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TIN AND ZINC OXIDE COMPOSITE DYE-SENSITIZED SOLAR CELLS WITH AN EXTREMELY THIN LIQUID FILM AS THE REDOX ELECTRON MEDIATOR

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Some major issues that hamper the stability of dye-sensitized solar cells (DSCs) are dye degradation, liquid electrolyte leakage, and evaporation. This can occur because of sealing imperfections and photocatalytic reactions that transpire at the TiO_2 surface triggered by the ultraviolet component of solar radiation in the presence of water. To overcome imperfections in sealing, solid-state DSCs can be developed. In these cells, the liquid redox mediator is replaced by a p-type hole conducting material. Compared to their liquid equivalents, solid hole conductors typically have lower electron mobility. Hence, recombination reactions predominate in solid-state DSCs, and the cells exhibit poorer power conversion efficiencies. The photo-degradation of both dye and the electrolyte can be eliminated by adopting less photocatalytically active larger band-gap n-type oxide semiconductors with the conduction band edge positioned competently. SnO_2 (band gap 3.8 eV) fulfils this condition, but DSCs based on SnO_2 working electrodes are inefficient due to the rapid recombination reactions. This can be overcome by applying an ultra-thin layer of higher band gap oxide to cover the crystallite surface of SnO_2. In this work, the usual liquid electrolyte (I^-/I_3^-) was used to fill the pores of the SnO_2/ZnO composite working electrode, sensitized with the N719 dye. Then, the excess electrolyte was wiped off. Finally, these pores were sealed using graphite powder. This treatment annihilates losses due to evaporation and leakage while sustaining high electron mobilities. An optimum energy conversion efficiency of 3.06% was obtained for this DSC with the corresponding cell parameters of open circuit voltage 0.57 V, short circuit current density 8.19 mA cm^{-2}, and fill factor 0.66 under 1.5 AM illumination. A maximum incident photon to the current conversion efficiency of 39% was attained in the wavelength range from 510 nm to 535 nm.

Keywords: Dye-sensitized solar cell, Graphite, Tin oxide, Zinc oxide