Dye-doped liquid crystal device switchable between reflective and transmissive modes

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As liquid crystal devices (LCDs) is smaller and lighter, outdoor use of LCDs has been increasing rapidly. Under outdoor environment, it is difficult to achieve good display performance because of surface reflections. For good visibility under both indoor and outdoor environments, transflective LCDs have been developed [1]. Transflective LCDs, in which each pixel is divided into reflective and transmissive sub-pixels, suffer from low light efficiency problem. To obtain high efficiency, device switchable between reflective and transmissive modes have been proposed. For operation in both reflective and transmissive modes without sub-pixel division, it requires an additional LC layer for mode switching.

LCD mode switchable between reflective and transmissive modes without image inversion problem has been proposed [2]. In this device, image inversion caused by a reflective polarizer was eliminated by using dye-doped liquid crystal. However, in the reflective mode, it has poor dark state because it relies only on the light absorption by dye-doped liquid crystal. In this paper, we propose a dye-doped LCD which is operated in the bistable chiral splay nematic (BCSN) mode for the superior dark state in the reflective mode. The operating principle of the proposed device is described in Figs. 1(a) and 1(b). We use the splay state as the initial state of the transmissive mode, whereas the π-twist state is used as the initial state of the reflective mode. By using the BCSN mode, the dark state of the reflective mode is improved because of change of the polarization state as well as the light absorption. In the transmissive mode, a fringe field is applied between grid electrodes and the bottom common electrode, whereas a vertical electric field applied between top and bottom common electrodes is used for the reflective mode.

Measured transmittances of the previous and the proposed devices were 0.02 % in the dark state and 27 % in the bright state. Measured reflectance curves of the previous and the proposed devices are shown in Fig. 1(c). In the dark state of the reflective mode, reflectances of the previous and the proposed cells were 6.6 % and 4.9 %, respectively. Compared with the previous cell, the dark state reflectance of the proposed cell is lower by 25 %. In the bright state, reflectances of both devices were 27 % at 10 V.

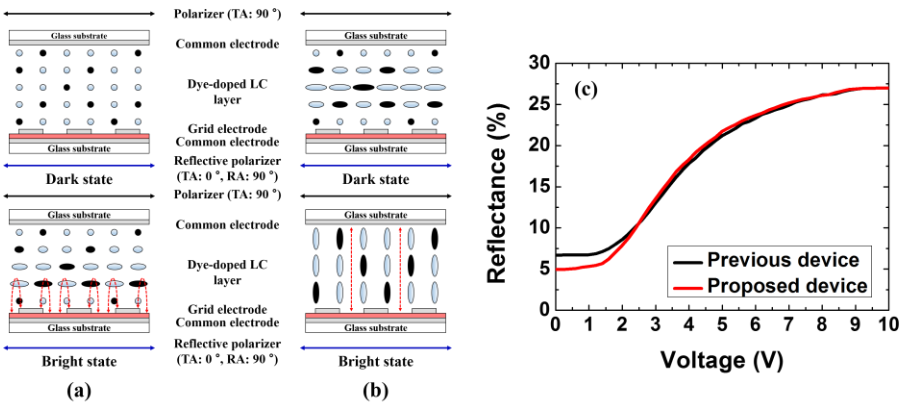

Fig. 1. Operating principle of (a) the transmissive and (b) the reflective modes. (c) Measured voltage-reflectance curves.

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References

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