

**EFFECT OF RARE EARTH METAL OXIDES ( $\text{Dy}_2\text{O}_3$ ,  $\text{Er}_2\text{O}_3$ ,  $\text{Yb}_2\text{O}_3$ )  
ON PROPERTIES OF CELLULOSE BASED COMPOSITE  
POLYMER ELECTROLYTE**

**HASYA HUSNA BINTI ALIAS**

**Final Year Project Report Submitted in  
Partial Fulfilment of the Requirements for the  
Degree of Bachelor of Science (Hons.) Chemistry  
in the Faculty of Applied Sciences  
Universiti Teknologi MARA**

**JULY 2019**

## TABLE OF CONTENTS

	<b>Page</b>
<b>ACKNOWLEDGEMENTS</b>	iii
<b>TABLE OF CONTENTS</b>	iv
<b>LIST OF TABLES</b>	v
<b>LIST OF FIGURES</b>	vi
<b>LIST OF ABBREVIATIONS</b>	vii
<b>ABSTRACT</b>	xi
<b>ABSTRAK</b>	xii
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Background of study	1
1.2 Problem statement	3
1.3 Significance of study	4
1.4 Objectives	4
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>5</b>
2.1 Solid Polymer Electrolyte	5
2.2 Carboxymethyl cellulose	7
2.3 Composite Polymer Electrolyte	9
<b>CHAPTER 3 METHODOLOGY</b>	<b>12</b>
3.1 Materials	12
3.2 Preparation of solid biopolymer film	12
3.3 Sample Characterization	15
3.3.1 Electrochemical Impedance Spectroscopy (EIS)	15
3.3.2 Fourier Transform Infrared (FTIR) Spectroscopy	15
3.3.3 X-Ray Diffractometer (XRD)	16
3.3.4 Tensile	16
<b>CHAPTER 4 RESULTS AND DISCUSSION</b>	<b>17</b>
4.1 Physical Properties	17
4.2 Electrochemical Impedance Spectroscopy (EIS)	20
4.3 Fourier Transform Infrared (FTIR) Spectroscopy	23
4.4 X-Ray Diffractometer (XRD)	30
4.5 Tensile	32
<b>CHAPTER 5</b>	<b>35</b>
5.1 Conclusion	35

5.2	Recommendations	36
	<b>CITED REFERENCES</b>	37
	<i>CURRICULUM VITAE</i>	42

## LIST OF TABLES

<b>Table</b>	<b>Caption</b>	<b>Page</b>
2.1	Ionic conductivity of CMC Solid Polymer Electrolyte.	8
2.2	Ionic conductivity of SPE with rare earth metal.	11
2.3	Sample design for SPE systems.	13
4.1	SPE films' composition with rare earth metal.	19
4.2	Ionic conductivity of the SPE films.	20
4.3	The wavenumbers of main functional groups.	29
4.4	Values of tensile strength for SPE.	33

## ABSTRACT

### **EFFECT OF RARE EARTH METAL OXIDES (Dy<sub>2</sub>O<sub>3</sub>, Er<sub>2</sub>O<sub>3</sub>, Yb<sub>2</sub>O<sub>3</sub>) ON PROPERTIES OF CELLULOSE BASED COMPOSITE POLYMER ELECTROLYTE**

The objectives of this study are to fabricate CMC – LiTFSI SPE and to measure the effect of rare earth metal oxides on properties of SPE. Solution casting method were used where CMC as polymer host and LiTFSI were combined to form SPE and three types of rare earth metal which are Dy<sub>2</sub>O<sub>3</sub>, Er<sub>2</sub>O<sub>3</sub> and Yb<sub>2</sub>O<sub>3</sub> were added as filler. The SPE film samples were characterized using Electrochemical Impedance Spectroscopy (EIS), Fourier Transform Infrared (FTIR) Spectroscopy, X-Ray Diffractometer (XRD) and Tensile. For the EIS analysis, the addition of LiTFSI increased the ionic conductivity of CMC from  $9.14 \times 10^{-8} \text{ Scm}^{-1}$  to  $2.91 \times 10^{-7} \text{ Scm}^{-1}$ , but incorporation of rare earth metal to CMC-LiTFSI decreased the ionic conductivity. The FTIR spectra shows the complexation of Li<sup>+</sup> with all electron donor atoms in CMC structure and there was a shifting of O-H peak after the addition of LiTFSI, but after the addition of rare earth metal, the O-H peaks shifts to lower wavenumber. XRD results show that addition of LiTFSI reduces the peak intensity which indicates the polymer system becomes more amorphous while the addition of rare earth metal increases the crystalline peak. These XRD results supported the EIS results, ion transport is faster in amorphous phase thus increase the ionic conductivity. For the analysis of Tensile, the addition of LiTFSI salt increase the tensile strength while the addition of rare earth metal decrease the tensile strength due to the disturbance intermolecular interaction to the polymer matrix. In conclusion, the addition of rare earth metal decreased the ionic conductivity and reduced the mechanical properties of CMC-based SPE.