UNIVERSITI PUTRA MALAYSIA

OPTICAL AND ELECTRICAL PROPERTIES OF CONDUCTING POLYTHIOPHENE/POLYVINYL ALCOHOL COMPOSITES SYNTHESIZED BY GAMMA-RAY IRRADIATION METHOD

AIMAN MOFTAH A. DANDI

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By

AIMAN MOFTAH A. DANDI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

September 2012

DEDICATION

TO MY PARENTS.

Words cannot express my gratitude.....

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Professor Elias Saion, PhD

Faculty: Science

Electrically conducting polythiophene (PTh) was prepared from 2-thiopheneacetyl chloride at different concentrations of 9.1, 16.7, 23.1, 28.6 and 33.3 wt% dispersed in polyvinyl alcohol (PVA) films. The sample films were irradiated in a γ-ray chamber at different doses of 0, 10, 20, 30, 40 and 50 kGy at ambient conditions. Upon gamma irradiation, the 2-thiopheneacetyl chloride monomer polymerized into conducting PTh by loosing H^+ ions and formed conducting species of polarons.

The SEM morphology of PTh/PVA composite of optimum 2-thiopheneacetyl chloride concentration and absorbed dose of 28.6 wt% and 30 kGy respectively, shows a good morphology with spherical size, 0.7 µm in diameter and spreaded uniformly in the PVA matrix. The UV-visible absorption peak of this PTh composite red-shifted to 400 nm and the intensity increases with increase of concentration and dose until the optimum values. The optical band gap energy E_g decreases with an increase of monomer concentration and absorbed dose. For examples, E_g decreased from 3.38 eV at 0 kGy to 3.19 eV at 30 kGy for 9.1 wt% and from 2.35 eV at 0 kGy to 2.15 eV at 30 kGy for 28.6 wt%.

The impedance analyzer was used to determine the electrical conductivity and found that the conductivity increased with increase of monomer concentration and absorbed dose until they reached the optimum amounts. The direct current dc component is the major conductivity due to the formation of polarons in the PTh chain structure. For examples, the dc conductivity increased from 5.2×10^{-7} S/m at 0 kGy to 2.6×10^{-5} S/m at 30 kGy for 9.1 wt% and from 2.8×10^{-4} S/m at 0 kGy to 9.8×10^{-4} S/m at 30 kGy for 28.6 wt%.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SIFAT OPTIK DAN ELEKTRIK KOMPOSIT POLITIOPIN KONDUKSI/ALKOHOL POLIVINAL DISINTESIS DENGAN KAEDAH PENYINARAN SINAR GAMA

Oleh

AIMAN MOFTAH A. DANDI

September 2012

Pengerusi: Profesor Elias Saion, PhD

Fakulti: Sains

Politiopin (PTh) mengkonduksi elektrik telah disediakan daripada 2-tiopenasetil klorida pada kepekatan berbeza iaitu 9.1, 16.7, 23.1, 28.6 dan 33.3 wt% dan diadunkan dalam film alcohol polivinil (PVA). Film-film sampel disinarkan dalam kebuk sinar-gama pada dos sinaran berbeza iaitu 0, 10, 20, 30, 40 dan 50 kGy pada tekanan dan suhu bilik. Setelah disinarkan monomer 2-tiopenasetil klorida terpolimer kepada PTh mengkonduksi dengan kehilangan ion H^+ dan membentuk spesis mengkonduksi polaron.

Marpologi SEM bagi komposit PTh/PVA pada kepekatan 2-tiopenasetil klorida dan dos terserap optimum pada masing-masing 28.6 wt% dan 30 kGy menunjukkan marfologi terbaik berstruktur sefara dengan diameter 0.7 μm yang ditaburkan seragam dalam matrik PVA. Puncak penyerapan UV-tampak komposit PTh/PVA pada 400 nm dan keamatannya bertambah dengan pertambahan kepekatan dan dos sehingga nilai-nilai optimum. Tenaga jalur terlarang optik E_g berkurangan dengan pertambahan kepekatan monomer dan dos. Sebagai contoh, E_g berkurang daripada 3.38 eV at 0 kGy kepada 3.19 eV pada 30 kGy untuk kepekatan 9.1 wt% dan daripada 2.35 eV pada 0 kGy kepada 2.15 eV pada 30 kGy untuk kepekatan 28.6 wt%.

Analisis impedan telah digunakan untuk menentukan kekonduksian elektrik dan didapati kekonduksian bertambah dengan pertambahan kepekatan monomer dan dos terserap pada nipai-nilai optimum. Komponen arus terus dc adalah konduksi major kerana pembantukan polaron dalam struktur rantai PTh. Sebagai contoh, kekonduksian arus terus bertambah daripada 5.2×10^{-7} S/m pada 0 kGy kepada 2.6×10^{-5} S/m pada 30 kGy untuk kepekatan 9.1 wt% dan daripada 2.8×10^{-4} S/m pada 0 kGy kepada 9.8×10^{-4} S/m pada 30 kGy untuk kepekatan 28.6 wt%.

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I certify that a Thesis Examination Committee has met on 5 September 2012 to conduct the final examination of Aiman Moftah A. Dandi on his thesis entitled "OPTICAL AND ELECTRICAL PROPERTIES OF CONDUCTING POLYTHIOPHENE/POLYVINYL ALCOHOL COMPOSITES SYNTHESIZED BY GAMMA-RAY IRRADIATION METHOD" in accordance with the 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 of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

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

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AIMAN MOFTAH A. DANDI

Date:

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