

**EFFECT OF DOPING FILLERS TOWARDS
CORN STARCH BASED GREEN POLYMER
ELECTROLYTES**

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**FACULTY OF SCIENCE
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2012

**EFFECT OF DOPING FILLERS TOWARDS CORN
STARCH BASED GREEN POLYMER
ELECTROLYTES**

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**DISSERTATION SUBMITTED IN FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE**

**DEPARTMENT OF PHYSICS
FACULTY OF SCIENCE
UNIVERSITY OF MALAYA
KUALA LUMPUR**

2012

UNIVERSITI MALAYA

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ABSTRACT

Corn starch based polymer electrolytes with lithium perchlorate, (LiClO_4), as dopand salt, silica (SiO_2) and barium titanate (BaTiO_3) as fillers were prepared using solution-casting technique. The prepared corn starch based polymer electrolytes were subjected to scanning electron microscopy (SEM), A.C. impedance spectroscopy, differential scanning calorimetry (DSC), thermal gravimetry analysis (TGA), water solubility test, linear sweep voltammetry (LSV), cyclic voltammetry (CV), galvanostatic charge discharge and low frequency impedance spectroscopy. The addition of fillers alters the ionic conduction mechanism and structural properties of the polymer electrolytes. Ionic conductivity studies were carried out and it was found that the polymer electrolyte systems of corn starch: LiClO_4 (60:40), corn starch- LiClO_4 : SiO_2 (96:4) and corn starch- LiClO_4 : BaTiO_3 (90:10) reaches the maximum ionic conductivity of $1.55 \times 10^{-6} \text{ S cm}^{-1}$, $1.23 \times 10^{-4} \text{ S cm}^{-1}$ and $1.84 \times 10^{-4} \text{ S cm}^{-1}$, respectively. The addition of filler resulted in better heat resistivity, thermal stability and structural properties. The highest conducting polymer films from each system were used to fabricate electrical double layer capacitor (EDLC) cells. The fabricated cells show wide electrochemical stability windows $\sim 2.7 \text{ V}$. Charge discharge profiles show the EDLCs fabricated have stable performance up to 500 cycles with 90 % efficiency. The highest specific capacitance obtained from the fabricated EDLC cells is 16.22 F g^{-1} . Corn starch polymer electrolytes have shown promising results in EDLC application.

ABSTRAK

Polimer elektrolit yang terdiri daripada kanji jagung dengan lithium perchlorate (LiClO_4), sebagai garam tambahan, silica (SiO_2) dan barium titanate (BaTiO_3) sebagai pengisi telah dihasilkan dengan menggunakan kaedah teknik pengacuan larutan. Polimer elektrolit sampel disiapkan dengan jumlah kadungan pengisi yang berbeza dan kemudian, ia dikaji dengan mikroskop elektron pengimbasan (SEM), spektroskopi impedans (A.C. *Impedance*), calorimeter pengimbasan pembezaan (DSC), Analisis gravimetri termal (TGA), ujian keterlarutan air, voltammetri pengimbasan linear (LSV), voltammetry berkitar (CV), galvanostatik caj dan pelepasan caj dan spektroskopi impedans frekuensi rendah. Penambahan suapan dalam polimer elektrolit telah mengubahsuai mekanisme konduksi ionik dan sifat struktur. Kajian ionik konduktiviti telah dijalankan dan mendapati polimer elektrolit mengandungi LiClO_4 , SiO_2 , and BaTiO_3 masing-masing mencapai konduktiviti ionik maksimum $1.55 \times 10^{-6} \text{ S cm}^{-1}$ (40 wt.%), $1.23 \times 10^{-4} \text{ S cm}^{-1}$ (4 wt.%) and $1.84 \times 10^{-4} \text{ S cm}^{-1}$ (10 wt.%). Penambahan pengisi mengakibatkan peningkatan kestabilan haba dan rintangan haba serta modifikasi struktur. Polimer elektrolit yang menunjukkan ionik konduktiviti maksimum telah dipilih untuk menjalani ujian pembuatan kapasitor lapisan ganda listrik, EDLC. Sel yang telah dipasang telah menunjuk kestabilan elektrik yang luas, $\sim 2.7 \text{ V}$. Ujian caj dan pelepasan caj telah menunjukkan keputusan yang amat memuaskan sehingga 500 kitaran dengan kecekapan sel 90%. Kapasitan maksimum yang terdapat daripada EDLC sel ialah 16.22 F g^{-1} .

ACKNOWLEDGEMENT

First, I would like to take this opportunity to express my thoughtful gratitude to Dr Ramesh T. Subramaniam who not only serves as a supervisor but also as a model role for me through his patience, diligence and wisdom despite failure and hardship. Not to forget, Prof Dr Abdul Kariem for his supervision and constant support.

I extend my heartfelt appreciation to lab mates and lab officer who have helped me throughout the project. I cherish the moments that we coped with the difficulties and challenges. Their assistance and understanding make it easier for me to finish the research work in time.

Sincere thanks to all my lab members (Liew Qian Wen, Lim Chin Shen, Sim Lina, Teo Li Peng, Din and etc.) from Center of Ionics in University of Malaya as they assist me to improve the understanding on my research field and useful information. Furthermore, my appreciation also goes to Center of Ionics, University of Malaya as it provides the instruments, facilities and apparatus for me to complete my research work. I would also like to express my greatest appreciation to my beloved family members and my loves one who have been supporting and encouraging me through the difficulty.

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LIST OF ABBREVIATION

| | |
|-----------------|--|
| σ | Conductivity in S cm ⁻¹ |
| l | Thickness of the film sample in cm |
| R_b | Bulk resistance, Ω |
| A | Surface area of the stainless steel blocking electrodes in cm ² |
| σ_0 | The pre-exponential factor |
| E_a | Activation energy |
| k | Boltzmann constant |
| T | Absolute temperature |
| ε' | Real parts of dielectric |
| ε'' | Imaginary part of dielectric |
| M' | Real part of modulus |
| M'' | Imaginary part of modulus |
| $\tan \sigma$ | Dissipation factor |
| T_g | Glass transition temperature in $^{\circ}\text{C}$ |
| T_m | Melting point in $^{\circ}\text{C}$ |
| W_s | Water solubilities in % |
| W_0 | Weight of dried samples |
| W_1 | Weight of dried samples after water soaking |
| ESR | Equivalent series resistance |
| η | Coulombic efficiency |
| C_c | Charge capacitance |
| C_d | Discharge capacitance |

| | |
|--------------------|------------------------------------|
| C | Specific capacitance in $F g^{-1}$ |
| ΔI | Discharge current in A |
| ΔV | Voltage scan |
| m | Mass of electrode in g |
| j | Average current in A |
| v | Scan rate in $V s^{-1}$ |
| C_m | Specific capacitance in $F g^{-1}$ |
| IR_{drop} | Voltage drop in V |
| i | Discharge current |
| P | Power |
| E | Energy stored |
| R_{ct} | Charge transfer resistance |
| W | Warburg element |
| R_p | Pore resistance |
| C_{ct} | Charge transfer capacitance |
| C_{dl} | Double layer capacitance |
| R_t | Overall resistance |
| f | Frequency in Hz |