High Efficiency backlight System for 3D Display

*Jiangang Lu*and Yijun Wang*
National Engineering Lab for TFT-LCD materials and Technologies, and Department of Electronic Engineering, Shanghai Jiao Tong University, Shanghai 200240, ,P. R. China
Tel.:86-21-3420-7914, E-mail: lujg@sjtu.edu.cn

Over the years the visual quality of 2D displays has almost reached perfection. The development of 3D display systems is the next major step to enhance the visual experience. [1] Among the 3D display technologies, autostereoscopic display shows the great potential for commercial application. However there are still several issues to be overcome before its wide applications, such as low optical efficiency, high crosstalk, and resolution degradation. [2] This article proposes a novel backlight module that integrates dual layer strip patterned organic light emitting diode (DLSP-OLED) to improve the optical efficiency of barrier type of 2D/3D switchable display. [3] In addition, a high directional backlight using an integrated light guide plate [4] is proposed for high resolution scanning liquid crystal (LC) prism type 3D display. [5]

A DLSP-OLED backlight module comprising dual layer strip patterned OLED with two glass substrates and a thin-film encapsulation (TFE) layer, is proposed to enhance the optical efficiency. Some special designs have been employed to improve the optical efficiency in this configuration. The absorption type barrier (e.g., LC barrier type) is replaced by the reflection type (cathode of DLSP-OLED) with the high reflective index material, which can effectively reflect lights back to glass substrate for recycling. The bottom layer OLED are patterned as the strip type and only in locations corresponding to the slits of the parallax barrier to extract more rays from backlight. Moreover, based on micro-cavity effect, the structure of bottom layer OLED has been optimized so that the angular distribution can be compressed compared with the Lambertian distribution. Consequently, more rays can be converged to the slits, resulting in a higher light out-coupling. In this case, the optical efficiency of the DLSP-OLED backlight module can effectively increase in 3D mode. The results indicated that the backlight module with a thin form factor (1.1 mm) can achieve uniformity of 91% in 2D mode, and increased optical efficiency by a factor of 2.8 with a crosstalk of less than 6% in 3D mode, compared with the conventional 2D/3D switchable display. A fast switching rate (1 ms) with simple operation can eliminate the visual fatigue caused by flicker during the switching. In addition, this configuration can function localized 3D display by modulating the DLSP-OLED individually.

To perform a high resolution scanning type 3D display, a high directional backlight system that combined a composite microstructure light guide plate (LGP) with a collimated light source was proposed. The collimated planar light was expanded from a point light source and guided towards the normal direction by utilizing the micro-prism array on LGP. High uniformity of spatial luminous, 91%, with a narrow viewing cone of $\pm 4°$ can be achieved without additional optical films which may dramatically decrease the crosstalk of the scanning type 3D display. Moreover, compared to the conventional backlight, only 5% of power consumption was needed to keep the same luminance, hence, the optical efficiency increased by a factor of 1.47.

Acknowledgment

This work was supported in part by 973 Program (2013CB328804) and NSFC (61275026), and financially supported by China Star Optoelectronics Technology CO. LTD.

References

1. A. Redert, R. P. Berretty, C. Varekamp, O. Willemsen, J. Swillens, and H. Driessen, *Proc. of 3D Data processing, Visualization, and Transmission Third Int'l Symp.,* 429 (2006).
2. J.G. Lu, X. F. Sun, Y. Song, and H.-P. D. Shieh, *J. Disp. Technol. 7*(4), 215 (2011).
3. Y.-J. Wang, J. Liu, J. Tan, B.-R. Yang, W.-X. Ding, G.-F. He, W.-C. Chao, J.-G. Lu, and H.-P. D. Shieh, *J. Disp. Technol.*, 10(5), 352 (2014).
4. Y.-J. Wang, S.-H. Ouyang, W.-C. Chao, J.-G. Lu, and H.-P. D. Shieh, *Opti. Expr.*, 23(2), 1567, (2015).

5. J. Tan, Y.-J. Wang, S.-B. Ni, J.-L. Zhu, E.-W. Zhong, and J. G. Lu, *SID Symp.*, 1992 (2013)