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The Role of n-p Junction electrodes in minimizing charge recombinations in dye-sensitized solar cells

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The composite electrodes comprising of n-type TiO_2 and p-type NiO oxides when sensitized with Ru-dye showed short-circuit photocurrent (Isc) of 17 mA and open-circuit photovoltage (Voc) of 750 mV compared to Isc of 12 mA and 700 mV for TiO_2 electrode. The efficiency of the NiO coated solar cell is 30% higher than that of bare TiO_2. Formation of a n-p junction between TiO_2 and NiO contributes to enhanced efficiency. In addition, NiO acts as a barrier for charge recombination leading to higher solar cell performance. The highest cell efficiency was obtained immersing TiO2 thin films in Ni^{2+} solution and converting them to NiO by firing and the optimum NiO coating thickness was found to be only a few angstroms. The energy levels of the excited dye and the band positions of TiO_2 and NiO suggest that the electron transfer from the excited dye to the underlying n-type oxide layer occurs by tunneling through the p-type NiO layer. The negative shift of the flat-band potential of the NiO coated TiO_2 electrode compared to TiO_2 also could be one of the reasons for higher photovoltage observed for TiO_2/NiO electrode. The highest cell efficiencies were obtained immersing TiO_2 thin films in Ni^{2+} solution and converting them to NiO by firing and the optimum NiO coating thickness was found to be only a few angstroms. The energy levels of the excited dye and the band positions of TiO_2 and NiO suggest that the electron transfer from the excited dye to the underlying n-type oxide layer occurs by tunneling through the p-type NiO layer.

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