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EFFICIENCY ENHANCEMENT IN SnO_2 BASED DYE-SENSITIZED SOLAR CELLS BY INCORPORATING PLASMONIC GOLD NANOPARTICLES

K. Umair[1,2*], M.A.K.L. Dissanayake[1,2] and G.K.R. Senadeera[1,3]

[1]National Institute of Fundamental Studies, Kandy, Sri Lanka
[2]Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka
[3]Department of Physics, The Open University of Sri Lanka, Nugegoda, Sri Lanka
[*]umair.ka@nifs.ac.lk

Dye-sensitized solar cells (DSSCs) are photoelectrochemical cells and promising candidates to replace expensive silicon solar cells because of reasonably high efficiency and lower production cost. Due to the wider band gap, notable photostability and high charge mobility, SnO_2 is an attractive semiconductor material for DSSCs. Series of DSSCs were fabricated using SnO_2 photoanodes sensitized with Indoline D149 and incorporating different amounts (1 – 4 μL) of gold nanoparticle solution (AuNPs) containing 70 - 80 nm sized particles by the drop casting method. These were characterized by photocurrent density-voltage (*J – V)* and open circuit voltage decay measurements, incident photon-to-electron conversion efficiency (IPCE) spectroscopy, and electron impedance spectroscopy (EIS). Under the illumination of 100 mW cm^{-2} (AM 1.5), the efficiency of the DSSC with SnO_2 photoanode without AuNP was 2.28%, while the optimized efficiency of the DSSC with AuNP incorporated plasmonic SnO_2 (Au@SnO_2) was 2.89%. The efficiency increase (~ 26.7%) of the plasmonic DSSCs appears to be due to the increased short-circuit photocurrent density from 6.48 mA cm^{-2} to 9.19 mA cm^{-2} (~ 41.8%) by enhanced light harvesting caused by the surface plasmon resonance effect. Significant enhancement in IPCE was observed upon the use of Au@SnO_2 in DSSCs. Further, EIS analysis showed that the incorporation of plasmonic Au metal nanoparticles leads to about 35% lower interfacial charge transfer resistance at the SnO_2/electrolyte interface which essentially increases the rate of charge transfer at this interface and increase the power conversation efficiency of the solar cells.

Keywords: Au nanoparticles, Indoline D149, Plasmonic, Power conversion efficiency, SnO_2