UNIVERSITY PUTRA MALAYSIA

POTENTIOSTATIC, CYCLIC VOLTAMMETRIC AND PULSED ELECTRODEPOSITION OF CADMIUM SELENIDE THIN FILMS

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By

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Chairman : Profesor Zulkarnain bin Zainal,
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Cadmium selenide thin films were electrodeposited on the indium tin oxide (ITO) conducting glass substrate from an electrolyte containing of CdSO$_4$ and SeO$_2$ by potentiostatic (PSD), cyclic voltammeric (CVD) and pulsed electrodeposition (PED) technique. The cyclic voltammetry experiments were also carried out to determine the range of potential for deposition of CdSe through potentiostatic and pulse techniques. Potentiostatic electrodeposition experiments have been carried out at varying deposition potential, deposition time and bath temperature. For CVD the effect of varying the number of cycle, scan rate, and deposition at different bath temperature were studied. While the effect of different pulse potential and duty cycles were investigated for PED.

X-ray diffraction confirmed that polycrystalline CdSe of hexagonal structure was formed on the ITO substrate for PSD technique, while for CVD and PED technique, mixture of hexagonal and cubic CdSe phase were observed. The films exhibited n-type
semiconducting behavior for PSD but p-type for CVD. Heating the sample prepared by CVD at 550°C, removes unwanted selenium element, enhanced the morphology of the film and changed the semiconducting behavior from p-type to n-type. More interesting, as deposited PED films showed both n-type and p-type behavior based on their response to the light illumination. SEM micrograph confirmed the polycrystalline nature of all deposits. In these three techniques, the photoactivity, composition, grain size and shape of the film were found to be dependent on the electrodeposition condition.

CdSe thin film was successfully obtained from the mixture of 0.06 M CdSO₄ and 0.005 M of SeO₂ solution at potential -0.68V vs Ag/AgCl for preparation through PSD. Thicker films were formed at prolong deposition time. The PSD of CdSe was most suitable to be carried out at room temperature. Lower number of cycle and scan rate are preferable for CVD, with potential range between -1.0V to 1.0V. Smooth and well adherent samples were obtained. CVD technique produces selenium rich sample. But the excess of selenium could be eliminated by calcination at 550°C. PED produces smooth and compact films at -0.8V with 50% duty cycles. Among these three techniques, potentiostatic was found to be able to produce nearly stoichiometric of CdSe thin films. The optical absorption studies revealed that all films have direct optical band gap energy values, E_g, in the range of 1.7 to 2.0 eV.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperuan untuk ijazah Master Sains.

ELEKTROENAPAN POTENSIOSTATIK FILM NIPIS CADMIUM SELENIDE MELALUI TEKNIK VOLTAMMETRI KITARAN DAN DENYUTAN

Oleh

NORHIDAYAH AHMAD WAZIR

Mac 2010

Pengerusi : Profesor Zulkarnain bin Zainal, PhD

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Kadmium selenida telah dielektroenapkan di atas kepingan indium tin oxide (ITO) daripada larutan elektrolit yang mengandungi CdSO$_4$ and SeO$_2$ melalui teknik enapan potensiostatik (PSD), enapan voltammetrik kitaran (CVD) dan enapan denyutan (PED).

Eksperimen siklik voltammetri dibuat untuk menentukan julat keupayaan untuk pengelektroenapkan CdSe melalui kaedah potensiostatik (PSD) dan enapan denyutan (PED). Kesaran perubahan beberapa parameter telah dikaji semasa eksperimen (PSD) iaitu keupayaan pengenapan, jangka masa pengenapan, dan suhu elecktrolit. Bagi elektroenapan CVD, kesan mengubah bilangan kitaran, kadar imbasan dan suhu elektrolit yang berbeza dikaji. Sementara itu, kesan magnitud keupayaan denyutan, kitaran kerja tempoh denyutan dan kesan suhu elektrolit yang berbeza juga dikaji.

CdSe telah dienapkan daripada larutan 0.06M CdSO₄ an 5mM of SeO₂ pada keupayaan -0.68V terhadap Ag/AgCl bagi penyediaan melalui kaedah PSD. Filem yang lebih tebal diperoleh apabila masa elektroenapan dipanjangkan. Bagaimanapun, bagi teknik ini, penyediaan filem lebih sesuai dijalankan pada suhu bilik. Bilangan kitaran dan kadar imbasan yang rendah lebih sesuai untuk mengenapkan CdSe melalui CVD. Teknik ini menghasilkan sampel yang kaya selenium. Walaubagaimanapun, selenium boleh disingkirkan melalui pemanasan filem nipis pada suhu 550ºC. Teknik PED menghasilkan filem yang rata dan padat pada keupayaan -0.80 V dengan 50% kitar kerja. Elektroenapan CdSe dengan kaedah ini juga lebih sesuai dilakukan pada suhu bilik.
Diantara ketiga-tiga teknik ini, PSD didapati boleh menghasilkan filem yang hampir stoikiometri. Serapan optikal menunjukkan semua filem yang diperoleh memiliki luang tenaga bagi peralihan terus dalam lingkungan 1.70 to 2.10 eV.
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I certify that a Thesis Examination Committee has met on ____________ to conduct the final examination of Norhidayah Ahmad Wazir on her Master of Science thesis entitled “Potentiostatic, Cyclic Voltammetric and Pulsed Electrodeposition of CdSe Thin Films” in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master degree.

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Date: 15 July 2010
DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.

NORHIDAYAH AHMAD WAZIR

Date:
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