An ultrathin iridium oxide hole extraction layer on P3HT: PCBM bulk hetero-junction organic photovoltaic's cells

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Transparent conducting oxides (TCO) are the integral part of the present day electro-optic devices as transparent conducting electrodes (TCE) in solar cells, displays and solid-state lighting [1-2]. Indium Tin Oxide (ITO), traditionally used as a transparent electrode material due to its high transmittance (> 90%) and good electrical conductivity (R_s < 15 Ω/sq) [3-4].

In this study, an ultrathin iridium oxide was deposited on glass/ITO substrate using radio frequency magnetron sputtering for the applications of organic photovoltaic's cells. Iridium oxide (IrO_x), used as the hole extraction layer (HEL) in order to replace poly (3,4-ethylenedioxythiophene): poly(styrene-sulfonate) PEDOT:PSS in organic photovoltaic's (OPV) cells with poly(3-hexylthiophene):phenyl-C60-butyric acid methyl ester (P3HT: $PC_{60}BM$). IrO_x is a transparent conducting oxides, and the work function of the IrO_x (> 5.1 eV) is higher than that of ITO (4.5 ~ 4.7 eV). Moreover, IrO_x has a surface with hydrophobic nature. Thus, HEL of IrO_x between ITO anodes and active layer improve the extraction of holes. IrO_x (0.5 nm) coated on ITO glass substrate shows the transmittances of 84.10% in the visible range. The transmittance decreased when the thickness of the IrO_x increased from 1.0 to 3.0 nm. The iridium oxide has a blue black color due to intraband transitions within the Ir t_{2g} band. When the thickness of IrO_x becomes thick, the absorption could increase because of the increase of intraband transition. The OPV cell with IrO_x (1.0 nm) exhibits increased power conversion efficiency as 3.51% under 100 mW/cm^2 illumination with an air mass (AM 1.5G) condition, higher than that of 3.28% with PEDOT: PSS. Chemically stable IrO_x enabling easy device fabrication could therefore be used as an alternative material for PEDOT: PSS and is applicable to general anode HELs on organic electronics.

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