

## **Numerical simulation of top-emitting organic light-emitting diodes with electron and hole blocking layers**

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### **Abstract**

The few reported high-contrast organic light-emitting diodes (OLEDs) all deal with bottom-emitting OLEDs and may not be readily adapted for top-emitting OLEDs (TOLEDs), which have a few technical merits over bottom-emitting devices for high-performance active-matrix OLED displays (AMOLEDs). The thin-film transistors on the back-plane of an AM substrate reduce the aperture ratio of a pixel that decreases the display brightness. A TOLED, which can provide a more flexible pixel design on an opaque AM substrate, represents a promising technique for achieving a high aperture ratio AMOLED. In this work, the characteristics of TOLEDs with  $\alpha$ -NPD and LiF blocking layers are numerically investigated with the APSYS simulation program. The  $\alpha$ -NPD layer is used as an electron blocking layer, while the LiF layer is used as a hole blocking layer. The TOLED structure used in this study is based on a real device fabricated in lab by Yang et al. (Appl. Phys. Lett. 87, 143507, 2005). The simulation results indicate that when the TOLED device is with either  $\alpha$ -NPD or LiF blocking layer, the luminance efficiency and radiative recombination rate at the same drive voltage can be markedly improved. The TOLED with  $\alpha$ -NPD blocking layer has the best performance when the position of light emission is located at the anti-node of the standing wave due to micro-cavity effect. The TOLED with LiF blocking layer has improved performance because the LUMO of Alq3 can be lowered by band bending, which leads to better carrier balance and thus increased radiative recombination rate.

Key words: OLED; Blocking layer; Micro-cavity effect;  
Numerical simulation