



US009733522B2

(12) **United States Patent**
Choi et al.

(10) **Patent No.:** **US 9,733,522 B2**
(45) **Date of Patent:** **Aug. 15, 2017**

(54) **LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR MANUFACTURING THE SAME**

(71) Applicant: **LG Display Co., Ltd.**, Seoul (KR)

(72) Inventors: **Wonjin Choi**, Seoul (KR); **Sejin Jang**, Paju-si (KR)

(73) Assignee: **LG Display Co., Ltd.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 420 days.

(21) Appl. No.: **14/327,763**

(22) Filed: **Jul. 10, 2014**

(65) **Prior Publication Data**

US 2015/0146147 A1 May 28, 2015

(30) **Foreign Application Priority Data**

Nov. 27, 2013 (KR) 10-2013-0145506

(51) **Int. Cl.**

G02F 1/1337 (2006.01)

G02F 1/1339 (2006.01)

G02F 1/1333 (2006.01)

(52) **U.S. Cl.**

CPC **G02F 1/133723** (2013.01); **G02F 1/1333** (2013.01); **G02F 1/1339** (2013.01); **G02F 1/13378** (2013.01); **G02F 1/133305** (2013.01); **G02F 1/13377** (2013.01); **G02F 1/133784** (2013.01); **G02F 2202/28** (2013.01)

(58) **Field of Classification Search**

CPC .. G02F 1/13394; G02F 1/1334; G02F 1/1337; G02F 1/133711; G02F 2001/133715; G02F 2001/13398

USPC 349/123, 127, 156, 87, 92
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,621,553 A 4/1997 Nishiguchi et al.
5,870,162 A 2/1999 Fujimori et al.
6,014,188 A * 1/2000 Yamada G02F 1/13334
345/37

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1625715 A 6/2005
CN 1982966 A 6/2007

(Continued)

OTHER PUBLICATIONS

European Patent Office, Search Report and Opinion, European Patent Application No. 14181549.8, Mar. 19, 2015, seven pages.

(Continued)

Primary Examiner — Thanh-Nhan P Nguyen

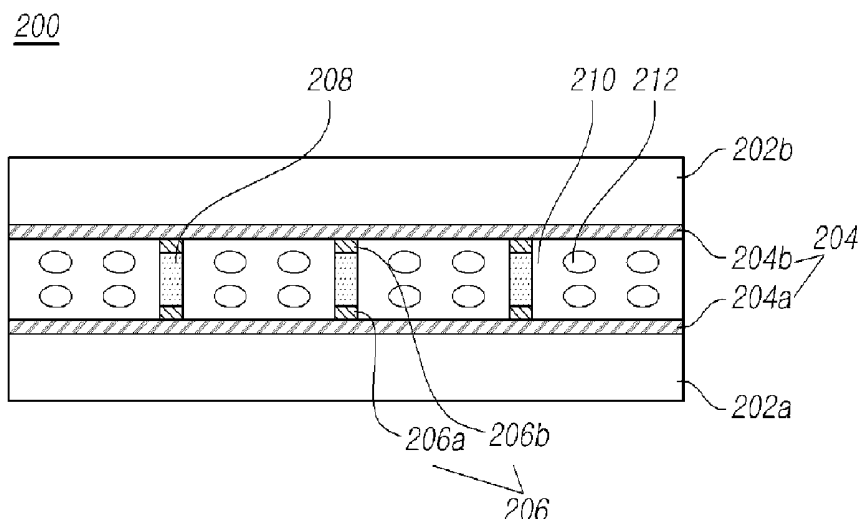
(74) *Attorney, Agent, or Firm* — Fenwick & West LLP

(57)

ABSTRACT

The present disclosure provides a liquid crystal display device and a method for manufacturing the same. The device includes: a first substrate; a second substrate spaced apart from and opposite to the first substrate; a first lower alignment layer formed on an upper surface of the first substrate; a first upper alignment layer formed on a lower surface of the second substrate; a second alignment layer formed in an array on either or both of an upper surface of the first lower alignment layer and a lower surface of the first upper alignment layer; a polymer barrier positioned between the first substrate and the second substrate, the polymer barrier formed on the array of the second alignment layer; and a liquid crystal positioned between the polymer barriers.

17 Claims, 11 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

6,115,098 A * 9/2000 Kume G02F 1/1393
349/130
2004/0032561 A1 2/2004 Kumar et al.
2006/0285061 A1 * 12/2006 Woo G02F 1/1333
349/156
2008/0036960 A1 2/2008 Ding et al.

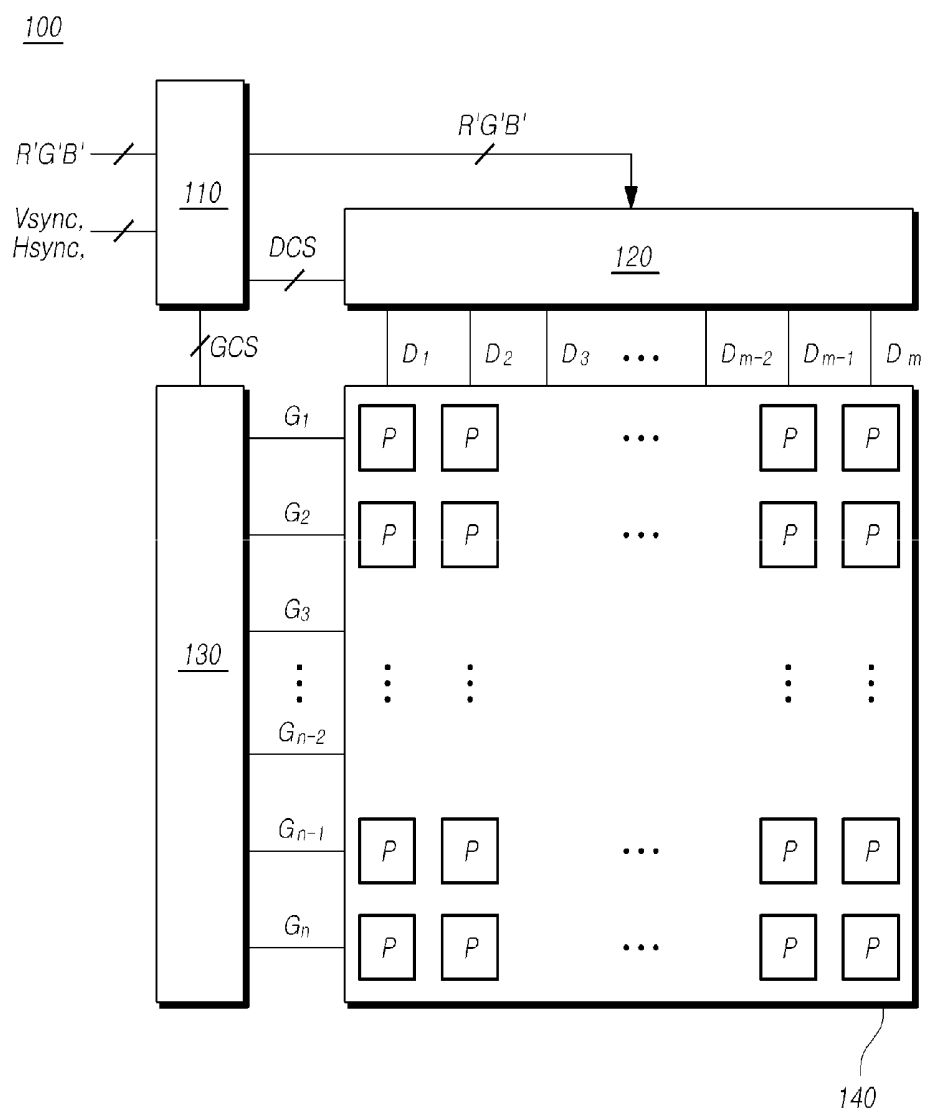
FOREIGN PATENT DOCUMENTS

CN 1991479 A 7/2007
CN 102819146 A 12/2012
JP 2006-91200 A 4/2006

OTHER PUBLICATIONS

Chinese Office Action, Chinese Application No. 201410389861.3,
Feb. 27, 2017, 7 pages (with concise explanation of relevance).

* cited by examiner

FIG. 1

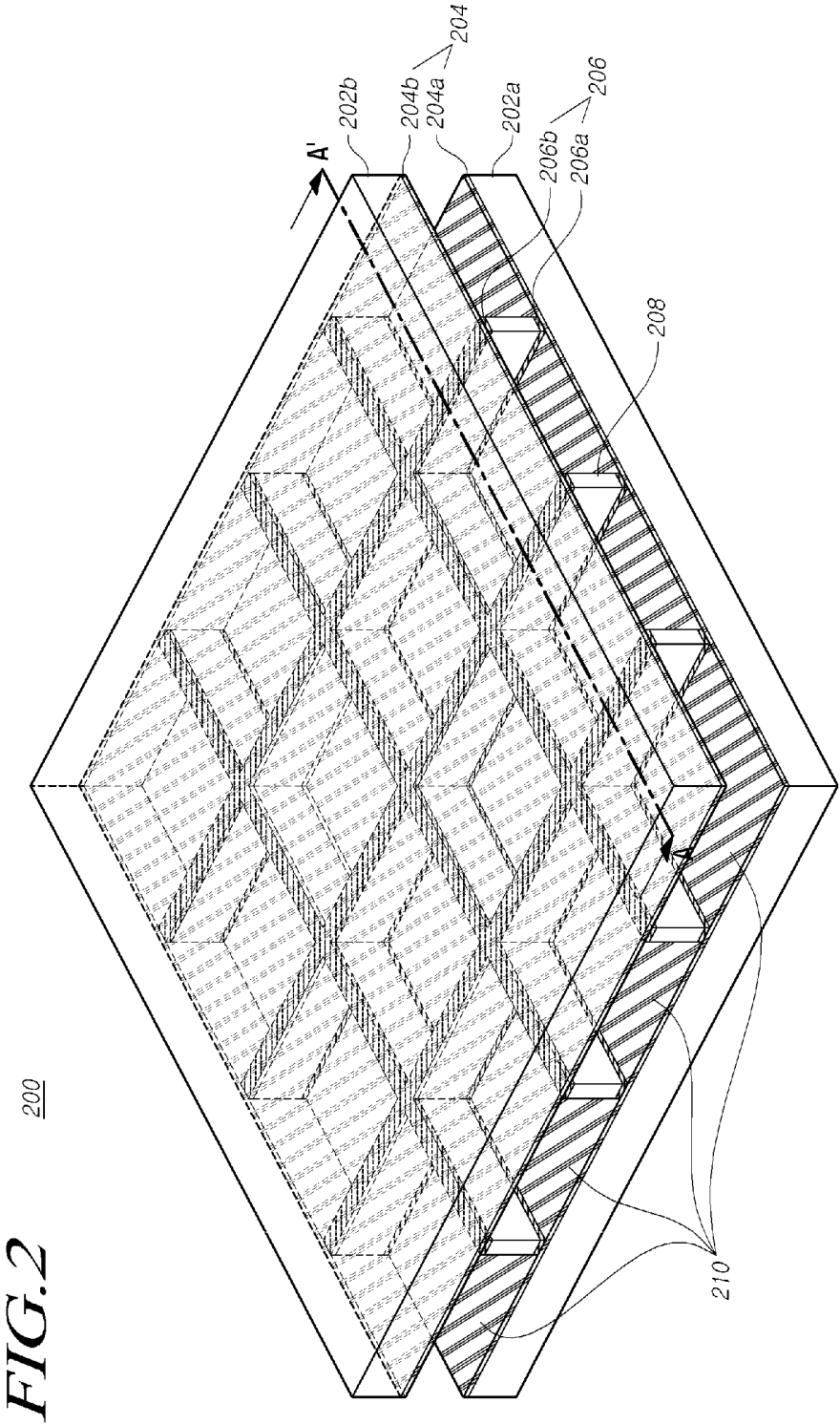
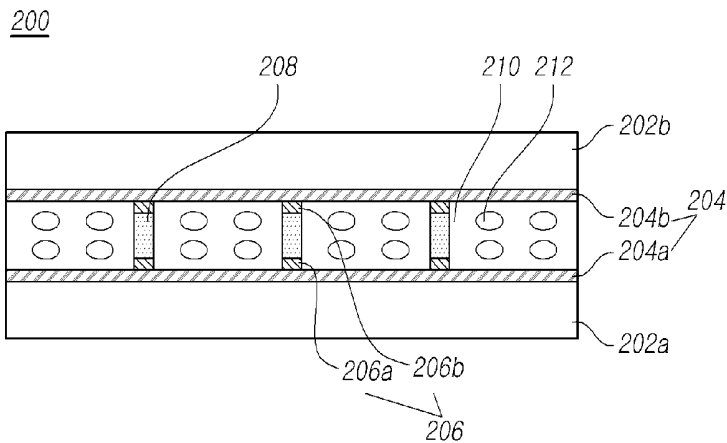
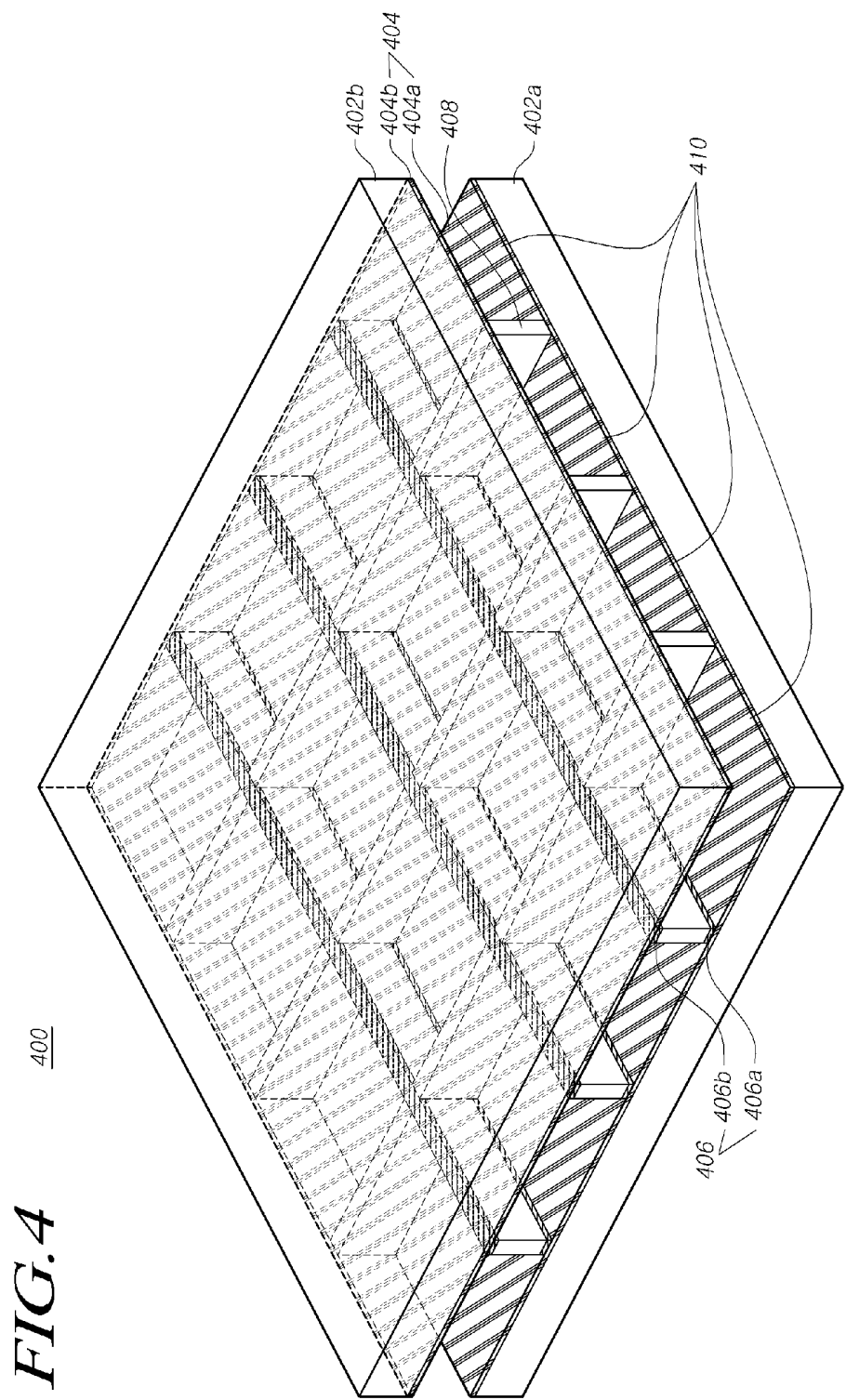


FIG. 3





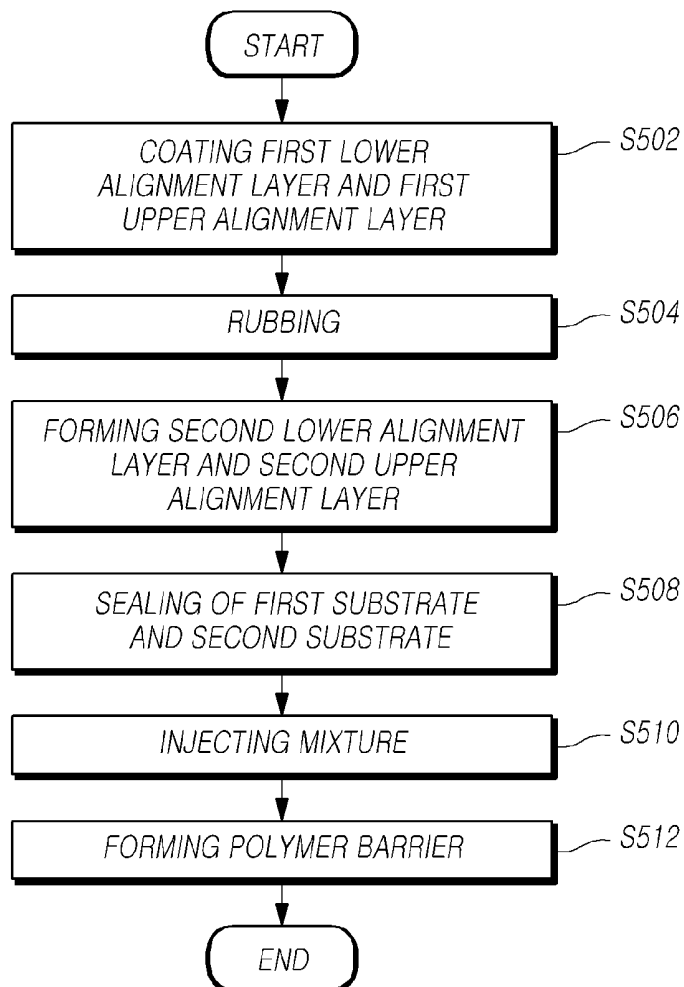
*FIG. 5*500

FIG. 6A

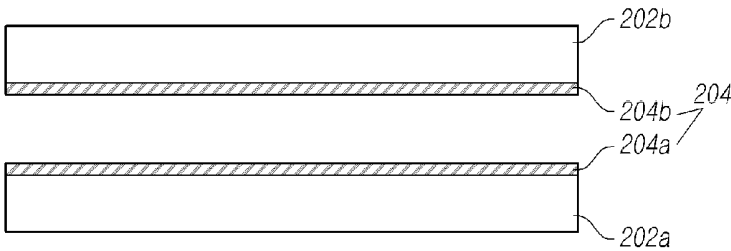


FIG. 6B

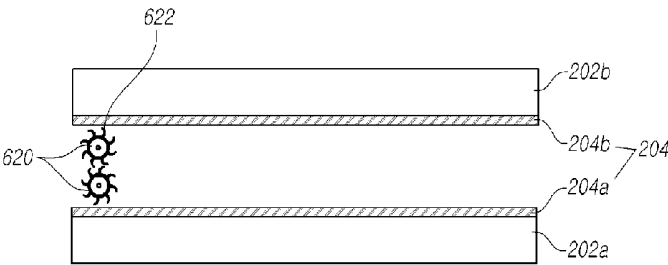


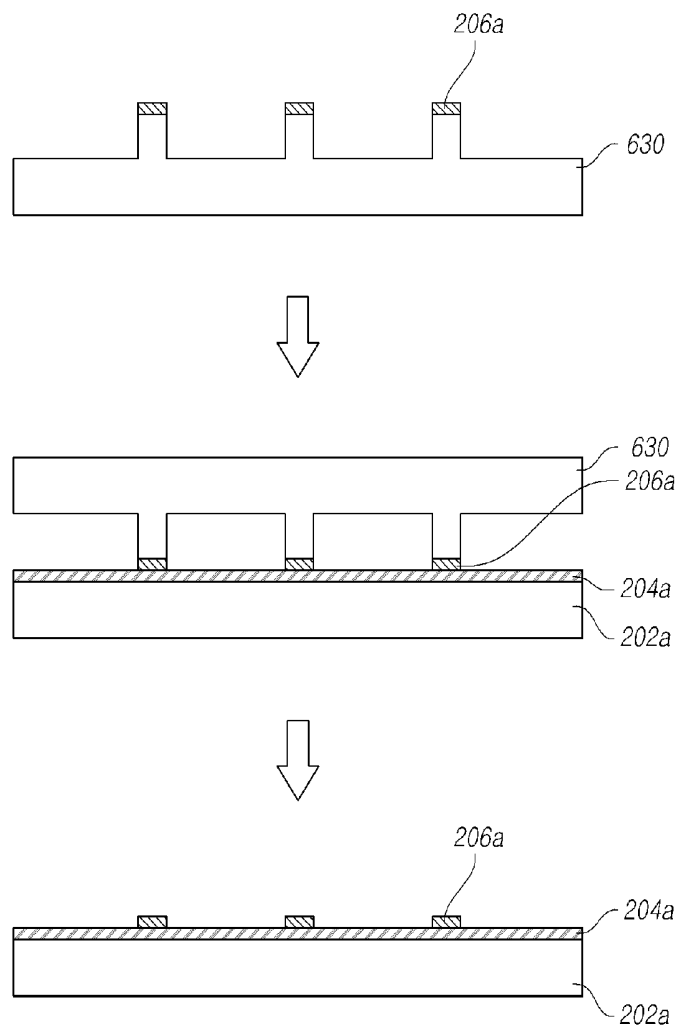
FIG. 6C

FIG. 6D

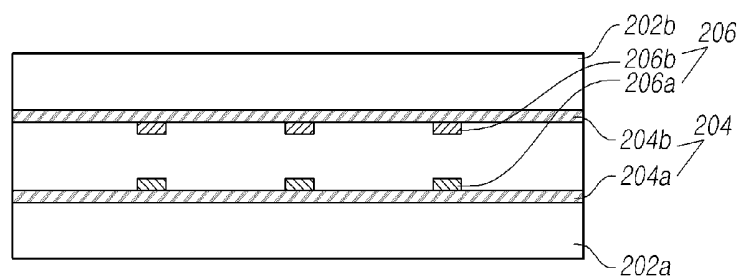


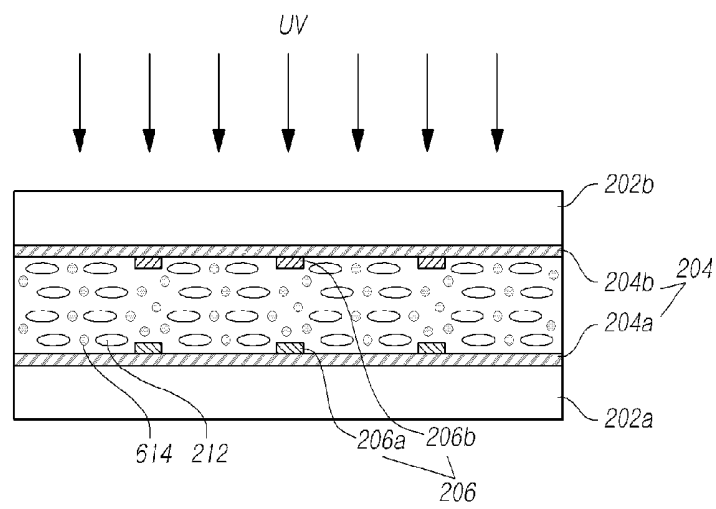
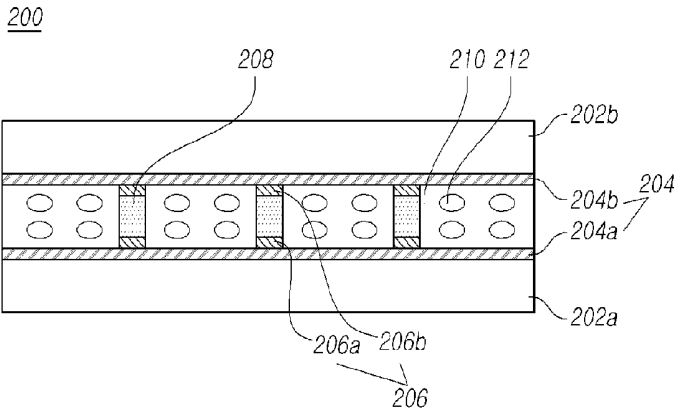
FIG. 6E

FIG. 6F



LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from and the benefit under 35 U.S.C. §119(a) of Korean Patent Application No. 10-2013-0145506, filed on Nov. 27, 2013, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

1. Field

The present invention relates to a liquid crystal display device and a method for manufacturing the same.

2. Description of the Prior Art

A liquid crystal display device technology, by continuous evolving, is replacing a fixed-type display market using an existing CRT (Cathode-Ray Tube), and is being expanded to a DID (Digital Information Display) or PID (Public Information Display) market by increasingly enlarging a display device for a laptop, a computer monitor, a TV, etc. Further, the liquid crystal display device technology is also keeping its position in a mobile area. Because the liquid crystal display devices use a glass substrate, these devices can be easily broken and not deformed. Therefore, the liquid crystal display devices using a glass substrate have a disadvantage in that a display size is limited, and thus it is inconvenient to carry. To overcome this disadvantage, researches on the next generation display, which is unbreakable and deformable by using a flexible substrate instead of a glass substrate, are being actively studied.

In the case of the liquid crystal display device using a liquid crystal in methods for implementing the flexible display, because a plastic-based substrate is used, a liquid crystal in a liquid state is not restricted to a pixel inside depending on the bending of the substrate, and it is necessary to maintain a cell gap to be uniform.

Further, to obtain uniform brightness and a high contrast ratio, an aligning the injected liquid crystal molecules in a certain direction is required. Currently, the most widely used method for aligning a liquid crystal is an alignment method by rubbing. This rubbing method forms regular micro grooves on the surface of an alignment layer by rubbing after applying an alignment layer material (polyimide) on a substrate.

In LCD devices, if a cell gap is not maintained in the liquid crystal display device, problems, such as increased image retention or stains on the surface of the panel, may occur.

SUMMARY

An aspect of the present disclosure is to provide a liquid crystal display device and a method for manufacturing the same, which can reduce image retention of a liquid crystal display device and firmly maintain a cell gap.

To achieve the aspect described above, the present disclosure provides a liquid crystal display device including a first substrate; a second substrate spaced apart from and opposite to the first substrate; a first lower alignment layer formed on an upper surface of the first substrate; a first upper alignment layer formed on a lower surface of the second substrate; a second alignment layer formed in an array

either or both of an upper surface of the first lower alignment layer and a lower surface of the first upper alignment layer; a polymer barrier positioned between the first substrate and the second substrate, the polymer barrier formed on the array of the second alignment layer; and a liquid crystal positioned between the polymer barriers.

In another aspect of the present disclosure, a method for manufacturing a liquid crystal display device includes a step of forming a first lower alignment layer on an upper surface of a first substrate; a step of forming a first upper alignment layer on a lower surface of a second substrate spaced apart from and opposite to the first substrate; a step of forming a second lower alignment layer on either or both of an upper surface of the first lower alignment layer or a lower surface of the first upper alignment layer, the second lower alignment layer formed in an array; a step of sealing the first substrate and the second substrate; a step of injecting a mixture, which includes a liquid crystal and one or more of monomers, between the first substrate and the second substrate; and a step of forming a polymer barrier between the second lower alignment layer and the second upper alignment layer from the injected one or more monomers, the polymer barrier formed on the array of the second alignment layer.

In another aspect of the present disclosure provides a liquid crystal display device including a first lower alignment layer; a first upper alignment layer parallel to the first alignment layer; a polymer barrier orthogonal to the first upper alignment layer and to the first lower alignment layer, the polymer barrier including a first end proximate to the first upper alignment layer and a second end proximate to the first lower alignment layer, the polymer barrier formed in an array; and a first adhesive layer formed in the array of the polymer barrier between the polymer barrier and at least one of the first lower alignment layer and first upper alignment layer.

In another aspect of the present disclosure, a method for manufacturing a liquid crystal display device includes a step of forming a first upper alignment layer on an upper surface of a first substrate; forming a first lower alignment layer on an lower surface of a second substrate spaced apart from and opposite to the first substrate; forming an adhesive layer on at least one of the first upper alignment layer and the first lower alignment layer, the adhesive layer formed in an array; injecting a mixture including a liquid crystal and one or more of monomers between the first substrate and the second substrate; and forming a polymer barrier in the array between the adhesive layer and at least one of the first lower alignment layer and the first upper alignment layer.

The present disclosure has effects by which image retention of a liquid crystal display device can be reduced and a cell gap can be firmly maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present disclosure will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a system configuration diagram relating to a liquid crystal display device to which embodiments of the present disclosure are applied;

FIG. 2 is a schematic perspective diagram showing the liquid crystal display device of FIG. 1, according to an embodiment of the present disclosure;

FIG. 3 is a sectional diagram of the liquid crystal display device illustrated in FIG. 2 having been cut in an AA' direction;

FIG. 4 is a schematic perspective diagram showing a liquid crystal display device according to another embodiment of the present disclosure;

FIG. 5 is a schematic flowchart relating to a method for manufacturing a liquid crystal display device according to another embodiment of the present disclosure; and

FIG. 6A to FIG. 6F are diagrams showing a method for manufacturing a liquid crystal display device according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, embodiments of the present disclosure will be described with reference to the accompanying drawings. In the following description, the same elements will be designated by the same reference numerals although they are shown in different drawings. Further, in the following description of embodiments of the present disclosure, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the main idea of the present disclosure unclear.

In the description of the elements of the present disclosure, terms “first”, “second”, “A”, “B”, “(a)”, “(b)” and the like may be used. These terms are merely used to distinguish one element from another element, and do not limit a true nature, a sequence or an order of the corresponding element. In the case that it is described that a certain structural element “is connected to”, “is coupled with”, or “is in contact with” another structural element, it should be interpreted that another structural element may “be connected to”, “be coupled with”, or “be in contact with” other structural elements as well as that the certain structural element is directly connected to or is in direct contact with another structural element. Likewise, when it is described that a certain element is formed “on” or “under” another element, it should be understood that the certain element may be formed either directly or indirectly via a still another element on or under the another element.

FIG. 1 is a system configuration diagram relating to a liquid crystal display device to which embodiments of the present disclosure are applied.

Referring to FIG. 1, the liquid crystal display device 100 includes a liquid crystal display panel 140, a data driver 120, a gate driver 130, and a timing controller 110.

First, the timing controller 110 outputs a data control signal (DCS) for controlling a data driver 120 and a gate control signal (GCS) for controlling a gate driver 130 based on a vertical/horizontal sync signal (Vsync, Hsync) and a video signal (RGB), which are input from a host system, and an external timing signal such as a clock signal (CLK). Further, the timing controller 110 may convert the video signal (RGB) input from the host system into a format of a data signal used in the data driver 120, and supply the converted video signal (R'G'B') to the data driver 120.

In response to the data control signal (DCS) and the converted video signal (R'G'B'), which are input from the timing controller 110, the data driver 120 converts the converted video signal (R'G'B') into the data signal (an analog pixel signal or a data voltage), which is a voltage value corresponding to a gradation value, and supplies the converted data signal to a data line.

In response to the gate control signal (GCS) input from the timing controller 110, the gate driver 130 supplies a scan signal (a gate pulse or a scan pulse, and a gate-on signal) to a gate line sequentially.

Meanwhile, the liquid crystal display panel 140 may be the liquid crystal display device including two substrates, a liquid crystal layer positioned between the two substrates, and a single alignment layer or a plurality of alignment layers.

A first substrate of the liquid crystal display panel 140 may be implemented to a COT (Color filter On TFT) structure. In this case, a black matrix and a color filter may be formed on the first substrate.

Further, the first substrate (a lower substrate) of the liquid crystal display panel 140 may include a plurality of data lines (D1 to Dm wherein m is a natural number), a plurality of gate lines (or scan lines) (G1 to Gn wherein n is a natural number) intersecting with the data lines (D1 to Dm), a plurality of transistors formed at intersections of the data lines (D1 to Dm) and the gate lines (G1 to Gn), a plurality of pixel electrodes for charging the data voltage to liquid crystal cells, and storage capacitors connected to the pixel electrodes to maintain the voltages of the liquid crystal cells.

A second substrate (an upper substrate) of the liquid crystal display panel 140 may include a black matrix and a color filter.

Meanwhile, the pixels (P) of the liquid crystal display panel 140 are formed in pixel regions defined by the data lines (D1 to Dm) and the gate lines (G1 to Gn), and placed in a matrix form. The liquid crystal cells of pixels are driven by an electric field applied depending on a voltage difference between a data voltage applied to a pixel electrode and a common voltage applied to a common electrode, thereby adjusting the transmission amount of incident light.

Such liquid crystal display panel 140 may be implemented to any of known liquid crystal modes, such as a Twisted Nematic (TN) mode, a Vertical Alignment (VA) mode, an In Plane Switching (IPS) mode, and a Fringe Field Switching (FFS) mode.

In this case, the common electrode may be formed on the second substrate in a driving mode driven by a vertical electric field such as the TN mode and the VA mode, and the first substrate with the pixel electrode in a driving mode driven by a horizontal electric field such as the IPS mode and the FFS mode.

Hereafter, embodiments relating to the liquid crystal display device 100 including the liquid crystal display panel 140 described in FIG. 1 will be described in detail.

FIG. 2 is a schematic perspective diagram showing the liquid crystal display device of FIG. 1, according to an embodiment of the present disclosure, and FIG. 3 is a sectional diagram of the liquid crystal display device illustrated in FIG. 2 having been cut in an AA' direction.

Referring to FIG. 2 and FIG. 3, the liquid crystal display device 200 includes a first substrate 202a, a second substrate 202b, which is spaced apart from and opposite to the first substrate 202a, a first lower alignment layer 204a formed on an upper surface of the first substrate 202a, a first upper alignment layer 204b formed on a lower surface of the second substrate 202b (hereafter, the first lower alignment layer 204a and the first upper alignment layer 204b are collectively referred to as a first alignment layer 204), a second lower alignment layer 206a formed on an upper surface of the first lower alignment layer 204a, a second upper alignment layer 206b formed on a lower surface of the first upper alignment layer 204b (hereafter, the second lower alignment layer 206a and the second upper alignment layer

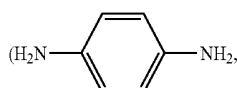
5

206b are collectively referred to as a second alignment layer **206** or alternatively, reflecting its adhesive properties, “adhesive layer **206**”), a polymer barrier **208** formed between the first substrate **202a** and the second substrate **202b**, and a liquid crystal **212** positioned in a liquid crystal filling area **210**.

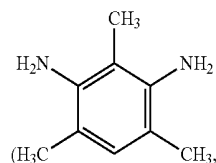
First, the first substrate **202a** and the second substrate **202b** may be plastic-based compounds, such as polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polycarbonate (PC), polyethersulphone (PES), polyarylate (PAR), polycyclic olefin (PCO), and polyimide (PI), but they are not limited thereto. The first substrate **202a** and the second substrate **202b** may be selected by taking into account of glass transition temperature, thermal expansion coefficient, and dimensional stability, and in particular, a PI-based compound may be suitable for the first substrate **202a** and the second substrate **202b** because it has high thermal stability.

The first substrate **202a** and the second substrate **202b**, which are plastic-based substrates, may be applied to a flexible display device which may be curved or bent, and the flexible display device requires a structure by which a cell gap may be maintained, which will be described below. The cell gap corresponds to a distance separating the first substrate **202a** and the second substrate **202b**.

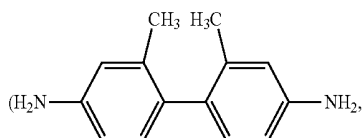
The first alignment layer **204** may be composed of the polyimide-based compound. As an example, the first alignment layer **204** may include a compound formed by reacting at least one or more compounds (diamines) of 1,4-PDA



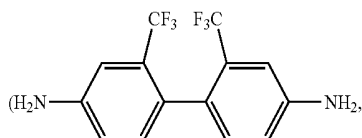
1,4-phenylene diamine), DAM



diamino mesitylene), m-TB-HG

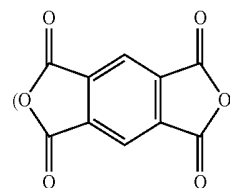


dimethyl diamino biphenyl), and TFMB

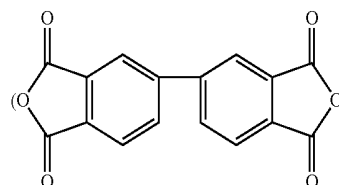


trifluoromethyl diamino biphenyl) with at least one or more compounds (dianhydrides) of PMDA

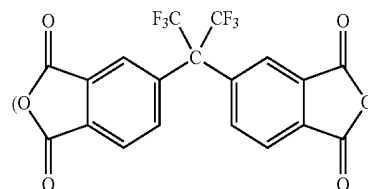
6



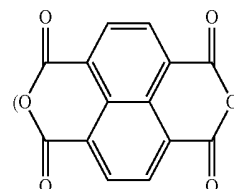
10 benzene tetracarboxylic dianhydride), BPDA



15 bipthalic anhydride), 6FDA



25 (hexafluoroisopropylidene)diphthalic anhydride), and NTDA



35 naphthalene tetracarboxylic dianhydride). The first lower alignment layer **204a** and the first upper alignment layer **204b** configuring the first alignment layer **204** may be the same compound, but they may be different compounds.

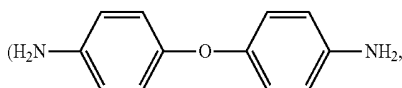
The first alignment layer **204** may include a compound having a hydrophobic functional group. The hydrophobic functional group is a functional group which may have a non-polar bond or a weak polar bond. Therefore, an adhesion of the first alignment layer **204** including a compound having a hydrophobic functional group, with the polymer barrier **208** is low. In some examples, the adhesion is 0.05 N/cm. For adhesions this low, the adhesion is negligible and does not affect the movement of liquid crystal molecules and monomer. As a result, an adsorption of a monomer forming the polymer barrier **208** through a thermal-curing process or a photo-curing process, may be prevented, thereby reducing an image retention of the liquid crystal display device **200**.

A rubbing process may be performed on the surface of the first alignment layer **204** to align liquid crystals. Rubbing patterns of the first lower alignment layer **204a** and the first upper alignment layer **204b** may be the same, but they are not limited thereto, and may also vary depending on the liquid crystal mode.

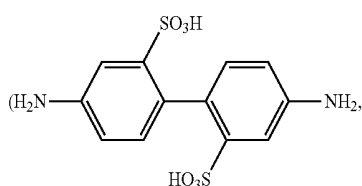
7

A thickness of the first alignment layer **204** may be about 1 nm to 20 nm, but it is not limited thereto.

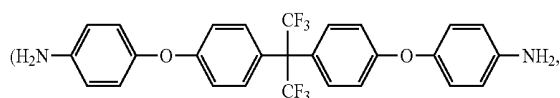
Next, the second alignment layer **206** may be composed of the polyimide-based compound. As an example, the second alignment layer **206** may include a compound formed by reacting at least one or more compounds (diamines) of ODA



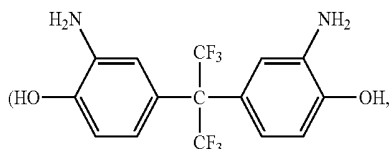
oxydianiline), BDSA



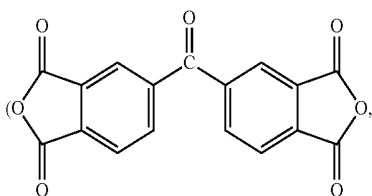
diphenyl disulfonic acid), HFBAPP



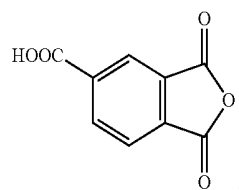
(aminophenoxy)phenyl hexafluoropropane), and AHFP



(aminohydroxyphenyl)hexafluoropropane) with at least one or more compounds (dianhydrides) of BTDA

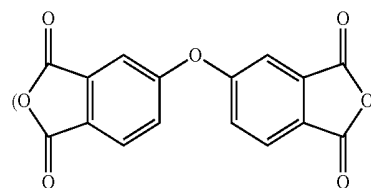


benzophenone tetracarboxylic dianhydride), TMA



trimellitic anhydride), and ODPA

8



oxydiphtalic anhydride). The second lower alignment layer **206a** and the second upper alignment layer **206b** may be the same compound, or different compounds.

The second alignment layer **206** may include a compound having a hydrophilic functional group. The hydrophilic functional group is the functional group which may form a hydrogen bond or has a polar bond. Because the compound having the hydrophilic functional group has higher surface energy than the compound having a hydrophobic functional group, an adhesion of the second alignment layer **206** including the compound having the hydrophilic functional group, with the polymer barrier **208** is high. In some examples, the adhesion is greater than 0.5 N/cm (which can be 10 times (or greater) than the adhesion of the first alignment layer). As a result, the cell gap of the liquid crystal display device **200** may be firmly maintained.

The second alignment layer **206** may be patterned so as to correspond to a part or all of the polymer barriers **208** forming an array. However, in FIG. 2 and FIG. 3, the liquid crystal display device **200** that all of the second alignment layer **206** and the polymer barrier **208** were corresponded was illustrated. That is, the liquid crystal display device **200** that the second alignment layer **206** was patterned so as to correspond to the polymer barrier **208** formed in one direction as well as the polymer barrier **208** formed in other direction perpendicular to the one direction was illustrated.

Further, the second alignment layer **206** may be formed on only one of the upper surface of the first lower alignment layer **204a** or the lower surface of the first upper alignment layer **204b**. However, in FIG. 2 and FIG. 3, as an example, the liquid crystal display device **200** that the second lower alignment layer **206a** and the second upper alignment layer **206b** were formed so as to correspond to all of an upper end and a lower end of the corresponding polymer barrier **208** was illustrated.

Meanwhile, if the first substrate **202a** and the second substrate **202b** of the liquid crystal display device **200** are composed of plastic materials, the polymer barrier **208** may be formed within a non-display region of the liquid crystal display device **200** to maintain the cell gap and prevent a problem that a seal is burst due to the leaning of liquid crystals **212**.

The polymer barrier **208** is formed by a polymerization reaction of the monomer injected with the liquid crystal **212** through phase separation by a photo-curing process or a thermal-curing process. In addition to the monomer, an initiator for initiating the polymerization reaction and a cross-linking agent for increasing the rigidity of the polymer barrier **208**, with the liquid crystal **212** may be further included.

The array form of the polymer barrier **208** may be variously designed, and an array form of the second alignment layer **206** may vary accordingly. As an example, in FIG. 2, the liquid crystal display device **200** on which the polymer barriers **208**, which were spaced side-by-side, were cross-formed three by three was illustrated.

Further, a thickness or an array shape of the polymer barrier may vary depending on the amount of monomer and the rate of phase separation.

The monomer may be an acrylate-based compound. As an example, the monomer may be at least one or more compounds of EHA (ethylhexyl acrylate), trimethylhexyl acrylate, ethoxyethyl acrylate, isobutyl acrylate, isooctyl acrylate, isodecyl acrylate, octadecyl acrylate, tert-butyl acrylate, ethyl acrylate, methyl acrylate, butyl acrylate, lauryl acrylate, lauryl methacrylate, pentafluoropropyl acrylate, hexafluoroisopropyl acrylate, trifluoroethyl acrylate, bisphenol A dimethyl acrylate, bisphenol A propoxylate diacrylate, trimethylpropane propoxylate triacrylate, trimethylhexyl acrylate.

The initiator for forming the polymer barrier 208 may be a photo-initiator, such as dibenzoyl peroxide, dicumyl peroxide, and tert-butyl peroxybenzoate, but it is not limited thereto.

The cross-linking agent may be PEGDA, HDDA, TPGDA, TMPTA, TMPTMP, and TMPTMA, but it is not limited thereto. While the polymer barrier 208 is formed, the cross-linking agent plays a role of bonding between functional groups within a polymer chain to more firmly create the polymer barrier 208.

Finally, the liquid crystal filling area 210 is formed between the first substrate 202a and the second substrate 202b, which are separated through the polymer barrier 208, and then the liquid crystal is filled in the liquid crystal filling area 210. As a result, light is transmitted depending on an alignment of the liquid crystal filled in the liquid crystal filling area 210, and in some cases, a monomer (a residual monomer), which is not used in the formation of the polymer barrier 208, may be included in the liquid crystal filling area 210.

FIG. 4 is a schematic perspective diagram showing a liquid crystal display device according to another embodiment of the present disclosure.

Hereafter, the same parts as FIG. 2 relating to the materials or properties of the components will be briefly described or omitted.

Referring to FIG. 4, the liquid crystal display device 400 includes a first substrate 402a, a second substrate 402b, which is spaced apart from and opposite to the first substrate, a first lower alignment layer 404a formed on an upper surface of the first substrate 402a, a first upper alignment layer 404b formed on a lower surface of the second substrate 402b (hereafter, the first lower alignment layer 404a and the first upper alignment layer 404b are collectively referred to as a first alignment layer 404), a second lower alignment layer 406a formed on an upper surface of the first lower alignment layer 404a, a second upper alignment layer 406b formed on a lower surface of the first upper alignment layer 404b (hereafter, the second lower alignment layer 406a and the second upper alignment layer 406b are collectively referred to as a second alignment layer 406), a polymer barrier 408 formed between the first substrate 402a and the second substrate 402b, and a liquid crystal filling area 410 provided by forming the polymer barrier 408.

The first substrate 402a and the second substrate 402b may be a plastic material, and particularly, may be PI-based materials having good thermal stability.

The first alignment layer 404 may be a polyimide-based compound formed by reacting at least one or more of diamine compounds with at least one or more of dianhydride compounds as described above.

Further, the first alignment layer 404 may include a compound having a hydrophobic functional group, and may be formed with a compound of which the adhesion with a polymer barrier is low.

Meanwhile, the second alignment layer 406 may be a polyimide-based compound formed by reacting at least one or more of diamine compounds with at least one or more of dianhydride compounds as described above.

Further, the second alignment layer 406 may include a compound having a hydrophilic functional group, and is formed with a compound of which the adhesion with the polymer barrier 408 is large, and for example, is formed so as to correspond to some of the polymer barrier 408. That is, in FIG. 4, the liquid crystal display device 400 on which the second alignment layer 406 was formed so as to correspond to only the polymer barriers 408 which are parallel in one direction was illustrated.

The three polymer barriers 408 of one direction are cross-formed with the three polymer barriers 408 of another direction perpendicular to the one direction, and the thicknesses of these polymer barriers 408 may be equally formed. Spaces between polymer barriers 408 in each direction, and a space between the first substrate 402a and the second substrate 402b are defined as the liquid crystal filling area 410, and liquid crystals are arranged in the liquid crystal filling area 410.

Next, a method for manufacturing the liquid crystal display device 200 will be described in FIG. 5 to FIG. 6F.

FIG. 5 is a schematic flowchart relating to a method for manufacturing a liquid crystal display device according to another embodiment of the present disclosure.

Referring to FIG. 5, the method for manufacturing a liquid crystal display device 500 includes a step of coating the first lower alignment layer 204a on the upper surface of the first substrate 202a; a step of coating the first upper alignment layer 204b on the lower surface of the second substrate 202b, which is spaced apart from and opposite to the first substrate 202a (S502); a step of rubbing the first lower alignment layer 204a and the first upper alignment layer 204b (S504); a step of forming the second lower alignment layer 206a on the upper surface of the first lower alignment layer 204a; a step of forming the second upper alignment layer 206b on the lower surface of the first upper alignment layer 204b (S506); a step of sealing the first substrate 202a and the second substrate 202b (S508); a step of injecting the mixture including the liquid crystal 212 and one or more of monomers between the first substrate 202a and the second substrate 202b (S510); and a step of forming the polymer barrier 208 between the second lower alignment layer 206a and the second upper alignment layer 206b.

First, the first substrate 202a and the second substrate 202b may be a plastic compound, such as PET, PEN, PC, PES, PAR, PCO, and PI, but they are not limited thereto.

The step of coating the first lower alignment layer 204a and the step of coating the first upper alignment layer 204b (S502) is a process of applying the first lower alignment layer 204a and the first upper alignment layer 204b on the whole surfaces of the upper surface of the first substrate 202a and the lower surface of the second substrate 202b, and may be performed by one process of a dry coating process, a wet coating process such as a spin coating process, and a printing process such as a screen printing or an inkjet printing, but they are not limited thereto.

Next, the step of rubbing the first lower alignment layer 204a and the first upper alignment layer 204b (S504) is a step of unidirectionally aligning side chains by rubbing the alignment layer of the thin film form by rotating a rubbing

roll wrapped with a rubbing cloth, after applying the first lower alignment layer **204a** and the first upper alignment layer **204b** in a thin film form on the substrates, and curing. However, various processes, such as light irradiation process, in addition to the rubbing process may be applied.

The step of forming the second lower alignment layer **206a** on an upper surface of the first lower alignment layer **204a** and the step of forming the second upper alignment layer **206b** on a lower surface of the first upper alignment layer **204b** (S506) are performed by a soft lithography process, but they are not limited thereto.

The soft lithography process is a process of forming a pattern with an ink of a soft material, and a micro contact printing process, a nano imprinting lithography process, a dip pen lithography process, a micro molding process, and a micro transfer printing process are included in the soft lithography process. The micro contact printing was described as an example in embodiments of the present disclosure, but it is not limited thereto. Detailed process will be described in detail with reference to FIG. 6C.

The second lower alignment layer **206a** and the second upper alignment layer **206b** may be patterned so as to correspond to a part or all of the polymer barrier **208**, which will be formed later, and the cell gap of the liquid crystal display device **200** may be more firmly maintained when the second lower alignment layer **206a** and the second upper alignment layer **206b** correspond to more parts of polymer barrier **208**.

Then, the step of sealing the first substrate **202a** and the second substrate **202b** is performed, and then the step of injecting a mixture including one or more monomers, an initiator, and a cross-linking agent with a liquid crystal **212** in a space between the sealed substrates is performed.

The monomer may be an acrylate-based compound, but it is not limited thereto. The monomer forms the polymer barrier **208** through a radical polymerization during a photo-curing process or a thermal-curing process.

The initiator may be a photo-initiator, such as dibenzoyl peroxide, dicumyl peroxide, and tert-butyl peroxybenzoate, but it is not limited thereto, and may be an initiator which responds to heat. The initiator plays a role as an initiator for a polymerization reaction.

The mixture may include a cross-linking agent, such as PEGDA, HDDA, TPGDA, TMPTA, TMPTMP, and TMPTMA, but it is not limited thereto. While the polymer barrier **208** is formed, the cross-linking agent plays a role of bonding between functional groups within a polymer chain to more firmly create the polymer barrier **208**.

This mixture may be a mixture in which two or more acrylate monomers, an initiator, and a cross-linking agent are mixed in a certain ratio, and the ratio of the monomers may be determined so as to correspond to a polymer barrier.

Finally, the step of forming the polymer barrier **208** between the second lower alignment layer **206a** and the second upper alignment layer **206b** is performed. The polymer barrier **208**, for example, may be formed by a phase separation phenomena according to UV irradiation, but it is not limited thereto. Further, the polymer barrier **208** may be formed by thermal-curing using heat, or by irradiating a light, which belongs to a different area, in addition to UV light.

As described above, the method for manufacturing the liquid crystal display device **200** was fully described. Hereafter, as another embodiment of the present disclosure, the specific method for manufacturing the liquid crystal display device **200** illustrated in FIG. 2 and FIG. 3 will be described in detail.

FIG. 6A to FIG. 6F are diagrams showing a method for manufacturing a liquid crystal display device according to another embodiment of the present disclosure.

Referring to FIG. 6A, first, the step of coating the first lower alignment layer **204a** and the first upper alignment layer **204b**, respectively, on the upper surface of the first substrate **202a** and the lower surface of the second substrate **202b** is performed.

The first substrate **202a** and the second substrate **202b** may be a plastic material for a flexible display device.

The first substrate **202a** and the second substrate **202b** are washed, and then a thermal treatment process for ensuring a tolerance in a process to which heat is applied may be included because a plastic-based material has a relatively low thermal expansion coefficient.

The coating process is a process by which the first lower alignment layer **204a** and the first upper alignment layer **204b** are applied on whole surfaces of both the upper surface of the first substrate **202a** and the lower surface of the second substrate **202b**, and may be performed by a spin coating process, which is one of wet coating processes.

Referring to FIG. 6B, the rubbing process is performed on the first lower alignment layer **204a** and the first upper alignment layer **204b**.

The rubbing process is a process of unidirectionally aligning molecules by rubbing the first lower alignment layer **204a** and the first upper alignment layer **204b** by rotating a rubbing roll **620** wrapped with a rubbing cloth **622**. Thereafter, liquid crystals **212** are aligned in the direction in which molecules are aligned by the rubbing roll **620**.

Referring to FIG. 6C, a process, which the second lower alignment layer **206a** is formed by a micro contact printing method, is illustrated.

The micro contact printing method is a simple process which may be applied when a pattern is transferred, and goes through a process, which creates a template of a pattern formation on a stamp substrate **630**, applies an ink of the second lower alignment layer **206a** material on the created template, and then prints the pattern on the first lower alignment layer **204a**. Further, the second upper alignment layer **206b** may be formed in the same method even though it was not illustrated in FIG. 6C.

The second lower alignment layer **206a** and the second upper alignment layer **206b** may be patterned so as to correspond to all of the polymer barrier **208**, which will be formed later, and thus the cell gap of the liquid crystal display device **200** may be firmly maintained.

Meanwhile, the second lower alignment layer **206a** may include a compound having a hydrophilic functional group, and because a compound having a hydrophilic functional group has higher surface energy than a compound having a hydrophobic functional group, an adhesion per unit area of the second alignment layer **206a** including a compound having a hydrophilic functional group, with the polymer barrier **208** is relatively large.

Referring to FIG. 6D, the first substrate **202a** and the second substrate **202b** are sealed.

Subsequently, referring to FIG. 6E, as an example, the step of injecting a mixture including one or more monomers **614**, a photo-initiator, and a cross-linking agent with a liquid crystal **212** in a space between the first substrate **202a** and the second substrate **202b**, which were sealed, is performed.

The monomer **614** may be an acrylate-based compound, and the phase separation characteristic and the thickness of the polymer barrier **208** may be controlled by adjusting the content of the monomer **614**.

13

After injecting a mixture in the space, ultraviolet (UV) light is irradiated on it so that a radical polymerization reaction is initiated by a photo-initiator.

Referring to FIG. 6F, the polymer barrier **208** is formed, thereby completing the liquid crystal display device **200**. Therefore, the liquid crystal filling area **200** is created between the polymer barriers **208**, and the liquid crystal **212** and the monomer **614**, which is not used to the formation of the polymer barrier **208**, are positioned in the liquid crystal filling area **200**.

The polymer barrier **208** is formed so as to correspond to the second alignment layer **206**, and the forming process of it is as follows. A mask on which a pattern is formed is positioned on a top or bottom of the liquid crystal display device **200**, and UV light is irradiated from the top or bottom of the liquid crystal display device **200**. As a result, the phase separation occurs by the polymerization reaction of monomers **614** performed in a region on which UV light is irradiated, thereby forming the polymer barrier **208** in the region, and the liquid crystals are separated and positioned in a region on which UV light is not irradiated, that is, a display region.

As described above, the liquid crystal display device **200** and the method for manufacturing the same were described with reference to the accompanying drawings. In summary, the liquid crystal display device **200** according to embodiments of the present disclosure includes the alignment layers (**204**, **206**) which are formed by a double, and the first alignment layers (**204a**, **204b**) are formed with a compound having a hydrophobic functional group which has a relatively low adhesion with the polymer barrier **208** to prevent a phenomenon by which a monomer, which remains after forming the polymer barrier **208**, is adsorbed on the first alignment layers (**204a** and **204b**), thereby occurring image retention. Further, the second alignment layer **206** is formed with a compound having a hydrophilic functional group which has a relatively high adhesion with the polymer barrier **208** to have an effect by which a cell gap is relatively firmly maintained.

As described above, embodiments of the present disclosure have been described with reference to the accompanying drawings, but the disclosure is not limited thereto.

Further, the terms “includes”, “constitutes”, or “has” mentioned above mean that a corresponding structural element is included unless they have no reverse meaning. Accordingly, it should be interpreted that the terms may not exclude but further include other structural elements. All the terms that are technical, scientific or otherwise agree with the meanings as understood by a person skilled in the art unless defined to the contrary. Common terms as found in dictionaries should be interpreted in the context of the related technical writings not too ideally or impractically unless the present disclosure expressly defines them so.

What is claimed is:

1. A liquid crystal display device comprising:

a first substrate;

a second substrate spaced apart from and opposite to the first substrate;

a first lower alignment layer formed on an upper surface of the first substrate;

a first upper alignment layer formed on a lower surface of the second substrate;

a second alignment layer formed in an array on either or both of an upper surface of the first lower alignment layer and a lower surface of the first upper alignment layer;

14

a polymer barrier positioned between the first substrate and the second substrate, the polymer barrier formed on the array of the second alignment layer; and

a liquid crystal positioned between the polymer barriers.

2. The liquid crystal display device of claim 1, wherein the second alignment layer comprises a second lower alignment layer formed on a first lower alignment layer, and a second upper alignment layer formed on a first upper alignment layer.

3. The liquid crystal display device of claim 1, wherein adhesion per unit area of each of the first upper alignment layer and the first lower alignment layer with the polymer barrier is lower than adhesion per unit area of the second alignment layer with the polymer barrier.

4. The liquid crystal display device of claim 1, wherein the first lower alignment layer and the first upper alignment layer comprise a compound having a hydrophobic functional group.

5. The liquid crystal display device of claim 1, wherein the second alignment layer comprises a compound having a hydrophilic functional group.

6. The liquid crystal display device of claim 1, wherein the first lower alignment layer, the first upper alignment layer, and the second alignment layer are composed of a polyimide-based compound.

7. The liquid crystal display device of claim 1, wherein the first lower alignment and the first upper alignment layers are a polyimide-based compound formed from at least one or more compounds of 1,4-PDA (1,4-phenylene diamine p-phenylenediamine), DAM (2,4-diamino mesitylene), m-TB-HG (2,2'-dimethyl-4,4'-diaminobiphenyl), and TFMB (2,2'-bis(trifluoromethyl)-4,4'-diaminobiphenyl) with at least one or more compounds of PMDA (1,2,4,5-benzenetetracarboxylic dianhydride), BPDA (4,4'-biphenyl dicarboxylic dianhydride), 6FDA (4,4'-(Hexafluoroisopropylidene)diphthalic anhydride), and NTDA (1,4,5,8-naphthalenetetracarboxylic dianhydride).

8. The liquid crystal display device of claim 1, wherein the second alignment layer is a polyimide-based compound formed from at least one or more compounds of ODA (4,4'-oxydianiline), BDSA (4,4'-diaminodiphenyl-2,2'-disulfonic acid), HFBAPP (2,2'-bis[4-(4-aminophenoxy)phenyl]hexafluoropropane), and AHHP (2,2-bis(3-amino-4-hydroxyphenyl)hexafluoropropane) with at least one or more compounds of BTDA (3,3',4,4'-benzophenonetetracarboxylic dianhydride), TMA (trimellitic anhydride), and ODPA (4,4'-oxydiphthalic anhydride).

9. The liquid crystal display device of claim 1, wherein the second alignment layer is patterned so that the second alignment layer corresponds to at least a portion of the polymer barrier.

10. The liquid crystal display device of claim 1, wherein the second alignment layer is patterned to match all of the polymer barrier.

11. The liquid crystal display device of claim 1, wherein the monomer is an acrylate-based compound.

12. A liquid crystal display device comprising:

a first lower alignment layer;

a first upper alignment layer parallel to the first lower alignment layer;

a polymer barrier orthogonal to the first upper alignment layer and to the first lower alignment layer, the polymer barrier including a first end proximate to the first upper alignment layer and a second end proximate to the first lower alignment layer, the polymer barrier formed in an array;

15

a first adhesive layer formed in the array of the polymer barrier between the polymer barrier and at least one of the first lower alignment layer and first upper alignment layer; and

a second adhesive layer between the second end of the polymer barrier and the first lower alignment layer, wherein at least one of the first adhesive layer and the second adhesive layer comprises a hydrophilic functional group.

13. The liquid crystal display device of claim **12**, wherein at least one of the first lower alignment layer and the first upper alignment layer comprises a hydrophobic functional group.

14. The liquid crystal display device of claim **12**, wherein at least one of the first lower alignment layer and the first upper alignment layer has an adhesive power of less than 0.05 N/cm, and at least one of the first adhesive layer and the second adhesive layer has an adhesive power of more than 0.5 N/cm.

16

15. A display device comprising:

a first substrate;

a second substrate;

a first alignment layer formed on the first substrate and the second substrate;

a second alignment layer formed in an array on one or both of the first alignment layer;

a polymer barrier is configured to maintain a gap between the first substrate and the second substrate; and

a liquid crystal positioned between the first substrate and the second substrate,

wherein the polymer barrier is corresponding to the second alignment layer and formed by an acrylate-based monomer.

16. The display device of claim **15**, the first alignment layer further comprising a hydrophobic functional group.

17. The display device of claim **15**, the second alignment layer further comprising a hydrophilic functional group.

* * * * *

专利名称(译)	液晶显示装置及其制造方法		
公开(公告)号	US9733522	公开(公告)日	2017-08-15
申请号	US14/327763	申请日	2014-07-10
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	CHOI WONJIN JANG SEJIN		
发明人	CHOI, WONJIN JANG, SEJIN		
IPC分类号	G02F1/1337 G02F1/1339 G02F1/1333		
CPC分类号	G02F1/133723 G02F1/1333 G02F1/1339 G02F1/13378 G02F1/133305 G02F1/133377 G02F1/133784 G02F2202/28		
优先权	1020130145506 2013-11-27 KR		
其他公开文献	US20150146147A1		
外部链接	Espacenet USPTO		

摘要(译)

本公开提供了一种液晶显示装置及其制造方法。该装置包括：第一基板；与第一基板间隔开并与第一基板相对的第二基板；形成在第一基板的上表面上的第一下取向层；形成在第二基板的下表面上的第一上取向层；第二取向层，在第一下取向层的上表面和第一上取向层的下表面中的任一个或两个上形成阵列；位于第一基板和第二基板之间的聚合物阻挡层，聚合物阻挡层形成在第二对准层的阵列上；和位于聚合物屏障之间的液晶。

