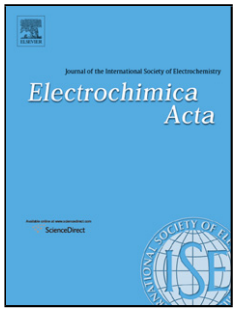

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A Study of the Efficiency Enhancement of the Gel Electrolyte-based SnO_2 Dye-sensitized Solar Cells Through the Use of Thin Insulating Layers

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Abstract

Even though SnO_2 has promising electronic properties such as higher election mobility among the high band gap semiconductor nanoparticles that are commonly used in Dye-sensitized Solar Cells (DSCs), the cell efficiency of SnO_2-based DSCs is considerably low due to high electron recombination; especially through the nanoparticle surface. There have been a few successful attempts in reducing this recombination through the use of very thin insulating layers to cover the surfaces of the nanoparticles in liquid electrolyte-based DSCs. There is enough evidence that this process enhances the efficiency of SnO_2-based DSCs. Some of the practical limitations associated with the liquid electrolyte-based DSCs' such as electrolyte leakage, solvent evaporation and sealing imperfections can be suppressed through the use of gel polymer electrolytes. In this study, we have investigated the effect of different coating materials: $CaCO_3$, MgO and Al_2O_3 on the cell performance of DSCs based on gel electrolytes. In all cases, there was a considerable increase in Open Circuit Voltage (V_{OC}) and Short-Circuit Current Density (J_{SC}). The enhancement was found to depend on the insulator/SnO_2 molar ratio in all cases. $CaCO_3$-coated DSCs gave the best enhancement compared to other systems. The composite system having a molar ratio of 0.12:1 of $CaCO_3$ to SnO_2 showed 46% increase of V_{OC}, 50% increase of J_{SC} and 233% increase of efficiency compared to the pure SnO_2-based devices. We have employed several experimental techniques and theories to explain the observed performance of the DSC devices fabricated with the above insulating layers and two different gel electrolytes based on $Pr_4N^+I^-$ and LiI salts.

Keywords: Gel electrolyte; dye-sensitized solar cells; electron lifetime; recombination resistance; insulating coating layer;