



UNIVERSITI PUTRA MALAYSIA

**PREPARATION AND CHARACTERIZATION OF CROSS-LINKED
NATURAL RUBBER/MULTI-WALLED CARBON NANOTUBE/CLAY
NANOCOMPOSITES**

MOHAMMADREZA GHORBANI

FS 2011 31

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NATURAL RUBBER/MULTI-WALLED CARBON NANOTUBE/CLAY
NANOCOMPOSITES**

By

MOHAMMADREZA GHORBANI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
In Fulfillment of the Requirements for the Degree of Master of Science**

April 2011

DEDICATION

I would like to dedicate this work to the love of my life, Elham, who has always been next to me on this long journey; to my brother, Ahmad, who has been always so proud and supportive of his younger brother.



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

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Chairman: Prof. Dato' Wan Md Zin bin Wan Yunus, PhD

Faculty: Science

Polymer composites have a wide range of applications in electronics, transportation, construction and consuming products. In recent years, polymer/clay nanocomposites have been extensively studied due to improved properties of the material produced. In addition, polymer/nanotube nanocomposites have been given a special attention because of the unique properties of carbon nanotubes. One of the problems of using these fillers separately is the existence of their agglomerations. It was suggested to overcome this problem and also to obtain new properties of the products by using of two fillers.

In this study, nanocomposites of natural rubber (NR)/Octadecylamine modified montmorillonite (ODA-MMT), NR/multi-walled carbon nanotube (MWNT) and NR/MWNT/ODA-MMT, crosslinked by Luperox 231xl-40, were prepared by using melt blending method and characterized. The NR/ODA-MMT nanocomposites

produced were of intercalation and exfoliation types as proved by XRD and TEM analyses. The presence the ODA-MMT in the composites improved their tensile strength of around 40%, storage modulus and thermal stability. Similar effects (of around 30% increases in tensile strength) were observed when the ODA-MMT was replaced with 3.00 phr MWNT which was dispersed as single and agglomerated fibers, in the composites.

When both a mixture MWNT and ODA-MMT were used in the nanocomposites, the dispersion of the MWNT in the matrix improved, although some of the fibers were still in the agglomerated form. Addition of 3.00 phr of the MWNT increases 9% of the tensile strength higher compared to that of the NR/ODA-MMT nanocomposite but decreases the thermal stability. However, when the MWNT was chemically treated and used in the nanocomposites, both storage modulus and thermal stability were enhanced, despite insignificant effect on the tensile strength.

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

**PENYEDIAAN DAN PENCIRIAN NANOKOMPOSIT GETAH ASLI
BERANGKAI SILANG/KARBON NANOTIUB/TANAH LIAT**

Oleh

MOHAMMADREZA GHORBANI

April 2011

Pengerusi: Prof. Dato' Wan Md Zin bin Wan Yunus, PhD

Fakulti: Sains

Komposit polimer mempunyai pelbagai aplikasi yang meliputi bidang elektronik, pengangkutan, pembinaan dan produk pengguna. Dalam beberapa tahun terakhir ini, komposit polimer/ tanah liat telah banyak diberi tumpuan kerana peningkatan yang bermakna sifat polimer yang diperolehi dengan menggunakan sedikit sahaja tanah liat. Disamping itu, komposit polimer/karbon nanotub pula telah banyak diberikan perhatian kerana sifat unik karbon nanotub. Salah satu masalah dalam penyediaan komposit polimer/tanah liat atau polimer/karbon nanotub ialah pengumpulan bahan pengisi. Satu cadangan yang telah dibuat untuk mengatasi masalah ini ialah penggunaan campuran dua bahan pemenuh.

Dalam penyelidikan ini tiga komposit iaitu komposit getah asli/tanah liat, getah asli/karbon nanotub dan getah asli/karbon nanotub/tanah liat, yang telah dirangkaisilangkan dengan Luperox 231xl-40, telah disediakan dengan menggunakan

pencampur melebur dan dicirikan. Komposit getah asli/tanah liat yang dihasilkan adalah dari jenis interkalasi dan/atau ekpoliasi sebagaimana ditunjukkan oleh analisis pembelauan sinar-X dan mikroskopi elektron penghantaran. Kehadiran ODA-MMT dalam komposit meningkatkan kekuatan regangan, modulus setoran dan kestabilan terma. Kesan yang sama diperolehi, tetapi dengan nilai yang berbeza, apabila ODA-MMT digantikan dengan 3% karbon nanotub, walau pun ujud sebagai campuran gentian tunggal dan gumpalan dalam komposit yang dihasilkan.

Apabila kedua-dua karbon nanotub dan tanah liat digunakan secara serentak dalam komposit, sebaran karbon nanotub menjadi lebih baik walaupun gumpalannya masih lagi ujud, Penambahan 3% karbon nanotub meninggikan sedikit kekuatan regangan tetapi merendahkan kestabilan terma. Walau bagaimana pun, apabila karbon nanotub yang dirawat secara kimiadigunakan, sungguh pun tidak memberi kesan kepada kekuatan regangan, tetapi telah meningkatkan modulus setoran dan kestabilan terma komposit yang dihasilkan.

ACKNOWLEDGEMENT

I would like to thank my advisor, Professor Dato Dr.Wan Md Zin Wan Yunus for patient guidance and constant encouragement through my study and research at UPM. From him I learned a lot of experimental and theoretical chemistry, technical writing, and the meaning of hard work. I would like to thank the Department of Chemistry that allowed me to conduct research and enjoy decent conditions in Malaysia. I am grateful to associate Professor Dr. Mansor Ahmad for serving on my thesis committee, and also Dr. Nor Azowa Ibrahim.

I thank, Lim Chee Siong for contributing his time, skill and smile to my experiments. I thank all laboratory assistants in Chemistry Department, particularly Mr Nazri. I thank all the staffs of FTIR, TGA, CHNS, and DMA units in Faculty of Science, and also all staff in Scanning Electron Microscopy Unit, Mr Raffie, and Transmission Electron Microscopy, Mr. Ho for their assistances. I also appreciate Dr. Jamaliah Sharif for her dedication in providing my samples in high resolution transmission electron microscopy (HRTEM) unit at Malaysia Nuclear Agency.

I certify that an Examination Committee has met on January 2011 to conduct the final examination of Mohammadreza Ghorbani on his Master of Science thesis entitled "Preparation and Characterization of Natural Rubber/Multi-walled Carbon nanotubes /Clay Nanocomposites" 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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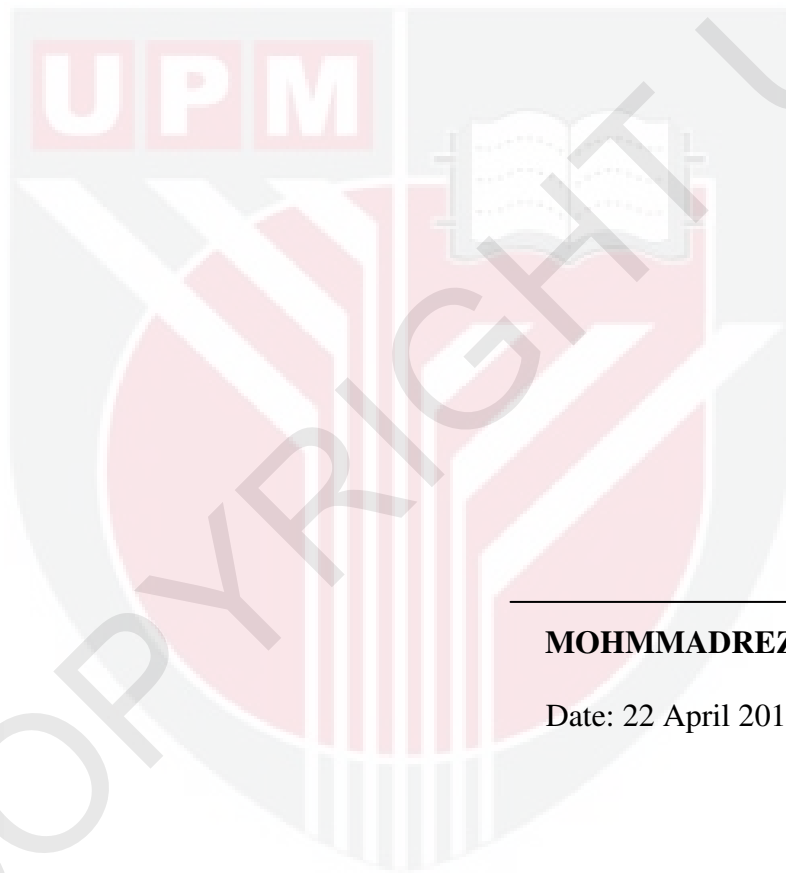
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DECLARATION

I declare that the thesis is my original work except 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.



MOHMMADREZA GHORBANI

Date: 22 April 2011

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