Electrochemical impedance and X-ray photoelectron spectroscopic analysis of dye-sensitized liquid electrolyte based SnO2/ZnO solar cell

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Abstract

A dye-sensitized solar cell based on interconnected SnO2 nanoparticle matrix covered with a thin outer shell of ZnO, N719 dye, I−/I3− in acetonitrile liquid electrolyte system and lightly platinized FTO counter electrode shows significantly enhanced performance when compared to similar cells made with either pristine SnO2 or pristine ZnO interconnected nanoparticles. Attempts have been made to investigate the reasons for such an improvement using the information obtained from X-ray photoelectron spectroscopy (XPS) and the electrochemical impedance spectroscopy (EIS). The XPS results reveal that the interconnected nanoparticluar SnO2 matrix surfaces are fully covered by a ∼1 nm thick outer shell of a ZnO layer. EIS results disfavour the idea of direct injection of electrons from the excited dye molecules across the thin outer shell of ZnO into the conduction band of SnO2 but supports the fact that electrons are first injected to the CB of ZnO and subsequently to the CB of SnO2 particles both involving trapping and detrapping at each stage. The electron transport along the interconnected SnO2 nanoparticles also involves anomalous diffusion characterized by a straight line of inclination greater than 45° in the complex impedance plot. This anomalous diffusion is attributed to the trap mediated electron transport.