

UNIVERSITI TEKNOLOGI MARA

**MODIFIED NATURAL RUBBER
SOLID POLYMER ELECTROLYTES**

SITI NOR HAFIZA BT MOHD YUSOFF

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

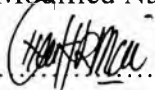
Faculty of Applied Sciences

December 2013

AUTHOR'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 degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Siti Nor Hafiza Bt. Mohd Yusoff
Student I.D. No. : 2010612002
Programme : Master of Science (AS780)
Faculty : Applied Sciences
Thesis Title : Modified Natural Rubber Solid Polymer Electrolytes
Signature of Student : .....
Date : December 2013

ABSTRACT

Solid polymer electrolytes comprise of epoxidized natural rubber (ENR) and methyl-grafted natural rubber (MG) as polymer hosts added with LiClO_4 were prepared by solution casting technique. Glass transition temperature (T_g) obtained by using differential scanning calorimetry (DSC) and the ionic conductivity evaluated from bulk resistance (R_b) determined using the impedance spectroscopy point towards the higher solubility of the lithium salt in MG rubber. Moreover, two T_g s are observed for the MG-salt electrolyte system whereas only one T_g is obtained for the ENR-salt system at all salt concentrations. The carboxyl group of the MG is found to have a better solvation capability than the oxirane group of ENR. Ionic conductivities (σ) and dielectric constants (ϵ') are observed to increase with ascending salt content. The dependency of ϵ' on salt concentration is more pronounced at low frequencies from 50 to approximately 1.0×10^4 Hz. A power law dependence of ionic conductivity on salt concentration is also observed in which the lower charge carrier mobility in ENR as compared to MG is in good agreement with its lower conductivity. The higher dissolution of lithium salt in MG as compared to ENR is also evident in spectroscopic results by FTIR.

TABLE OF CONTENTS

	Page
AUTHOR'S DECLARATION	ii
ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF SYMBOLS	x
LIST OF ABBREVIATIONS	xii
CHAPTER ONE: INTRODUCTION	
1.1 Background of the Research	1
1.2 Problem Statement	3
1.3 Significance of Study	4
1.4 Objectives of Study	4
1.5 Scope of Study	5
CHAPTER TWO: LITERATURE REVIEW	
2.1 Polymer	6
2.1.1 Polymer-salt Complex	8
2.1.2 Elastomer-salt System	11
2.1.3 Polymer Blends-Salt System	16
CHAPTER THREE: METHODOLOGY	
3.1 Sample Preparations	19
3.1.1 Purification of Modified Natural Rubber (MNR)	19
3.1.2 Preparation of MNR/LiClO ₄ Film	19
3.2 Gel Permeation Chromatography (GPC)	21
3.3 Nuclear Magnetic Resonance (NMR)	21
3.4 Grafting Efficiency of the MG Rubber	22

3.5	Thermogravimetric Analyzer (TGA)	23
3.6	Differential Scanning Calorimeter (DSC)	23
3.7	Impedance Spectroscopy (IS)	24
3.8	Fourier Transform Infrared (FTIR)	24
3.9	Dynamic Mechanical Analyzer (DMA)	25

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1	Characteristics of Modified Natural Rubber	26
4.2	Determination of the Molar Masses of the Rubber Samples	26
4.3	Calculation of Mol % of Epoxy and PMMA Content in MNR	30
4.4	Grafting Efficiency of MG-Rubber	32
4.5	Glass Transition Temperature	33
4.6	Conductivity	36
	4.6.1 Ionic Conductivity	36
	4.6.2 Power Law Dependence of Conductivity on Salt Content	39
	4.6.2.1 Introduction	39
	4.6.3 Dielectric Function	44
4.7	FTIR	47
4.8	Dynamic Mechanical Analysis	55

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1	Conclusion	59
5.2	Recommendations	60

REFERENCES	61
-------------------	----

APPENDICES	68
-------------------	----