Influence of PCBM Layer on Bipolar Conduction in n-type SnO_2 Thin Film Transistors

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Antimony-doped tin-oxide (ATO) is an n-type inorganic semiconductor with bandgap of 3.8 eV and represent a promising and alternative low-cost transparent semiconducting layer for application in transparent and flexible electronics, such as transistors, solar cells and sensors. PCBM (Phenyl-C_{61}-butyric acid methyl ester) is a known n-type organic semiconductor with bandgap of 2.4 eV, used as electron acceptor in organic photovoltaic cells. Current vs. Voltage curves show that typical n-type Thin Film Transistors (TFT) are obtained with Sb:SnO_2 thin films deposited by sol-gel on Si/SiO_2 (100 nm) substrates, where the Si works as back gate and evaporated aluminum as drain and source electrodes [1]. An abnormal bipolar conduction is observed after the deposition of PCBM on the working devices, even though a ratio of electrons/holes higher than 1 is still found after producing the hybrid heterojunction. The decrease (increase) in negative (positive) charge carrier conduction is explained by trapping of electrons from the conduction band of the SnO_2 by the LUMO of the PCBM under positive gate bias, and injection of positive charge carriers from the organic layer under negative gate bias. The ratio of transconductance in accumulation regime over inversion regime, g_{acc}/g_{inv}, decreases from 2.7 to 0,43 after the hybridization, and the threshold voltage for holes conduction, $V_{T(holes)}$, is also decreased from -30V to -25V.

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