



RISTCON 2020

"Sustainability through advancement in science and technology"

Proceedings
of
7th Ruhuna International
Science and Technology Conference
January 22nd, 2020

Abstracts and Plenary Lectures



Faculty of Science
University of Ruhuna
Matara, Sri Lanka

Poly (methyl methacrylate) based gel-polymer electrolytes for sodium-ion secondary batteries - A comparative study with different ionic salts

Jayamaha J.H.T.B.¹, Menisha G.^{1,2}, Keppetiyawa K.G.H.S.¹, Senavirathna S.L.N.¹, Vignarooban K.^{1*}, Sashikesh G.³, Veluathamurthy K.³, Wijayasinghe H.W.M.A.C.⁴ and Dissanayake M.A.K.L.⁴

¹*Department of Physics, Faculty of Science, University of Jaffna, Jaffna, Sri Lanka*

²*University College of Jaffna, 29 Brown Road, Jaffna, Sri Lanka*

³*Department of Chemistry, Faculty of Science, University of Jaffna, Jaffna, Sri Lanka*

⁴*National Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka*

Natural abundance of sodium in the Earth's crust and also in the oceans has popularized sodium-ion batteries (SIBs) as a low-cost alternative to expensive lithium-ion batteries. A few types of SIBs are already in the commercial markets for stationary energy storage applications, but they employ liquid electrolytes. Due to the larger size of Na⁺ ions compared to that of Li⁺ ions, the ionic conductivity of sodium-ion conducting solid electrolytes would be insufficient for practical applications. A common strategy adopted has been to develop gel-polymer electrolytes (GPEs). In this work, we developed Poly (methyl methacrylate) (PMMA) based GPEs with four different ionic salts (NaBF₄, NaPF₆, NaCF₃SO₃ and NaClO₄) dissolved in EC:PC (ethylene carbonate and propylene carbonate, 1:1 wt%) mixture. Among the four different GPE samples investigated by Electrochemical Impedance Spectroscopy (EIS) and FTIR techniques, the best ambient temperature ionic conductivity of 3.7 mS cm⁻¹ was obtained for PMMA:NaClO₄:EC:PC (18:6:38:38 wt%) GPE. Variation of ionic conductivity with inverse temperature showed Arrhenius behavior with almost constant activation energies of about 0.17 eV for all the samples. Broadening of the FTIR vibrational bands at 670-1000 and 1400-1600 cm⁻¹ is ascribed to the lowering of crystallinity resulting from the formation of PMMA/Na⁺ complex through Na⁺ ion solvation by the polymer host. The best conducting GPE (18PMMA:6NaClO₄:38EC:38PC wt%) synthesized with NaClO₄ ionic salt is highly suitable for practical applications in SIBs as it has sufficient ambient temperature ionic conductivity in the order of mS cm⁻¹.

Keywords: sodium-ion batteries, gel-polymer electrolytes, electrochemical impedance spectroscopy, ionic conductivity and vibrational modes

Acknowledgements: This research was funded by the World Bank (DOR Project # 62) under the AHEAD operation of the Ministry of Higher Education.

*Corresponding author: kvignarooban@gmail.com