UNIVERSITI TEKNOLOGI MARA

CHARATERIZATION OF CORNSTARCH-BASED SOLID POLYMER ELECTROLYTE WITH GRAPHENE OXIDE FOR SODIUM ION BATTERIES

SYAKIRAH BINTI SHAHRUDIN

Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy
(Science)

Faculty of Applied Sciences

June 2019

ABSTRACT

In this work, Corn Starch (CS) was used as the principle host to prepare CS-Sodium salt using solution casting technique. The film of CS-NaI electrolyte with ratio 75:25 yielded highest conductivity which is $(1.43 \pm 0.12)\times10^{-04}$ Scm^{-}1. The increase in conductivity is also attributed to the increase in amorphousity in the electrolyte as shown from X-ray Diffactogram (XRD) result. The interaction between the polymer and salt were confirmed by Fourier Transform Infrared Spectroscopy (FTIR) studies where interactions occurred between Na^{+} with CS. However, the conductivity value is still not high enough for device application. In order to improve the conductivity of the optimum salted system, Graphene Oxide (GO) was added into the CS-NaI polymer electrolyte system. The system containing 4wt.% of GO exhibited the highest ionic conductivity of $(2.49\times10^{-03} \pm1.53\times10^{-05})$ Scm^{-1}. The GO seems to enhance conductance due to the fact that it is providing more effective paths for the migration of conducting ions. In temperature-dependent study, the solid polymer electrolytes (SPEs) follow the Arrhenius thermal activated model. In structural study using FTIR and XRD, complexations between polymer, salt and GO were confirmed for all SPEs. Furthermore, Thermal studies using Thermogravimetric (TGA) and Differential Scanning Calorimetry (DSC) thermograms demonstrated that decomposition temperature (T_{dc}) and glass transition temperature (T_g) for CS shift upon complexation with iodide salt and GO. The activation energy obtained for CS-NaI is 0.12eV and CS-NaI with GO is 0.08eV. The collected data from Electrical Impedence Spectroscopy (EIS) were analyzed in various complex planes such as impedance, admittance and permittivity for dielectric studies. Ionic transference number were found 0.97 and 0.96 for the optimum composition of salted system and filler system. This implies that the samples are ionic in nature. FESEM revealed that when 4 wt% GO is added, the surface of the electrolyte exhibits increase distribution of porous structure which is the ionic conductivity of an electrolyte is influenced by the porosity since the pore connectivity is important for the transportation of the charge carriers in the electrolyte. Lastly, the optimum solid polymer electrolyte for both systems which are 75:25/CS:NaI and 75:25/CS:NaI-4 wt. % GO respectively were chosen as electrolytes in battery fabrication. Open Circuit Voltage (OCV) shows 1.68 V for 75:25/CS:NaI while the result increases to 2.38 V with addition of 4 wt. % GO in the electrolyte. These two sodium batteries showed better performance with discharge capacity of 114 µAh/g for CS:NaI system and 218 µAh/g for addition of GO into the polymer electrolyte system.

ACKNOWLEDGEMENT

In the name of ALLAH The Most Gracious and Most Merciful, I am very grateful to Him for allowing me to complete my Ph.D studies. I would like to take this opportunity to express my thanks and gratitude to all people below for their contributions to my study, which made it better in many ways.

I have been very fortunate to work under the supervision of Prof. Dr. Hjh. Azizah Hanom Ahmad, whose thoughtful advice and captivating spirit contribute to the quality of this study. I greatly appreciate the time she spent on helping me and giving me sound advice and ample assistance, and I extend my most sincere thanks to her. Her contribution in the completion of my project means a lot to me and I am indebted to her.

I am also grateful to all my family and whole family of ICC Lab Universiti Teknologi MARA for their support and guidance. Last but not least, Million thanks to those who involve directly and indirectly for helping me to achieve the success of this project.

TABLE OF CONTENTS