UNIVERSITI PUTRA MALAYSIA

EFFECT OF GAS ADSORPTION ON ELECTRICAL RESISTANCE OF CARBON NANOTUBES

AMIN FIROUZI

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EFFECT OF GAS ADSORPTION ON ELECTRICAL RESISTANCE OF CARBON NANOTUBES

By

AMIN FIROUZI

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

June 2010

DEDICATION

To my beloved parents

For their dedication and commitment

To my sweetheart, Fahimeh

For her love, patience and sacrifices

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

EFFECT OF GAS ADSORPTION ON ELECTRICAL RESISTANCE OF CARBON NANOTUBES

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Chairman: Dr. Shafreeza Binti Sobri, PhD

Faculty: Faculty of Engineering

Gas sensors have wide applications in everyday life, whether in industry, medical, agriculture and environmental monitoring. A good sensor should be selective, sensitive, responsive, reliable and cost effective. Currently available gas sensors are lacking in one or more of these criteria. Therefore, there is a need to develop new sensing materials and technologies.

Since the discovery of Carbon nanotubes (CNTs), their synthesis and application in nanotechnology and Nano-Electro-Mechanical System (NEMS) have been investigated. Many applications have been implemented based on their unique electronic, mechanical, chemical and optoelectronic properties. One area of applications is in gas sensors for detecting oxygen, flammable and toxic gases. In particular, the effect of gas environment on the electronic properties of carbon nanotubes has recently attracted certain attention. Gas adsorption in carbon nanotubes is an important issue for both fundamental research and technical application of nanotubes.

This research was carried out to investigate the adsorption effect of carbon dioxide and methane towards the electrical resistance of CNTs thin film. Two different CNTs employed in this research were synthesized by Floating Catalyst Chemical Vapor Deposition (FC-CVD) method on quartz substrate under benzene bubble and methane flow rate as a hydrocarbon source, while ferrocene as a catalyst precursor. Hydrogen and argon act as carrier and purge gas respectively, were fixed for both synthesis.

From the research, it can be deduced that FC-CVD method produced high quality CNTs at temperatures of 700˚C and 950˚C for benzene and methane, respectively. The grown CNTs showed good responses to the same concentration of methane and carbon dioxide at room temperature. It was also observed that the CNTs device behaves as a p-type semiconductor when exposed to gaseous molecules. The recovery process is complete only for methane in both samples.

Therefore, CNTs should be promising to fabricate novel miniaturized chemical sensors and it is expected that many applications of CNT-based sensors will be explored in future as the interest of the nanotechnology research community.

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

KESAN PENJERAPAN GAS KE ATAS RINTANGAN ELEKTRIK TIUB-TIUB NANO KARBON

Oleh

AMIN FIROUZI

Jun 2010

Pengerusi : Dr. Shafreeza Binti Sobri, PhD

Fakulti : Kejuruteraan

Pengesan gas telah meluas dalam kehidupan harian, sama ada dalam industri, perubatan, pertanian dan pengawasan persekitaran. Pengesan yang bagus sepatutnya terpilih, sensitif, kos yang efektif, responsif, boleh dipercayai dan berkesan. Kini pengesan-pengesan gas yang boleh didapati adalah kekurangan dalam atau lebih didalam beberapa kriteria. Oleh itu, terdapat satu keperluan untuk membangunkan bahan-bahan dan teknologi.

Sejak penemuan bagi Carbon nanotiub (CNTs), sintesis mereka dan permohonan dalam nanoteknologi dan Nano Electro Mechanical System (NEMS) telah disiasat. Banyak permohonan telah dilaksanakan berdasarkan mereka unik elektronik, mekanikal, kimia dan ciri-ciri optoelektronik. Satu bidang permohonan-permohonan adalah dalam pengesan-pengesan gas untuk mengesan oksigen, mudah terbakar dan gas-gas toksik. Khususnya, kesan gas itu persekitaran pada ciri-ciri elektronik itu tiub-tiub nano karbon telah baru-baru ini perhatian tertentu terpikat. Penjerapan gas

dalam tiub-tiub nano karbon adalah satu isu penting untuk penyelidikan asas kedua-dua dan permohonan teknikal nanotiub.

Penyelidikan ini telah dijalankan untuk menyiasat kesan penjerapan karbon dioksida dan metana ke rintangan elektrik bagi CNTs filem nipis. Dua CNTs berbeza diambil bekerja dalam penyelidikan ini disintesiskan oleh Floating Catalyst Chemical Vapor Deposition (FC-CVD) kaedah pada kuarza subtrate di bawah gelembung benzena dan kadar aliran metana seperti hidrokarbon sumber, manakala ferosena seperti satu pemangkin pelopor. Hidrogen dan perbuatan argon sebagai pembawa dan gas membersih masing-masing, telah ditetapkan untuk sintesis kedua-dua.

Daripada penyelidikan, ia boleh disimpulkan yang kaedah FC-CVD menghasilkan berkualiti tinggi CNTs pada suhu 700 celsius dan 950 celsius untuk benzebe dan metana, masing-masing. CNTs hidup menunjukkan respons-respons yang bagus untuk tumpuan sama metana dan karbon dioxideat suhu bilik. Ia juga memerhatikan bahawa CNTs peranti berkelakuan seperti satu semikonduktor jenis-p apabila terdedah untuk molekul-molekul bergas. Proses pemulihan itu adalah lengkap hanya untuk metana dalam kedua-dua contoh-contoh.

Oleh itu, CNTs harus menjanjikan untuk memfabrikasi novel pengesan-pengesan kimia bersaiz kecil dan ia dijangka banyak permohonan itu CNT – berpangkalan pengesan-pengesan akan menjadi menjelajah kemudian hari sebagai kepentingan nanoteknologi masyarakat penyelidikan.

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Finally, special thanks for my family whom continuous support and love had drive me forward.

I certify that a Thesis Examination Committee has met on 21 June 2010 to conduct the final examination of Amin Firouzi on his thesis entitled "Effect of Gas Adsorption on Electrical Resistance of Carbon Nanotubes " 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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Date: 12 August 2010

DECLARATION

I hereby declare that the thesis is based on my original work except for quotation 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.

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AMIN FIROUZI

Date:

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