

HALL EFFECT AND ELECTRICAL STUDIES  
OF CHLOROPHYLL-POLYPYRROLE THIN FILMS  
DEPOSITED ON INDIUM-TIN OXIDE

NORLAILY BINTI ABDUL RASHID

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**Thesis Submitted in Fulfillment of the Requirement for  
the Degree of Master of Science in the  
Faculty of science and Technology  
Universiti Malaysia Terengganu**

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*Special for*

*My dad, Abdul Rashid bin Jusoh*

*and in memory of my late mum, Allahyarhamah Aini bt. Shafeai*

*Thanks for your endless love, doa, enthusiastic support and happy moments*

*and*

*my beloved siblings, Kak Na, Kak La, Kak Ja, Kak Jie, Leng, and Hafiz*

*my brothers in law, abe man, abe naz, abe ise, abe sharil*

*my lovely nephew, adik K and adik Harith*

*Special thanks for my grand mum, mok.*

*Thank you for everything,*

*I love you all*

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in fulfillment of the requirement for the degree of Master of Science

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**March 2011**

**Chairperson : Associate Professor Salleh Bin Harun, Ph.D.**  
**Member : Hasiah Binti Salleh, Msc.**  
**Mohd Ikmar Nizam Bin Mohamad Isa, Ph.D.**  
**Faculty : Science and Technology**

A relatively novel technology, polymer solar cells have been under investigate in universities, national laboratories and several companies around the world. In comparison to the silicon-based devices, polymer solar cells are lightweight (which is important for small autonomous sensors), disposable, inexpensive to fabricate, flexible, customizable on the molecular level, and environmental friendly. The setback of the solar cell is its energy conversion factor. One way to increase the efficiency is to fabricate materials which have high mobility values and high concentration of the charge carrier. The present work is considered crucial and beneficial in industries and in research field.

The Polypyrrole, Chlorophyll and its combination thin film have been successfully prepared on Indium Tin Oxide (ITO) substrate by spin coating technique at room temperature. The thin film thickness was varied between 0

layer and 50 layers. In this work, Hall Effect, electrical properties, energy gap and thickness measurement of thin film deposited on ITO were characterized.

The results of Hall Effect measurement of thin film indicated that the charge carriers are holes and Hall voltage decreased as thickness increased. For electrical properties, Four Point probes, Ultra-Violet Visible Spectroscopy (UV-Vis) and surface profiler were used. The electrical conductivity of the samples were measured in two conditions; in the dark condition and under different light intensities (varied between  $10 \text{ W/m}^2$  and  $100 \text{ W/m}^2$ ). The combination of PPy:CHLO with 1:10 ratio (at 30 layers) showed a stable result and was most suitable for solar cell applications. From UV-Vis results, the thin film of the composite PPy:CHLO with 10:1 ratio exhibited the lowest value of energy gap. The range of thickness measurement was 115.52 nm and 134.22 nm. Consequently, the thin films deposited on the ITO substrate have improved the electrical performance of the substrate, this particular sample is suitable for fabrication into a solar cell.

**Keywords:** Polypyrrole, Chlorophyll, Hall effect measurement, Electrical properties

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

**KESAN HALL DAN KAJIAN ELEKTRIKAL FILEM NIPIS KLOROFIL-POLIPYROL DIBENTUK DI ATAS INDIUM TITANIUM OKSIDA**

**NORLAILY BINTI ABDUL RASHID**

**March 2011**

**Pengerusi** : **Profesor Madya Salleh Bin Harun, Ph.D.**  
**Ahli** : **Hasiah Binti Salleh, Msc.**  
**Mohd Ikmar Nizam Bin Mohamad Isa, Ph.D.**  
**Fakulti** : **Sains dan Teknologi**

Teknologi novel, sel-sel suria polimer telah berada di bawah penyelidikan di universiti-universiti, makmal-makmal kebangsaan dan beberapa syarikat seluruh dunia. Dalam perbandingan bagi silikon berpangkalan alat-alat, sel-sel suria polimer ringan (yang mana penting untuk pengesanan-pengesanan berautonomi kecil), pakai buang, tidak mahal mereka, fleksibel, mudah diubah suai pada peringkat molekul, dan mesra alam sekitar. Halangan sel suria ialah faktor penukaran tenaganya. Satu cara akan meningkatkan kecekapan bahan-bahan untuk difabrikasi yang mana mempunyai nilai-nilai mobiliti yang tinggi dan kepekatan tinggi pembawa cas. Di dalam laporan kerja ini dianggap kritikal dan bermanfaat dalam industri-industri dan dalam bidang penyelidikan.

Filem nipis polipirol, klorofil dan kombinasinya telah dihasilkan di atas substrat Indium tin oksida (ITO) melalui teknik pemutar bersalut pada suhu bilik. Ketebalan filem nipis dipelbagaikan ketebalannya iaitu di antara 0 lapisan dan 50 lapisan. Di dalam kajian ini, pencirian kesan Hall, pencirian elektrik, tenaga pemisah dan pengukuran ketebalan telah diuji kepada filem nipis yang telah di hasilkan di atas substrat ITO.

Keputusan pengukuran kesan Hall keatas sampel filem nipis telah menentukan jenis pembawa cas adalah lohong dan voltan Hall juga didapati menurun apabila ketebalan sampel bertambah. Untuk pencirian elektrik, penduga empat kaki, spectroscopi UV-Vis dan profiler permukaan telah digunakan. Kekonduksian elektrik sampel telah diukur di dalam dua keadaan; di dalam gelap dan di bawah keamatan cahaya yang berbeza (dipelbagaikan di antara  $10 \text{ W/m}^2$  dan  $100 \text{ W/m}^2$ ). Komposit PPy:CHLO dengan 1:10 (pada 30 lapisan ketebalan) menunjukkan keputusan stabil dan ini bermakna ia adalah sampel yang terbaik untuk diaplikasi pada sel solar. Daripada keputusan spectroscopi UV-Vis, komposit filem nipis PPy:CHLO dengan nisbah 10:1 menunjukkan tenaga pemisah yang paling rendah. Manakala, julat ketebalan filem nipis adalah 115.52 nm sehingga 134.22 nm. Oleh itu, filem nipis yang didepositkan di atas ITO substrat telah meningkatkan prestasi kekonduksian elektrik ITO substrat dan sampel ini sesuai untuk fabrikasi kepada sel solar.

**Kata Kunci:** Polipirol, klorofil, pengukuran kesan Hall, pencirian elektrik,