PRODUCTION OF CARBON NANOTUBES FOR GAS SENSOR APPLICATION

By

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

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This work is dedicated

to

my beloved husband, Mohd. Rosdi Naim and all my sweethearts,

Sakinah, Kamilah, Izzati, Hanisah and Afifah.

Abstract of 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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Gas sensors have a wide application 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.

Carbon nanotubes have a potential to be developed as a new gas sensing material due to their inherent properties such as small, high strength, high electrical and thermal conductivity, and high specific surface area. As a result, it is possible to create a miniaturized sensor, which can lead to low power consumption, lighter and low cost.

This research was carried out to investigate the absorption effect of the following selected gases namely, carbon dioxide, ammonia, acetylene, natural gas and hydrogen towards the change of resistance of CNTs pellet as sensor signal. CNTs used in this research were synthesized by means of Floating Catalyst Chemical Vapor Deposition (FC-CVD) method. Benzene was used as a hydrocarbon source while ferrocene as a source of catalyst with Hydrogen and Argon as carrier and purge gas respectively.

From the research, it can be concluded that FC-CVD method produced high quality CNTs at temperature range of 750˚C-850˚C. CNTs show high sensitivity towards ammonia, acetylene and carbon dioxide at room temperature. Maximum increment in CNTs pellets' resistance upon exposure to ammonia, acetylene and carbon dioxide are 21.75, 26.53 and 18.91 respectively. However, for natural gas and hydrogen no detection was observed at room temperature. It is predicted that sensor activity can be enhanced by doping the CNTs and/or increasing the temperature of the sensing activity.

It is expected that many applications of CNT-based sensors will be explored in future as the interest of the nanotechnology research community in this field increases. However, CNTs have yet to overcome many technological barriers in order to fulfill their potential as the preferred material for sensor applications.

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

PENGHASILAN KARBON NANOTIUB UNTUK APLIKASI PENDERIA GAS

Oleh

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Penderia gas digunakan dengan meluas di dalam kehidupan seharian, sama ada di dalam industri, perubatan, pertanian dan juga kawalan alam sekitar. Penderia yang baik mestilah mempunyai ciri-ciri berikut; selektif, sensitif, responsif, dan boleh diharap dengan harga yang berpatutan. Penderia gas yang ada di pasaran pada masakini tidak mempunyai kesemua kriteria-kriteria yang berkenaan. Oleh sebab itu, adalah menjadi keperluan untuk membangunkan teknologi dan bahan penderia yang baru.

Karbon nanotiub berpotensi untuk dibangunkan sebagai bahan baru bagi penderia gas disebabkan oleh ciri-ciri inheren seperti bersaiz kecil, mempunyai kekuatan yang tinggi, konduktiviti elektrik dan haba yang tinggi serta luas permukaan spesifik yang besar. Oleh itu, adalah

berkemungkinan untuk menghasilkan penderia bersaiz miniatur, di mana ia boleh mengurangkan penggunaan tenaga, ringan dan juga lebih murah.

Kajian ini dijalankan untuk menyiasat kesan penyerapan gas-gas seperti; karbon dioksida (CO_2), amonia (NH_3), asetilena (C_2H_2), gas asli (metana) dan hidrogen (H_2) terhadap perubahan rintangan elektrik pelet karbon nanotiub sebagai isyarat penderia. Karbon nanotiub yang digunakan dalam kajian ini dihasilkan dari kaedah Pemendapan Wap Kimia bermangkin terapung. Benzena digunakan sebagai sumber hidrokarbon manakala ferosin pula digunakan sebagai mangkin. Gas hidrogen dan gas argon masing-masing digunakan sebagai gas pembawa dan gas pembersih.

Kesimpulan yang dapat dibuat dari kajian ini ialah, kaedah Pemendapan Wap Kimia bermangkin terapung menghasilkan karbon nanotiub berkualiti tinggi pada lingkungan suhu 750˚C-850˚C. Karbon nanotiub juga menunjukkan sensitiviti yang tinggi terhadap penyerapan gas ammonia, asetilena dan karbon dioksida pada suhu bilik. Kenaikan maksima rintangan elektrik pelet karbon nanotiub terhadap penyerapan gas ammonia, asetilena dan karbon dioksida masing-masing ialah 21.75, 26.53 dan 18.91. Walaubagaimanapun, bagi gas asli dan hidrogen, tiada sebarang perubahan dapat dikesan pada suhu bilik. Adalah diramalkan, aktiviti penderia dapat ditingkatkan dengan cara *doping* dan/atau meningkatkan suhu di mana aktiviti penderia dijalankan.

Adalah dijangkakan aplikasi-aplikasi penderia berdasarkan karbon nanotiub ini akan diekplorasikan lagi di masa depan kerana terdapat peningkatan kepentingan di dalam kajian nanoteknologi. Walaubagaimanapun, karbon nanotiub perlu mengatasi banyak halangan-halangan teknologi untuk memenuhi potensi sebagai bahan pilihan bagi aplikasi penderia.

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I certify that an Examination Committee has met on 2nd June 2006 to conduct the final examination of Faizah Md Yasin on her Master of Science thesis entitled "Production of Carbon Nanotubes for Gas Sensor Application" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

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

_____

FAIZAH MD YASIN

Date :

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