

Viewing Angle Control Mode Using Nematic Bistability of π cell

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Abstract

To control viewing angle, various methods have been introduced by many LC display researchers [1-3]. Almost, however, they require side cost due to additional optical components. In this letter, as another merit of bistable nematic display, we present viewing angle control liquid crystal display using two stable states, splay and 180°-twist at π cell with 3-terminal electrodes. Splay state of normally darkness under crossed nicol shows WVA by horizontal switching with interdigitated electrode like in-plane switching (IPS) mode and fringe field switching (FFS) mode [4, 5]. The dark state of IPS or FFS modes can be obtained easily by initially aligning the surface LC parallel to the transmissive axis of light-input polarizer. The bright state of them can also be achieved simply when LC director is rotated by about 45° by horizontal field. On the other hand, when input LC director coincides with transmissive axis of input polarizer under crossed polarizer, the optical transmittance in 180°-twisted nematic LC configuration is a bright state. When LC layer becomes a bend state by appropriate vertical field with top and bottom electrodes, ϕ becomes 0 and then $T = 0$ as a dark state. π -twist state of normally brightness under crossed nicol shows NVA by vertical switching as twisted nematic mode.

In order to confirm the optical characteristics of the proposed two LC structures, we used DIMOS (Autoronic Melchers) to compute their properties numerically. We can achieve a contrast ration (CR) greater than 10:1 from almost all viewing areas in the contours having polar angle limits of 80°. In the case of the 180°-twisted mode, CR values greater than 10:1 are limited to 40° along the diagonal. In order to confirm the simulated results, we prepared a cell by adding chiral additive (S-811) in LC to achieve the stable 180° twisted state. The cell thickness (d) and cell thickness-to-pitch (p) ratio, d/p , of the fabricated LC cell were 3.85 μm and 0.15, respectively. As estimated in the numerical calculation, we can achieve wide viewing angle characteristics in the splay state (over 175° in terms of CR=10:1 with azimuthally 0° and 90° directions and 110° at both diagonal directions). The 180°-twisted mode shows NVA characteristics in all directions except a direction parallel to the rubbing direction (under 45° in terms of CR=10:1 in all directions). In summary, viewing angle control liquid crystal display using two stable states, splay and 180°-twist at π cell was proposed. The splay state is operated by a horizontal field for WVA, the while 180°-twist state is operated by vertical switching for NVA. As a result, we can easily control the viewing angle of the LC cell.

References

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