The Optical Technology to Improve the Gamma-Curve in Liquid Crystal Display Modes

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During the past 20 years, liquid crystal displays (LCDs) have been so much successful in display market, and widely used for entire displays from mobiles to TV application display larger than 40 inches. The most reason why LCDs are successful is due to high image quality in all viewing directions by developing of the many new liquid crystal (LC) modes such as wide view-twisted nematic (WV-TN) [1], 4-domain twisted nematic (4D-TN) [2], multi-domain type of vertical alignment (MVA) [3], in-plane switching (IPS) [4] and fringe-field switching (FFS) [5].

Recently, the optical performance of LCDs is depended on not only wide-viewing angle property but also the viewing direction in all gray scales on-voltage state. Therefore, image distortions, which can be obtained by measuring the γ-curve, occur in the middle gray level in the off-axis direction in spite of the optical improvement in all viewing directions. In order to improve this γ-curve distortion in the oblique direction, several methods have been proposed to improve the viewing angle properties in the gray scales by applying a novel electrode structure [6, 7]. However, these methods require complex cell structures, such as two times the number of the transistor compared to a conventional thin film transistor (TFT) LCD [6], or a different electrode structure domain in the sub-pixel [7].

In this paper, we introduced an optical technology, which can reduce the *γ*-curve distortion without any deterioration in the viewing angle or contrast ratio in the dark state by using retardation films only, for the WV-TN, 4D-TN, and MVA LCD mode. The proposed optical structure of LCD modes applied a pairing of a positive *A*-film and a negative *A*-film with same retardation in the conventional LC modes without any change in cell structure. In order to optimize the optical parameter of used films, we calculated the polarization difference between the on-axis and off-axis as functions of the optical axes and the retardation (*Δ*nd) under the voltage applied state. From the calculated results, we confirmed the *γ*-curve distortion of each LC mode with the proposed optical configuration in all viewing direction can be improved more than 60 % compared to conventional optical configurations.

References:

[1] Mori H, *Jpn. J. Appl. Phys*. **36**, 1068-1072 (1997).

[2] S. I. Jo, S. W. Choi, Y. J. Lee, Y. K. Moon, Y. C. Yang, C. J. Yu, and J.-H. Kim, *J. Appl. Phys.* **109**, 084501 (2011).

[3] S. G. Kim, S. M. Kim, Y. S. Kim, H. K. Lee, S. H. Lee, G.-D. Lee, J.-J. Lyu, and K. H. Kim, *Appl. Phys. Lett.* **90**, 261910 (2007).

[4] M. Oh-e, and K. Kondo, *Appl. Phys. Lett.* **67**, 3895-3897 (1995).

[5] S. H. Lee, S. L. Lee, and H. Y. Kim, *Appl. Phys. Lett.* **73**, 2881-2883 (1998).

[6] K. H. Kim, K. H. Lee, S. B. Park, J. K. Song, S. N. Kim, and J. H. Souk, *in The 18th International Display Research Conference Asia Display (Society for Information Display, 1998)*, pp. 383-386.

[7] K. Ohmuro, S. Kataoka, T. Sasaki, and Y. Koike, *Dig. Tech. Papers* **28**, 845 (1997)

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