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Improvement of Sensitivity of Indirect-type Organic X-ray Detector Using Amorphous IGZO Interfacial Layer

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In this paper, we examined the role of amorphous indium-gallium-zinc-oxide (a-IGZO) interfacial layer between PBDB-T1):PC70BM2) active layer and LiF/Al cathode to improve the sensitivity of indirect-type organic X-ray detector. According to the energy band diagram described in Fig 1a, the a-IGZO layer can block hole transport and also enhance electron transport from the active layer. Using a RF magnetron sputter deposition method, a-IGZO of different thicknesses were grown on the active layer and then current density-voltage (J-V) characteristics (Fig 1b) of fabricated detectors without a CsI(Tl) scintillator were measured under illumination of an AM 1.5 G filtered Xe lamp close to the solar spectrum. The highest power conversion efficiency (PCE) was 7.4% obtained from the detector with the a-IGZO layer grown for 6 min. Compared with the detector without the a-IGZO layer, the PCE value increased by 37%. When the a-IGZO was grown on the active layer, the transmittance was noticeably increased in the range of 450 nm and 650 nm (Fig 1c). At 560 nm, the emission peak of the CsI (Tl) scintillator, the transmittance increased by 27.9% compared to the absence of the a-IGZO layer. Carrier mobility of the detector was calculated following Mott-Curney space charge-limited current model (Fig 1d). Due to improved conductivity and reduced interfacial traps, the detector with the a-IGZO layer grown for 6 min showed the highest mobility of 5.44×10-4 cm2/V•s. The detector with the same a-IGZO layer showed the highest sensitivity of 2.11 mA/Gy•cm2, which was 22% higher sensitivity than the detector without the a-IGZO layer.

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