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Numerical simulation of bright white multilayer organic light-emitting diodes

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Abstract

Transferring existing color filter technology to an organic light-emitting diode (OLED) display can greatly simplify the fabrication of a full-color OLED since only a white light emission device is required. In this work, the optical and electronic properties of bright white multilayer OLEDs, typically with a structure of metal/LiF/Alq3/EML/TPD/ITO constructed by Lim et al., are numerically investigated with the APSYS simulation program. Specifically, the emission/absorption spectra of the Alq3 (Green), Alq3:DCM (Red), and SA (Blue) light-emitting layers (EMLs) as well as the energy band diagrams, electron-hole recombination rates, electroluminescence, current-voltage, and luminancecurrent characteristics of the simulated OLED devices are investigated and compared to the experimental results. The physical models utilized in this work are similar to those presented by Ruhstaller et al. and Hoffmann et al. The simulated results indicate that the emission spectra of the Alq3, Alq3:DCM, and SA light-emitting layers obtained in this study are in good agreement with those obtained experimentally by Zugang et al. We study the optical and electronic properties of the OLEDs consisting of several dotted-line doped layers (DLDLs) and adjust all emission layers to enhance the luminance efficiency. Finally, we insert m-MTDATA and CuPc buffer layers onto the ITO anode. Using the double-buffer layer structure, the device performance can be greatly improved through the relative alignment of the energy levels of the layers to enhance the holes injection and transportation. Structural optimization for the OLED devices with better optical and electronic performance is also discussed.

Key words: OLED; White light; Doping; Numerical simulation