KLCC 2016, Vol. 17,
Reprints available directly from the publisher

High brightness transflective display using TN LC cell and OLED

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We propose a transflective display for high brightness characteristics. This mode operates in a whole pixel configuration consisting of the OLED and TN LC cell which are used for backlight and reflector, and switching device, respectively. It is a single cell gap cell and single LC mode transflective display device. As a result, we get simple structure and high bright state.

1. Introduction

As information display industry develops there have been an increase of demand for low power consumption display. Therefore many researches of transflective display have been done [1,2]. Transflective display reduces the power consumption by using the ambient light as light source for the LCD. On the contrary, transflective display uses back light as the light source while dark circumstance. To achieve transflective display device needs multi-cell gap structure in a single cell. Also it needs two different modes in a single cell. But these structure causes complex fabrication process, non-uniform deformations of LC molecules. Also it brings different threshold voltage and response time.

Here, we propose single cell gap structure and single mode transflective display using OLED as a back light and a reflector and TN mode for the liquid crystal layer. While bright circumstance display device uses both OLED and ambient light as a light source at the same time. In this way it is able to achieve high brightness display. And while dark circumstance cathode layer of the OLED is used as a reflector meaning no additional layer of reflector is needed.

Figure 1 shows the operating method for proposed transflective display device. For the transmissive mode while no voltage is applied the polarization axis of the light from the OLED is changed from 0° to 90° by the TN mode. Polarization axis of the light which passed through the TN LC layer is parallel to the transmission axis of the polarizer of the top substrate leading to the bright state. And if the voltage is applied to the LC layer the TN alignment is changed to vertical alignment leading to zero birefringence. In this case polarization axis of the light is not changed. So the light is blocked because the polarization axis is perpendicular to the top substrate polarizer which leads to the dark state.

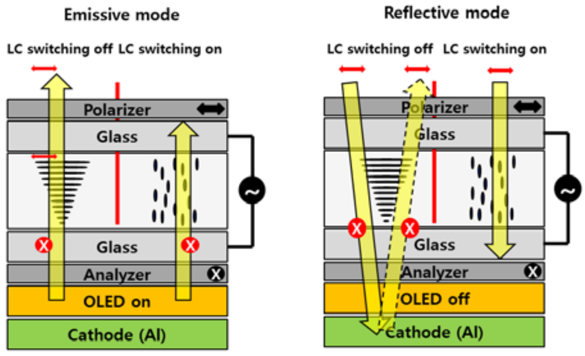

Figure 1 The schematic diagrams of the transflective display

While no voltage is applied for the reflective mode the polarization axis of the light from outside of the device is changed from 90° to 0° by the TN layer. After passing through the TN layer the light is reflected by the cathode of the OLED. Even though the light is reflected the polarization axis doesn't change because it is linearly polarized light. And again because of the TN layer the polarization axis changes from 0° to 90° by the TN layer which makes the light able to pass the polarizer of the top substrate

When voltage is applied to the LC layer no light can pass through the polarizer of the top substrate because vertically aligned LC layer doesn't change the polarization axis of the reflected light.

2. Experimental procedure

OLED was made using F8BT as a EML layer which was spin coated. The thickness of F8BT layer was 70nm. 75nm of Aluminum layer for cathode was thermally evaporated. 150nm of ITO layer was used for anode. Also, PEDOT:PSS was used for hole transport layer which thickness was 70nm. And for electron injection layer calcium was thermally evaporated of about 20nm.

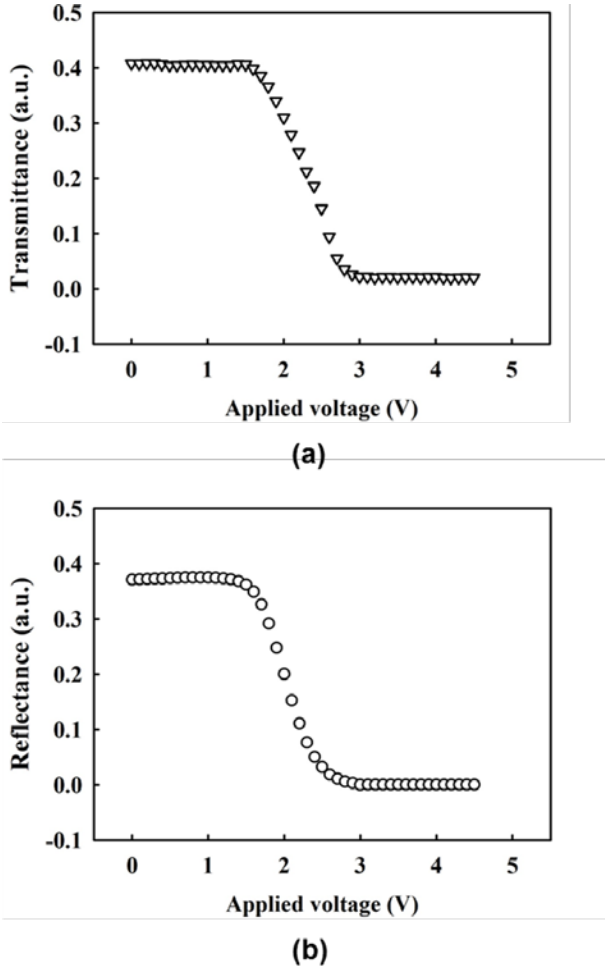

Figure 2 Measured electro-optical characteristics of the fabricated sample (a) voltage-electroluminance, (b) voltage-reflection characteristics.

Alignment layer for TN LC cell was AL22620 (JSR) which were spin coated and baked at 100°C for 10 minutes and 210°C for 1 hour. MAT-03-382 was used for LC layer which were injected above 90°C.

Figure 2 shows the electro-optic (EO) characteristics. The light intensity was normalized. For the transmissive mode OLED luminance was used as the input intensity and ambient light was used for reflective mode. The maximum intensity of reflected and transmitted light is 0.4 which is almost same as conventional TN LC mode.

3. Conclusion

We propose a simple structure high brightness transflective mode consisting of TN LC and OLED. TN LC layer is used to control the intensity of the light and OLED is used to reflect the ambient light and as a back light for the device. It is a unique structure for transflective because of its single cell gap and single mode. Also it is able to use both ambient light and the back light while bright circumstatance.

References

[1] K. Fujimori, Y. Narutaki, Y. Itoh, N. Kimura, S. Mizushima, Y. Ishii, and M. Hijikigawa, SID'02, 1382 (2002).

[2] X. Zhu, Z. Ge, T. X. Wu, and S.-T. Wu, J. Display Technology 1, 15 (2005).