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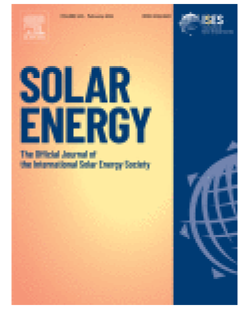

Plasmonic gold nanoparticle incorporated MgO-coated SnO_2 photoanode for efficiency enhancement in dye-sensitized solar cells

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Abstract

SnO_2 is an attractive semiconducting material suitable for application as the photoanode in dye sensitized solar cells (DSSCs) due to its wide energy band gap and notable photo stability. However, improved solar cell performance can be achieved only by using composites of SnO_2 with other materials like MgO, ZnO, Al_2O_3 and $CaCO_3$. In this study, plasmonic DSSCs were fabricated using MgO coated SnO_2 (SnO_2:MgO) based photoanodes incorporating gold nanoparticles (Au NP) having the size in the 30 – 35 nm range and sensitized with ruthernium N719 dye. Photoanodes were characterized by UV–VIS spectroscopy and the DSSCs were characterized by current–voltage (*J–V)* measurements, incident photon-to-electron conversion efficiency (IPCE) measurements and electrochemical impedance spectroscopy (EIS). Under the illumination of 100 mW cm^{-2} (AM 1.5), the efficiency (η) of the reference DSSC with

pristine SnO_2 photoanode was 1.52%, where as the efficiency of the optimized plasmonic DSSC with Au NP incorporated SnO_2:MgO photoanode (Au: SnO_2:MgO) was an impressive 4.69%. This efficiency enhancement of about 208% compared to the reference DSSC appears to be due to the increased open-circuit voltage (V_{OC}) of 725.6 and increased short-circuit photocurrent density (J_{SC}) of 9.06 mA cm^{-2} respectively evidently caused by the reduced electron recombination by ultra-thin MgO barrier layer and the enhanced light harvesting caused by the local surface plasmon resonance (LSPR) effect due to Au nanopraticles. EIS analysis showed that the incorporation of plasmonic Au metal nanoparticles leads to a decrease in the series resistance (R_S) and the interfacial charge-transfer resistance (R_{CT}) at the SnO_2/electrolyte interface.