Use of MoS_2 as hole injection layer for polarizer-free organic light emitting diodes

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In order to improve the ambient contrast ratio in organic light emitting diodes (OLEDs), a circular polarizer (CP) has been used to suppress ambient light reflection. However, the use of a CP has many drawbacks such as decreased flexibility, increased cost, and more than 50% absorption loss of the OLED. In this work, we report that patterned MoS_2 nanosheets obtained by mechanical rubbing (R-MoS_2), ion-beam treatment (I-MoS_2), and rubbing/ion-beam treatment (RI-MoS_2) can efficiently function as hole transport layers and templates for alignment of an emissive layer {poly(9,9-dioctylfluorene-alt-benzothiadiazole), poly [(9,9-di-n-octylfluorenyl-2,7-diyl)-alt-(benzo [2,1,3]thiadiazol-4,8-diyl)] (F8BT)} with a nematic liquid crystal phase toward highly efficient polarized OLEDs.

The Electroluminescence (EL) spectrum of the N-MoS_2-based OLED is clearly unchanged under different rotation angles of the polarizer, indicating that the OLED fabricated on N-MoS_2 is not polarized. In contrast, the EL spectra of the R-MoS_2-, I-MoS_2-, and RI-MoS_2-based OLEDs dropped dramatically as the polarizer was rotated. The maximum polarization ratios for the R-MoS_2-, I-MoS_2-, and RI-MoS_2-based OLEDs are approximately 19.8, 21.7, and 166.7, respectively, at 540 nm. In Figure 1, the output spectra obtained when the transmission axis of the polarizer was 0 ◦ and 90 ◦ appear in red and black, respectively. Thus, the average polarization ratios for the emission spectra of the R-MoS_2-, I-MoS_2-, and RI-MoS_2-based OLEDs were calculated to be 11.5, 12.3, and 62.5, respectively. The insets in Figure 1(a)–(d) are emission images of the R-MoS_2-, I-MoS_2-, and RI-MoS_2-based OLED devices at different rotation angles (0 ◦, 45 ◦, and 90 ◦) of the polarizer, which support the results in Figure 1 (a)–(d). These data suggest that RI-MoS_2 is the optimal hole transport layer for high-efficiency polarized OLEDs.

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Figures

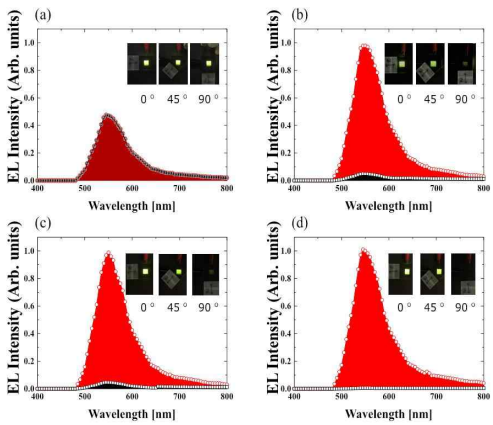

Figure 1: EL spectra of (a) N-MoS2-, (b) R-MoS2-, (c) I-MoS2-, and (d) RI-MoS2-based OLEDs. The output spectra taken when the transmission axis are shown in red and black, respectively. The insets are optical images of OLED devices obtained at different rotation angles (0 ◦, 45 ◦, and 90 ◦) of the polarizer.