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Fabrication and Investigation of P3HT:PCBM Bulk Heterojunction Based Organic Field Effect Transistors Using Dielectric Layers of PMMA:Ta_2O_5 Nanocomposites

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Abstract

In this work, we have fabricated top-gate/bottom-contact type Organic Field Effect Transistors (OFETs). A poly(3-hexylthiophene) (P3HT):[6,6]-phenyl C61-butyric acid methyl ester (PCBM) blend with 1:1 wt/wt ratio was used as the semiconducting layer, and poly(methyl methacrylate)(PMMA):Ta_2O_5 blends with varying concentration of Ta_2O_5 were used as dielectric layers of the devices. Interdigitated type source-drain electrodes on a glass substrate were coated with a semiconducting layer, which was followed by the deposition of dielectric layer and a top aluminum gate contact in sequence. Dielectric layers were prepared as the blends of PMMA:Ta_2O_5 with Ta_2O_5 wt/wt concentrations of 0%, 3%, 7%, 10%, 20% and 50%. Structural and electrical characterization of PMMA:Ta_2O_5 nanocomposite films were carried out using scanning electron microscope (SEM) and dielectric analyzer respectively. Dielectric constant of PMMA:Ta_2O_5 nanocomposites was found to increase with the increasing concentration of Ta_2O_5. Devices that were processed using 0 wt% and 3 wt% concentration of Ta_2O_5 exhibited a typical p-type OFET behavior with hole mobility of 2.68×10^{-3} and 3.42×10^{-3} cm^2/Vs respectively. Whereas, the devices with 7 wt% and higher concentration of Ta_2O_5 showed electron mobility in addition to hole mobility, indicating