Poly(Methyl Methacrylate) (PMMA) Based Gel Polymer Electrolytes for Possible Application in Dye Sensitized Solar Cells

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Abstract

Solar cells are considered as an economical and environmental friendly solution for the global energy demand. Dye-sensitized solar cells (DSCs) offer low production cost and many possibilities for further development. In general, a DSC composed of a dye-sensitized photo-electrode, a counter electrode and an electrolyte. The intention of this work is to prepare new gel polymer electrolyte (GPE) in order to address the issues of poor chemical and physical stability in DSCs. The efficiency drop originates from the lower ionic conductivity in GPEs is attempted to solve using mixed salts and performance enhancers. Under this study, Poly(methyl methacrylate), PMMA, based series of GPEs with a mixture of two salts, LiI and Pr_4NI (Tetrapropylammonium Iodide), were prepared by changing the salt mass fractions. Ethylene carbonate and propylene carbonate were incorporated to the electrolyte to enhance the ionic conductivity and 4-tert-butylpyridine and 1-butyl-3-methyl imidazolium iodide were added to enhance DSC performance. In addition to the characterization of electrolytes, a set of DSCs were assembled by employing the series of electrolytes investigated. The temperature dependence of conductivity in the electrolytes showed Vogel–Tammann–Fulcher (VTF) behaviour with the activation energy in the range of 0.07-0.09 eV. The highest conductivity in the temperature range from 30 °C to 75 °C was given by the electrolyte containing 60% of LiI and 40% of Pr_4NI with respect to the total salt weight and the ionic conductivity of the electrolyte at 30 °C was 3.20×10^{-3} Scm^{-1}. The frequency dependence of the real and imaginary parts of the dielectric constant at different temperatures were investigated to understand the electrical properties of the GPEs. Highlighting the positive effects of using PMMA based GPEs, the investigated DSCs showed very good short-term stability. Highest efficient cells showed energy conversion efficiencies above 5%.

Keywords: Dye-sensitized solar cells, gel polymer electrolytes, Poly(methyl methacrylate), binary salts