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OPTIMIZING THE PERFORMANCE OF CADMIUM SULFIDECOATED NANOPOROUS TITANIUM DIOXIDE / POLY (3-HEXYLTHIOPHENE) SOLAR CELLS

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ABSTRACT

This work reports a study of the effects of Cadmium Sulfide (CdS) interlayer on the performance of the Nanoporous Titanium dioxide (TiO_2)/Poly (3-hexylthiophene)(P3HT) solar cells. CdSnano layers with different thicknesses were successfully grown on TiO_2 nanoparticles by chemical bath deposition (CBD) technique with different deposition times. UV– Vis–NIR spectroscopic and Atomic Force Microscopic measurements were taken for studying optical and structural properties of Titanium dioxide (TiO_2)/Poly (3-hexylthiophene)(P3HT) nanocomposite film with varying CdS interlayer thicknesses while current-voltage (I–V) and external quantum efficiency (EQE) measurements were done for evaluating the corresponding devices. Overall efficiency is optimized when the CdS deposition time is 12 minutes which is consistent with AFM images as the images confirm the uniform distribution of chemical bath deposited CdS layer on porous TiO_2 until deposition time is 12 minutes. Roughness of CdS film decreased when the deposition time of CdS is increased further. The short-circuit current density (J_{SC}) and hence overall efficiency is declined when the CdS deposition time is more than 12 minutes. The increment of CdS deposition time showed a gradual decrement in the EQE spectra at 520 nm due to the lower polymer intake due to the CdS filled pores in TiO_2 electrode as confirmed by the AFM images.The reduction in the J_{SC} may also be attributed to lowering interfacial area. On the other hand, a steady and continuous increment in the open circuit voltage (V_{OC}) were also observed with increased CdS deposition time and increased up to 0.81 V when the CdS layer deposition time was 24 minutes. This may attribute to the isolation of P3HT and TiO_2 interfaces and the higher built-in voltage at CdS – P3HT interface when to compare with TiO_2 – P3HT interface. An optimized CdS coated porous TiO_2/P3HT solar cell shows the overall efficiency of over 2.4 % under the illumination of 70 mW/cm^2 at A.M 1.5 conditions.

Keywords: hybrid solar cell, Titanium dioxide, P3HT, Cadmium Sulfide, chemical bath deposition