Nanoporous TiO_2 solar cells sensitised with a fluorene-thiophene copolymer

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Abstract

Composites of nanostructured metal oxides with conjugated polymers are promising material combinations for efficient solar energy conversion. However, performance of such combinations is normally limited by the low interfacial area of planar structures and poor charge carrier mobility of the polymer. In this study, we focus on TiO_2 with a high hole-mobility polymer, poly (9,9'-dioctylfluorene-co-bithiophene) (F8T2). Transient optical spectroscopy confirms that efficient photo-induced electron transfer occurs from F8T2 to TiO_2 in both planar TiO_2/F8T2 structures and in high surface area, porous TiO_2/F8T2 structures. Recombination between the positive polaron in the polymer and electron in the TiO_2 is remarkably slow (~ms) in both cases. The influence of layer thickness and surface morphology on cell performance was examined. The best cell was made with reduced layer thickness and increased surface morphology and offered an external quantum efficiency of 11.5% and monochromatic power efficiency of 1 at.% 440 nm. This cell produced an open circuit voltage V_{oc} of 0.80 V and a short circuit current density of approximately 300 μA/cm^2 under simulated air mass (AM) 1.5 illumination. However, the power conversion efficiency is limited by a poor fill factor, which is attributed to an energy barrier at the polymer/metal interface. We investigate this problem using alternative polymer and top contact metals.

Author keywords

Electrodes; Nanostructure; Polymer; Solar cells; Thiophene; Titanium dioxide

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