Efficient hybrid polymer/TiO_2 solar cells using a multilayer structure

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Abstract

This study focuses on systems consisting of high hole-mobility MEHPPV based polymers or a fluorene-bithiophene co-polymer in contact with different nanocrystalline TiO_2 films. We use photoluminescence quenching, time of flight mobility measurements and optical spectroscopy to characterize the exciton transport, charge transport and light harvesting properties, respectively, of the polymers, and correlate these material properties with photovoltaic device performance. We find that the polymer properties with greatest influence on device efficiency are the polymer exciton diffusion length and absorption range, followed by the hole mobility. We have also studied the photovoltaic performance of these TiO_2/polymer devices as a function of active layer thickness. Device performances are significantly improved by introducing a PEDOT layer between the polymer and the top Au electrode and by reducing the thickness of the active layers. The optimized devices have peak external quantum efficiencies ≈ 40 % at the polymer's maximum absorption wavelength and yield short circuit current densities ≥ 2 mA cm^{-2} for air mass (AM) 1.5 conditions (100 mW cm^{-2}, 1 sun). The AM 1.5 open circuit voltage reaches 0.64 V and the fill factor 0.43, resulting in an overall power conversion efficiency of 0.58 %.

Author keywords

Exciton diffusion length; Hole mobility; Nanocrystalline TiO_2; PEDOT; Polymer; Solar cells

Indexed keywords

Engineering controlled terms: Charge transfer; Excitons; Hole mobility; Multilayers; Nanostructured materials; Polymers; Titanium dioxide

Engineering uncontrolled terms: Exciton diffusion length; Optical depth; PEDOT; Sensitization

Engineering main heading: Solar cells