo reactive polymer is formed on the surface of the substrate 1 to form a vertical alignment layer, an unpolarized light having a wavelength of 365nm with an enough irradiation energy is irradiated from an inclined angle of 60 degrees from the substrate surface using a photo mask having a checker board pattern with the same pattern size as the alignment domain 3A and 3B (or 6A and 6B). The checker board pattern of the photo mask which corresponds to the horizontal alignment domain 3B (or 6B) transmits the light, while the checker board pattern which corresponds to the vertical alignment domain 3A (or 6A) does not transmit the light, then only the part of the alignment layer 3 (or the alignment layer 6) under the checker board pattern of the photo mask corresponding to the horizontal alignment domain 3B (or 6B) is converted to a horizontal alignment layer having an anchoring direction in this inclined direction of the irradiation light (that is, having a few degrees of pretilt angle).

[0034] In this way, a liquid crystal display device wherein two orientation states of the liquid crystal, that is, a substantially vertical orientation state as shown in Fig.2 (a) and a substantially horizontal orientation state as shown in Fig.2(b) are both stable in the absence of an electric field and have a memory characteristic, and the switching between these stable orientation states is possible by the vertical electric field generated by applying a voltage between a pair of plate-like electrode layers 2 and 5 formed on the respective substrate opposing each other, could be obtained.

[0035] The liquid crystal device operates as a display device, for example, by interleaving the liquid crystal device with two polarizing plates 8 and 9 in such a way that the each polarizing transmission axes crosses at right angles to each other. At this time, it is possible to display a black color with the substantially vertical orientation state shown in Fig.2(a) and a white color with the substantially horizontal orientation state shown in Fig.2(b) due to a birefringent effect by changing the anchoring direction of the alignment layer 3 and 6 from a substantially horizontal alignment to a substantially intermediate direction (the direction of 45 degrees) of the transmission

axes of polarizing light crossed each other. In order to increase the transmittivity of the white display in the substantially horizontal orientation state, it is preferable to set the retardation of the liquid crystal layer as a half wave plate by controlling the anisotropy of refractive index (A_n) of the liquid crystal material and the thickness of the liquid crystal layer.

[0036] It is also possible obtain a display device using so-called "guest-host effect" by introducing a pigment molecule having an absorption dichroism into the liquid crystal material as a component or to construct a reflection type display device utilizing the plate-like electrode layer of one substrate as an opaque electrode layer which also acts as a reflector.

[0037] Fig.3 is a view showing the configuration of a liquid crystal display device using nematic liquid crystal according to a second embodiment of the present invention.

[0038] In this figure, two transparent glass plates with 1.1mm thickness with polished surfaces are used as a substrate 11 and a substrate 14.

[0039] A transparent electro-conductive layer composed of indium tin oxide (ITO) is formed on the substrate 11 as a plate-like electrode layer 12.

[0040] Next, a fine vertical alignment layer 13 is obtained on the electrode layer 12 after applying and drying a solution of a material for the alignment layer, poly[2-(4-phenylazophenoxy)ethyl methacrylate] having azobenzene moiety on the substrate 11.

[0041] Photo-sensitive material used here is not limited to the above described polymer, but any material may be used if it has a similar anchoring effect and has also an ability of changing the anchoring level under ultra-violet irradiation.

[0042] As a photo-sensitive material, for an example, a polyimide type material for the alignment layer, RN-1338, produced by Nissan Chemical Industries, Co. Ltd. is also applicable to the present invention. Similarly to the above described azobenzene material, this material RN-1338 forms a vertical alignment layer when it has been spin cast on a substrate as a thin film, while it is converted to a horizontal alignment layer with the anchoring direction in right angle with the polarized plane of the incident light by irradiating with a linearly polarized light having 250nm wavelength having enough irradiation energy.

[0043] Next, an unpolarized ultraviolet light is irradiated using a mercury-xenon lamp as a light source provided with a band pass filter having a central wavelength of 365nm from an inclined angle of 60 degrees from substrate surface with a light intensity of about $0.2\text{J}/\text{cm}^2$. The light irradiation is performed through a photo mask with a square checker board pattern as shown in Fig.1, in which the size of the partitioned small area is $1\mu\text{m}^2$, and then a horizontal alignment layer having the anchoring direction in the plane of inclined irradiated light (with pretilt angle of about 5 degrees) is formed in the parts only where the light is transmitted through the photo mask.

[0044] Above described pattern shape and intensity of irradiated light are only examples and it is preferable to adjust them according to the photo sensitive materials to be used and the characteristics of liquid crystal materials.

5 For example, if there is a large difference in the anchoring force between resulting vertical and horizontal alignment layers depending on the alignment layer materials to be used, it is preferable to change the amount of the area of the checker board pattern corresponding to white and black colors relatively to adjust the resulting anchoring force multiplied by the area to be nearly equivalent between the vertical and horizontal alignment.

10 **[0045]** As for another substrate 14, a plate-like electrode layer 15 and an alignment layer 16 are also formed quite similarly to the substrate 11.

15 **[0046]** Next, the surfaces of the two substrates 11, 14 having an alignment anchoring ability are arranged to oppose each other and a cell is constructed by mediating a spacer including dispersed spherical polymer beads and a sealing material in peripheral part of the substrates.

20 **[0047]** Next, a liquid crystal composition including a liquid crystal material MLC-2048 of Merck Co. Ltd. mixed with an appropriate quantity of a neutral pigment material D85E63of BDH Co. Ltd. as a dichroic pigment 17A is injected in vacuum between the substrates of the liquid crystal cell to form a liquid crystal layer 17, and the cell is sealed with a sealing material of an UV-curing resin to obtain a liquid crystal panel.

25 **[0048]** The liquid crystal composition MLC-2048 is a nematic composition used for two frequencies driving with crossover frequency of 23kHz in which the dielectric anisotropy ($\Delta\epsilon$) is positive for low frequencies and negative for high frequencies.

30 **[0049]** The thickness of the liquid crystal layer after injection of liquid crystal is adjusted to be $10\mu\text{m}$ by the spacer.

35 **[0050]** Next, a polarizing plate 18 (G1220DU, Nitto Denko, Co. Ltd.) is attached on the light source side of the substrate 11 so that its transmission axes of polarized light is in parallel to the horizontal anchoring direction of the substrate 11.

40 **[0051]** Then, a liquid crystal display device is obtained after connecting a driving circuit enabling two frequencies driving and a light source for a back light and the like.

45 **[0052]** The relationship between the wave form of driving voltage and an electro-optic characteristic of the liquid crystal display device using nematic liquid crystal according to the second embodiment is illustrated below using Fig.4.

50 **[0053]** Tr in Fig.4(a) represents the variation of transmittivity of the liquid crystal display device in accordance with the variation of the wave form of driving voltage. V in Fig.4(b) represents the wave form of the driving voltage applied between ITO electrodes 12 and 15.

55 **[0054]** As shown in these figures, in the liquid crystal display device in accordance with the present embodiment, a switching between the orientation states of the liquid crystal in the liquid crystal layer corresponding to

bright state [see Fig.2(a)] and dark state [see Fig.2(b)] becomes possible using a guest-host effect of a dichroic pigment 17A by the selective variation of the frequency of driving AC voltage.

[0055] Next, a third embodiment of the present invention is illustrated below.

[0056] In the third embodiment, referring to Fig.5, a reflector type liquid crystal display device includes a plate-like electrode layer 25 formed on the substrate 24 opposing to substrate 21, plate-like electrode layer 22 and alignment layer 23, and the plate-like electrode layer 25 also acts as a reflector. The fabrication of an alignment layer 26 on the substrate 24 is carried out by simple coating and drying in a similar way with the second embodiment except that any inclined irradiation of an ultraviolet light is not performed.

[0057] In this third embodiment, the alignment layer 26 operates as a uniform vertical alignment layer because the layer is not irradiated with an ultraviolet light.

[0058] Fig.6 is a schematic view showing the two memory stable states of liquid crystal orientation and the switching between two stable orientation states with memory effect in accordance with this embodiment. As shown in this figure, the two stable orientation states with memory effect is a vertical orientation state shown in Fig.6(a), and a so-called hybrid orientation state shown in Fig.6(b), because the alignment layer 26 is a vertical alignment layer.

[0059] The light absorption by a dichroic pigment 27A in the latter hybrid orientation state is about a half of the horizontal orientation state of the second embodiment [see Fig.2(b)]. However, the configuration of the device is a reflection type in the third embodiment, therefore, the light transmitted through the liquid crystal device passes the liquid crystal layer twice, that is, at the moment of incidence and reflection, then the total light absorption (accordingly also the contrast) is nearly the same as in the case of the second embodiment.

[0060] Accordingly, the electro-optical characteristic of this third embodiment is nearly the same as that of the second embodiment illustrated in Fig.4.

[0061] In the third embodiment, the required number of steps for the production of the liquid crystal display device can be reduced because the irradiation of inclined ultraviolet light is only required for the alignment layer 23 on the substrate 21 side.

[0062] Furthermore, in the third embodiment, it is possible to improve viewing angle characteristics using a so-called multi-domain pixel configuration. In the configuration, the anchoring direction substantially horizontal to the substrate surface in alignment domains of alignment layer 23 is configured in a plurality of different directions on the plurality of sub-pixel regions (pixel domains) in a pixel. In the pixel domains, for example, in the case that an original pixel is divided into two sub-pixels, the size of a new pixel domain is the half of the original pixel (conventionally, one side is several 10 μ m to 110 μ m) and a large number of alignment domains with

the size of about 1 μ m square are included in the large pixel domains.

[0063] The present invention is not limited within above embodiments, and various modifications are possible according to the object of the present invention, which should not be excluded from the scope of the present invention.

[0064] In the above embodiment, a material with a neutral absorption spectral characteristic (black pigment) is used as a dichroic pigment added to liquid crystal material. It is also possible to carry out a color display by adjusting absorption spectral characteristics.

[0065] It is also possible to make a configuration without any polarizing plate and the like, by laminating two liquid display devices of the second embodiment (rotating one plate with an angle of 90 degrees relative to the other plate).

[0066] Furthermore, it is possible to construct a liquid crystal display device provided with active devices such as a thin film transistor and the like on each pixel.

[0067] In summary, according to the present invention, it is possible to easily fabricate a liquid crystal display device using nematic liquid crystal, having a display memory characteristic and low power consumption with a high yield.

INDUSTRIAL APPLICABILITY

[0068] The liquid crystal display device of the present invention is easily fabricated with a high yield and it is appropriate for the liquid crystal display device using nematic liquid crystal with a display memory characteristic and low power consumption.

Claims

1. A liquid crystal display device using nematic liquid crystal material, comprising first (1) and second (4) substrates forming a pair of substrates (1,4), at least one of the substrates being transparent, and a liquid crystal layer (7) interposed between the pair of substrates (1,4), first (2) and second (5) plate-like electrode layers, wherein the first plate-like electrode layer (2) is located on a surface of the first substrate (1) and the second plate-like electrode layer (5) is located on a surface of the second substrate (4), at least one of the plate-like electrode layers (2,5) being transparent, wherein an electric field is imposed therethrough by applying a voltage to the plate-like electrode layers(2,5); and the device further comprising an alignment layer (3,6) arranged between the liquid crystal layer (7) and at least one substrate of the pair of substrates (1,4), wherein both of the two liquid crystal orientation states are stable and have a memory characteristic

in the absence of an electric field and the liquid crystal layer (7) comprises a liquid crystal material capable of showing positive or negative sign with respect to dielectric anisotropy thereof depending on the frequency of an applied alternating electric field **characterised in that** the alignment layer (3,6) comprises a plurality of alignment domains adapted to align the liquid crystal in a plurality of different directions including a substantially vertical direction and a substantially horizontal direction to the surface of the substrate, wherein the alignment domains have a checker board-like pattern and are sized so that the overall orientation of the liquid crystal molecules aligned by the alignment layer (3,6) corresponds to one of two uniform liquid crystal orientation states.

2. The liquid crystal display device of claim 1, wherein a material forming the alignment layer (3,6) comprises a photo reactive material.
3. The liquid crystal display device of any preceding claim, further comprising a polarizing plate on at least one substrate of the pair of substrates (1,4).
4. The liquid crystal display device of any preceding claim, wherein the liquid crystal layer (7) comprises a pigment molecule having an absorption dichroism as a constituent.
5. The liquid crystal display device of any preceding claim, further comprising a light reflector arranged on at least one substrate of the pair of substrates (1,4).
6. The liquid crystal display device of any preceding claim, wherein the substantially horizontal direction to the surface of the substrate of the alignment domains is different from one another in a plurality of sub-pixel regions in a pixel.

Patentansprüche

1. Flüssigkristall-Anzeigevorrichtung, die ein nematisches Flüssigkristallmaterial verwendet, umfassend ein erstes (1) und ein zweites (4) Substrat, die ein Paar Substrate (1, 4) bilden, wobei zumindest eines der Substrate transparent ist, und eine Flüssigkristallschicht (7), die zwischen das Paar Substrate (1, 4) eingefügt ist, eine erste (2) und eine zweite (5) plattenartige Elektrodenschicht, wobei sich die erste plattenartige Elektrodenschicht (2) auf einer Oberfläche des ersten Substrats (1) befindet und sich die zweite plattenartige Elektrodenschicht (5) auf einer Oberfläche des zweiten Substrats (4) befindet, wobei zumindest eine der plattenartigen Elektrodenschichten (2, 5) transparent ist, wobei ein elektrisches Feld durch

diese durch Anlegen einer Spannung an die plattenartigen Elektrodenschichten (2, 5) eingepreßt ist; und

wobei die Vorrichtung ferner eine Ausrichtungsschicht (3, 6) umfasst, die zwischen der Flüssigkristallschicht (7) und zumindest einem Substrat des Paares Substrate (1, 4) angeordnet ist,

wobei die zwei Flüssigkristall-Orientierungszustände beide stabil sind und eine Speichercharakteristik bei Abwesenheit eines elektrischen Felds haben und die Flüssigkristallschicht (7) ein Flüssigkristallmaterial umfasst, das imstande ist, ein positives oder negatives Zeichen in Bezug auf seine dielektrische Anisotropie in Abhängigkeit von der Frequenz eines angelegten alternierenden elektrischen Felds zu zeigen, **dadurch gekennzeichnet, dass**

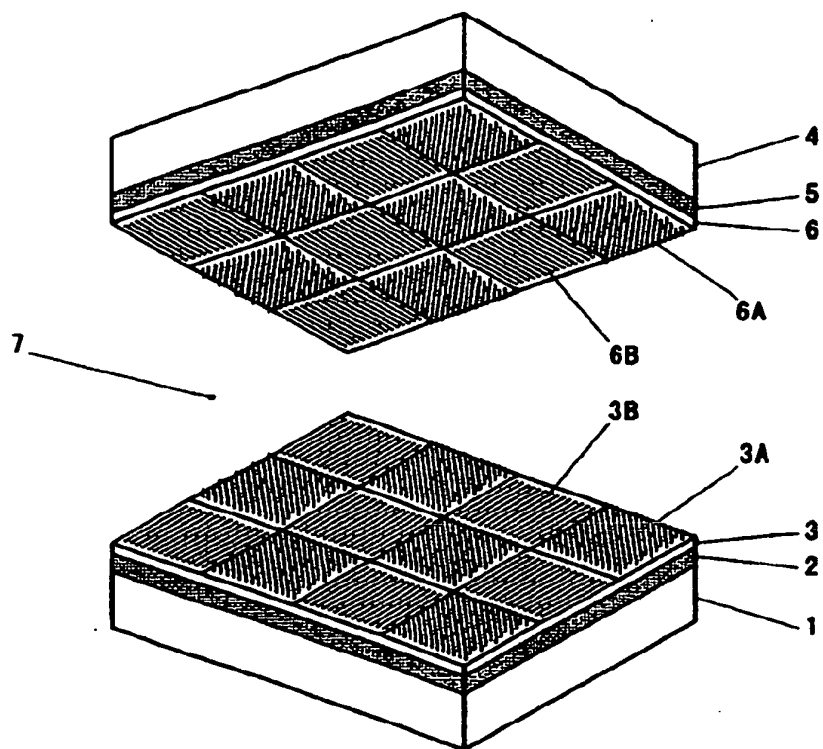
die Ausrichtungsschicht (3, 6) mehrere Ausrichtungsdomänen umfasst, die dazu ausgelegt sind, das Flüssigkristall in mehrere verschiedene Richtungen, einschließlich einer im Wesentlichen vertikalen Richtung und einer im Wesentlichen horizontalen Richtung, zur Oberfläche des Substrats auszurichten, wobei die Ausrichtungsdomänen ein schachbrettartiges Muster haben und so dimensioniert sind, dass die Gesamtorientierung der von der Ausrichtungsschicht (3, 6) ausgerichteten Flüssigkristallmoleküle einem von zwei gleichförmigen Flüssigkristall-Orientierungszuständen entspricht.

2. Flüssigkristall-Anzeigevorrichtung nach Anspruch 1, wobei ein Material, das die Ausrichtungsschicht (3, 6) bildet, ein fotoreaktives Material umfasst.
3. Flüssigkristall-Anzeigevorrichtung nach irgendeinem vorhergehenden Anspruch, ferner umfassend eine polarisierende Platte auf zumindest einem Substrat des Paares Substrate (1, 4).
4. Flüssigkristall-Anzeigevorrichtung nach irgendeinem vorhergehenden Anspruch, wobei die Flüssigkristallschicht (7) ein Pigmentmolekül umfasst, das einen Absorptionsdichroismus als Bestandteil aufweist.
5. Flüssigkristall-Anzeigevorrichtung nach irgendeinem vorhergehenden Anspruch, ferner umfassend einen Lichtreflektor, der auf zumindest einem Substrat des Paares Substrate (1, 4) angeordnet ist.
6. Flüssigkristall-Anzeigevorrichtung nach irgendeinem vorhergehenden Anspruch, wobei sich die im Wesentlichen horizontale Richtung zur Oberfläche des Substrats der Ausrichtungsdomänen von einer weiteren in mehreren Subpixelzonen in einem Pixel unterscheidet.

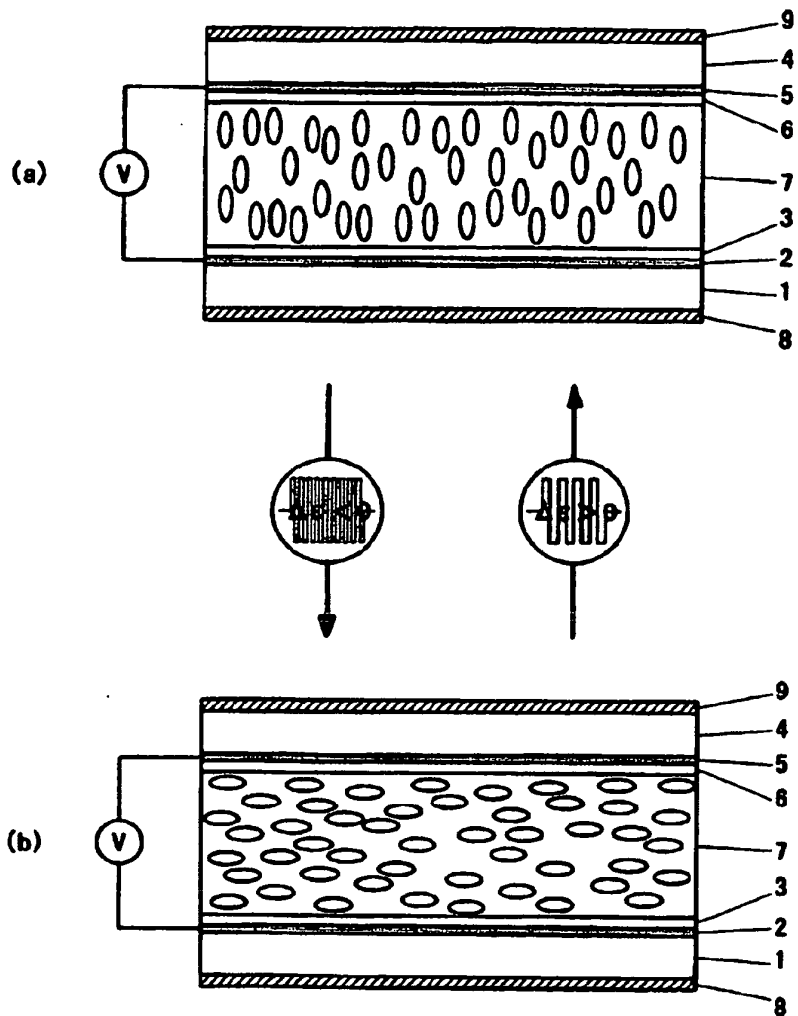
Revendications

1. Un dispositif d'affichage à cristaux liquides utilisant un cristal liquide nématique, comprenant un premier (1) et un deuxième (4) substrats formant une paire de substrats (1, 4), au moins un des substrats étant transparent, et une couche de cristaux liquides (7) interposée entre la paire de substrats (1, 4), une première (2) et une deuxième (5) couches d'électrodes planaires, la première couche d'électrodes planaires (2) se trouvant sur une surface du premier substrat (1) et la deuxième couche d'électrodes planaires (5) se trouvant sur une surface du deuxième substrat (4), au moins une des couches d'électrodes planaires (2,5) étant transparente et un champ électrique étant imposé à travers par l'application d'une tension sur les couches d'électrodes planaires (2,5) ; et le dispositif comprenant également une couche d'orientation (3,6) disposée entre la couche de cristaux liquides (7) et le/ou les substrats (1,4), dans lequel les deux états d'orientation des cristaux liquides sont stables et possèdent une caractéristique de mémoire en l'absence de champ électrique et la couche de cristaux liquides (7) comprend un matériau de cristaux liquides capable de présenter un signe positif ou négatif pour son anisotropie diélectrique en fonction de la fréquence d'un champ électrique alternatif appliqué, **se caractérisant par le fait que** la couche d'orientation (3,6) comprend plusieurs domaines d'orientation adaptés pour orienter les cristaux liquides dans plusieurs directions différentes, y compris une direction sensiblement verticale et une direction sensiblement horizontale par rapport à la surface du substrat, les domaines d'orientation possédant un motif en damier et des dimensions telles que l'orientation globale des molécules des cristaux liquides orientées par la couche d'orientation (3,6) correspond à l'un de deux états d'orientation uniformes des cristaux liquides.
 2. Le dispositif d'affichage à cristaux liquides de la revendication 1, dans lequel un matériau formant la couche d'orientation (3,6) comprend un matériau photoréactif.
 3. Le dispositif d'affichage à cristaux liquides de n'importe laquelle des revendications précédentes, comprenant également une plaque de polarisation sur au moins un des deux substrats (1,4).
 4. Le dispositif d'affichage à cristaux liquides de n'importe laquelle des revendications précédentes, dans lequel la couche de cristaux liquides (7) comprend une molécule de pigment ayant un dichroïsme d'absorption comme constituant.
 5. Le dispositif d'affichage à cristaux liquides de n'im-
6. Le dispositif d'affichage à cristaux liquides de n'importe laquelle des revendications précédentes, dans lequel la direction sensiblement horizontale par rapport à la surface du substrat des domaines d'orientation varie de l'un à l'autre dans plusieurs régions de sous-pixel d'un pixel.
 - porte laquelle des revendications précédentes, comprenant également un réflecteur de lumière disposé sur au moins un des deux substrats (1,4).

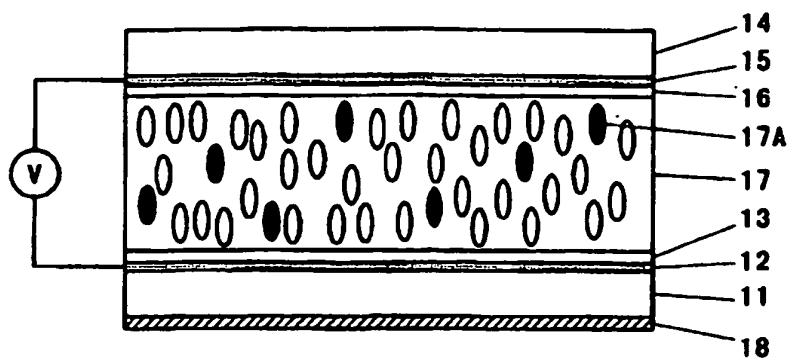
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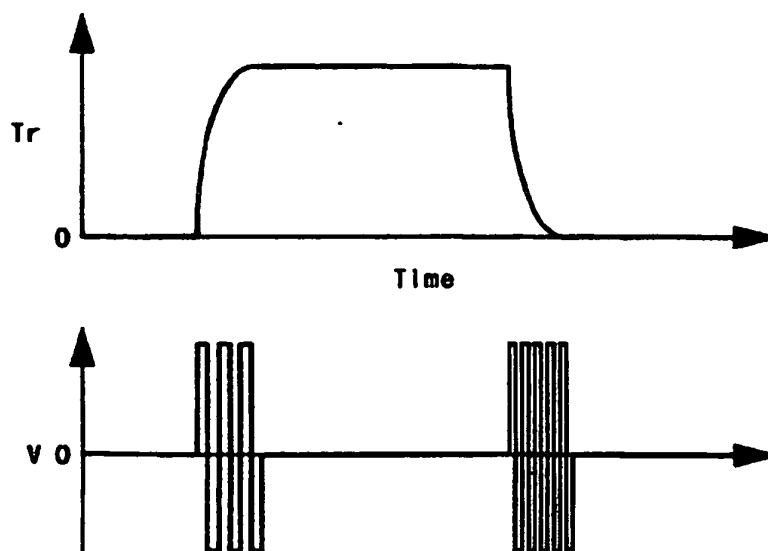
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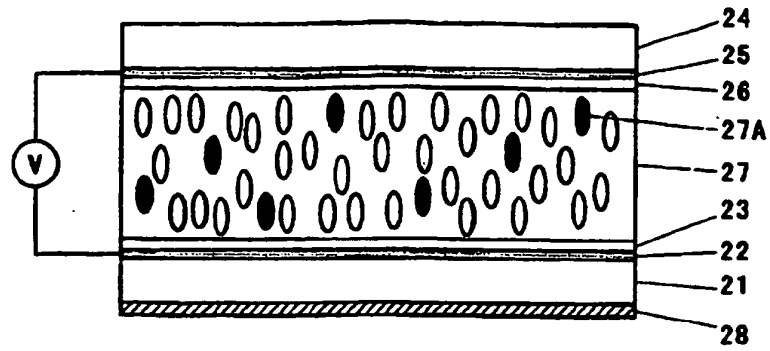
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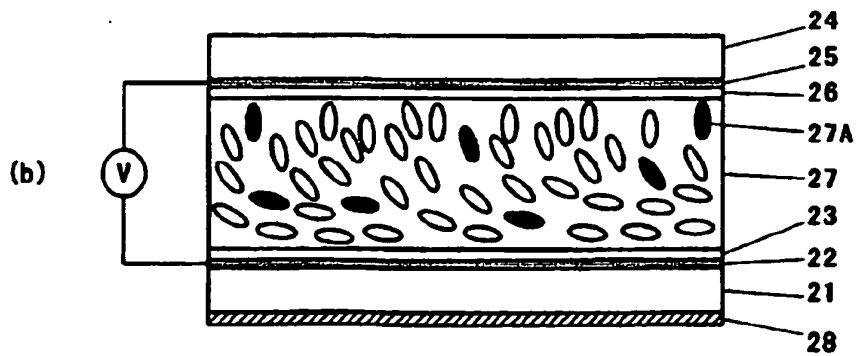
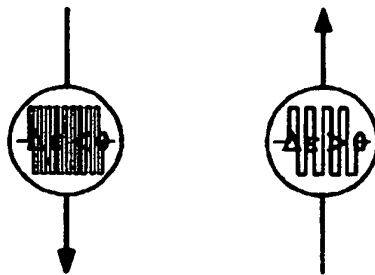
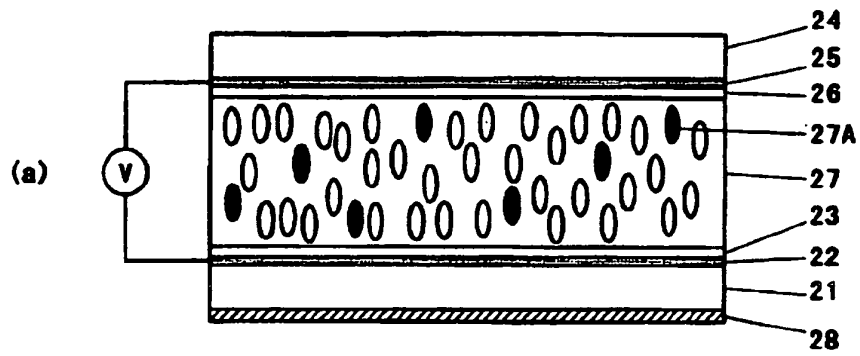
4]



5]



6]



REFERENCES CITED IN THE DESCRIPTION

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