METHYLCELLULOSE DOPED GLYCOLIC ACID BIOPOLYMER ELECTROLYTE: PREPARATION, CONDUCTIVITY, AND IONIC TRANSPORT STUDY

By
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A thesis submitted in partial fulfilment 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
2009

JABATAN SAINS FIZIK
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DECLARATION

I hereby declare that this thesis entitled METHYLCELLULOSE DOPED GLYCOLIC ACID BIOPOLYMER ELECTROLYTE: PREPARATION, CONDUCTIVITY, AND IONIC TRANSPORT STUDY is the result of my own research except as cited in the references.

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ACKNOWLEDGEMENTS

First and foremost, I would like to extend my deepest gratitude to my supervisor, Dr Mohd Ikmar Nizam bin Mohamad Isa for his offer to conduct my research under his supervision and his guidance through every milestone of this project. Without his knowledgeable guidance and dedication towards this research, the end result would not be a grand success as it is now.

Special thanks go out to my family especially my father, Mr Cheah Kim Hai. His believe in me and my abilities were my main source of motivation to give my best in this project. It is with his believe in me that I was able to overcome every obstacle that came my way confidently and successfully.

I would also like to thank Mr Nik Aziz bin Nik Ali, Mr Mohd Fatihah bin Othman, Mr Santana Dee Cologne Jani, and the rest of the master students of the Physical Science Department, Faculty of Science and Technology, Universiti Malaysia Terengganu for all their help and for guiding me with their knowledge and experience in times of uncertainties. Without their knowledgeable insights, I would have not been able to complete this project successfully.

To my project group members, Clement Lee Chin Yong and Heng Siaw Gek, I would like to thank them for all that we have been through together. Without them, I would have not been able to discuss and share each others' experience in the process of completing this project. I am glad that throughout the project we were able to encourage one another from the start until the end. This project will surely be a memorable chapter in our lives.

To our Final Year Project Coordinator, Yang Mulia Engku Abdul Ghapur Che Engku Ali, I offer my thanks and appreciation for his hard work and commitment in ensuring that the projects run smoothly as planned. His efforts truly helped the final year students under the Physical Science Department, Faculty of Science and Technology, Universiti Malaysia Terengganu in delivering our best for our project.

My heartfelt thanks also go out to the officers and laboratory staff of the Physical Science Department, Faculty of Science and Technology, Universiti Malaysia Terengganu for their dedication in ensuring that the students are able to carry out our projects with minimal delays and problems.

Last but not least, my lecturers, course mates and friends, all of whom contributed in one way or another in the completion of this project. Truly this project is no ordinary feat and each of you helped me to overcome it through your help one way or another.

Thank you all very much.

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ABSTRACT

Thin films of methylcellulose (MC) doped with various weight percentage (wt. %) of glycolic acid (GA) were produced through solution cast technique to obtain a solid polymer electrolyte (SPE) in a form of a biopolymer. The study determines the feasibility of producing a proton conducting biopolymer of MC doped with GA (MC-GA) thin films, suitable for applications in batteries and fuel cells. The films obtained were transparent and mechanically strong. Electrochemical Impedance Spectroscopy (EIS) studies were conducted to analyse the conductivity and ionic transport properties of the MC-GA thin films. The samples were tested over a frequency range from 50 Hz to 1 MHz with the sample sandwiched between two stainless steel electrodes loaded with spring pressure. The highest conductivity, s, of MC-GA thin films obtained in room temperature was 7.16 x 10^{-10} S cm^{-1}. The Transference Number Measurement (TNM) studies were conducted to determine and correlate the ionic diffusion phenomena with the conductivity behaviour of the MC-GA thin film electrolytes. The calculated ionic transference number, t_{ion}, in the electrolytes were obtained from the current-normalised ionic transference number, I_{ion}, measured when the sample was subjected to a fixed direct current (DC) voltage of 1.5 V across the sample sandwiched between two stainless steel electrodes loaded with spring pressure. The s values were found to be directly proportional and controlled by the ionic mobility, μ, and ionic diffusion coefficient, D. The values of μ_+ and D_+ were higher than μ_- and D_- respectively, implying that the MC-GA thin film biopolymer electrolytes are proton conductors.

ELEKTROLIT BIOPOLIMER METILSELULOSA BERDOPAN ASID GLIKOLIK: KAJIAN PENYEDIAAN, KEKONDUKSIAN, DAN PEMBAWA IONIK

ABSTRAK

Film nipis metilselulosa (MC) yang telah didop dengan peratusan berat (wt. %) asid glikolik (GA) telah dihasilkan melalui teknik tebaran larutan untuk mendapatkan satu elektrolit polimer pepejal (*solid polymer electrolyte*, SPE) dalam bentuk biopolimer. Kajian ini menetukan kebolehupayaan penghasilan satu biopolimer filem nipis MC yang telah didop dengan GA yang berkonduksi berasaskan proton yang seterusnya sesuai untuk pengaplikasian dalam bateri dan sel sumber tenaga. Filem-filem nipis yang diperoleh bersifat lutsinar dan mempunyai kekuatan mekanikal yang lasak. Kajian Spektroskopi Impedans Elektrokimia, atau *Electrochemical Impedance Spectroscopy* (EIS), telah dijalankan untuk menganalisa kekonduksian dan perihal gerakan ion untuk filem nipis MC-GA. Sampel-sempel kemudiannya diuji dalam julat frekuensi 50 Hz hingga 1 MHz dengan sampel diapit oleh dua elektrod besi keluli yang dimuatkan dengan tekanan spring. Kekonduksian, s, tertinggi filem nipis MC-GA pada suhu bilik ialah 7.16×10^{-10} S cm^{-1}. Pengukuran Nombor Pemindahan, atau *Transference Number Measurement* (TNM), telah dijalankan untuk mengenalpasti dan mengaitkan hubungan di antara fenomena difusi ionik dengan kekonduksian elektrolit filem nipis MC-GA. Nilai nombor pemindahan ionik, t_{ion}, dalam elektrolit telah diperoleh dari nombor pemindahan ionik yang telah dinyahubah, I_{ion}, yang telah diukur semasa sampel dikenakan arus terus (*direct current*, DC) dengan voltan 1.5 V merentasi sampel yang diapit oleh dua elektrod besi keluli yang dimuatkan dengan tekanan spring. Nilai-nilai s didapati berkadar terus dan dimanipulasi oleh kebolehgerakan ion, μ, dan pekali difusi, D. Nilai-nilai μ_+ dan D_+ didapati lebih tinggi daripada nilai-nilai μ_- dan D_-, memperihalkan elektrolit biopolimer filem nipis MC-GA merupakan konduktor proton.