Effect of Counter Ion in an Iodide Ion Conducting Gel-Polymer Electrolyte Intended for Dye Sensitized Solar Cells - A Comparative Study between Potassium Iodide and Tetrahexylammonium Iodide

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Abstract

Quasi-solid-state dye-sensitized solar cells (DSSCs) give higher stability and reasonably good efficiency compared to those of liquid electrolytes based solar cells. It was recently revealed that counter ions in electrolytes intended for DSSCs have an influence on solar cell performance. In this work, the effect of the counter ion is studied using an iodide ion conducting gel-polymer electrolyte based on host polymer, polyacrylonitrile (PAN) and plasticizers, ethylene carbonate (EC) and propylene carbonate (PC). Two electrolytes, one using potassium iodide (KI) and the other using tetrahexylammonium iodide (Hex_4NI), were prepared by hot press method. The electrolyte containing KI shows significantly higher conductivity compared to that of the tetrahexylammonium iodide. The room temperature conductivity of KI based electrolyte was found to be 3.74 $mScm^{-1}$. The temperature dependence of electrolytes shows VTF behaviour and data fitting revealed that the pre-exponential factor and activation energy of KI based electrolyte is higher and has values of 130.96 Sm^{-1} K1/2 and 0.032 eV respectively. In-depth analysis of the dielectric properties of the electrolytes was conducted to understand the charge transport behaviour. The energy conversion efficiencies of DSSCs containing Hex_4NI and KI are 5.06 and 6.05 %, respectively under the illumination of 1000 Wm^{-2} irradiation (1.5 AM). The Electrolytes and solar cells were characterized further by using electrochemical impedance analysis. The real and imaginary parts of the dielectric constant of the electrolyte samples were calculated at different temperatures. The frequency dependence of the dielectric function is analysed to understand the polarization behaviour of the species in the electrolyte.