

**Numerical simulation of optical and electronic properties for
multilayer organic light-emitting diodes and its application in
engineering education**

Chang, Shu-Hsuan; Chang, Yung-Cheng; Yang, Cheng-Hong;
Chen, Jun-Rong; Kuo, Yen-Kuang

Abstract

Organic light-emitting diodes (OLEDs) have been extensively developed in the past few years. The OLED displays have advantages over other displays, such as CRT, LCD, and PDP in thickness, weight, brightness, response time, viewing angle, contrast, driving power, flexibility, and capability of self-emission. In this work, the optical and electronic properties of multilayer OLED devices are numerically studied with an APSYS (Advanced Physical Model of Semiconductor Devices) simulation program. Specifically, the emission and absorption spectra of the Alq₃, DCM, PBD, and SA light-emitting layers, and energy band diagrams, electron-hole recombination rates, and current-voltage characteristics of the simulated OLED devices, typically with a multilayer structure of metal/Alq₃/EML/TPD/ITO constructed by Lim et al., 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, DCM, PBD, and SA light-emitting layers obtained in this study are in good agreement with those obtained experimentally by Zungang et al. Optimization of the optical and electronic performance of the multilayer OLED devices are attempted. In order to further promote the research results, the whole numerical simulation process for optimizing the design of OLED devices has been applied to a project-based course of OLED device design to enhance the students' skills in photonics device design at the Graduate Institute of Photonics of National Changhua University of Education in Taiwan. In the meantime, the effectiveness of the course has been proved by various assessments.

The application of the results is a useful point of reference for the research on photonics device design and engineering education. Therefore, it proffers a synthetic effect between innovation and practical application.

Key words: Electronic properties; Numerical simulation; OLED;
Optical properties