

Light Extraction Behavior of White OLEDs: spectral dependence

*Mei Meng, Dai Gun Yoon, and Byung Doo Chin**

Department of Polymer Science and Engineering, Dankook University,

152 Jukjeon-ro, Suji-gu, Yongin-si, Gyeonggi-do, 448-701, Korea

Tel.:82-31-8005-3587, E-mail*: bdchin@dankook.ac.kr

Current approaches on the light extraction technology of organic light emitting diodes (OLEDs) are usually focused to single-color emission. Since solid-state lighting devices with OLED were utilizing the white emission with various color temperature and spectral characteristics, it is important to understand the relationship between light extraction efficiency and spectral behavior of OLEDs.

In this study, solution-processed internal and external out-coupling structures for white OLED were investigated [1]. Suitable size and thickness of inside scattering layer (SCL) with nanoscale titanium dioxide (TiO_2) particles were selected in combination with metal grid-polymer composite printable anode system. Transmittance and haze, as a function of particle size and thickness of scattering layer, were characterized. Structure of WOLED with scattering layer used in this study is Glass/SL($3\mu\text{m}$)/ PEDOT: PSS(60nm)/Ag grid/DNTPD(50nm)/TAPC(20nm)/mCP:Firpic-10wt% (20nm)/CBP:Ir(piq) $_2$ acac-8wt% (10nm)/Bphen(30nm)/LiF (2nm)/Al(100nm). The matrix of scattering layer was negative photoresist polymer (Ormocomp[®]). For the external out-coupling structure, microlens formed by convective self-assembly patterns was employed; polystyrene latex beads (Alfa Aesar) and polymethylmethacrylate powder were used for regular and irregular microbeads. For white OLED with internal scattering layer only, maximum luminous efficiency was 8.8 cd/A (158% improvement), while the control device shows 5.6 cd/A. In case of device with irregular microlens, efficiency was 7.0 cd/A (126% improvement). White OLED with both internal and external outcoupling layer combination shows 10.1 cd/A, which is achieving 181% improvement compared to reference device (Fig 1a). For a further understanding on the relationship between light extraction and OLED's spectral characteristics, we have fabricated various white OLED structures for comparison. Structure of tandem white OLED with TiO_2 scattering layer used in this study is Glass/SCL/Ag grid/PEDOT:PSS/DNTPD/ TAPC/mCP:Firpic-10wt%/CBP:Ir(piq) $_2$ acac-8wt%/Bphen/CGL/DNTPD/TAPC/CBP:Ir(piq) $_2$ acac-8wt%/Bphen/ LiF/Al, as shown in Fig 1c. Tuning of the white emission spectra was done by relative thickness variation. Analysis on the experimental results, light extraction for different range of spectra, was also compared with simulation.

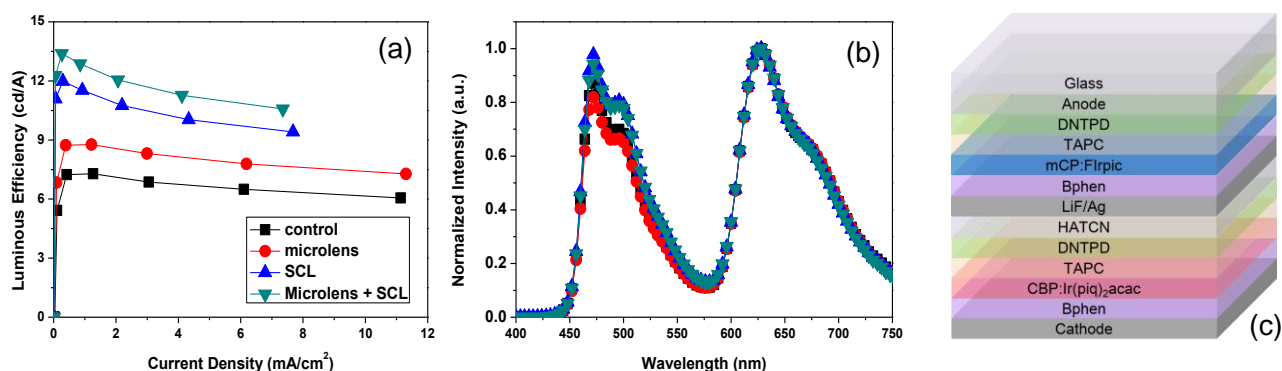


Fig. 1 Current density-luminous efficiency (a), spectral behavior (b) of non-tandem white OLED for combinational effect of light extraction layer. Tandem white OLED structure for investigation (c).

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References

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