MoS_2/GO composites for hole injection layer in organic light emitting diodes

Soo Young Kim
Minjoon Park, Thang Phan Nguyen

School of Chemical Engineering and Materials Science, Chung-Ang University, 84 Heukseok-ro, Dongjak-gu, Seoul 06974, Republic of Korea

sooyoungkim@cau.ac.kr

Two-Dimensional MoS_2 and graphene oxide (GO) can be used in organic light emitting diode (OLED) as hole injection layer (HIL) after work function modification. MoS_2 was made by using BuLi intercalation method. Also GO was synthesized using a modified Hummers method. In this work, nanocomposite of MoS_2 and GO were employed as a hole-injection layer to improve the efficiency and air stability of OLED. The OLED with nanocomposite layer show a degraded performance with a luminance power efficiency (LPE), which is lower than that of OLED with poly(3,4-ethylenedioxythiophene): poly(styrene sulfonate) (PEDOT:PSS) layer.

Figure 1 shows the characteristics of OLEDs containing MoS_2-GO composite HILs. The turn-on voltage at 10 cd/m^2 decreased from 4.3 to 4.24 V as the GO content in the MoS_2-GO composite increased to 40 wt%. Accordingly, the maximum power efficiency increased from 3.12 to 3.77 lm W^{-1} (from MoS_2-GO 10:0 to 6:4). However, turn-on voltage increased to 4.29 V as the GO content increased to 80 wt%. As a result, maximum power efficiency decreased to 3.2 lm W^{-1} for MoS_2-GO 2:8. These results revealed that OLEDs with HILs fabricated using MoS_2-GO composites with similar contents of MoS_2 and GO provide the best performances. In the case of the GO HIL, the OLED showed the lowest turn-on voltage of 4.15 V and the highest power efficiency of 4.94 lm W^{-1}. The work functions of MoS_2 and GO are reported to be 4.6 and 4.8 eV, respectively. Therefore, the OLED with GO HIL showed the best performance due to the lowest roughness and high work function of GO.

The properties of nanocomposite layer were examined using atomic force microscopy, field-emission scanning electron microscopy, x-ray photoelectron spectroscopy and ultraviolet photoelectron spectroscopy. Based on these characterization data, the origin of improved device performances was investigated.

Acknowledgement

This research was supported in part by a National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIP) (No. 2014R1A2A1A11051098, 2015K1A3A1A59073839).

Figures

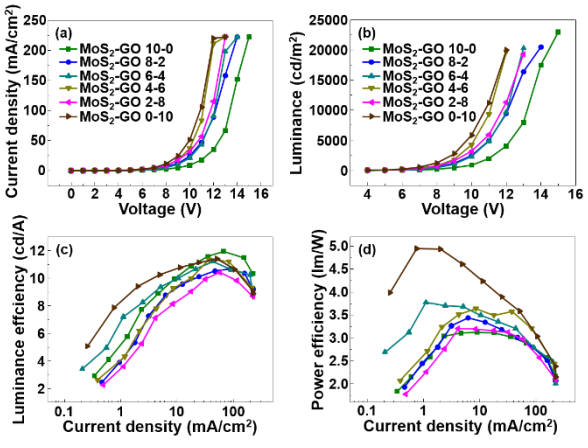

Figure 1: (a) Current-density–voltage, (b) luminance-voltage, (c) luminance-efficiency–current-density, and (d) power-efficiency–current-density characteristics of organic light-emitting diode devices with MoS_2–GO composite as hole injection layer.