SYNTHESIS AND CHARACTERISATION OF CARBON NANOTUBES PREPARED USING PULSED LASER ABLATION DEPOSITION TECHNIQUE

ISMAYADI BIN ISMAIL

ITMA 2007 1
SYNTHESIS AND CHARACTERISATION OF CARBON NANOTUBES PREPARED USING PULSED LASER ABLATION DEPOSITION TECHNIQUE

By

ISMAYADI BIN ISMAIL

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

March 2007
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In appreciation of their love and sacrifices, this thesis is dedicated to Parents Ismail Awang and Mek Esah Awang, beloved wife Sakinah Shamsudin and my son Zafran Hakim. Not forgetting my brothers and sisters Kakak, Wani, Azli, Adik and to those who have supported me throughout my studies.
SYNTHESIS AND CHARACTERISATION OF CARBON NANOTUBES PREPARED USING PULSED LASER ABLATION DEPOSITION TECHNIQUE

By

ISMAYADI BIN ISMAIL

March 2007

Chairman:  Associate Professor Noorhana Yahya, PhD
Faculty:  Institute of Advanced Technology

Carbon nanotubes (CNTs) has been the focus of a virtual storm research, both to better understand its unique properties and to harness its potential in commercial applications such as hydrogen storage, atomic force microscopy probe, microelectronic transistor, electrical field emitter of flat panel display. There are two main premises in this research project; the first premise was to synthesis the CNTs via Pulsed Laser Ablation Deposition (PLAD) technique, and the second premise was to study the effect of Fe2O3 as catalyst on the magnetic properties of the deposited materials.

This work reports the formation of carbon web-like nano structure synthesized in a T-shape stainless steel chamber. ND:YAG laser with 532nm wavelength and 10.24 W power was used to ablate the target of graphite and catalyst. Fe2O3 and NiO were mixed separately as the catalyst with graphite (carbon) to form the target. The vacuum level was kept at 5 mtorr with argon gas flowing from bottom of the
chamber. The soot that was deposited on the glass substrate was then characterized using X-Ray Diffraction (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), EDX and Vibrating Sample Magnetometer (VSM).

The SEM images confirm a web-like structure formed after the ablation. The graphite target that was ablated with laser does not form web-like structure. However, when NiO or Fe$_2$O$_3$ were introduced as the oxide catalysts, the web-like structure was formed successfully. The TEM pictures proved the web-like structure is the carbon nanotubes. Magnetic characterization via VSM was conducted after the CNTs structure was confirmed. From the magnetic characterization, we found that CNTs behaves as non-magnetic material due to the absence of the hysteresis curve. When it was filled with Fe$_2$O$_3$, the magnetic properties enhanced tremendously. It was also concluded that these Fe$_2$O$_3$ nano particles magnetic materials were trapped in the tubes. The CNTs acted as nano-wires and were able to induce the magnetization of the magnetic particles.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

SINTESIS DAN PENCIRIAN TIUB NANO KARBON DIHASILKAN MENGGUNAKAN TEKNIK PEMENDAPAN ABLASI DENYUTAN LASER

Oleh
ISMA'ADYI BIN ISMAIL

Mac 2007

Pengerusi: Profesor Madya Noorhana Yahya, PhD
Fakulti: Institut Teknologi Maju

Tiub nano karbon (CNT) telah menjadi fokus bagi banyak projek penyelidikan kini, di mana fokusnya adalah untuk memahami dengan mendalam cirri-ciri uniknya dan juga menggunakan potensinya dalam aplikasi komersial yang telah digiatkan dengan hebat seperti tempat simpanan hidrogen, prob mikroskop berskala atom, transistor mikroelektronik dan pemancar medan elektrik skrin panel rata. Ada dua objektif utama dalam projek penyelidikan ini, salah satunya adalah mengsintesiskan CNT melalui teknik pemendapan ablasi denyutan laser dan keduanya adalah mengkaji kesan Fe₂O₃ sebagai katalis terhadap sifat magnet bahan yang termendap.

Paras vakum dibiarkan pada 5mtorr dengan gas Argon mengalir dari bawah kebuk. Jelaga terhasil termendak di atas substrat kaca yang kemudiannya dicirikan dengan XRD (Serakan Sinar-X), SEM (Mikroskop Imbasan Elektron), TEM (Mikroskop Transmisi Elektron), EDX (Pembelauan Elektron Sinar-X) dan VSM (Sampel Tergetar Magnetometer).

ACKNOWLEDGEMENTS

First of all, I would like to extend my deepest gratitude to Allah s.w.t., for giving me the strength, the faith, the wisdom, the confidence, the courage and the helps needed to complete my thesis.

Secondly, I would like to give my greatest appreciation to my dear supportive supervisor, Assoc. Prof. Dr. Noorhana Yahya for her superb supervision, generosity, patience, endurance, and dedication throughout the whole of this project. Also not forgetting my co-supervisor, Dr. Lim Kean Pah for his support particularly on the set-up of the Pulsed Laser Ablation Deposition System. The hard work of Dr. Lim has contributed to the success of our system.

I would also like to thank the Head of Laboratory, Prof. Dr. Mohd Zobir Hussein for giving me the encouragement to do this research.

I would like to thank Miss Azilah Bt. Abdul Jalil, Mr. Saparis, Mrs. Edah, Mr. Ho, Mrs. Noraini, Mr. Rafiuszaman (SEM and TEM unit) and Miss Yusnita, (XRD, Universiti Putra Malaysia) for their guidance on using the instruments.

The acknowledgement should also be given to the fruitful discussions from my interaction with our nanotechnology research group member, such as Shamsul Ezzad, Ramadhan Al-Habashi, Beh Hoe Guan, Samaila Bawa Waje, and Hashim Saad.
Special thanks to Ma and Abah, wife (Sakinah Shamsudin) and son (Zafran Hakim), brothers and sisters who have helped so much to endure my difficult moments during my studies.

Finally, thank you to the Ministry of Science, Technology and Innovation (MOSTI) of Malaysia under IRPA grant, vot 09-02-04-0855-EA001 for the financial support.
I certify that an Examination Committee has met on 23rd March 2007 to conduct the final examination of Ismayadi Bin Ismail on his Master of Science thesis entitled "Synthesis and Characterisations of Carbon Nanotubes (CNTs) Prepared Via Pulse Laser Ablation Deposition Technique" 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 the relevant degree. Members of the Examination Committee are as follows:

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Date:
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 UPM or other institutions.

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<td>Nd:YAG</td>
<td>Neodymium Aluminium Garnet</td>
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<td>PLAD</td>
<td>Pulsed Laser Ablation Deposition</td>
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<td>CNTs</td>
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<td>SWNT</td>
<td>Single Walled Carbon Nanotube</td>
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<td>MWNT</td>
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CHAPTER 1

INTRODUCTION

1.0 Introduction of Carbon Nanotubes

Carbon nanotubes (CNTs) are tubular carbon molecules with properties that make them potentially useful in extremely small scale electronic and mechanical applications. They exhibit unusual strength and unique electrical properties, and extremely efficient conductors of heat.

A carbon nanotubes has a structure similar to a fullerene, but where a fullerene’s carbon atoms form a sphere, a carbon nanotube is cylindrical and each end is capped with half a fullerene molecule. Their name derives from their size, carbon nanotubes are on the order of only a few nanometres wide (on the order of one ten thousandth the width of a human hair), and their length can be millions of times greater than their width.

Carbon nanotubes is composed entirely of sp² bonds, similar to graphite. Stronger than sp³ bonds found in diamond, this bonding structure provides them with their unique strength. They can naturally align themselves into “ropes” held together by Van der Waals force. Under high pressure, carbon nanotubes can merge together, trading some sp² bonds for sp³ bonds, giving great possibility for producing strong, unlimited-length wires. (Yildrim et al., 2000).