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Efficient Organic-Inorganic Hybrid Hole Injection Layer for Organic Light-Emitting Diodes by Aqueous Solution Doping

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An aqueous solution-processed hole injection layer, MoO_3 doped copper phthalocyanine-3,4',4'',4'''-tetra-sulfonated acid tetra sodium salt (TS-CuPc), in organic light-emitting diodes (OLEDs) via an environmentally-friendly and easy fabrication process. The generation of a charge transfer complex in TS-CuPc:MoO_3 composite films is confirmed by absorption spectra and X-ray photoemission spectroscopy (XPS) measurements. The TS-CuPc:MoO_3 interfacial layer based device exhibited lower driving voltage and higher efficiency than the pristine TS-CuPc based one. Enhanced hole injection in OLEDs is attributed to the decreased hole barrier at the ITO side, which is in agreement with the Schottky thermal emission evaluation. The efficient modification of ITO by TS-CuPc:MoO_3 is further confirmed by ultraviolet photoemission spectroscopy (UPS) measurements. Specifically, over 65% enhancement in power efficiency is achieved compared to the device without any interfacial modification, the improved performance of MoO_3:TS-CuPc based devices is attributed to the reduced hole-injecting barrier height at the anode/doped HIL interface, and the reduced bulk resistivity in the doped HIL. What's more, the crystallization of TS-CuPc film could be alleviated by doping with MoO_3. Meanwhile, MoO_3 diffusion can be suppressed, which is beneficial to the device performance to some extent.

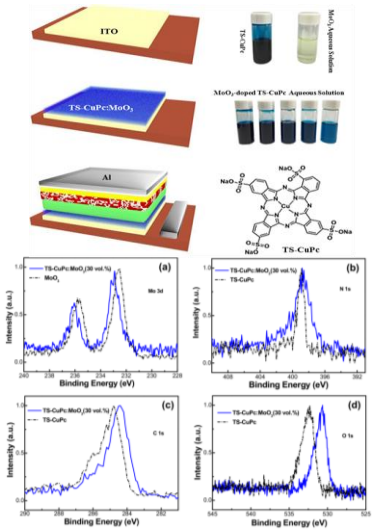

Fig. A schematic diagram of the device structure and XPS core-level spectra of (a) Mo 3d of MoO_3 and TS-CuPc:MoO_3 (30%) films; (b) N 1s, (c) C 1s and (d) O 1s of TS-CuPc and TS-CuPc:MoO_3 (30%) films.films.

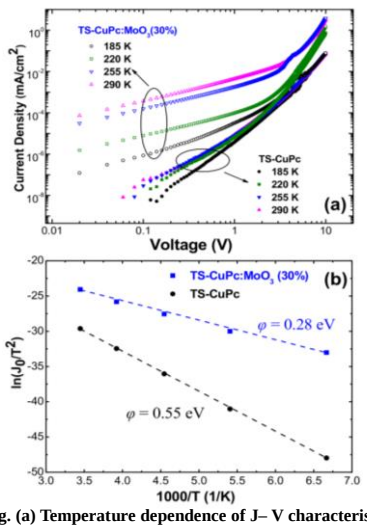

Fig. (a) Temperature dependence of J– V characteristics in TS-CuPc and TS-CuPc:MoO_3 (30%) based hole-dominant devices; (b) the relationships between ln J_0 / T^2 and 1/ T, respectively. J_0 is current density at zero voltage by extrapolating straight lines to the ordinal point in the plot of ln J vs. $V^{1/2}$.

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