Polymer solar cells based on P3HT:PC71 BM doped at different concentrations of isocyanate-treated graphene

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Abstract

In this work, we report the effect of the doping with solution-processable functionalized graphene (SPFGraphene) the active film of polymer solar cells (PSCs) under the bulk heterojunction (BHJ) structure. Cells were based on a poly (3-hexylthiophene) (P3HT) and [6,6]-phenyl C71-butyric acid methyl ester (PC71BM) blend. The SPFGraphene was blended with a P3HT:PC71BM mixture (1:0.8 w/w) at different ratios: 0, 3, 6, 9, 12 and 15 wt.%. Device architecture was ITO/PEDOT:PSS/P3HT:PC71BM:SPFGraphene/PFN/FM, where FM = Field's metal is an eutectic alloy (Bi/In/Sn: 32.5%, 51%, and 16.5%, respectively) with a melting point above 62 °C. FM was used as cathode and deposited by drop-casting in a vacuum-free process. We used the alcohol/water-soluble conjugated polymer, poly [(9,9-bis(3′-(N,N-dimethylamino) propyl)-2,7-fluorene)-alt-2,7-(9,9-dioctylfluorene)] (PFN) as an electron transport layer (ETL). The best results were obtained with 6 wt.% of SPFGraphene: a short-circuit current density (JSC) of 7.20 mA cm−2, an open-circuit voltage (VOC) of 0.560 V, a fill factor (FF) of 0.53, and a power conversion efficiency (PCE) of 2.15% were reached. This means an increase of ∼59% in comparison with the PCE of undoped devices (0 wt.% of SPFGraphene). Our reported PCE is larger than those of previous reports using similar materials and graphene in the active layer. The SPFGraphene can be well dispersed with the P3HT and PC71BM to form a homogeneous solution, which could improve exciton dissociation as well as provides the transport pathway of the electron species. Additionally, a statistical study is also discussed for the photovoltaic (PV) parameters at different SPFGraphene contents.