Study on promoting transmittance on dielectric multi-layers for IGZO LCD displays

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1. Introduction

In recent years, IGZO is widely used in TFT-LCD owing to its good electric properties comparing to a-Si[1-3]. The first prototype of 85-inch 8K4K 120Hz LCD with BCE-IGZO structure from CSOT in the world attracted many peers' eyes in 2016[4]. With the increase of TV size and refresh rate from customer's demand, IGZO is good choice to satisfy the technical index instead of a-Si. To overcome this shortcomings, complex layers of SiOx and SiNx is a welcome solution for GI and top passivation insulator (PV) layers with the high permittivity and process. From our previous study in numerical simulation, the complex layer could result in color shift and low transmittance for R, G and B. In this paper, the optimization experiments was carried out to demonstrate the theoretical prediction and adopted in a demo of IGZO TFT LCD displays.

2. Results and Discussions

From the experiment in this study, the multiple layers of SiOx and SiNx in bottom gate and top passivation insulator of aperture area might introduce different efficiencies for R/G/B components in backlight. Due to the phase mismatch between different dielectric materials (n_{SiOx} ~ 1.5, n_{SiNx} ~ 1.9) and guided-wave absorbent mode existence in optically denser medium, the layered structure of SiOx and SiNx plays a critical role for optical propagation to improve the transmittance. Therefore, it is useful to promote the performance of display with a-IGZO channel to optimize the insulator layers structure to realize high transmittance for backlight through single glass.

3. Transmittance in Aperture Area

In TFT-LCD, transmittance is one of most important factors for open cells in relation to the contrast ratio and luminance. Notably, transmittance is also calculated from the single glass transmittance for backlight. The cost and energy consumption of backlight is a critical problem if an open cell with low transmittance. Transmittance is related to not only materials and process, but also the arrangement of different materials due to the theory of optics physics. As shown in Figure 2, there are several peaks of strong optical absorption corresponding to the central wavelength of R, G and B, which could lead to low efficiency of optical transmission in dielectric multi-layers for total backlight. It demonstrated that the dielectric multi-layers with different structures and ratios could results in various transmission band gaps in the experiment. Therefore, it could be an important method to promote the transmittance for LCD displays via optimizing the layers structures.

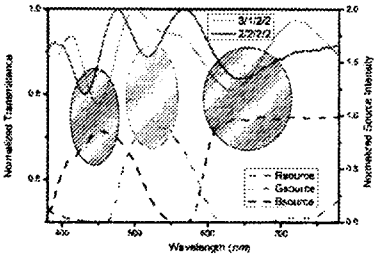

Figure 2: The transmittance spectra of multilayered structure and color filter in simulation and experiment. Inset: the distribution

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5. References

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