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Photoelectrochemical Solar Cells Based on Conjugated Polymers on Dye-Sensitized TiO₂ Electrodes

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Dye-sensitized semiconductor nanocrystalline solar cells are promising as an inexpensive, renewable energy sources [1,2]. Briefly, these cells consist of a nanoporous working electrode of titanium dioxide (nc-TiO₂) semiconductor nanoparticles (ca. 10-25 nm in diameter) coated with a monolayer of a charge-transfer dye on a conducting glass substrate; a liquid electrolyte of acetonitrile or a mixture of ethylene/propylene carbonate with the redox couple I₂/KI or iodide/triiodide, and a platinized counter-electrode of conducting glass. Recent efforts in a dye-sensitized TiO₂ nanocrystalline solar cell research are focused on replacing the liquid electrolyte with a solid-state analogy (by using a hole conducting material) to eliminate practical problems with sealing and degradation.

Polymer materials which behave as a hole-conductors are of practical interest as replacements for the liquid electrolyte since they are inexpensive and can be tailored chemically to fit a wide range of purposes. For nanoporous electrode, the solid material must penetrate into the pores between the nanoparticles, making contact with the adsorbed dye, and so the average molecular weight (and size) of the material is a consideration. In principle, the dye/electrolyte or dye/hole transporting material combination of the Grätzel cell can be replaced by a single conjugated polymer layer, bringing together the function of light absorption and charge (hole) transport in a single material. In this work, we present the photovoltaic properties of P3OT/dye coated porous nanocrystalline or compact TiO₂ and P3OT/porous nanocrystalline or flat TiO₂ devices deposited on the SnO₂:F or ITO conducting glasses. In the present study we show also comparative results of I-V characteristics as well as incident photon to current conversion efficiencies under different conditions.

O' Regan, B. And Grätzel, M., Nature 1991, 353, 757.

[2]Nazeeruddin, M. K.; Kay, A.; Rodicio, I.; Humphry-Baker, R.; Müller E.; Liska, P.; Vlachopoulos, N.; Grätzel, M. J. Am. Chem. Soc. 1993, 115, 6382.