UNIVERSITI PUTRA MALAYSIA

PREPARATION AND CHARACTERIZATION OF HIGH- DENSITY POLYETHYLENE/POLYSTYRENE/CLAY NANOCOMPOSITES

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PREPARATION AND CHARACTERIZATION OF HIGH- DENSITY POLYETHYLENE/POLYSTYRENE/CLAY NANOCOMPOSITES

BY

SUSSAN AZIZY

Thesis Submitted to the School of Graduate Studies, Universiti Putera Malaysia, in Fulfillment of the Requirements for the Master of Science

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

PREPARATION AND CHARACTERIZATION OF HIGH -DENSITY POLYETHYLENE/ POLYSTYRENE/CLAY NANOCOMPOSITES

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Chairman: Professor Wan Md Zin Wan Yunus, PhD

Faculty: Science

Polymer/clay nanocomposites, materials composed of polymer matrices and clay particles with which at least one dimension of the clay particles is in the nanometer range. The nanocomposites exhibit significant improvement of some properties compared to those of the original polymers. Blend of polyethylene (PE) and polystyrene (PS) are widely used in industry but suffer from some drawbacks such as low toughness and low service temperature. This work is an attempt to overcome the disadvantages of high density polyethylene/polystyrene (HDPE/PS) blends through the addition of clay by melt blending to produce HDPE/PS/clay nanocomposites.

In order to improve compatibility between polymer and clay particles, sodium montmorillonite (Na-MMT) was modified by octadecylamine (ODA) to produce octadecylamine montmorillonite (ODA-MMT). Preparation of the nanocomposites was carried out by melt blending of the ODA-MMT and the HDPE/PS blends in the ratio of 80/20 using an internal mixer. The nanocomposites were characterized using transmission electron microscopy (TEM), x-ray diffraction (XRD), scanning electron microscopy (SEM), thermogravimetric analysis (TGA) and tensile testing.

The x-ray data and TEM images of the nanocomposites exhibit that the polymer has been intercalated into MMT layers. The tensile strength and tensile modulus of the nanocomposites improve with the increase of organoclay content. Meanwhile, the percentage of elongation at break decreases with the addition of the filler. TGA results show thermal stability of the nanocomposites improves with the increase of organoclay content of up to 5.00 wt% compared to that of the polymer blend. The SEM micrographs reveal that the presence of organoclay slightly promotes the miscibility of the polymer phases and somewhat decreases the flexibility of nanocomposite. In order to improve further HDPE/PS nanocomposite properties, PE-gr-MA was added into the composites. The optimum concentration of PE-gr-MA, based on x-ray data and maximum tensile properties was 1.00 wt%. The x-ray and TEM results of the nanocomposites reveal that the nanocomposites have intercalated structure. The thermal stability and tensile properties of nanocomposites are enhanced compared to

that of the original nanocomposites. The SEM micrographs show that the presence of PE-gr-MA greatly increases miscibility but decreases the flexibility of the nanocomposites.

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

PENYEDIAAN DAN PENCIRIAN- POLIETILENA KETUMPATAN TINGGI/POLISTIRENA/TANAH LIAT NANOKOMPOSIT

Oleh

SUSSAN AZIZY

January 2011

Pengerusi: Professor Wan Md Zin Wan Yunus, PhD

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Polimer nanokomposit adalah komposit yang disediakan dari polimer dan tanah liat, dimana sekurang-kurangnya satu dimension tanah liat adalah berukuran nanometer. Nanokomposit biasanya mempamerkan ciri-ciri yang lebih baik berbanding dengan polimer asal. Adunan polietilena (PE) dan polistirena (PS) digunakan dengan meluas dalam industri tetapi mempunyai kelemahan seperti mempunyai kekuatan dan suhu penggunaan yang rendah. Kajian ini adalah usaha untuk mengatasi keburukan adunan HDPE/PS melalui pembentukan nanokomposit dengan kaedah pengadunan leburan.

Untuk memperbaiki kebolehcampuran antara polimer dan tanah liat, natrium montmorilonit (Na-MMT) telah diubahsuai dengan oktadesilamina (ODA) untuk

menghasilkan montmorilonit oktadesilamina (ODA-MMT). Kemudian nanokomposit disediakan dari ODA-MMT dan HDPE/PS pada nisbah 80/20 dengan menggunakan pengadun dalaman. Nanokomposit dicirikan dengan menggunakan mikroskopi penghantaran elektron (TEM), belauan sinar-x (XRD), mikroskopi pengimbasan elektron (SEM), analisis termogravimetri (TGA) dan ujian ketegangan.

Data x-ray dan mikrograf TEM nanokomposit menunjukkan bahawa polimer telah disisipkan ke dalam lapisan MMT. Kekuatan tegangan dan modulus tegangan nanokomposit meningkat dengan penambahan kandungan tanah liat organik. Sementara itu, pemutusan pemanjangan mengecil dengan kenaikan kandungan pengisi. Keputusan TGA menunjukkan kestabilan haba nanokomposit menaik dengan peningkatan kandungan tanah liat organik sehingga 5.00 wt% berbanding dengan adunan polimer asal. Mikrograf SEM mendedahkan kehadiran tanah liat organik meninggikan kebolehcampuran antara muka polimer. Untuk meningkatkan lagi ciri-ciri nanokomposit, polietilena bercangkukan malik anhidrid (PE-gr-MA) digunakan dalam penyediaan komposit. Berdasarkan data x-ray dan ciri-ciri tegangan maksimum, 1.00 wt% PE-gr-MA adalah memadai untuk menghasilkan nanokomposit yang terbaik di mana kestabilan haba dan ciri-ciri tegangan nanokomposit ditingkatkan berbanding dengan nanokomposit asal. Mikrograf SEM menunjukkan kehadiran PE-gr-MA meningkatkan meninggikan kebolehcampuran antara muka polimer tetapi mengurangkan kebolehlenturan.

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I certify that an Examination Committee has met on **14.1.2011** to conduct the final examination of **Sussan Azizy** on her **Master of Science** thesis entitled "**Preparation and Characterization of High Density-Polyethylene/Polystyrene Blend/Clay Nanocomposites"** in accordance (Chairman) with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. 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 fulfillment 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 for quotation and citation which have been dully acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

SUSSAN AZIZY

Date: 14 January 2011

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