Solid state solar cell made from nanocrystalline TiO_2 with a fluorene-thiophene copolymer as a hole-conductor

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Abstract

We study the charge recombination kinetics and photovoltaic performance of composites of poly (9,9-dioctylfluorene-co-bithiophene) polymer with nanocrystalline TiO_2. Transient optical spectroscopy confirms that photoexciation of the polymer leads to electron transfer to the TiO_2 and indicates that charge recombination is slow with a half-life of 100µs to 10ms. Polymer penetration into thick porous TiO_2 layers is improved by melt-processing and treatment of the TiO_2 surface. We study the photovoltaic characteristics of devices with different layer thickness and interface morphology. Quantum efficiency (QE) of all devices is increased by reducing the TiO_2 and polymer layer thickness. Inserting a thin porous TiO_2 layer in to a thin bi-layer device increases the QE by a factor of five. The improved device shows peak QE and monochromatic power conversion efficiencies of over 11% and 1% at 440nm respectively. The device produced a short-circuit current density of 300µAcm^{-2}, a fill factor of 0.24 and an open-circuit voltage of 0.8V under AM1.5 illumination. The fill factor is increased from 0.24 to 0.40 by introducing an additional dip-coating layer and overall power conversion efficiency is increased by 50%. However, the device produced degraded current-voltage characteristics. We investigate this using an alternative polymers and different top contact metals.

Author keywords

Nanocrystalline TiO_2; Polymer; Solar cells

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