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The influence of ZnO-PVP nano composites morphology on photovoltaic parameters in polymer/fullerene bulk heterojunction solar cells

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Organic solar cell (OSC) materials have recently gained rich attention due to capable of efficient power conversion, cost-effective, mechanically flexible and light weight solar cells. At the same time further materials developments for high performance will be necessary for commercial production of organic photovoltaics. The increase of efficiency has resulted from the low band gab materials, combination of polymer:fullerene and presence of transport layers. In this regard, the authors have achieved an efficient photovoltaic performance by inserting polyvinylpyrrolidone (PVP) capped zinc oxide (ZnO) nano particles as electron transport layer in Poly[[9-(1-octylnonyl)-9H-carbazole-2,7-diyl]-2,5-thiophenediyl-2,1,3-benzothiadiazole-4,7-diyl-2,5-thiophenediyl] (PCDTBT) and [6,6]-phenyl C71 butyric acid methyl ester (PC71BM) polymer solar cells. ZnO-PVP nano composites were synthesized by sol-gel technique utilizing zinc acetate dihydrate precursor. ZnO-PVP electron transport layers with various thickness and different surface morphology are prepared by adjusting the concentration of the precursor sol. The electron transport layer and photocurrent active layers were fabricated by spin coating technique which enables high uniformity over the surface and low cost solar cells. The ZnO layer without PVP capping also prepared and compared with those of ZnO-PVP layers. Atomic force microscopy analysis reveals the homogeneous and dense surface morphology with increase in zinc content. From the optical spectra, it can be observed that all ZnO and ZnO-PVP layers show good optical transmittance in the entire visible region. In addition we performed UV-Ozone treatment on the ZnO-PVP nano composite films to remove the PVP polymer from the surface to ensure the good contact between the ZnO and PCBM. It is found that the enhanced device performance mainly depends on the dense and homogeneous ZnO-PVP layer which enhance the short-circuit current density and the fill factor due to improvement in the contact between the electron transport layer and the active layer.

Keywords: Polymer solar cells, electron transport layer, PCDTBT:PC71BM, Spin coating.

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