Abstract

Solar energy, amongst all other non-conventional energy resources is a promising and freely available source of enormous energy. Third generation photovoltaic devices like organic and hybrid photovoltaic devices hold the key for cost-effective and efficient harvesting of solar energy. This dissertation is based on the investigations on efficiency enhancement in zinc oxide (ZnO) based hybrid and organic bulk heterojunction solar cells using various routes.

Nanostructured ZnO based hybrid solar cells were fabricated using MDMO-PPV (Poly[2-methoxy-5-(3′,7′-dimethyloctyloxy)-1,4-phenylenevinylene]) polymer. N, N`-Dioctyl- 3, 4, 9, 10- Perylenedicarboximide (PTCDI-C_8) nanoribbons have been investigated for enhancing the photovoltaic performance of these devices. A donor-acceptor (D/A) PCDTBT (Poly[N-9′-heptadecanyl-2,7-carbazole-alt-5,5-(4′,7′-di-2-thienyl-2′,1′,3′-benzothiadiazole)]) co-polymer system having enhanced absorption in the visible region has been studied for photovoltaic application along with ZnO nanorods. The variation of charge transport property, optical absorbance, morphology and chemical compositional behavior of the PCDTBT co-polymer system upon changing the polymer processing condition have been investigated and correlated with the change in the photovoltaic parameters.

Bulk heterojunction devices using PCDTBT and $PC_{71}BM$ (Phenyl-C71-Butyric-Acid-Methyl Ester) polymers have been studied using solution processed ZnO electron transporting layer. The efficacy of charge collection at the ZnO cathode has been discussed by introducing a vacuum deposited fullerene (C_{70}) interlayer between photoactive polymer blend and the ZnO electron transporting layer. The improvement of solar cell efficiency has been investigated in context with the change in surface homogeneity and XPS studies. Furthermore, an exhaustive comparative study on two different n-type organic small molecules with different molecular origin has been made for altering the ZnO/active polymer interface in P3HT: PCBM based bulk heterojunction devices. The role of various facets of these organic interfacial modifiers such as the ability to passivate surface traps, improving the compatibility with the active polymer blend, electron mobility, and the efficacy of charge transfer at the organic-inorganic interfaces have been studied for determining an efficient organic modified ZnO cathode interlayer.

An organo-metal halide perovskite $MAPbI_3$ (Methylammonium lead iodide) material having absorbance in the whole visible region of the solar spectrum has been studied for photovoltaic application in conjunction with ZnO nanorod array. Accelerated degradation of $MAPbI_3$ perovskite on ZnO nanorods under thermal ageing has been investigated and the ageing time has been optimized to yield decent device efficiencies.

Keywords: Inverted solar cell, ZnO, hybrid, bulk heterojunction, interface modifier, $MAPbI_3$.