THE STUDY OF MARINE MICROALGAE CHLOROPHYLL AS DYE FOR HYBRID SOLAR CELL

NIK AZIZ BIN NIK ALI

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Abstract of thesis presented to the Senate of University Malaysia Terengganu
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Main Supervisor : Mohd Ikmar Nizam Bin Mohamad Isa, Ph.D.

Co-Supervisor : Hasiah Binti Salleh, Ph.D.

School : Fundamental Science

The solar electricity is presently a rapidly growing but often relatively expensive renewable energy form. Recently however, new molecular photovoltaic (PV) materials have been developed, which could enable a production of low-cost solar cells in the future. To address the latter issues, the development of chlorophyll from marine microalgae based on hybrid solar cell (HSC) with nano structured oxide and conjugated polymer were investigated. Chlorophyll (CHLO) dye from marine microalgae (*Chlorella* s.p.) has been extracted and their optical properties were study using fourier transform infrared (FTIR) and ultraviolet-visible spectroscopy (UV-VIS). The highest extracted CHLO content is from dimethylformamide (DMF) solvent which is 21.4 $\mu g/ml$ for CHLO *a* and 12.0$\mu g/ml$ for CHLO *b*. Then, it was followed by methanol, ethanol and acetone with the CHLO *a* is 16.0, 13.5 and 3.3 $\mu g/ml$ and CHLO *b* is 8.2, 5.1 and 4.7 $\mu g/ml$ respectively. The conducting polymer poly-3Hexylthiophene (P3HT) was synthesized in a glove bag filled with nitrogen gas. The functional group for P3HT was confirmed by using FTIR. There are a few group of functional group that were observed in P3HT

which are O-H, C=C, C-H_2, C-H_3 and C-S. Then, the UV-VIS was used to calculate the energy band gap in the P3HT. The energy band gap for P3HT is 2.39eV (direct) and 2.09eV (indirect). The nano-structured, zinc oxide (ZnO) has been synthesized by hydrothermal method at temperature 95^{o}C for one (1) hour, three (3) hours and five (5) hours respectively. The X- ray diffraction (XRD) result is in agreement with the standard diffraction pattern of hexagonal phase ZnO wurtzite structure. The diameter of ZnO for sample A is smaller than sample B with the range from 140 to 240 nm, and their lengths are up to several micrometers. The Hall Effect measurements (HEM) were performed using the Hall Effect machine with Leois-JSF software. The hall coefficients for the material used for fabrication HSC are -2.193, -1.690, -1.628 and -2.211 for ZnO, P3HT, CHLO and HSC respectively. From the HEM it was found that, polarity sign of $V_{H\ avg}$ and polarity sign of $R_{H\ avg}$ obtained were negative for all samples. Lastly, the materials were then spin coated on the ITO coated glass and fabricated using physical vapor deposition (PVD). The performance of the HSC is reviewed in terms of the energy band gap, electrical conductivity and the energy conversion efficiency. The efficiency of assemble HSC was evaluated and simulated using custom made technique with Keithley 4200 Semiconductor Characterisation System (SCS) and yellow light illumination of 100W Philips bulb (SOFTONE 100W E27 240V) with incident light intensity 100Wm^{-2}. The highest efficiency of HSC for design I is 4.61E-2% which is sample A3-10 and the highest efficiency of HSC for design II is 0.85E-2% which is sample A2P1-10. The highest efficiency for both design were achieved at ten (10) layers of CHLO for the samples with 0.1M at the time duration for ZnO growing is less than 5 hours.

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KAJIAN TERHADAP KLOROFIL MIKRO ALGA MARIN SEBAGAI PEWARNA UNTUK SEL SOLAR HIBRID

NIK AZIZ BIN NIK ALI

September 2014

Penyelia Utama : Mohd Ikmar Nizam Bin Mohamad Isa, Ph.D.

Penyelia Bersama : Hasiah Binti Salleh, Ph.D.

Pusat Pengajian : Sains Asas

Tenaga elektrik solar adalah satu bentuk tenaga boleh diperbaharui yang kini berkembang pesat tetapi selalunya agak mahal. Sekarang ini, bahan-bahan baru molekul fotovoltaik (PV) telah dikaji, yang membolehkan penghasilan sel solar yang berkos rendah dimasa akan datang. Bagi menangani masalah tersebut, kajian tentang sel solar hibrid (HSC) berasaskan klorofil daripada alga marin bersaiz mikro dengan oksida berstruktur nano dan polimer konjugat telah dikaji. Pewarna Klorofil (CHLO) daripada alga marin bersaiz mikro (*Chlorella* sp.) telah diektrak dan ciri-ciri optiknya dikaji menggunakan FTIR dan UV-VIS. Nilai tertinggi CHLO yang diekstrak adalah dari pelarut dimetilformamida (DMF) iaitu 21.4 μ*g/ml* untuk CHLO *a* dan 12.0μ*g/ml* untuk CHLO *b*. Kemudian ianya diikuti oleh pelarut methanol, etanol dan asiton masing-masing dengan jumlah CHLO *a* adalah 16.0, 13.5 dan 3.3 μ*g/ml* dan CHLO *b* adalah 8.2, 5.1 dan 4.7 μ*g/ml*. Kemudian, polimer konduksi (P3HT) telah disintesis dalam sarung beg yang dipenuhi dengan gas nitrogen. Kumpulan berfungsi untuk P3HT disahkan dengan menggunakan FTIR. Terdapat beberapa kumpulan berfungsi yang dijumpai dalam P3HT iaitu O-H,

C=C, C-H_2, C-H_3 and C-S. Kemudian UV-VIS digunakan untuk mengira jurang jalur tenaga dalam P3HT. Jurang jalur tenaga untuk P3HT adalah 2.39eV (langsung) dan 2.09eV (tidak langsung). Bahan bukan organik, ZnO telah disintesis melalui kaedah hidroterma di bawah suhu 95^{o}C selama satu (1) jam, tiga (3) jam dan lima (5) jam. Hasil belauan x- ray (XRD) adalah sesuai dengan standard pola belauan fasa ZnO struktur hexagonal. Diameter ZnO untuk sampel A adalah lebih kecil berbanding sampel B dengan beza antara 140 ke 240nm and panjangnya mencecah beberapa micrometer. Pengukuran kesan Hall (HEM) dilakukan dengan menggunakan mesin kesan Hall dengan perisian Leois-JSF. Hall koefisien untuk bahan yag digunakan dalam fabrikasi HSC adalah -2.193, -1.690, -1.628 dan -2.211 untuk ZnO, P3HT, CHLO dan HSC. Berdasarkan HEM didapati bahawa, sifat cas kekutuban $V_{H\ avg}$ dan $R_{H\ avg}$ yang diperolehi adalah bersifat negatif untuk semua sampel. Akhir sekali, bahan tersebut kemudiannya disalut dengan penyalut berputar pada kaca ITO dan difabrikasi menggunakan pemendapan wap fizikal (PVD). Prestasi HSC dikaji dari segi jurang jalur tenaga, kekonduksian elektrik dan kecekapan penukaran tenaga. Kecekapan peranti HSC telah dikaji dan disimulasi menggunakan teknik yang direka sendiri dengan menggunakan instrumen sistem pengukuran semikonduktor (SCS) Keithley 4200 dan mentol Phililips 100W (SOFTONE 100W E27 240V) bercahaya kuning dengan keamatan cahaya 100Wm^{-2}. Kecekapan tertinggi HSC bagi reka bentuk I adalah 4.61E-2% iaitu sampel A3-10 dan kecekapan tertinggi HSC bagi reka bentuk II adalah 0.85E-2% iaitu sampel A2P1-10. Kecekapan tertinggi bagi kedua-dua reka bentuk dicapai pada sepuluh (10) lapisan CHLO untuk sampel dengan 0.1 M pada tempoh masa untuk ZnO tumbuh kurang dari 5 jam.