A Phosphonic Acid Anchoring Analogue of the Sensitizer P1 for p-Type Dye-Sensitized Solar Cells

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We report the synthesis and characterization of the first example of an organic dye, PP1, for p-type dye-sensitized solar cells (DSCs) bearing a phosphonic acid anchoring group. PP1 is structurally related to the benchmarking dye, P1, which possesses a carboxylic acid anchor. The solution absorption spectra of PP1 and P1 are similar (PP1 has λmax = 478 nm and εmax = 62,800 dm3 mol$-$1 cm$-$1), as are the solid-state absorption spectra of the dyes adsorbed on FTO/NiO electrodes. p-Type DSCs with NiO as semiconductor and sensitized with P1 or PP1 perform comparably. For PP1, short-circuit current densities (JSC) and open-circuit voltages (VOC) for five DSCs lie between 1.11 and 1.45 mA cm$-$2, and 119 and 143 mV, respectively, compared to ranges of 1.55–1.80 mA cm$-$2 and 117–130 mV for P1. Photoconversion efficiencies with PP1 are in the range 0.054–0.069%, compared to 0.065–0.079% for P1. Electrochemical impedance spectroscopy, open-circuit photovoltage decay and intensity-modulated photocurrent spectroscopy have been used to compare DSCs with P1 and PP1 in detail.
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