Abstract No: 117 ***Physical Sciences***

PARTICLE SIZE OF ALUMINIUM OXIDE NANO-FILLER ON THE PERFORMANCE OF DYE-SENSITIZED SOLAR CELLS AND PROPERTIES OF GEL-POLYMER ELECTROLYTES

R.P. Chandrika[1*], K.G.D.T.B. Kahawaththa[1], L.K. Narangammana[1,2], J.P. Liyanage[1,2], W.M.K.B.N. Wijayaratne[1,2] and T.M.W.J. Bandara[1,2]

[1]Postgraduate Institute of Science, University of Peradeniya, Sri Lanka
[2]Department of Physics, Faculty of Science, University of Peradeniya, Sri Lanka
[*]pathma.chandrika@gmail.com

In recent years, research on the influence of nano-composite gel polymer electrolytes on the performance of Dye-Sensitized Solar Cells (DSSCs) has obtained great attention. In this study, Aluminium Oxide (Al_2O_3) nanoparticles of different sizes were integrated into the poly-iodide-based gel-polymer electrolyte to investigate the filler size dependence on the conductivity of the electrolyte. The performance of DSSCs, offering a novel approach to improve the properties of the poly-iodide-based electrolyte for better efficiency, was also investigated. Al_2O_3 nanoparticles (Sigma-Aldrich) with average particle sizes of 15 nm, 75 nm and 300 nm were added to the gel-polymer electrolyte and stirred for 15 min at 100 ℃. The Al_2O_3 filler content was kept fixed at 15 wt% relative to the polymer (polyethylene oxide) weight. The nanocomposite gel-polymer electrolytes were sandwiched between the photo-sensitized multi-layer (6-layer) Titanium Dioxide anodes with the dye N719 and the Platinum counter-electrodes to assemble DSSCs. The ionic conductivities of electrolytes calculated using complex impedance analysis at 30 ℃ are 10.79, 6.44, and 5.40 mS/cm for 15, 75, and 300 nm filler sizes, respectively. The conductivity enhancement with added Al_2O_3 can be attributed to Lewis acid-base type interactions between the ionic species in the electrolyte and the filler. This creates free spaces in the polymer matrix that facilitate easier ion transfer. Increasing conductivity with decreasing particle size can be attributed to the increase of the effective surface area of fillers, which provides more active sites for interactions. The temperature dependence of conductivities exhibited Vogel Tamman-Fulcher behaviour. The efficiency of DSSCs containing nano-composite electrolytes increases with a decrease in the particle size of the nanofiller. Power conversion enhancement of the DSSCs could be due to the improvement of conductivity in the electrolyte. DSSC assembled with the polymer electrolyte containing Al_2O_3 with particle size 15 nm showed the best performance with the largest photoelectric conversion efficiency of 5.98%, resulting in 19.4% enhancement compared to the efficiency of the reference DSSC assembled with filler-free gel-polymer electrolyte (5.01%).

Financial assistance from the PGIS, University of Peradeniya (Grant No. PGIS/2022/12, PGIS/2022/04) is acknowledged

Keywords: Aluminium oxide, Dye-sensitized solar cells, Ionic conductivity, Nano-composite electrolyte, Power conversion efficiency