Ionic Liquid Treated Non-Polymer Gel Electrolyte for Magnesium-ion Battery Application

N.P.L.P. Dharmarathna[1*], H.N.M. Sarangika[1], V.P.S. Perera[2], H.M.B.I. Gunathilaka[3] and E.G.O.D. Egodawaththa[1]

[1]*Sabaragamuwa University of Sri Lanka, Belihuloya, 70140, Sri Lanka*
[2]*Open University of Sri Lanka, Nawala, 10250, Sri Lanka*
[3]*Industrial Technology Institute, Colombo 7, 00700, Sri Lanka*
[*]*lahiruprabath320@gmail.com*

This study focuses on the design and synthesis of a novel, cost-effective non-polymer gel electrolyte incorporating magnesium borohydride ($Mg(BH_4)_2$), ionic liquid (IL) (1-butyl-1-methylpyrrolidinium bis (trifluoromethanesulfonyl) imide ($PYR_{14}TFSI$)), ethylene glycol (EG), and fumed silica (SiO_2) to address the problem of low ionic conductivity in electrolytes for rechargeable magnesium batteries. Under this project, a liquid electrolyte sample series was prepared by varying the molar ratio of EG to $Mg(BH_4)_2$ ([200:1], 200:2], [200:2.5], [200:3], and [200:4]) at room temperature (27 ^oC). Their conductivity measurements were taken for the sample series at room temperature. The highest conductivity achieved was 4.628×10^{-4} S/cm, and the molar ratio of EG to $Mg(BH_4)_2$ for the corresponding sample was (200:2.5). Ionic liquid was added to the best conducting sample ($Mg(BH_4)_2$ / EG) by varying the volume of the ionic liquid (30.0, 50.0, 70.0, 80.0, and 100.0 µl), and another liquid electrolyte sample series was prepared. Their conductivity measurements were taken for the sample series at room temperature. The highest conductivity achieved was 1.0728×10^{-3} S/cm, and the corresponding sample consisted of a volume of ionic liquid of 70.0 µl. Finally, fumed silica (SiO_2) was added to the best conducting sample ($Mg(BH_4)_2$ / EG / ionic liquid) by varying the weight of fumed silica (20.0, 40.0, 60.0, and 80.0 mg) and the final gel electrolyte sample was prepared at room temperature. The gel electrolyte sample was optimized ($Mg(BH_4)_2$ / EG / ionic liquid / SiO_2), and the corresponding sample consisted of the mass of fumed silica (80.0 mg). Their conductivity measurement was taken for the gel electrolyte sample at room temperature. The conductivity of the gel-electrolyte was 5.5701×10^{-3} S/cm. The ionic conductivity of this gel electrolyte can be improved further, and it can be used to check performance with magnesium-ion batteries.

Keywords: Ionic Liquid, Fumed Silica, Magnesium Borohydride, Ethylene Glycol, Gel-Electrolyte