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Viewing Angle Control of Liquid Crystal Display with a Additive Thermal Control Layer

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We suggest a continuously viewing angle control mode of liquid crystal display by additive thermal control layer [ATCL]. It is composed of homeotropically aligned liquid crystal layer between two substrates that have patterned transparent electrode for providing Joule heating on the bottom substrate. In the proposed concept for viewing angle, wide viewing angel LCD modes such as Fringe-Field Switching (FFS), Patterned Vertical Aligned (PVA), nematic mode, and In-Plane Switching (IPS) mode can be used as a main panel. In this research, we use normal PVA mode as a main panel and the result shows that it is possible to control continuously viewing angle by modulating the retardation of ATCL in this LCD.

1. Introduction

Viewing angle control of liquid crystal displays (LCDs) is very important issues in terms of information protection. Also information on the display screen would be shared to people in public spaces. Various techniques such as PVA, FFS, and IPS have been widely developed to improve viewing angle characteristics of nematic LCDs [1-3]. To satisfy those characteristics in the display environment, the viewing angle control of display is one of the crucial factors in the private and public purposes. The wide viewing angle [WVA] is for the public, and the narrow viewing angle [NVA] is for the personal needs. To control the viewing angle, there are some methods that have been proposed such as complicatedly compensated multiple LC layers or dual backlight system [4-9].In the previous researches, however, they focused on the compensation of LC alignment with the main panel. For this reason the complex optic system as well as high cost components has to be employed to establish WVA and NVA control mode simultaneously.

In this paper, we propose a simply new method for viewing angle control of liquid crystal display by additive thermal control layer [ATCL]. It is operated by the Joule heating from patterned electrode. When the ATCL is in the nematic phase without heating, the optical properties of LCD at off axis are totally influenced by ATCL. So the narrow viewing angle is achieved. On the other side, when the ATCL is in the isotropic phase by Joule heating, the optical properties of LCD are determined by the only main panel. So the wide viewing angle can be achieved. We used normal PVA mode as the main LCD panel and the result shows that it is possible to control viewing angle by modulating the retardation of ATCL in this LCD.

2. Experimental

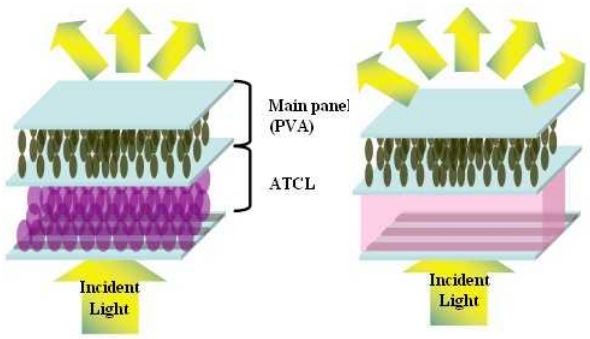

Figure 1. Schematic diagram of viewing angle control LCD with ATCL. (a) is nematic state (NVA) and (b) is isotropic state (WVA)

We used LC which has relatively low nematic to isotropic transition temperature because of

reduction of power for heating and fast transition time between WVA and NVA. We choose K15(5CB) liquid crystal, produced from Merck, whose transition temperature is about 35. By using this LC, viewing angle can be obtained by temperature control within 3~4℃.

3. Results and Discussion

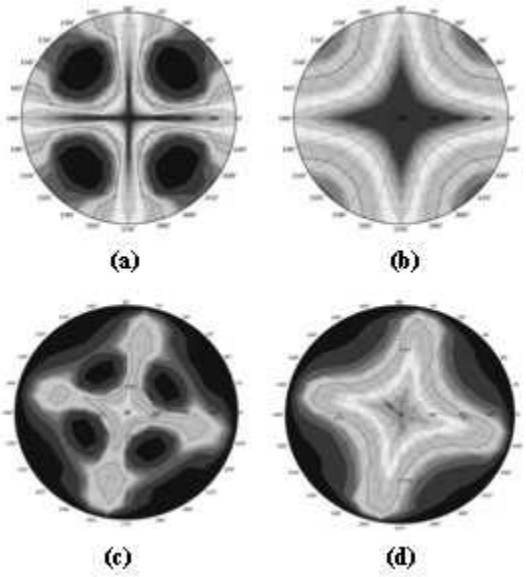

Figure 2. Simulation and measurement of contrast result of PVA-ACTL cell. (a) and (b) are simulated result of PVA from nematic to isotropic state. (c) and (d) are measured result of the same condition cell.

Figure 2 shows the contrast change by modulating the retardation of ATCL. The front contrast is almost the same when the ATCL is neamtic state or isotropic state in the simulation and measurement. But the diagonal view shows obviously different when the ATCL is in the NVA and WVA. The control voltage of ATCL required for isotropic state is about 2.5 V.

4. Conclusion

We proposed a new viewing angle control method by additive thermal control layer [ATCL] with patterned electrical ITO lines giving Joule heating on a substrate. This proposed LCD mode has very simple optical structure and easy to fabrication. We can modulate the retardation of the ATCL. Consquently, the viewing angle of the main panel can be switched.

5. Acknowledgement

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6. References

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