

Description

Background of the Invention

- This invention relates to liquid crystal devices useful in liquid crystal displays (LCDs), as well as other devices such as optical shutters.

In a conventional LC cell the interior major surfaces of the glass plates, with electrodes deposited thereon, are each coated with a thin polymer. The polymer layers are rubbed (e.g., with a cloth) to orient the polymer chains or to form microscopic grooves along a predetermined direction. The LC molecules contacting the polymer align themselves along that direction by interacting with the polymer chains or the microscopic grooves. Thus, the polymer layers are known in the LC art as alignment coatings. In the absence of such layers, the LC molecules at the cell surface would tend to orient themselves randomly in contrast with having a preferred orientation established by the boundary conditions of the alignment coating.

Nematic LC materials, for example, can be easily aligned by coating both of the interior surfaces of the cell with a polymer (usually a polyimide) and by unidirectional rubbing of both of the polymer layers. If an appropriate crystalline polymer is used, such a surface treatment can also align smectic LC materials.

The orientation of LC molecules at surfaces is usually described in terms of the tilt bias angle (α) defined as the angle made between the liquid crystal director and the plane of the surface (see FIG. 2, inset). When α is zero or nearly zero degrees (i.e., $\alpha = 0 \pm 5^\circ$), the orientation is referred to as "homogeneous", and, when it is ninety or nearly ninety degrees (i.e., $\alpha = 90 \pm 5^\circ$), it is referred to as "homeotropic". It is generally a simple matter to produce LC orientations which are either homogeneous or homeotropic, but it has been much more difficult to achieve orientations with α between these extremes. For example, unidirectional homogeneous alignment is typically produced by rubbing a polymer-coated surface, and homeotropic alignment can be produced by treatment of a surface with a surfactant such as a silane or a chromium complex (J. Cognard, *Molecular Crystal Liquid Crystal*, Suppl. 1, p. 1 (1982)). There are several types of liquid crystal devices, however, which require high-tilt angles in the range of about 20-50 degrees: the super-twisted birefringent (SBE) LCD (T.J. Scheffer, et al., *Society for Information Display 85 Digest*, p. 120 (1985)), the optical shutter pi-cell, (P. J. Bos, et al., *Society for Information Display 83 Digest*, p. 30, (1983)), the cholesteric bistable LCD (D. W. Berreman, et al., *Applied Physics Letters*, Vol. 37, p. 1072, (1980)), and the tilted-hybrid phase-change guest-host LCD

(R. W. Filas, *Society for Information Display 84 Digest*, p. 206, (1984)). The conventional method for producing such high-tilt surfaces has been to employ high-vacuum evaporation of materials such as silicon monoxide at oblique evaporation angles. (E. Guyon, et al., *Letters in Applied and Engineering Sciences*, Vol. 1, p. 19, (1973)). SiO can also be used to produce homogeneous alignment. When the evaporation angle is $30^\circ \pm 10^\circ$ to the plane of the surface, homogeneous alignment of LCs occurs in a direction orthogonal to the evaporation direction. Using this technique, H. L. Ong, et al., *Journal of Applied Physics*, Vol. 57, No. 2, p. 186, (1985), describe tilted alignment of nematic LCs by using microscopically inhomogeneous surfaces. The surfaces consisted of small patches or islands of one material (i.e., the silane DMOAP) favoring homeotropic alignment surrounded by a matrix of another material (i.e., SiO) favoring homogeneous (planar) alignment. However, this procedure is time-consuming and can limit the substrate size which in turn limits the size of the display.

In view of the difficulties in achieving high-tilt angles, a chemical process would be highly desirable. The only previously known example of high-tilt produced chemically is given in a paper by G. Porte, *Journal of Physics (Paris)*, Vol. 37, p. 1245 (1976). He observed that by treating a clean glass surface with a monolayer of aliphatic monoamines of varying alkyl chain length, n , the orientation of the nematic N-(p-methoxybenzylidene)-p'-butylaniline (MBBA) to be either tilted ($6 < n < 10$) or homeotropic ($12 < n < 16$). In his experiments, the liquid crystal was allowed to flow by capillarity into a cell, and the tilt direction was determined by the flow direction of the liquid. This method naturally produces antiparallel tilt (FIG. 5, p. 1247) on the two surfaces, which is not generally desirable. Although he claims that it is possible to produce uniform parallel tilt (FIG. 6, p. 1247) by heating to the isotropic phase and then cooling very slowly with a temperature gradient between the two surfaces, such an approach would not be practical for device applications.

U.S.-A-3 854 793 discloses a liquid crystal device and mentions the idea of combining two surfactants. High tilt alignment is not considered.

According to the present invention there is provided a device as claimed in claim 1.

The invention embodies a liquid crystal device having relatively high-tilt alignment coatings; i.e., coatings which align LCs at relatively high-tilt angles produced by applying to the surface to be coated a composite of two or more surface coupling agents, one of which, if applied alone, would cause the LC director to make an angle α_1 with the surface and another of which, if applied alone, would yield α_2 , but together in combination they

produce an acute angle α_3 different from α_1 and α_2 . The surface of the coating in contact with the molecules is chemically homogeneous, not microscopically inhomogeneous as in Ong et al.,supra.

The term homogeneous used here to describe the spatial uniformity of the surface of the coating should not be confused with the word homogeneous used earlier to describe LC molecules whose directors are oriented parallel to the surface on which the coating is formed.

The combination may be formed by depositing a layer of one alignment material, and reacting it with another, or by forming a combination of such materials, which may or may not react with one another, and then forming a layer from the combination on the surface. By varying the relative concentrations of the agents in the combination, it is possible to balance the surface forces to give any desired tilt angle such as $\alpha_3 = 5^\circ$ to 85° . Mechanically deforming the coating along a predetermined direction produces the desired oriented high-tilt boundary condition. Unlike the high-vacuum evaporation approach, there is no intrinsic limitation on the size of the substrate and all angles between homogeneous and homeotropic can be achieved with essentially equal ease.

Brief Description of the Drawing

The invention, together with its various features and advantages, can be readily understood from the following more detailed description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a schematic, isometric view of a LCD in accordance with one embodiment of our invention;

FIG. 2 is a graph of tilt angle versus composition by weight of a mixture of N-methylaminopropyltrimethoxysilane (MAP) and octadecyltrimethoxysilane (OTS). The graph also shows the effect of the age of the solution.

Detailed Description

With reference now to FIG. 1, there is shown a schematic, isometric view of a portion of a liquid crystal (LC) device, illustratively a cell for use in a liquid crystal display (LCD). The cell includes confinement means such as a pair of essentially parallel plates 10 and 20 which bound a LC material 30 therebetween. The LC material may include a single LC constituent or a plurality of such constituents. Among the suitable LC materials are those which are aligned when undergoing a transition (e.g., when cooled) from an isotropic phase to a nematic or cholesteric phase, even though operation of the device may occur with the LC in a

different phase (e.g., smectic). However, operation may also occur, of course, in a nematic or cholesteric phase.

The plates 10 and 20, which are virtually transparent to light, have interior major surfaces on which are deposited electrodes 12 and 22. Where light is to be transmitted through an electrode, it should also be made of virtually transparent material. In an arrangement for matrix addressing or multiplexing the electrodes are patterned to form arrays of closely spaced stripes, with the two arrays being oriented transverse (e.g., perpendicular) to one another. Thus, the LC volume in the region of overlap of each pair of stripes defines a picture element (pel).

The individual pels are selectively addressed by means of suitable electronic circuitry illustratively depicted as a switching source 40 connected to the array of electrodes 22 and a switching source 50 connected to the array of electrodes 12. For simplicity, only two connections to each array are shown. The sources 40 and 50 apply suitable voltages across selected electrodes, thereby applying an electric field E across a preselected pel. The field across the liquid crystal is essentially perpendicular to the cell surfaces.

When used in the common reflection mode, the cell is also provided with a reflector (not shown) which reflects light transmitted through the cell for retransmission out of the viewing surface.

In order to align the molecules of the LC material 30, the cell is further provided with a pair of alignment coatings 80 and 90 on the interior surfaces of the cell. An optional adhesion-promoting layer (not shown) may be applied to the surfaces prior to depositing the coatings. These coatings, which are typically very thin (e.g., on the order of 50-100 Å), cover the plates, or the electrodes, or both. Typically, however, the coatings 80 and 90, as shown, cover the electrodes 12 and 22 as well as the interstitial spaces therebetween. In accordance with one aspect of our invention, coating 80 aligns adjacent molecules of the LC at a predetermined angle α_3 (FIG. 2, inset) which is determined by its composition, and coating 90 aligns adjacent molecules at a predetermined angle α_3 (FIG. 2, inset) which is determined by its composition. The two angles α_3 and α_3 may or may not be equal to one another, but typically coatings 80 and 90 produce high-tilt; that is, angles α_3 and α_3 in the range of, say, 5° to 85° . Each alignment layer is mechanically deformed (e.g., by rubbing its surface with a cloth) along a predetermined direction. However, the predetermined direction for one coating may be different from that for the other coating. The projections of the long axis of the LC molecules adjacent the coatings are aligned along the predetermined directions.

In addition, the LCD includes means for providing optical contrast, illustratively polarizers 60 and 70 formed on the glass plates 10 and 20. The polarizers are oriented with respect to the predetermined (rubbing) directions in a manner well known in the art. Alternatively, contrast can be provided by including a dichroic dye in the LC. In some cases, the dye and a polarizer can be used together.

In one embodiment of our invention, alignment coating 80 is a composite of two or more surface coupling agents (alignment materials) one of which, if applied alone, would cause the LC director to make an angle α_1 with the surface and another of which, if applied alone, would yield α_2 , but together in combination they produce α_3 different from α_1 and α_2 . The surface of the composite coating in contact with the molecules is chemically homogeneous, not microscopically inhomogeneous as in Ong et al., *supra*.

The composite coating may be formed by depositing a first layer of one alignment material, and then forming thereon a second layer of another alignment material. The two layers react with one another so that a surface layer is formed therebetween. The surface layer provides essentially complete coverage of the first layer, and the unreacted portion of the second layer is removed. After mechanically deforming the coating along a predetermined direction, the now exposed surface layer produces oriented high-tilt alignment at α_3 .

In another embodiment of our invention, alignment coating 80 may be formed by combining different alignment materials and then forming a layer from the combination. The combination may be a mixture of agents which react with one another or which do not so react. In either case, the concentrations of the agents and possibly other factors (e.g., age, temperature) in the combination determine the particular tilt angle α_3 that will be produced by the alignment layer formed from that mixture. Thus, by varying the concentrations a range of tilt angles α_3 can be attained with different alignment layers. Similar comments apply to alignment coating 90, a combination of surface coupling agents yielding α_3 from constituents which, if taken alone, would produce α_1 and α_2 , where α_3 may be equal to α_3 , α_1 may be equal to α_1 , and α_2 may be equal to α_2 . In the case where they are equal, of course, the same combination may be used to produce both coating 80 and coating 90.

Illustratively, one constituent (e.g., MAP) of the mixture, if used alone, would produce homogeneous alignment (i.e., α_1 or $\alpha_1 \sim 0^\circ$) and another constituent (e.g., OTS), if used alone, would produce homeotropic alignment (i.e., α_2 or $\alpha_2 \sim 90^\circ$). But, when the two are mixed, they produced alignment at a tilt angle α_3 or α_3 which can range from

0° to 90° depending on their relative concentrations in the mixture. Thus, high-tilt angles of, say, 5° to 85° are readily attainable. The OTS and MAP materials described above are monomers, but combinations of monomers and polymers or of two or more polymers may also be suitable. For example, a chemically modified polymer comprising a polyimide (which alone produces homogeneous alignment) with attached homeotropic-inducing side chains can also be used. Many organic materials (including organo-metallic materials) find application in our invention.

Example

The following example describes LC devices in which the alignment coatings are formed by mixtures of MAP and OTS in various concentrations. The specific parameters and conditions given are illustrative only and are not intended to limit the scope of the invention unless otherwise stated.

An alignment coating of MAP produces homogeneous orientation of LC molecules, whereas a coating of OTS gives homeotropic orientation. Solutions of these materials (3% by weight) were prepared in isopropyl alcohol (IPA) containing 0.5% water and 0.04% acetic acid. These solutions were then combined in various ratios. The solutions were spun onto glass plates which had been previously coated with indium tin oxide, patterned photolithographically to form electrode pads and then cleaned. After being baked for 20 minutes at 120°C , rinsed with IPA, and dried in condensing freon vapors, the plates were buffed with a machine composed of a rotating cylindrical wheel coated with a polyester material and a moving platen which carried the plate beneath the wheel. Test cells were made using antiparallel rubbing directions on the two pieces of glass to produce a parallel-tilt angle configuration (see FIG. 2, inset). The test cells were filled with a nematic liquid crystal (Merck ZLI-1840 purchased from EM Chemicals, Hawthorne, New York), which has a clearing point at 90°C . Filling was done by capillarity in the isotropic phase. The direction of flow during filling was chosen to be perpendicular to the rubbing direction so that a well-aligned sample with the projection of the director in the rubbing direction verified the lack of flow-induced alignment.

Tilt angles were measured using well known magnetocapacitive techniques and well known optical (orthoscopic and conosopic) techniques.

The tilt angle obtained was found to be strongly dependent on the age of the solution used. As can be seen from FIG. 2, for a given weight ratio of MAP/OTS the tilt angle changes with solution age.

The qualitative effect of rubbing pressure on tilt angle was also investigated. At intermediate tilt

angles, pressure had little effect on the magnitude of the angle.

Temperature also affects the tilt angle, and the tilt was observed to decrease with increasing temperature, as is the case for SiO surfaces. The change of angle with temperature was reversible up to about 65 degrees C, but above 70 degrees C the tilt angle was found to increase with time until the sample became homeotropic.

It is to be understood that the above-described arrangements are merely illustrative of the many possible specific embodiments which can be devised to represent application of the principles of the invention. Numerous and varied other arrangements can be devised in accordance with these principles by those skilled in the art without departing from the spirit and scope of the invention.

Claims

1. A liquid crystal device comprising
a cell containing a liquid crystal material (30) and having first (10) and second (20) spaced, substantially parallel plates bounding said liquid crystal material,

thin film electrodes (12,22) formed on an interior major surface of each of said plates, and

alignment coatings (80,90) on both of said plates, and wherein

at least one of said alignment coatings is a first composite coating formed by a combination of one material which, if applied alone, would cause the molecules to orient themselves at an acute angle α_1 to one of said plates and another material which, if applied alone, would cause the molecules to orient themselves at an acute angle α_2 to said one plate, the surface of said first composite coating, which is in contact with said molecules, being chemically homogeneous,

CHARACTERIZED IN THAT said coatings are mechanically deformed so as to align the molecules of the liquid crystal material along a predetermined direction on each of said plates, and in that

said first composite coating causes said molecules to orient themselves at an acute angle α_3 , which is different from α_1 and α_2 .

2. The device according to claim 1
CHARACTERIZED IN THAT
the other alignment coating is a second composite coating formed by a combination of one material which, if applied alone, would cause the molecules to orient themselves at an acute angle α_1 to said other plate and another material which, if applied alone, would cause

the molecules to orient themselves at an acute angle α_2 to said other plate, but when combined together cause said molecules to orient themselves at said acute angle α_3 which is different from α_1 and α_2 , the surface of said second composite coating, which is in contact with said molecules, being chemically homogeneous.

3. The device of claims 1 or 2

CHARACTERIZED IN THAT

said one material of said first composite coating and second composite coating produces homogeneous alignment and said another material of said first composite coating and second composite coating produces homeotropic alignment.

4. The device according to claim 3

CHARACTERIZED IN THAT

said alignment materials comprise organic compounds.

5. The device according to claim 4

CHARACTERIZED IN THAT

said one material comprises MAP and said another material comprises OTS.

6. The device according to claim 5

CHARACTERIZED IN THAT

said liquid crystal material is aligned when undergoing a transition from an isotropic phase to a nematic or cholesteric phase.

7. The device according to claim 4

CHARACTERIZED IN THAT

said angles α_3 and α_3' are each within the range of about 5° to 85°.

8. A liquid crystal

device according to any one of preceding claims 1 to 7,

CHARACTERIZED IN THAT

said electrodes comprise a first array of electrodes on an interior major surface of one of said plates and a second array of electrodes on an interior major surface of the other of said plates, and further including

means (80,70) for providing optical contrast of electromagnetic radiation transmitted through said liquid crystal material, and

means (40,50) for applying voltage to selected ones of said electrodes in each of said arrays.

9. A method of fabricating a liquid crystal device according to any one of preceding claims 1 to 7, comprising the steps of:



angles, pressure had little effect on the magnitude of the angle.

Temperature also affects the tilt angle, and the tilt was observed to decrease with increasing temperature, as is the case for SiO surfaces. The change of angle with temperature was reversible up to about 65 degrees C, but above 70 degrees C the tilt angle was found to increase with time until the sample became homeotropic.

It is to be understood that the above-described arrangements are merely illustrative of the many possible specific embodiments which can be devised to represent application of the principles of the invention. Numerous and varied other arrangements can be devised in accordance with these principles by those skilled in the art without departing from the spirit and scope of the invention.

Claims

1. A liquid crystal device comprising

a cell containing a liquid crystal material (30) and having first (10) and second (20) spaced, substantially parallel plates bounding said liquid crystal material,

thin film electrodes (12,22) formed on an interior major surface of each of said plates, and

alignment coatings (80,90) on both of said plates, and wherein

at least one of said alignment coatings is a first composite coating formed by a combination of one material which, if applied alone, would cause the molecules to orient themselves at an acute angle α_1 to one of said plates and another material which, if applied alone, would cause the molecules to orient themselves at an acute angle α_2 to said one plate, the surface of said first composite coating, which is in contact with said molecules, being chemically homogeneous,

CHARACTERIZED IN THAT said coatings are mechanically deformed so as to align the molecules of the liquid crystal material along a predetermined direction on each of said plates, and in that

said first composite coating causes said molecules to orient themselves at an acute angle α_3 , which is different from α_1 and α_2 .

2. The device according to claim 1

CHARACTERIZED IN THAT

the other alignment coating is a second composite coating formed by a combination of one material which, if applied alone, would cause the molecules to orient themselves at an acute angle α_1 to said other plate and another material which, if applied alone, would cause

the molecules to orient themselves at an acute angle α_2 to said other plate, but when combined together cause said molecules to orient themselves at said acute angle α_3 which is different from α_1 and α_2 , the surface of said second composite coating, which is in contact with said molecules, being chemically homogeneous.

3. The device of claims 1 or 2

CHARACTERIZED IN THAT

said one material of said first composite coating and second composite coating produces homogeneous alignment and said another material of said first composite coating and second composite coating produces homeotropic alignment.

4. The device according to claim 3

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said alignment materials comprise organic compounds.

5. The device according to claim 4

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said one material comprises MAP and said another material comprises OTS.

6. The device according to claim 5

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said liquid crystal material is aligned when undergoing a transition from an isotropic phase to a nematic or cholesteric phase.

7. The device according to claim 4

CHARACTERIZED IN THAT

said angles α_3 and α_3 are each within the range of about 5° to 85°.

8. A liquid crystal

device according to any one of preceding claims 1 to 7,

CHARACTERIZED IN THAT

said electrodes comprise a first array of electrodes on an interior major surface of one of said plates and a second array of electrodes on an interior major surface of the other of said plates, and further including

means (60,70) for providing optical contrast of electromagnetic radiation transmitted through said liquid crystal material, and

means (40,50) for applying voltage to selected ones of said electrodes in each of said arrays.

9. A method of fabricating a liquid crystal device according to any one of preceding claims 1 to 7, comprising the steps of:



- (a) providing a pair of transparent plates (10,20) from which a liquid crystal cell is to be formed,
- (b) depositing thin film electrodes (12,22) on said plates,
- (c) forming alignment coatings (80,90) on each of said plates, this step including, with respect to at least one of said plates, combining at least two alignment materials for forming a first composite coating, one of said materials, if applied alone to said one plate, would cause molecules of the liquid crystal to orient themselves at an angle α_1 thereto, and another of said materials, if applied alone to said one plate, would cause molecules of the liquid crystal to orient themselves at an angle α_2 thereto, and applying the combination of said materials to said plate so as to form said first composite coating which causes said molecules to orient themselves at an angle α_3 thereto, where α_3 is different from α_1 and α_2 , the surface of said first composite coating, which is in contact with said molecules, being chemically homogeneous,
- (d) mechanically deforming said coatings so as to align the molecules of the liquid crystal along a predetermined direction on each of said plates, and
- (e) filling said cell with a liquid material which includes a liquid crystal.

10. The method according to claim 9, wherein

with respect to said other plate, step (c) further includes combining at least two alignment materials for forming a second composite coating one of said materials, if applied alone to said other plate, would cause molecules of the liquid crystal to orient themselves at an angle α_1' thereto, and another of said materials, if applied alone to said other plate, would cause molecules of said liquid crystal to orient themselves at an angle α_2' thereto, and applying the combination of said materials to said other plate so as to form said second composite coating which causes said molecules to orient themselves at an angle α_3' thereto, where α_3' is different from α_1' and α_2' and may be different from α_3 the surface of said second composite coating, which is in contact with said molecules, being chemically homogeneous.

Patentansprüche

1. Flüssigkristalleinrichtung mit:
einer Zelle mit einem Flüssigkristallmaterial (30) mit ersten (10) und zweiten (20) beabstan-

deten im wesentlichen parallelen Platten, die das Flüssigkristallmaterial beranden, dünnen Filmelektroden (12, 22), die auf einer inneren Hauptoberfläche jeder Platte ausgebildet sind und Ausrichtungsbeschichtungen (80, 90) auf beiden Platten und bei welcher wenigstens eine der Ausrichtungsbeschichtungen eine erste zusammengesetzte Beschichtung ist, die durch eine Kombination eines Materials, das, falls allein aufgebracht, die Moleküle veranlassen würde, sich unter einem spitzen Winkel α_1 zu einer der Platten auszurichten und eines anderen Materials, das, falls alleine aufgebracht, die Moleküle veranlassen würde, sich unter einem spitzen Winkel α_2 zu der besagten Platte auszurichten, gebildet ist, wobei die Oberfläche der ersten zusammengesetzten Beschichtung, die mit den Molekülen in Kontakt steht, chemisch homogen ist, dadurch gekennzeichnet, daß die Beschichtungen mechanisch deformiert sind, um so die Moleküle des Flüssigkristallmaterials entlang einer vorbestimmten Richtung von jeder Platte auszurichten, und daß die erste zusammengesetzte Beschichtung die Moleküle veranlasst, sich unter einem spitzen Winkel α_3 auszurichten, der von α_1 und α_2 verschieden ist.

2. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß

die andere Ausrichtungsbeschichtung eine zweite zusammengesetzte Beschichtung ist, die aus einer Kombination eines Materials gebildet wird, das, falls alleine aufgebracht, die Moleküle veranlassen würde, sich unter einem spitzen Winkel α_1' zu der anderen Platte zu orientieren und aus einem anderen Material, das, falls alleine aufgebracht, die Moleküle veranlassen würde, sich unter einem spitzen Winkel α_2' zu der anderen Platte zu orientieren, aber bei dem Kombinieren zusammen die Moleküle veranlaßt, sich unter einem spitzen Winkel α_3' zu orientieren, der von α_1' und α_2' verschieden ist, wobei die Oberfläche der zweiten zusammengesetzten Beschichtung, die mit den Molekülen in Kontakt steht, chemisch homogen ist.

3. Einrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß

das eine Material der ersten zusammengesetzten Beschichtung und der zweiten zusammengesetzten Beschichtung homogene Ausrichtung erzeugt, und daß das andere Material der ersten zusammengesetzten Beschichtung und der zweiten zusammengesetzten Beschichtung homeotrope Ausrichtung erzeugt.



4. Einrichtung nach Anspruch 3, dadurch gekennzeichnet, daß die Ausrichtungsmaterialien organische Zusammensetzungen enthalten.

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5. Einrichtung nach Anspruch 4, dadurch gekennzeichnet, daß das eine Material MAP enthält, und daß das andere Material OTS enthält.

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6. Einrichtung nach Anspruch 5, dadurch gekennzeichnet, daß das Flüssigkristallmaterial ausgerichtet wird, wenn es einem Übergang aus einer isotropen Phase zu einer nematischen oder cholesterischen Phase unterliegt.

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7. Einrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Winkel α_3 und α_3' beide in dem Bereich von ungefähr 5° bis 85° liegen.

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8. Flüssigkristalleinrichtung nach einem der vorhergehenden Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die Elektroden ein erstes Feld aus Elektroden auf einer inneren Hauptoberfläche einer der beiden Platten und ein zweites Feld aus Elektroden auf einer inneren Hauptoberfläche der anderen von beiden Platten umfassen und ferner enthalten:
eine Einrichtung (60, 70) zum Bereitstellen optischen Kontrastes für durch das Flüssigkristallmaterial transmittierte elektromagnetische Strahlung und
eine Einrichtung (40, 50) zum Anlegen einer Spannung an ausgewählte Elektroden in jedem Feld.

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9. Verfahren zur Herstellung einer Flüssigkristalleinrichtung nach einem der vorstehenden Ansprüche 1 bis 7, mit den Schritten:

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a) Bereitstellen eines Paares transparenter Platten (10, 20), aus welchen eine Flüssigkristallzelle zu bilden ist,

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b) Abscheiden dünner Filmelektroden (12, 22) auf den Platten,

c) Bilden von Ausrichtungsbeschichtungen (80, 90) auf jeder der Platten, wobei dieser Schritt in bezug auf wenigstens eine der Platten das Kombinieren wenigstens von zwei Ausrichtungsmaterialien zum Bilden einer ersten zusammengesetzten Beschichtung umfaßt, wobei eines der Materialien, falls allein auf eine Platte aufgebracht, die Moleküle des Flüssigkristalls veranlassen würde, sich unter einem Winkel α_1 zu die-

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ser zu orientieren, und ein anderes der Materialien, falls allein auf die eine Platte aufgebracht, die Moleküle veranlassen würde, sich unter einem Winkel α_2 zu dieser zu orientieren, und Aufbringen der Kombination dieser Materialien auf die Platte, um so die erste zusammengesetzte Beschichtung zu bilden, welche die Moleküle veranlaßt, sich unter einem Winkel α_3 zu dieser zu orientieren, wobei α_3 von α_1 und α_2 verschieden ist, wobei die Oberfläche der ersten zusammengesetzten Beschichtung, die mit den Molekülen in Kontakt steht, chemisch homogen ist,

d) mechanisches Deformieren der Beschichtungen, um so die Moleküle des Flüssigkristalls entlang einer vorbestimmten Richtung auf jeder der Platten auszurichten und

e) Füllen der Zelle mit einem flüssigen Material, das einen Flüssigkristall enthält.

10. Verfahren nach Anspruch 9,

in welchem in bezug auf die andere Platte der Schritt c) ferner das Kombinieren von wenigstens zwei Ausrichtungsmaterialien zum Bilden einer zweiten zusammengesetzten Beschichtung enthält, wobei eines der Materialien, falls allein auf die andere Platte aufgebracht, die Moleküle des Flüssigkristalls veranlassen würde, sich unter einem Winkel α_1' zu dieser auszurichten, und das andere der Materialien, falls allein auf die andere Platte aufgebracht, die Moleküle veranlassen würde, sich unter einem Winkel α_2' zu dieser zu orientieren, und Aufbringen der Kombination aus den Materialien auf die andere Platte, um so die zweite zusammengesetzte Beschichtung zu bilden, welche die Moleküle veranlaßt, sich unter einem Winkel α_3' zu dieser auszurichten, wobei α_3' von α_1' und α_2' verschieden ist und von α_3 verschieden sein kann, wobei die Oberfläche der zweiten zusammengesetzten Beschichtung, die mit den Molekülen in Kontakt steht, chemisch homogen ist.

Revendications

1. Un dispositif à cristal liquide comprenant une cellule contenant une matière à cristal liquide (30) et ayant des première (10) et seconde (20) lames pratiquement parallèles et espacées, enfermant la matière à cristal liquide,
des électrodes à couches minces (12, 22) formées sur une surface principale intérieure de chacune des lames, et
des revêtements d'alignement (80, 90) sur



les deux lames, et dans lequel

l'un au moins des revêtements d'alignement est un premier revêtement composite formé par une combinaison d'une matière qui, si elle était appliquée seule, ferait en sorte que les molécules s'orientent sous un angle aigu α_1 par rapport à l'une des lames, et d'une autre matière qui, si elle était appliquée seule, ferait en sorte que les molécules s'orientent sous un angle aigu α_2 par rapport à la lame précitée, la surface du premier revêtement composite qui est en contact avec les molécules étant chimiquement homogène,

CARACTERISE EN CE QUE

les revêtements sont déformés mécaniquement de façon à aligner les molécules de la matière à cristal liquide selon une direction prédéterminée sur chacune des lames, et en ce que

le premier revêtement composite fait en sorte que les molécules s'orientent sous un angle α_3 qui est différent de α_1 et α_2 .

2. Le dispositif de la revendication 1 CARACTERISE EN CE QUE

l'autre revêtement d'alignement est un second revêtement composite qui est formé par une combinaison d'une matière qui, si elle était appliquée seule, ferait en sorte que les molécules s'orientent sous un angle aigu α_1 par rapport à l'autre lame, et d'une autre matière qui, si elle était appliquée seule, ferait en sorte que les molécules s'orientent sous un angle aigu α_2 par rapport à cette autre lame, mais lorsque ces matières sont combinées ensemble, elles font en sorte que les molécules s'orientent sous un angle aigu α_3 qui est différent de α_1 et α_2 la surface du second revêtement composite qui est en contact avec les molécules étant chimiquement homogène.

3. Le dispositif des revendications 1 ou 2 CARACTERISE EN CE QUE

la matière mentionnée en premier pour le premier revêtement composite et le second revêtement composite produit un alignement homogène, et l'autre matière du premier revêtement composite et du second revêtement composite produit un alignement homéotrope.

4. Le dispositif selon la revendication 3 CARACTERISE EN CE QUE

les matières d'alignement consistent en composés organiques.

5. Le dispositif selon la revendication 4 CARACTERISE EN CE QUE

la matière mentionnée en premier consiste

en MAP et l'autre matière consiste en OTS.

6. Le dispositif selon la revendication 5 CARACTERISE EN CE QUE

la matière à cristaux liquides est alignée lorsqu'elle subit une transition d'une phase isotrope vers une phase nématique ou cholestérique.

7. Le dispositif selon la revendication 4 CARACTERISE EN CE QUE

les angles α_3 et α_3 sont chacun dans la plage d'environ 5° à 85° .

8. Un dispositif à cristal liquide selon l'une quelconque des revendications 1 à 7 précédentes, CARACTERISE EN CE QUE

les électrodes comprennent un premier réseau d'électrodes sur une surface principale intérieure de l'une des lames, et un second réseau d'électrodes sur une surface principale intérieure de l'autre lame, et il existe en outre des moyens (60, 70) pour produire un contraste optique pour le rayonnement électromagnétique qui est transmis à travers la matière à cristal liquide, et

des moyens (40, 50) pour appliquer une tension à certaines électrodes sélectionnées dans chacun des réseaux.

9. Un procédé de fabrication d'un dispositif à cristal liquide selon l'une quelconque des revendications 1 à 7 précédentes, comprenant les étapes suivantes :

(a) on fournit une paire de lames transparentes (10, 20) à partir desquelles on doit former une cellule à cristal liquide,

(b) on dépose des électrodes à couches minces (12, 22) sur les lames,

(c) on forme des revêtements d'alignement (80, 90) sur chacune des lames, cette étape comprenant, pour l'une au moins des lames, la combinaison d'au moins deux matières d'alignement pour former un premier revêtement composite, l'une de ces matières étant telle que si elle est appliquée seule à la lame précitée, elle conduit les molécules du cristal liquide à s'orienter sous un angle α_1 par rapport à la lame, et l'autre de ces matières étant telle que si elle est appliquée seule à la lame précitée, elle conduit les molécules du cristal liquide à s'orienter sous un angle α_2 par rapport à la lame, et l'application de la combinaison des matières précitées à la lame, pour former le premier revêtement composite sous l'effet duquel les molécules s'orientent sous un angle α_3 par rapport à la lame, avec α_3



différent de α_1 et α_2 , la surface du premier revêtement composite qui est en contact avec les molécules étant chimiquement homogène,

(d) on déforme mécaniquement les revêtements de façon à aligner les molécules du cristal liquide dans une direction prédéterminée sur chacune des lames, et

(e) on remplit la cellule avec une matière liquide qui contient un cristal liquide.

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10. Le procédé selon la revendication 9, dans lequel

en relation avec l'autre lame, l'étape (c) comprend en outre la combinaison d'au moins deux matières d'alignement pour former un second revêtement composite, l'une des matières précitées étant telle que, si elle est appliquée seule à cette autre lame, elle conduit les molécules du cristal liquide à s'orienter sous un angle α_1 par rapport à cette lame, et une autre des matières étant telle que, si elle est appliquée seule à l'autre lame, elle conduit les molécules du cristal liquide à s'orienter sous un angle α_2 par rapport à la lame, et l'application de la combinaison des matières précitées sur l'autre lame précitée, de façon à former le second revêtement composite sous l'effet duquel les molécules s'orientent sous un angle α_3 par rapport à lui, α_3 étant différent de α_1 et α_2 et pouvant être différent de α_3 , la surface du second revêtement composite qui est en contact avec les molécules étant chimiquement homogène.

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