Dalton Transactions

RSC Publishing

PAPER

Random nanowires of nickel doped TiO_2 with high surface area and electron mobility for high efficiency dye-sensitized solar cells

Cite this: *Dalton Trans.*, 2013, **42**, 1024

P. S. Archana,[a] E. Naveen Kumar,[a] C. Vijila,[b] S. Ramakrishna,[a,b] M. M. Yusoff[c] and R. Jose*[c]

Mesoporous TiO_2 with a large specific surface area (~150 m^2 g^{-1}) is the most successful material in dye-sensitized solar cells so far; however, its inferior charge mobility is a major efficiency limiter. This paper demonstrates that random nanowires of Ni-doped TiO_2 (Ni:TiO_2) have a dramatic influence on the particulate and charge transport properties. Nanowires (dia ~60 nm) of Ni:TiO_2 with a specific surface area of ~80 m^2 g^{-1} were developed by an electrospinning technique. The band gap of the Ni:TiO_2 shifted to the visible region upon doping of 5 at% Ni atoms. The Mott–Schottky analysis shows that the flat band potential of Ni:TiO_2 shifts to a more negative value than the undoped samples. The electrochemical impedance spectroscopic measurements showed that the Ni:TiO_2 offer lower charge transport resistance, higher charge recombination resistance, and enhanced electron lifetime compared to the undoped samples. The dye-sensitized solar cells fabricated using the Ni:TiO_2 nanowires showed an enhanced photoconversion efficiency and short-circuit current density compared to the undoped analogue. The transient photocurrent measurements showed that the Ni:TiO_2 has improved charge mobility compared with TiO_2 and is several orders of magnitude higher compared to the P25 particles.

Received 25th May 2012,
Accepted 2nd October 2012

DOI: 10.1039/c2dt31775c

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