UNIVERSITI TEKNOLOGI MARA

PREPARATION AND CHARACTERIZATION OF 49% METHYL-GRAFTED NATURAL RUBBER-BASED POLYMER GEL ELECTROLYTES FOR PROTON BATTERIES

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Master of Science

August 2011

Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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Date	25 August 2011

ABSTRACT

This thesis focuses on the preparation and characterization of liquid electrolytes (LEs), polymer gel electrolytes (PGEs), and composite polymer gel electrolytes (CPGEs). LEs were first prepared by dissolving ammonium triflate ($NH_4CF_3SO_3$) in propylene carbonate (PC) using various molar concentrations of $NH_4CF_3SO_3$. The optimum conductivity (0.7 M) of the liquid electrolyte (LE) was then gelled with different concentrations of MG49. The conductivity of PGE measured by electrical impedance spectroscopy (EIS) showed a noteworthy increase by one order (approximately 10^{-2} S cm^{-1}) when 3 wt.% MG49 was incorporated into 0.7 M of the LE. This phenomenon is best clarified by the breathing polymeric chain model. Although PGE has a high conductivity (1.23×10^{-2} S cm^{-1}), its physical properties need to be improved for practical application. Therefore, the PGE was dispersed with SiO_2 and Al_2O_3 to obtain CPGEs. The plot of log σ versus 1000/T for all systems implies that the systems follow the Arrhenius rule, in which conductivity is thermally assisted. ATR-FTIR spectroscopy was used to study the interaction between components. The changes in band vibration are observable primarily due to the interaction between the C=O of MG49 and NH_4^+ of ammonium triflate. An Ubbelohde viscometer was used to measure the viscosity of all systems, which is the only physical property discussed in the current thesis. PGE filled with 8 wt.% of SiO_2 and 7 wt.% of Al_2O_3 which are the highest conductivities of CPGE were chosen to fabricate a proton battery with the cell configuration of Zn || CPGE || MnO_2. The OCV and discharge characteristics of both cells were studied and compared. The CPGE cell with SiO_2 filler (Cell A) was the superior in all aspects because of its higher CPGE conductivity (7.55×10^{-3} S cm^{-1}) compared to Cell B (6.75×10^{-3} S cm^{-1}). Cell A stabilized at 1.49 V under an open cell condition, with discharge capacity of 17.85 mAh at a 0.5 mA current drain. Cell A also had the specific power and specific energy of 0.75 W Kg^{-1} and 26.78 Wh Kg^{-1}, respectively, at a 0.5 mA current drain.

ACKNOWLEDGEMENT

In the name of ALLAH most gracious, most merciful. Alhamdulillah, this thesis is finally completed with HIS will. I would take this opportunity to convey my earnest gratitude to all who has contributed in this thesis either directly or indirectly.

My deepest gratitude goes to my supervisor and my **'SIFU', ASSOC. PROF. DR. MUHD ZUAZHAN BIN YAHYA** and also to my co-supervisor, **DR. AB MALIK MARWAN BIN ALI** who always guide, help, and lead my way through all these years. With their passion, I have the courage to complete my M.Sc study. I am really grateful to have them as my supervisor and co-supervisor.

I would like to express my gratefulness to **MOSTI** for **NSF** scholarship awarded and mostly to **UiTM MALAYSIA** for being a platform for me to explore the world of **PHYSICS** till I got my B.Sc and now M.Sc.
To **Kak 'Aisyah, Kak Irma, Kak Yah, Sahak, Fariz,** and **Hizwa,** all the memories we shared through all these years especially in **ICFMD 2008** will cherish forever in my heart. Not to forget **Kak Masni, Kak Am, Amy, Linda, Mazid,** and my entire colleague.

A special thanks goes to my little sister, **AINNUR IZZATI** for being there when I am in need. Lastly and most essentially, thanks to Mak, **PN. FATIMAH BINTI ISMAIL** and Ayah, **TN. HJ. KAMISAN BIN SHOOD,** my big brother **MUAMMAR GADDAFI,** my sister **NUR-HAFIZA,** and my brother in-law, **SUFI BIN HASBULLAH** for all their endless love and support. **"MAK, AYAH THANK YOU FOR RAISING ME WELL".**

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