Viewing Angle Controllable Liquid Crystal Display by Thermally Variable Retardation Layer

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Abstract

To control the viewing angle, various methods have been proposed by adopting multiple LC layers or a dual backlight system [1-3]. However, these need very well designed optic combination between LC layer and optical component to satisfy simultaneously WVA and NVA.

In this paper, we suggest a viewing angle control mode of liquid crystal display by thermally variable retardation layer [TVRL], which is composed of homeotropically or homogeneously well aligned LC between two substrates and transparent ITO electrical heating lines on a substrate. In our optical concept, any LCD modes with wide viewing angle characteristics optimized by compensation films, such as IPS, PVA, FFS, and OCB can be used as main panel. When TVRL is in isotropic phase by heating, the optical properties of the LCD are determined by the only main panel and then, wide viewing angle (WVA) is maintained. On the other side, when TVRL is in aligned nematic phase by cooling or no heating, the optical properties of the LCD at off axis is influenced crucially by TVRL, even though them at front side do not change, and then narrow viewing angle(NVA) is achieved.

LC in TVRL had better have a relatively low nematic-isotropic transition temperature to lower power consumption by heating and reduce transition time between WVA and NVA. As a good case, we use E7 (Merk) of which transition temperature is about 58 ℃ as LC in TVRL in our experiment. The viewing angle control can be obtained by temperature control within about 5℃, namely 54 ~59 ℃. We simulated FFS mode with TVRL using commercial simulator supplied from TechWiz LCD, based on 2 by 2 Jones matrix. We analyze optical characteristics and voltage-transmittance curve. The simulated viewing angle characteristics, It is clearly different from NVA mode and WVA mode. We can achieve a contrast ratio (CR) greater than 10:1 from almost all viewing areas in the contours having polar angle limits of 80° in WVA with TVRL of isotropic phase. In the case of NVA with TVRL of nematic phase, CR values greater than 10:1 are limited to 20° along the diagonal.

References

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