Viewing-Angle Control and Fast Switching of a Hybrid-Aligned LC Cell

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The performance of liquid crystal display (LCD) has been continuously improved for high-quality displays. It is dominated by various key elements, including transmittance, contrast ratio, viewing angle, and response time. The fast response time is one of the most critical requirements for most LCD devices because it helps reduce motion blur and enhance optical efficiency. Moreover, a sub-millisecond switching time is required to implement the field sequential color technology, which helps achieve triple the optical efficiency and resolutions of LCDs. Meanwhile, the protection of personal information becomes important as various electronic devices have emerged [1]. For protecting personal or confidential information, the narrow viewing angle (NVA) devices are strongly required. However, to share informations with other people, the wide viewing angle (WVA) characteristics are also required in the same device.

In this paper, we demonstrate a hybrid-alignment LCD with chevron-shaped patterned electrodes, whose viewing angle can be continuously controlled by switching the bias voltage applied on the top electrode. Figure 1 shows operating principle of the proposed cell. For the NVA mode, there is no voltage applied on the top electrode and LC molecules are hybrid-aligned between crossed polarizers so that the leakage of the light occurs at off-axes in the dark state. The bright state can be obtained through downward tilting and twist deformation of the LCs by aplying an in-plane electric field, while switching to the dark state can be obtained through optically hidden relaxation initiated by applying a vertical electric field for a short time. For the WVA mode, a bias voltage (10 V) is applied on the top electrode all the time, the vertical electric field can make the LC molecules vertically-aligned. When the operating voltage is applied to the patterned electrodes, the in-plane electric field is generated, and the tilt down of LC molecules leads to the bright state. Thus, the viewing angle cone for contrast ratio larger than 10:1 can changes from 10° to the entire viewing angle. Moreover, both NVA mode and WVA mode have ultrafast switching time of less than 1 ms because both the turn-on and turn-off switching are forcibly controlled by applying an electric field [2, 3].

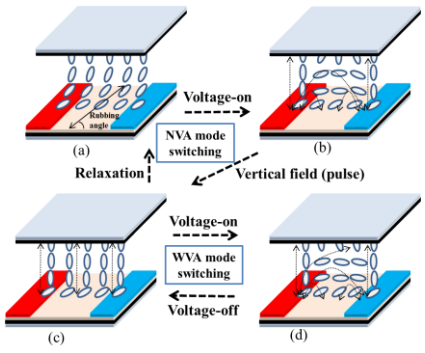

Fig. 1. Operating principle of the proposed cell

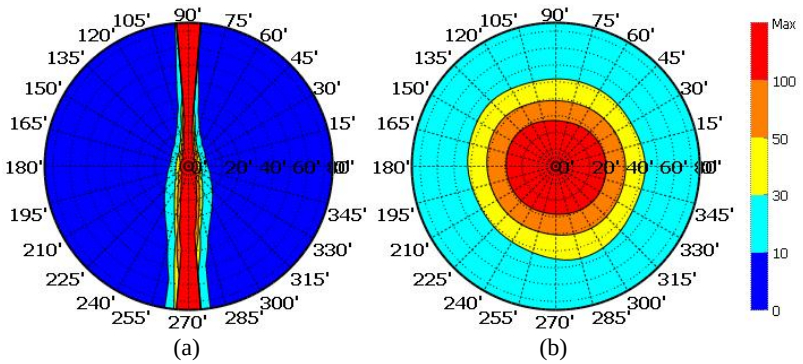

Fig. 2. Iso-contrast contour (a) NVA mode (b) WVA mode

Acknowledgment

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2014R1A2A1A01004943).

References

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