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(54) **DISPLAY MODULE, AND DISPLAY DEVICE**

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(58) **Field of Classification Search**

USPC 349/15, 201

See application file for complete search history.

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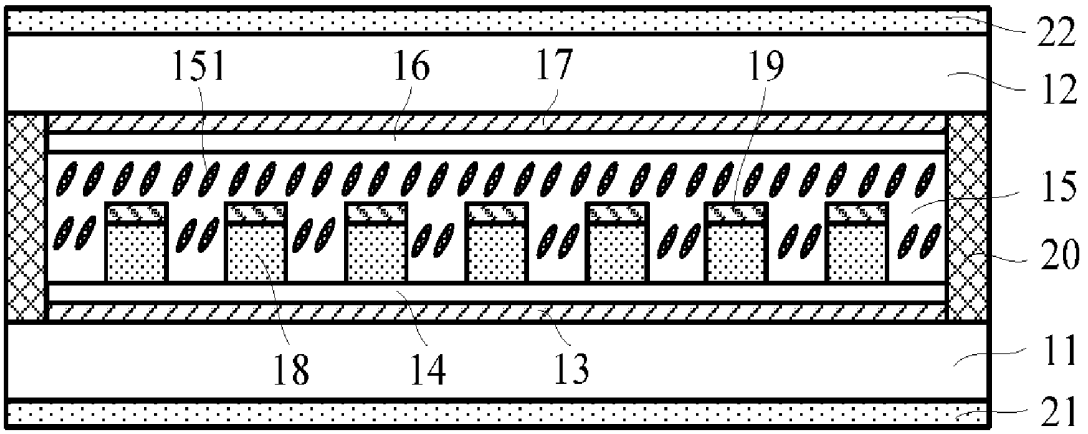
(57) **ABSTRACT**

The display module includes a first substrate, a second substrate, a first electrode, a liquid crystal layer, a second electrode, and a plurality of gratings and drive electrodes, wherein the liquid crystal layer includes only positive liquid crystal molecules; both a refractive index of the first electrode and a refractive index of the first substrate are greater than a normal refractive index n_o of liquid crystal in the liquid crystal layer; and a refractive index of each of the plurality of gratings lies between the normal refractive index n_o and an abnormal refractive index n_e of the liquid crystal.

20 Claims, 1 Drawing Sheet



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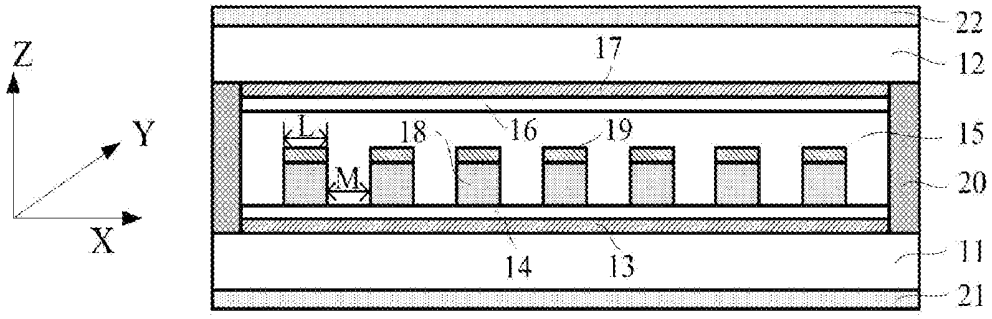

Fig. 1

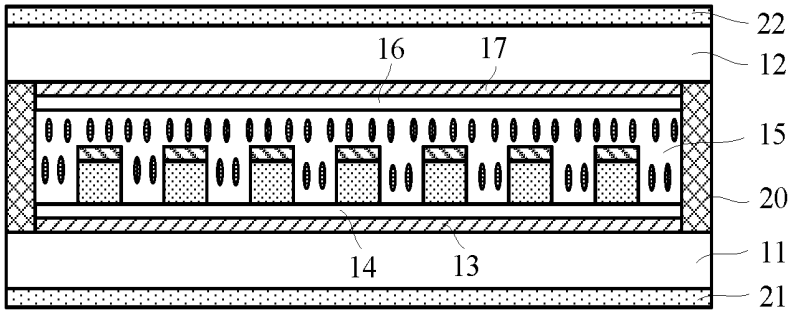

Fig. 2

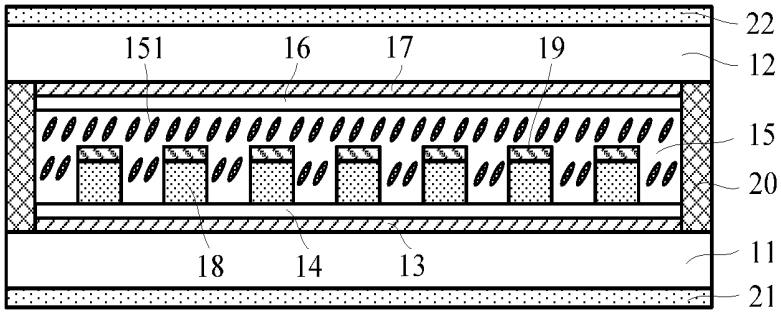

Fig. 3

DISPLAY MODULE, AND DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This Application claims priority to Chinese Patent Application No. 201710851177.6, filed on Sep. 20, 2017, the content of which is incorporated by reference in the entirety.

TECHNICAL FIELD

This disclosure relates to the field of display technologies, and particularly to a display module, and a display device.

DESCRIPTION OF THE RELATED ART

An optical waveguide display device in the related art includes a display module and a backlight module; and the display module includes an array substrate and a color filter substrate, both of which are cell-assembled with each other, and a liquid crystal layer arranged between the array substrate and the color filter substrate. The optical waveguide display device in the related art is generally fabricated by orienting the two substrates through rubbing alignment technology or non-rubbing alignment technology to induce an arrangement direction of liquid crystal molecules.

The optical waveguide structure of the display module in the related art is arranged on the array substrate, so the array substrate is generally oriented using polyimide (PI) by coating PI directly on an upper surface of the array substrate, thus resulting in poor uniformity of the orientation layer, and degrading a light exiting effect.

SUMMARY

Embodiments of the disclosure provide a display module, and a display device.

In one aspect, the embodiments of the disclosure provide a display module including a first substrate and a second substrate, both of which are cell-assembled with each other, and a first electrode, a liquid crystal layer, and a second electrode arranged between the first substrate and the second substrate in that order, wherein the display module further includes a plurality of gratings distributed in an array on a surface of the first electrode on a side thereof facing the liquid crystal layer, and drive electrodes arranged respectively on sides of respective gratings facing away from the first electrode; the liquid crystal layer includes only positive liquid crystal molecules; wherein both a refractive index of the first electrode and a refractive index of the first substrate are greater than a normal refractive index n_o of liquid crystal in the liquid crystal layer; and a refractive index of each of the plurality of gratings lies between the normal refractive index n_o and an abnormal refractive index n_e of the liquid crystal.

In some embodiments, the liquid crystal is blue-phase liquid crystal.

In some embodiments, the refractive index of the first electrode is greater or less than the refractive index of the first substrate.

In some embodiments, the display module further includes a first insulation layer arranged on the surface of the first electrode on the side thereof facing the liquid crystal layer, and a second insulation layer arranged on a surface of the second electrode on a side thereof facing the liquid crystal layer; the plurality of gratings are arranged on a surface of the first insulation layer on a side thereof facing the liquid crystal layer.

In some embodiments, both a refractive index of the first insulation layer and a refractive index of the second insulation layer are greater than the normal refractive index n_o of the liquid crystal.

In some embodiments, a length of each of the plurality of gratings is equal to a length of a corresponding drive electrode, and the length of each of the plurality of gratings is equal to a transverse spacing between adjacent gratings, along a row direction of the plurality of gratings; and a width of each of the plurality of gratings is equal to a width of a corresponding drive electrode, and the width of each of the plurality of gratings is equal to a longitudinal spacing between adjacent gratings, along a column direction of the plurality of gratings.

In some embodiments, a thickness of each of the plurality of gratings ranges from 200 nm to 1000 nm along a direction from the first substrate to the second substrate.

In some embodiments, all of the first electrode, the second electrode, and the drive electrodes are made of a transparent conductive material.

In some embodiments, the first electrode is a plate-shaped electrode, and has a thickness ranging from 100 nm to 1000 nm; and the second electrode is a plate-shaped electrode.

In some embodiments, the display module further includes a first protection layer arranged on a surface of the first substrate on a side thereof facing away from the second substrate, and a second protection layer arranged on a surface of the second substrate on a side thereof facing away from the first substrate.

In some embodiments, the first substrate is an array substrate, and the second substrate is a color filter substrate; or the first substrate is the color filter substrate, and the second substrate is the array substrate.

In another aspect, the embodiments of the disclosure provide a display device, including a display module, wherein the display module includes a first substrate and a second substrate, both of which are cell-assembled with each other, and a first electrode, a liquid crystal layer, and a second electrode arranged between the first substrate and the second substrate in that order, wherein the display module further includes a plurality of gratings distributed in an array on a surface of the first electrode on a side thereof facing the liquid crystal layer, and drive electrodes arranged respectively on sides of respective gratings facing away from the first electrode; the liquid crystal layer includes only positive liquid crystal molecules; wherein both a refractive index of the first electrode and a refractive index of the first substrate are greater than a normal refractive index n_o of liquid crystal in the liquid crystal layer; and a refractive index of each of the plurality of gratings lies between the normal refractive index n_o and an abnormal refractive index n_e of the liquid crystal.

In some embodiments, the liquid crystal is blue-phase liquid crystal.

In some embodiments, the refractive index of the first electrode is greater or less than the refractive index of the first substrate.

In some embodiments, the display module further includes a first insulation layer arranged on the surface of the first electrode on the side thereof facing the liquid crystal layer, and a second insulation layer arranged on a surface of the second electrode on a side thereof facing the liquid

crystal layer; the plurality of gratings are arranged on a surface of the first insulation layer on a side thereof facing the liquid crystal layer.

In some embodiments, both a refractive index of the first insulation layer and a refractive index of the second insulation layer are greater than the normal refractive index n_o of the liquid crystal.

In some embodiments, a length of each of the plurality of gratings is equal to a length of a corresponding drive electrode, and the length of each of the plurality of gratings is equal to a transverse spacing between adjacent gratings, along a row direction of the plurality of gratings; and a width of each of the plurality of gratings is equal to a width of a corresponding drive electrode, and the width of each of the plurality of gratings is equal to a longitudinal spacing between adjacent gratings, along a column direction of the plurality of gratings.

In some embodiments, a thickness of each of the plurality of gratings ranges from 200 nm to 1000 nm along a direction from the first substrate to the second substrate.

In some embodiments, all of the first electrode, the second electrode, and the drive electrodes are made of a transparent conductive material.

In some embodiments, the first electrode is a plate-shaped electrode, and has a thickness ranging from 100 nm to 1000 nm; and the second electrode is a plate-shaped electrode.

In some embodiments, the display module further includes a first protection layer arranged on a surface of the first substrate on a side thereof facing away from the second substrate, and a second protection layer arranged on a surface of the second substrate on a side thereof facing away from the first substrate.

In some embodiments, the first substrate is an array substrate, and the second substrate is a color filter substrate; or the first substrate is the color filter substrate, and the second substrate is the array substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to make the technical solutions according to embodiments of the disclosure more apparent, the drawings to which a description of the embodiments refers will be briefly introduced below, and apparently the drawings to be described below are merely illustrative of some of the embodiments of the disclosure, and those ordinarily skilled in the art can derive from these drawings other drawings without any inventive effort.

FIG. **1** is a schematic structural diagram of a display module according to the embodiments of the disclosure;

FIG. **2** is a schematic diagram of an operating state of liquid crystal molecules when a first electrode and a second electrode are powered on in the display module as illustrated in FIG. **1**; and

FIG. **3** is a schematic diagram of an operating state of liquid crystal molecules when the first electrode, the second electrode, and drive electrodes are powered on in the display module as illustrated in FIG. **1**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The technical solutions according to the embodiments of the disclosure will be described below clearly and fully with reference to the drawings in the embodiments of the disclosure, and apparently the embodiments to be described are only a part but not all of the embodiments of the disclosure. Based upon the embodiments here of the disclosure, all of the other embodiments which can occur to those ordinarily skilled in the art without any inventive effort shall fall into the scope of the disclosure.

The embodiments of the disclosure provide a display module and a display device, where the orientation of liquid crystal molecules is controlled using electrodes in the display module, so as to address the problem in the related art of a degraded light exiting effect of the display module due to poor uniformity of an orientation layer. Where the display device is a Liquid Crystal Display (LCD) or an Organic Light-Emitting Diode (OLED) display device.

As illustrated in FIG. **1**, FIG. **2**, and FIG. **3**, a display module according to the embodiments of the disclosure includes a first substrate **11** and a second substrate **12**, both of which are cell-assembled with each other, and a first electrode **13**, a liquid crystal layer **15** and a second electrode **17** arranged between the first substrate **11** and the second substrate **12** in that order.

Where the display module further includes a plurality of gratings **18** distributed in an array on a surface of the first electrode **13** on a side thereof facing the liquid crystal layer **15**, and drive electrodes **19** arranged respectively on sides of respective gratings **18** facing away from the first electrode **13**.

Where the liquid crystal layer **15** includes only positive liquid crystal molecules **151**; both a refractive index of the first electrode **13** and a refractive index of the first substrate **11** are greater than a normal refractive index n_o of liquid crystal in the liquid crystal layer **15**; and a refractive index of each of the plurality of gratings **18** lies between the normal refractive index n_o and an abnormal refractive index n_e of the liquid crystal.

The display module above according to the embodiments of the disclosure includes the plurality of gratings **18** distributed in an array at the liquid crystal layer **15**, and the drive electrodes **19** arranged respectively on sides of respective gratings **18** facing away from the first electrode **13**, and the liquid crystal layer **15** includes only the positive liquid crystal molecules **151**, and the refractive index of the first substrate **11** are greater than the normal refractive index n_o of liquid crystal in the liquid crystal layer **15**, and the refractive index of each of the plurality of gratings **18** lies between the normal refractive index n_o and the abnormal refractive index n_e of the liquid crystal, thus as illustrated in FIG. **2**, when the first electrode **13** and the second electrode **17** of the display module are powered on, all of the positive liquid crystal molecules **151** are arranged in vertical orientation, the liquid crystal molecules **151** between the gratings **18** constitute together an optical waveguide layer, and light rays can only be transmitted within the liquid crystal layer **15**, and cannot be transmitted through the liquid crystal layer **15**, so the display module is in a dark state. And as illustrated in FIG. **3**, when all of the first electrode **13**, the second electrode **17**, and the drive electrodes **19** are powered on, the positive liquid crystal molecules **151** are deflected from the vertical orientation under the action of the drive electrodes **19**, the optical waveguide layer consisted of the gratings **18** and the liquid crystal layer **15** is damaged, and the light rays can be transmitted through the liquid crystal layer **15**, and exit from the light exit side of the display module, so the display module displays in a grayscale mode. Since the orientation of the liquid crystal molecules **151** is controlled by forming an electromagnetic field using the drive electrodes **19** additionally arranged in the display module above according to the embodiments of the disclosure, the display module can control the orientation of the liquid crystal molecules **151** simply and uniformly to thereby address the

problem of a light exiting effect being degraded because the orientation layer becomes non-uniform in thickness due to non-uniform coating of the PI.

In some embodiments, as illustrated in FIG. **1** to FIG. **3**, the first substrate **11** and the second substrate **12** are cell-assembled with each other through a frame sealant **20**. Where the first substrate **11** is an array substrate or a color filter substrate, and correspondingly the second substrate **12** is the color filter substrate or the array substrate.

In some embodiments, as illustrated in FIG. **1** to FIG. **3**, the display module further includes a first insulation layer **14** arranged on the surface of the first electrode **13** on the side thereof facing the liquid crystal layer **15**, and a second insulation layer **16** arranged on a surface of the second electrode **17** on a side thereof facing the liquid crystal layer **15**; the plurality of gratings **18** are arranged on a surface of the first insulation layer **14** on a side thereof facing the liquid crystal layer **15**.

In some embodiments, as illustrated in FIG. **1** to FIG. **3**, the first electrode **13**, the first insulation layer **14**, the liquid crystal layer **15**, the second insulation layer **16**, and the second electrode **17** are stacked on a surface of the first substrate **11** on a side thereof facing the second substrate **12** in that order. Where the first electrode **13** is an anode or a cathode, and correspondingly the second electrode **17** is the cathode or the anode.

In some embodiments, the refractive index of the first electrode **13** is greater or less than the refractive index of the first substrate **11**; of course, the refractive index of the first electrode **13** can also be equal to the refractive index of the first substrate **11**, which will not be limited herein.

In some embodiments, the first electrode **13** and the second electrode **17** are plate-shaped electrodes or strip-shaped electrodes. In some embodiments, the first electrode **13** and the second electrode **17** are made of silver, molybdenum, or another transparent metal material; or are made of indium tin oxide (ITO), indium zinc oxide (IZO), or another transparent metal oxide material.

In some embodiments, a thickness of the first electrode **13** ranges from 100 nm to 10000 nm; a thickness of the second electrode **17** ranges from 100 nm to 1000 nm; and the thicknesses of the first electrode **13** and the second electrode **17** can be set as needed in a practical production process.

In some embodiments, as illustrated in FIG. **1** to FIG. **3**, the plurality of gratings **18** are distributed in an array in the liquid crystal layer **15**, i.e. the liquid crystal layer **15** covers the plurality of gratings **18**. In some embodiments, each of the plurality of gratings **18** is arranged corresponding to one of pixels, and each of the plurality of gratings **18** is arranged with a corresponding drive electrode **19** on a side thereof facing away from the first electrode **13** to control the orientation of the liquid crystal molecules **151** in the liquid crystal layer **15**.

In some embodiments, the liquid crystal in the liquid crystal layer **15** is blue-phase liquid crystal, and the liquid crystal in the liquid crystal layer **15** can also be made of a liquid crystal material applicable to a product in a Twisted Nematic (TN) display mode, a product in an In-Phase Switching (IPS) display module, a product in a Fringe Field Switching (FFS) display mode, or a product in a Vertical Alignment (VA) display module.

In some embodiments, both a refractive index of the first insulation layer **14** and a refractive index of the second insulation layer **16** are greater than the normal refractive index n_o of the liquid crystal in the liquid crystal layer **15**. In some embodiments, both the refractive index of the first insulation layer **14** and the refractive index of the second insulation layer **16** are greater or less than the refractive index of the first electrode **13**, or are greater or less than the refractive index of the first substrate **11**.

In some embodiments, the first insulation layer **14** and the second insulation layer **16** are made of a transparent organic medium.

In some embodiments, a thickness of the first insulation layer **14** ranges from 50 nm to 1000 nm, and a thickness of the second insulation layer **16** ranges from 50 nm to 1000 nm. For example, the thickness of the first insulation layer **14**, or the thickness of the second insulation layer **16** can be 50 nm, 60 nm, 70 nm, 80 nm, 90 nm, 100 nm, 110 nm, 120 nm, 130 nm, 140 nm, 150 nm, 160 nm, 170 nm, 180 nm, 190 nm, 200 nm, 210 nm, 220 nm, 230 nm, 240 nm, 250 nm, 260 nm, 270 nm, 280 nm, 290 nm, 300 nm, 350 nm, 400 nm, 450 nm, 500 nm, 550 nm, 600 nm, 650 nm, 700 nm, 750 nm, 800 nm, 850 nm, 900 nm, 950 nm, or 1000 nm, etc.

In some embodiments, as illustrated in FIG. **1**, a length L of each of the plurality of gratings **18** is equal to a length of a corresponding drive electrode **19**, and the length L of each of the plurality of gratings **18** is equal to a traverse spacing M between adjacent gratings **18**, in a row direction (i.e. X direction as illustrated in FIG. **1**) of the plurality of gratings **18**; and a width of each of the plurality of gratings **18** is equal to a width of a corresponding drive electrode **19**, and the width of each of the plurality of gratings **18** is equal to a longitudinal spacing between adjacent gratings **18**, in a column direction (i.e. Y direction as illustrated in FIG. **1**, where the Y direction is perpendicular to the X direction) of the plurality of gratings **18**.

In some embodiments, each of the plurality of gratings **18** is made of a transparent material.

In some embodiments, the refractive index of each of the plurality of gratings lies between the normal refractive index n_o and the abnormal refractive index n_e of the liquid crystal (including the normal refractive index n_o and the abnormal refractive index n_e); for example, the refractive index of each of the plurality of gratings **18** is equal to the normal refractive index n_o of the liquid crystal in the liquid crystal layer **15**.

In some embodiments, along the row direction of the plurality of gratings **18**, a period P of the plurality of gratings **18** is equal to a sum of the length L of each of the plurality of gratings **18**, and the spacing M between adjacent gratings **18**; and a duty ratio of the plurality of gratings **18** is equal to a ratio of the length L of each of the plurality of gratings **18** to the period P of the plurality of gratings **18**. In some embodiments, the duty ratio of the plurality of gratings **18** can be 0.5, or can be another value selected according to the direction and color of the exiting light.

Alike, the thickness of each of the plurality of gratings **18** can also be set as needed in practical. For example, the thickness of each of the plurality of gratings **18** can be set according to the optical binding capacity (such as a difference between a refractive index of an optical waveguide and a refractive index of a medium surrounding the optical waveguide, or a waveguide mode, etc.) of the optical waveguide layer, so long as the effect of the electrodes on the optical waveguide layer can be isolated well enough to prevent the light from being leaked in the dark state.

In some embodiments, as illustrated in FIG. **1**, the thickness of each of the plurality of gratings **18** ranges from 200 nm to 1000 nm along a direction from the first substrate **11** to the second substrate **12** (i.e. Z direction as illustrated in FIG. **1**, where the Z direction is perpendicular to the X direction and the Y direction). For example, the thickness of each of the plurality of gratings **18** can be 200 nm, 300 nm,

400 nm, 500 nm, 600 nm, 700 nm, 800 nm, 900 nm, or 1000 nm, along the direction from the first substrate **11** to the second substrate **12**.

In some embodiments, the thicknesses of gratings **18** corresponding to pixels with different colors are the same or different. For example, a grating **18** corresponding to an R pixel, a grating **18** corresponding to a G pixel, and a grating **18** corresponding to a B pixel have a same thickness, or have different thicknesses respectively.

In some embodiments, all of the first electrode **13**, the second electrode **17**, and the drive electrodes **19** are made of a transparent conductive material. In some embodiments, the transparent conductive material of which the first electrode **13**, the second electrode **17**, and the drive electrodes **19** are made is silver, molybdenum, or another transparent metal material, or is indium tin oxide (ITO), indium zinc oxide (IZO), or another transparent metal oxide material.

In some embodiments, the first electrode **13** is a plate-shaped electrode or a strip-shaped electrode, and when the first electrode **13** is a plate-shaped electrode, the thickness of the first electrode **13** ranges from 100 nm to 1000 nm, and for example, a thickness thereof can be 100 nm, 200 nm, 300 nm, 400 nm, 500 nm, 600 nm, 700 nm, 800 nm, 900 nm, or 1000 nm, etc. Alike, the second electrode **17** is a plate-shaped electrode or a strip-shaped electrode corresponding to the first electrode **13**, and when the second electrode **17** is a plate-shaped electrode, the thickness of the second electrode **17** ranges from 100 nm to 1000 nm, and for example, a thickness thereof can be 100 nm, 200 nm, 300 nm, 400 nm, 500 nm, 600 nm, 700 nm, 800 nm, 900 nm, or 1000 nm, etc.

In some embodiments, a thickness of each of the drive electrodes **19** ranges from 70 nm to 300 nm, and for example, a thickness thereof can be 70 nm, 80 nm, 90 nm, 100 nm, 110 nm, 120 nm, 130 nm, 140 nm, 150 nm, 160 nm, 170 nm, 180 nm, 190 nm, 200 nm, 210 nm, 220 nm, 230 nm, 240 nm, 250 nm, 260 nm, 270 nm, 280 nm, 290 nm, or 300 nm, etc.

In some embodiments, in order to improve the security of the display module, and to prevent the display module from being damaged, as illustrated in FIG. **1** to FIG. **3**, the display module further includes a first protection layer **21** arranged on a surface of the first substrate **11** on a side thereof facing away from the second substrate **12**, and a second protection layer **22** arranged on a surface of the second substrate **12** on a side thereof facing away from the first substrate **11**.

In some embodiments, the first protection layer **21** and the second protection layer **22** are made of glass, or another transparent material, e.g., polymethyl methacrylate (PMMA), polyethylene glycol terephthalate (PET), or Polycarbonate (PC), etc.

In some embodiments, the first substrate **11** and the second substrate **12** above are made of glass, resin, or another material, and the first substrate **11** and the second substrate **12** are required to be highly planar and parallel to each other. In some embodiments, both the thickness of the first substrate **11** and the thickness of the second substrate **12** range from 0.1 mm to 2 mm, and for example, the thickness of the first substrate **11** or the thickness of the second substrate **12** can be 0.1 mm, 0 2 mm, 0.3 mm, 0.4 mm, 0.5 mm, 0.6 mm, 0.7 mm, 0.8 mm, 0.9 mm, 1.0 mm, 1.1 mm, 1.2 mm, 1.3 mm, 1.4 mm, 1.5 mm, 1.6 mm, 1.7 mm, 1.8 mm, 1.9 mm, or 2 mm, etc.

Based upon the same inventive concept, the embodiments of the disclosure further provide a display device including the display module above according to any one of the embodiments of the disclosure. And reference can be made to the embodiments of the display module above for an implementation of the display device, so a repeated description thereof will be omitted here.

Evidently those skilled in the art can make various modifications and variations to the disclosure without departing from the spirit and scope of the disclosure. Thus the disclosure is also intended to encompass these modifications and variations thereto so long as the modifications and variations come into the scope of the claims appended to the disclosure and their equivalents.

The invention claimed is:

1. A display module, comprising a first substrate and a second substrate, both of which are cell-assembled with each other, and a first electrode, a liquid crystal layer, and a second electrode arranged between the first substrate and the second substrate in that order, wherein:

the display module further comprises a plurality of gratings distributed in an array on a surface of the first electrode on a side thereof facing the liquid crystal layer, and drive electrodes arranged respectively on sides of respective gratings facing away from the first electrode;

the liquid crystal layer comprises only positive liquid crystal molecules;

both a refractive index of the first electrode and a refractive index of the first substrate are greater than a normal refractive index n_o of liquid crystal in the liquid crystal layer; and

a refractive index of each of the plurality of gratings lies between the normal refractive index n_o and an abnormal refractive index n_e of the liquid crystal.

2. The display module according to claim **1**, wherein the liquid crystal is blue-phase liquid crystal.

3. The display module according to claim **1**, wherein the refractive index of the first electrode is greater or less than the refractive index of the first substrate.

4. The display module according to claim **1**, wherein the display module further comprises a first insulation layer arranged on the surface of the first electrode on the side thereof facing the liquid crystal layer, and a second insulation layer arranged on a surface of the second electrode on a side thereof facing the liquid crystal layer;

the plurality of gratings are arranged on a surface of the first insulation layer on a side thereof facing the liquid crystal layer.

5. The display module according to claim **4**, wherein both a refractive index of the first insulation layer and a refractive index of the second insul ation layer are greater than the normal refractive index n_o of the liquid crystal.

6. The display module according to claim **1**, wherein a length of each of the plurality of gratings is equal to a length of a corresponding drive electrode, and the length of each of the plurality of gratings is equal to a transverse spacing between adjacent gratings, along a row direction of the plurality of gratings; and

a width of each of the plurality of gratings is equal to a width of a corresponding drive electrode, and the width of each of the plurality of gratings is equal to a longitudinal spacing between adjacent gratings, along a column direction of the plurality of gratings.

7. The display module according to claim **1**, wherein a thickness of each of the plurality of gratings ranges from 200 nm to 1000 nm along a direction from the first substrate to the second substrate.

8. The display module according to claim **1**, wherein all of the first electrode, the second electrode, and the drive electrodes are made of a transparent conductive material.

9. The display module according to claim 1, wherein the first electrode is a plate-shaped electrode, and has a thickness ranging from 100 nm to 1000 nm; and the second electrode is a plate-shaped electrode.

10. The display module according to claim 1, wherein the display module further comprises a first protection layer arranged on a surface of the first substrate on a side thereof facing away from the second substrate, and a second protection layer arranged on a surface of the second substrate on a side thereof facing away from the first substrate.

11. The display module according to claim 1, wherein the first substrate is an array substrate and the second substrate is a color filter substrate; or the first substrate is the color filter substrate, and the second substrate is the array substrate.

12. A display device, comprising a display module, wherein the display module comprises a first substrate and a second substrate, both of which are cell-assembled with each other, and a first electrode, a liquid crystal layer, and a second electrode arranged between the first substrate and the second substrate in that order, wherein:

the display module further comprises a plurality of gratings distributed in an array on a surface of the first electrode on a side thereof facing the liquid crystal layer, and drive electrodes arranged respectively on sides of respective gratings facing away from the first electrode;

the liquid crystal layer comprises only positive liquid crystal molecules;

both a refractive index of the first electrode and a refractive index of the first substrate are greater than a normal refractive index n_o of liquid crystal in the liquid crystal layer; and

a refractive index of each of the plurality of gratings lies between the normal refractive index n_o and an abnormal refractive index n_e of the liquid crystal.

13. The display device according to claim 12, wherein the liquid crystal is blue-phase liquid crystal.

14. The display device according to claim 12, wherein the refractive index of the first electrode is greater or less than the refractive index of the first substrate.

15. The display device according to claim 12, wherein the display module further comprises a first insulation layer arranged on the surface of the first electrode on the side thereof facing the liquid crystal layer, and a second insulation layer arranged on a surface of the second electrode on a side thereof facing the liquid crystal layer;

the plurality of gratings are arranged on a surface of the first insulation layer on a side thereof facing the liquid crystal layer.

16. The display device according to claim 15, wherein both a refractive index of the first insulation layer and a refractive index of the second insulation layer are greater than the normal refractive index n_o of the liquid crystal.

17. The display device according to claim 12, wherein a length of each of the plurality of gratings is equal to a length of a corresponding drive electrode, and the length of each of the plurality of gratings is equal to a transverse spacing between adjacent gratings, along a row direction of the plurality of gratings; and

a width of each of the plurality of gratings is equal to a width of a corresponding drive electrode, and the width of each of the plurality of gratings is equal to a longitudinal spacing between adjacent gratings, along a column direction of the plurality of gratings.

18. The display device according to claim 12, wherein a thickness of each of the plurality of gratings ranges from 200 nm to 1000 nm along a direction from the first substrate to the second substrate.

19. The display device according to claim 12, wherein the first electrode is a plate-shaped electrode, and has a thickness ranging from 100 nm to 1000 nm; and the second electrode is a plate-shaped electrode.

20. The display device according to claim 12, wherein the first substrate is an array substrate and the second substrate is a color filter substrate; or the first substrate is the color filter substrate, and the second substrate is the array substrate.

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专利名称(译)	显示模块和显示装置		
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申请(专利权)人(译)	京东方科技集团股份有限公司.		
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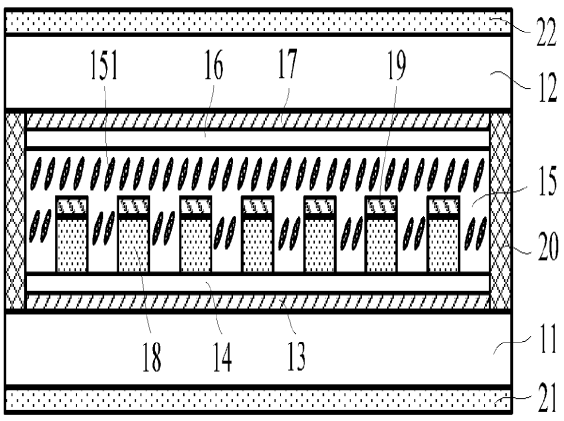
显示模块包括第一基板，第二基板，第一电极，液晶层，第二电极以及多个光栅和驱动电极，其中，液晶层仅包括正液晶分子。 第一电极的折射率和第一基板的折射率均大于液晶层中液晶的法线折射率nØ。 多个光栅的每一个的折射率在液晶的正折射率n Ø 和反折射率ne 之间。