

THE UNIVERSITY OF CHICAGO
LIBRARY

1960

THE UNIVERSITY OF CHICAGO
LIBRARY

1960

**PROTON CONDUCTING POLYMER ELECTROLYTE FILMS BASED ON
CHITOSAN COMPLEXED WITH ADIPIC ACID: AN ELECTRICAL AND
FTIR STUDY**

By
NOR AZWA ZAKARIA

A thesis submitted in partial fulfillment of
the requirements for the award of the degree of Bachelor of
Applied Science (Physics Electronics and Instrumentation)

**DEPARTMENT OF PHYSICAL SCIENCES
FACULTY OF SCIENCE AND TECHNOLOGY
UNIVERSITI MALAYSIA TERENGGANU
2008**



**JABATAN SAINS FIZIK
FAKULTI SAINS DAN TEKNOLOGI
UNIVERSITI MALAYSIA TERENGGANU**

PENGAKUAN DAN PENGESAHAN LAPORAN PITA I DAN II

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk: PROTON
CONDUCTING POLYMER ELECTROLYTE FILMS BASED ON CHITOSAN
COMPLEXED WITH ADIPIC ACID AN ELECTRICAL AN FTIR
STUDY

oleh NOR AZWA BT. ZAKARIA, no. matrik: UK12177

telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Fizik sebagai memenuhi sebahagian daripada keperluan memperoleh Ijazah SM SN GUNAAN (FIZ, ELEK & INST),
Fakulti Sains dan Teknologi, UMT.

Disahkan oleh:

Penyelia Utama
Nama: **DR. MOHD IKMAR NIZAM BIN MUHAMAD ISA**
Pensyarah
Cop Rasmi: Jabatan Sains Fizik
Fakulti Sains dan Teknologi
Universiti Malaysia Terengganu
21030 Kuala Terengganu

Tarikh: 5/5/08

Penyelia Bersama (jika ada)

Nama:

Cop Rasmi


Tarikh:

Ketua Jabatan Sains Fizik
Nama: **PROF. DR. SENIN BIN HASSAN**
Cop Rasmi: **Head**
Department of Physical Sciences
Faculty of Science and Technology
University Malaysia Terengganu
21030 Kuala Terengganu

Tarikh: 5 Me 2008

DECLARATION

I hereby declare that this theses entitled **PROTON CONDUCTING POLYMER ELECTROLYTE FILMS BASED ON CHITOSAN COMPLEXED WITH ADIPIC ACID: AN ELECTRICAL AND FTIR STUDY** is the result of my own research except as cited in the references.

Signature: 

Name: **Nor Azwa Zakaria**

Matrix No: **UK 12177**

Date: **5/MEI/2008**

ACKNOWLEDGEMENT

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

First and foremost, I am very grateful and thankful to Allah The All Mighty for giving me a good health, chance and strength to complete this research work. It took me a very strong determination to finish this thesis and as in returned I gained a lot of scientific knowledge which are priceless.

I am deeply indebted to my charming supervisor **Dr. Mohd Ikmar Nizam Mohamad Isa** whose help, stimulating suggestions and encouragement helped me in all the time of research for and writing of this thesis. Thank you for being such understanding, encouraging and tolerant during this period time.

I would like to express my gratitude to all those who gave me the possibility to complete this thesis. I want to thank all the staffs in the Department of Physical Sciences for giving me permission to commence this thesis in the first instance, to do the necessary research work and to use the departmental instruments. My sincere gratitude to master students, **Kartini** and **Nik Aziz**, for helping us during all the period time.

To my colleagues; **Muhammad Shahazmi**, **Mohd Fatihah** and **Santana D.C.Jani**, thank you very much for all the help and friendship given to me. We shared all the memories and experienced together during this wonderful journey in UMT. Inshaallah all the hard works will be paid. Not to mention, my spirits keeper **Wawa**, **Emi Liyana**, and **Dila** thank you for be there for me when I needed a shoulder. Even a simple kindness and taught have bring me to succeed finishing this thesis.

Last but not least, a very special gratitude to my parent; **Zakaria Abdullah** and **Zaiton Abu Bakar**, my brother and sisters; **Hussein**, **Nor Ain** and **Zharfan**. Without their prays and supports, I would not be able to gain knowledge and success now. Thank you for all the moral and continuous support throughout my education.

NOR AZWA ZAKARIA
April 2008

ABSTRACT

Solid Polymer Electrolyte (SPE) has a significant advantage over other type of polymer electrolyte. In order to enhance the conductivity of SPE, chitosan acetate doped adipic acid films were prepared by the solution cast technique. The characterizations of the samples were done by using Electrochemical Impedance Spectroscopy (EIS) over a wide range of frequency and temperature between 298 K and 353 K and Fourier Transform Infrared (FTIR) Spectroscopy. The highest ionic conductivity obtained for samples with 35 wt. % was $1.4 \times 10^{-9} \text{ S cm}^{-1}$ at room temperature. FTIR showed that complexation has occurred. FTIR exhibited shifts in amine and carbonyl bands at 1560 cm^{-1} and 1650 cm^{-1} . Peak at 1689 cm^{-1} has shifted to 1680 cm^{-1} indicates the deprotonation of COO^- in adipic acid and proved that the electrolyte is a proton conductor. Dielectric data were analyzed using complex permittivity ϵ^* and complex electrical modulus M^* for all the samples at various temperatures. Temperature-dependent ionic conductivity measurements were taken to analyze the mechanism of ionic conduction in polymer electrolytes. The temperature-dependent conductivity data obeys Arrhenius rule indicating the conductivity to be thermally assisted. The plot on Arrhenius rule shows that as temperature increases, the conductivity increases. The activation energy for the conduction decreased gradually with the increase in the acetic acid concentration. The highest dielectric loss is observed at lower frequencies and its value decreases when the frequencies increase. Both M_R and M_I show an increase at the higher frequency end.

ABSTRAK

Polimer Elektrolit Pepejal mempunyai beberapa kelebihan berbanding polimer elektrolit jenis yang lain. Bagi meningkatkan kekonduksian polimer elektrolit pepejal, kitosan yang dicampur dengan asid adipik disediakan dengan menggunakan teknik sebaran larutan. Pencirian sampel dijalankan dengan menggunakan EIS di dalam frekuensi yang lebar dan suhu di antara 298 – 353 K dan FTIR. Kekonduksian ionik yang diperolehi daripada sampel dengan 35 wt. % asid adipik ialah $1.4 \times 10^{-9} \text{ S cm}^{-1}$ yang diperolehi pada suhu bilik. Hasil daripada analisis FTIR menunjukkan berlakunya anjakan pada jalur amida dan karbonil pada 1560 cm^{-1} dan 1650 cm^{-1} . Puncak pada 1689 cm^{-1} teranjak ke 1680 cm^{-1} menunjukkan diprotonasi COO^- di dalam asid adipik dan membuktikan bahawa elektrolit adalah suatu konduktor proton. Data dielektrik dianalisis menggunakan permitiviti kompleks, ϵ^* dan modulus elektrik, M^* bagi semua sampel pada pelbagai suhu. Pengukuran pergantungan suhu kekonduksian ionik diambil bagi menganalisis mekanisme kekonduksian ionik dalam polimer elektrolit. Data kekonduksian melawan suhu mematuhi sifat Arrhenius, menunjukkan bahawa kekonduksian diakibatkan oleh suhu. Plot pada sifat Arrhenius menunjukkan bahawa apabila suhu meningkat, kekonduksian perlahan-lahan berkurang dengan pertambahan kepekatan asid adipik. Dielektrik lenyap (*dielectric loss*) yang paling tinggi diperhatikan pada frekuensi yang lebih rendah dan nilainya berkurangan apabila frekuensi bertambah. Kedua-dua M_r dan M_i menunjukkan pertambahan pada frekuensi tinggi.