

**UNIVERSITI TEKNOLOGI MARA**

**ELECTRICAL CONDUCTIVITY IN SALT –  
POLYMER SOLUTIONS**

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Thesis submitted in fulfillment of the requirements  
for the degree of  
**Master of Science**

**Faculty of Applied Sciences**

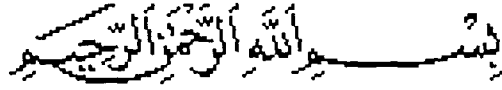
**November 2011**

## ABSTRACT

### ELECTRICAL CONDUCTIVITY IN SALT-POLYMER SOLUTIONS

Electrolytic conductivity ( $\kappa$ ) at 25.0 °C was measured in liquid electrolyte and liquid polymer electrolyte as a function of salt concentration ( $C_{\text{salt}}$ ) by AC conductivity meter. The effect of adding polymer into liquid electrolyte was discussed. Molar conductivity at infinite dilution ( $\Lambda_0$ ) of weak electrolyte lithium perchlorate ( $\text{LiClO}_4$ ) in tetrahydrofuran (THF) and acetonitrile (ACN), respectively was estimated from Ostwald's dilution law. The estimated  $\Lambda_0$  values for both  $\text{LiClO}_4$  in THF and  $\text{LiClO}_4$  in ACN are 76 and 24200  $\text{S cm}^2 \text{mol}^{-1}$ . The expected values for both systems are  $155.3 \pm 2.0$  and  $173.0 \pm 2.0 \text{ S cm}^2 \text{mol}^{-1}$ . The limitation of Ostwald's dilution law in estimation of  $\Lambda_0$  values for weak electrolytes is demonstrated in this study. We propose, a double-logarithmic plot of  $\kappa$  versus  $C_{\text{salt}}$  (power law) was introduced to determine the  $\Lambda_0$  for weak electrolytes. The power law proposed is linear for certain (finite) range of  $C_{\text{salt}}$ . The reference salt concentration ( $C_{\text{ref}}$ ) of the systems has to be estimated carefully. It is noted that,  $C_{\text{ref}}$  for each system that corresponding to the  $\Lambda_0$  is approximately half of the lowest  $C_{\text{salt}}$  concentration that still obeys the power law before the data starts to divert from the linearity of the power law. In order to estimate  $\Lambda_0$  value at 25.0 °C for  $\text{LiClO}_4$  in poly(ethylene oxide) (PEO) solution (PEO + ACN),  $C_{\text{ref}} = 3.0 \cdot 10^{-9} \text{ mol cm}^{-3}$  is adopted. PEO with different molecular weights,  $M_{\eta\text{S}} = 3 \cdot 10^5, 6 \cdot 10^5, 1 \cdot 10^6$  and  $4 \cdot 10^6 \text{ g mol}^{-1}$  were studied and are denoted as  $\text{PEO}_1$ ,  $\text{PEO}_2$ ,  $\text{PEO}_3$  and  $\text{PEO}_4$  respectively. The  $\kappa$  of the  $\text{LiClO}_4$  in PEO solutions was measured as a function of  $C_{\text{salt}}$ . The PEO solutions comprise of fixed PEO concentrations ( $C_{\text{PEO}}$ ) of  $\text{PEO}_1, \text{PEO}_2, \text{PEO}_3$  and  $\text{PEO}_4$  from 0.0005 to 0.010  $\text{g cm}^{-3}$ . In general, as  $C_{\text{PEO}}$ s increase for  $\text{LiClO}_4$  in PEO solutions,  $\Lambda_0$  values of the systems tend to show a descending trend. It is also noted, higher  $M_{\eta}$  of PEOs at  $C_{\text{PEO}} = \text{constant}$  demonstrate a descending tendency in  $\Lambda_0$ . This indicates lower ion mobility ( $K'$ ) in the electrolyte as calculated in this study. Finally, the degree of dissociation ( $\alpha$ ) for  $\text{LiClO}_4$  in PEO solution was calculated as a function of  $C_{\text{salt}}$  for different PEOs at different  $C_{\text{PEO}}$ s. Higher  $M_{\eta}$  PEOs result in the improvement of dissociation of  $\text{LiClO}_4$  in PEO solutions as compared to  $\text{LiClO}_4$  in ACN. At  $C_{\text{PEO}} = \text{constant}$ ,  $\alpha$  values are insignificantly different at higher  $C_{\text{PEO}}$ .

## ACKNOWLEDGEMENT



First of all I must sincerely thank Allah Almighty for giving me the strength and opportunity to complete my thesis. The acquisition of a master degree would not have been possible without the help and support of numerous individuals. I would like to take this opportunity to deeply thank the various people who, during the past few years in which this endeavor lasted, provided me with useful and helpful guide. I wish I could mention the name of all. I am grateful to the valuable and sincere services rendered by all of them. Without their care and consideration this thesis would likely not have matured.

I should render my thanks to one and only beloved supervisor, Dr. Chan Chin Han who acts as the woman behind of the scenes, for her guidance, encouragement and support in my work. In addition, my special thanks also go to Professor Dr. Mohamad Kamal Harun as my co-supervisor for the useful ideas and comments during the study. I would like to extend my special appreciation to Prof H. W. Kammer, Senior Visiting Professor in Faculty of Applied Science (FSG), UiTM Shah Alam, Selangor Malaysia. It was really a privilege to work under his guidance. He had guided me to a clearer and bigger point of view of this study. My thanks also go to Ministry of Science, Technology and Innovations (MOSTI) that had offered me the scholarship during the study.

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# CHAPTER 1

## INTRODUCTION

### 1.0 Introduction

Power sources for electric vehicles and portable electronic equipment have attained attention upon the discovery of electrochemical systems that store a large amount of energy, deliver high power output and utilize lightweight materials. Depending on the application, ideally they can be reversibly recharged. Most importantly, they should be mechanically and chemically stable in all environments for realistic commercial application [1]. Most of the commercially known electrolytes contribute to one or two of the above-described attributes, but the ideal electrolyte that fulfils all the mentioned requirements has remained very elusive to those involved in electrochemistry research. The discussion in the following section will start with electrolyte and afterwards will be extended to polymer electrolyte.

### 1.1 Electrolytes

In chemistry, an electrolyte is any substance containing free ions that make the substance electrically conductive. Electrolyte solution is normally formed when salt is placed into solvent such as water and the individual components dissociate due to the thermodynamic interactions between solvent and solute molecules, in a process called salivation [2-4]. For example, when table salt, NaCl, is placed in water, the salt (solid) dissolves into its component elements [c.f. Eq. (1)], according to the dissociation reaction.