

## The performance dependency of the organic based solar cells on the variation in InZnSnO thickness

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The performance dependence of the P3HT:PCBM based bulk hetero-junction (BHJ) organic solar cells (OSCs) on the electrical and the optical properties of amorphous InZnSnO (a-IZTO) electrodes as a difference in film thicknesses are examined. With an increasing of the a-IZTO thickness, the series resistance ( $R_{\text{series}}$ ) of the OSCs is reduced because of the reduction of sheet resistance ( $R_{\text{sheet}}$ ) of a-IZTO electrodes. Additionally, It was found that the photocurrent density ( $J_{\text{sc}}$ ) and the fill factor (FF) in OSCs are mainly affected by the electrical conductivity of the a-IZTO anode films rather than the optical transparency at thinner a-IZTO films. On the other hand, despite the much lower  $R_{\text{series}}$  comes from thicker anode films, the dominant factor affecting the  $J_{\text{sc}}$  became average optical transmittance of a-IZTO electrodes as well as power conversion efficiency (PCE) in same device configuration due to the thick anode films had as sufficiently low  $R_{\text{sheet}}$  to extract the hole carrier from the active material.