Polyacrylonitrile Based Gel Polymer Electrolyte for Rechargeable Magnesium Ion Batteries

N.A.T.H. Dias[1], H.M.J.C. Pitawala[1*], J.L. Ratnasekera[2], T.M.W.J. Bandara[3] and M.D.M. Nayanakanthi[1]

[1] *Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2] *Department of Physical Sciences, Rajarata University of Sri Lanka, Mihinthale, Sri Lanka*
[3] *Department of Physics and Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka*

The demand for energy storage devices has highly increased with the increment of the demand for electronic portable devices and electric vehicles. Therefore, developing rechargeable batteries has received the most attention. Among the components of a rechargeable battery, electrolyte is highly concerned as it is the medium for the transfer of charges between the pair of electrodes. Developing gel polymer electrolytes is mostly explored due to its favourable performances and minimum drawbacks compared to liquid electrolytes and solid electrolytes. In this research polyacrylonitrile based gel polymer electrolyte for magnesium ion batteries was prepared and characterized to investigate its physicochemical properties. Preparation of gel polymer electrolytes was carried out by a common solution casting technique using dimethyl sulfoxide as the solvent, magnesium trifluoromethanesulphonate as the salt and 1-butyl-1-methylpyrrolidinium bis(trifluoromethylsulfonyl)imide as the ionic liquid. Impedance spectroscopy, Fourier transform infrared spectroscopy, X-ray diffraction, and Differential scanning calorimetry was performed to analyse the prepared electrolyte samples. The maximum room temperature ionic conductivity of 2.33×10^{-3} S cm^{-1} and 3.33×10^{-3} S cm^{-1} were obtained for the sample before and after the addition of ionic liquid respectively. Considerable indications for the polymer-solvent, polymer-salt, and polymer-salt-ionic liquid interactions were investigated by analysing Fourier transform infrared spectroscopy. Although the crystallinity has increased with the addition of salt due to the formation of ion pairs and aggregates, the effect has been preserved with the addition of ionic liquid. The glass transition temperature has also increased from 80 ^{0}C to 104 ^{0}C after the coordination of polyacrylonitrile with magnesium trifluoromethanesulphonate, however, it is reduced to 102 ^{0}C after the addition of ionic liquid.

Keywords: Gel polymer electrolyte, Polyacrylonitrile, Magnesium trifluoromethanesulphonate, Ionic liquid, Ionic conductivity