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Improvement of Reverse Domain in Chiral Hybrid In-Plane Switching Liquid Crystal Mode by the Stacked Alignment Layers

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We propose an improved chiral hybrid in-plane switching (CH-IPS) liquid crystal mode with a stable domain. We studied an advanced method for improving the alignment stability of the CH-IPS mode through the surface modification using the stacked alignment layer. The enhanced azimuthal anchoring energy using by the stacked alignment layer, reverse domains of CH-IPS LC mode were disappeared. Consequently, we could obtain the CH-IPS liquid crystal mode with the enhanced brightness compared with the conventional mode.

1. Introduction

The liquid crystal displays (LCDs) have been studied and used for a wide range of display application. LCDs, such as twisted nematic (TN), vertically aligned (VA), in-Plane switching (IPS), and fringe-field switching (FFS) mode, have attracted great interest and have been widely developed since their excellent display.[1-4] Among them, in-plane switching (IPS) LCD mode, most widely used LCD mode, has a wide viewing angle property. However, since the LC directors on the electrodes are aligned vertically by the field direction, which gives rise to reduction of the transmittance of the LCD.

To solve these problems, the CH-IPS mode, adopted a twisted configuration and a hybrid alignment of the LCs. was proposed to improve the transmittance of the LCDs. [5] In the CH-IPS mode, the bright state was obtained under no applied voltage similar to that in the normally white TN mode, when applied voltage, LCs are rearranged to the direction of electric field which is the same as the optic axis of polarizer, so we can get dark state.

However, conventional CH-IPS mode has reverse domain. CH-IPS can't maintain the gray level and get the dark state due to reverse domain. In this paper, we proposed mono domain of CH-IPS using stacked layer.[6]

2. Experiment

The configuration of CH-IPS mode is shown fig. 1. We fabricated interdigitated indium-tin-oxide (ITO) electrodes by using photo-lithography process. After, we used a homogeneous LC alignment layer (SE7492, Japan Synthetic Rubber) on the top substrate. An interdigitated electrode for in-plane switching was formed on the bottom substrate. A homogenous LC alignment material was spin-coated on the pattered ITO glass bottom. After that, a homogeneous LC alignment material was spin-coated on the patterned ITO glass bottom. The spin-coated a homogeneous alignment layer of the bottom was spin coated the diluted homeotropic alignment layer which consists of 7 wt.% homeotropic layer (AL1H659 from Japan Synthetic

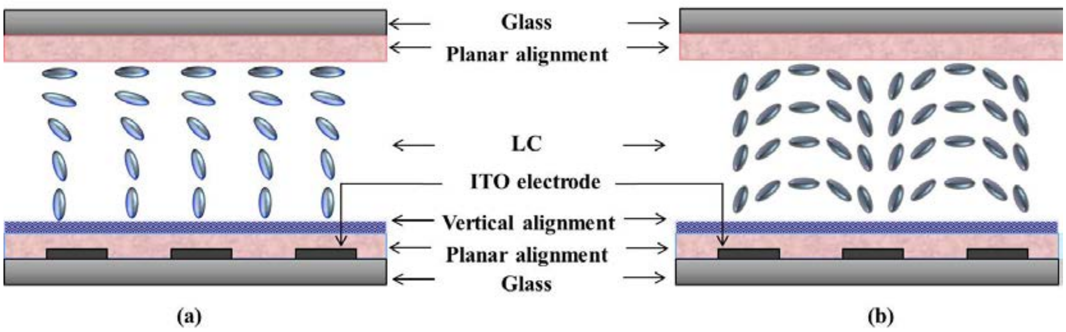
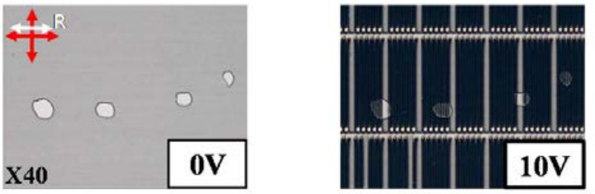


Figure 1. Schematic diagram of LC behavior at field off and on states in CH-IPS (a) bright state (b) dark state

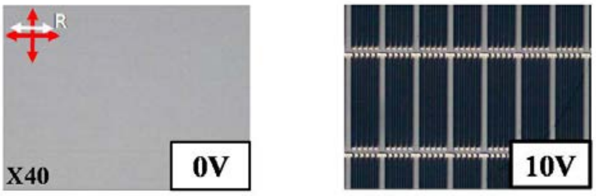
Rubber) and 93 wt.% solvent (n-methyl-pyrrolidon: buthyrolactone : butoxyethanol = 3:4:3).

Top and bottom substrates were assembled anti-parallel. The d/p and cell gap were set to 0.33 and 4.5um, respectively. In this case, the LC molecules were twisted 120° from the bottom to the top substrates, and its transmittance was over 90%. The LC was injected by capillary action at isotropic phase (T_{ni}: 91 °C). We placed two crossed polarizer with optics axes of 0° and 90° on the bottom and top substrates.

3. Result and discussion



(a)



(b)

Figure 2. Microscopic images of CH-IPS: (a) Conventional CH-IPS, (b) CH-IPS with the stacked layer.

Figure 2 shows the microscope images and photo images of the CH-IPS mode sample corresponding to applied voltage. As shown in fig. 2 (a), we can see that the discilination lines are formed between domains. When the voltage is applied to the conventional cell, it is difficult to maintain the gray level and get the dark state immediately due to the different behavior of reverse domain.

To remove reverse domains, we fabricated the improved CH-IPS LC cell using by surface modification using stacked alignment layer. By using the double layer structure with the homogeneous and homeotropic alignment layers, CH-IPS LC cell proposed in this work can be obtain enhanced azimuthal anchoring energy. As a result, CH-IPS LC cell could be acquired a stable LC alignment characteristic and higher transmittance compared with the conventional CH-IPS as shown in fig.2. (b).

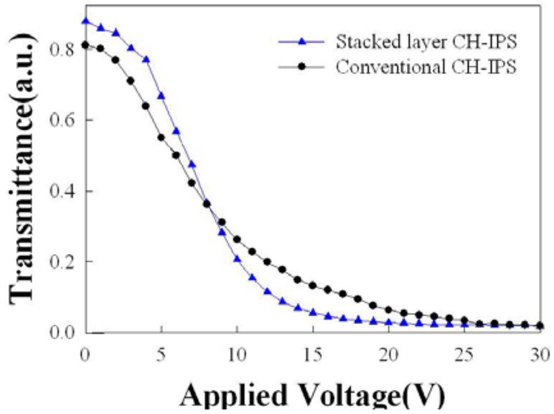


Figure 3. The measured E-O characteristics of the conventional CH-IPS and the stacked layer CH-IPS

Figure 3 shows the measured electro-optic (EO) characteristics of the conventional CH-IPS and proposed CH-IPS. The transmittance of the CH-IPS mode is about 10% higher than that of conventional CH-IPS mode.

4. Summary

We suggested the advanced controlled for improving uniform domain through the surface control by stacked layer. We proposed a mono domain CH-IPS using the stacked layer with IPS electrodes to achieve greater brightness than in the conventional IPS mode. The LC mode with the uniform transmittance which was removed the reverse domains could be obtained through the enhanced azimuthal anchoring energy of vertical alignment layer by planar alignment layer on the bottom substrate. Consequently, our CH-IPS LC mode could be obtained the higher transmittance compared with the conventional that.

5. Acknowledgements

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