UNIVERSITI PUTRA MALAYSIA

EFFECTS OF SELECTED TREATMENTS ON PROPERTIES OF PINEAPPLE LEAF FIBRE REINFORCED HIGH IMPACT POLYSTYRENE COMPOSITES

JANUAR PARLAUNGAN SIREGAR

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By

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JANUAR PARLAUNGAN SIREGAR

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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February 2011

Chairman : Professor Mohd Sapuan Salit, PhD, PEng

Faculty : Engineering

The objective of this study was to investigate the physical, mechanical, and thermal properties of pineapple leaf fibre (PALF) reinforced high impact polystyrene (HIPS) composites. PALF is one of the natural fibres that is rich in cellulose and has high tensile strength properties. The fibres were obtained from the leaves of the pineapple plant. The PALF fibres were ground and sieved into different sizes of fibres; 10-40, 40-60 and 60-80 meshes. Six different fibre loadings of 0%, 10%, 20%, 30%, 40% and 50% by weight of pineapple fibre were used to reinforcement in high impact polystyrene. Mixing PALF fibre and HIPS was carried out using a melt mixer and then the resulting material was compressed in the mould using a Carver laboratory press at temperature 165°C. The results showed that the addition of untreated PALF fibre to reinforce HIPS has decreased the tensile strength, flexural strength, impact strength of composites but increased the tensile moduli, flexural moduli and hardness of the composites. The decrease of the strength of

HIPS/PALF composites was due to the poor compatibility of hydrophilic PALF and hydrophobic HIPS matrix resulting in poor dispersion of fibre in the matrix and weak interfacial bonding between the fibres and HIPS matrix. Consequently this study also investigated the effect of alkali treatment and compatibilising agent to improve the mechanical and thermal properties of the composites. The PALF fibres were soaked in two different concentrations of NaOH solution which were fixed at 2% and 4% of sodium hydroxide (NaOH) solution. Two types of compatibilising agent were used in this research, namely polystyrene-*block*-poly(ethylene-*ran*-butylene*)*-*block*-poly*(*styrene-*graft*-maleic anhydride*)* and poly(styrene-*co*-maleic anhydride*)*. The addition of fibre treatment and compatibilising agent has improved the mechanical and thermal properties of PALF/HIPS composites. The study of the effect electron beam irradiation and the addition of croslinking agent also increased the mechanical properties of the composites.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN RAWATAN BAGI KOMPOSIT POLISTIRENA HENTAMAN TINGGI DIPERKUAT GENTIAN DAUN NANAS

Oleh

JANUAR PARLAUNGAN SIREGAR

February 2011

Pengerusi : Profesor Mohd Sapuan Salit, PhD, PEng

Fakulti : Kejuruteraan

Objektif penyelidikan ini adalah untuk mengkaji sifat fizikal, mekanikal dan termal bagi komposit polistirena hentaman tinggi diperkuat gentian daun nanas. Gentian daun nanas adalah salah satu gentian asli yang kaya dengan selulosa dan mempunyai sifat kekuatan tegangan yang tinggi. Gentian daun nanas diperolehi daripada daun pokok nanas. Gentian daun nanas telah dihancurkan dan diayak kepada saiz gentian yang berbeza: 10-40, 40-60 dan 60-80 jejaring. Enam pembebanan gentian daun nanas yang berbeza 0%, 10%, 20%, 30%, 40% and 50% mengikut berat telah digunakan bagi memperkuat komposit polistirena hentaman tinggi. Pencampuran gentian nanas dan polistirena hentaman tinggi telah dijalankan menggunakan sebuah pencampur leburan (sebuah pencampur intensif Brabender Plasticorder, model PL2000-6) dan bahan yang dihasilkan telah ditekan di dalam acuan menggunakan penekan makmal Carver pada suhu 165 °C. Penambahan gentian nanas tidak dirawat bagi memperkuat polistirena hentaman tinggi telah menurunkan sifat mekanikal komposit tetapi telah meningkatkan modulus tegangan,

modulus lenturan dan kekerasan komposit. Pengurangan sifat mekanikal bagi komposit polistirena hentaman tinggi/gentian nanas adalah disebabkan kebolehserasian yang rendah antara gentian nanas yang bersifat hidrofilik dan matriks polistirena hentaman tinggi yang bersifat hidrofobik yang menghasilkan serakan gentian yang tidak baik dalam matriks dan pengikatan antara muka yang lemah antara gentian dan matriks polistirena hentaman tinggi. Penyelidikan ini juga mengkaji kesan rawatan alkali dan agen penyerasi bagi memperbaiki sifat mekanikal dan termal komposit. Gentian nanas telah direndam dalam dua kepekatan yang berbeza iaitu 2% dan 4% larutan sodium oksida. Dua jenis agen penyerasi yang telah digunakan dalam penyelidikan adalah *polystyrene-block-poly(ethylene-ran-butylene)-block-poly(styrene-graft-maleic anhydride)* dan *poly(styrene-co-maleic anhydride).* Kesan prawatan gentian dan agen penyerasi telah meningkatkan sifat mekanikal dan termal bagi komposit polistirena hentaman tinggi diperkuat gentian daun nanas. Kajian bagi kesan penyinaran alur elektron dan agen pemautsilang telah juga meningkatkan sifat mekanikal komposit.

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I certify that a Thesis Examination Committee has met on the 11th of February 2011 to conduct the final examination of Januar Parlaungan Siregar on his thesis entitled "Effects of Selected Treatments on The Properties of Pineapple Leaf Fibre Reinforced High Impact Polystyrene Composites" in accordance with the Universities and University College 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 Doctor of Philosophy.

Members of the Thesis Examination Committee are follows:

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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 Doctor of Philosophy. The members of the supervisory Committee were as follows:

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_____
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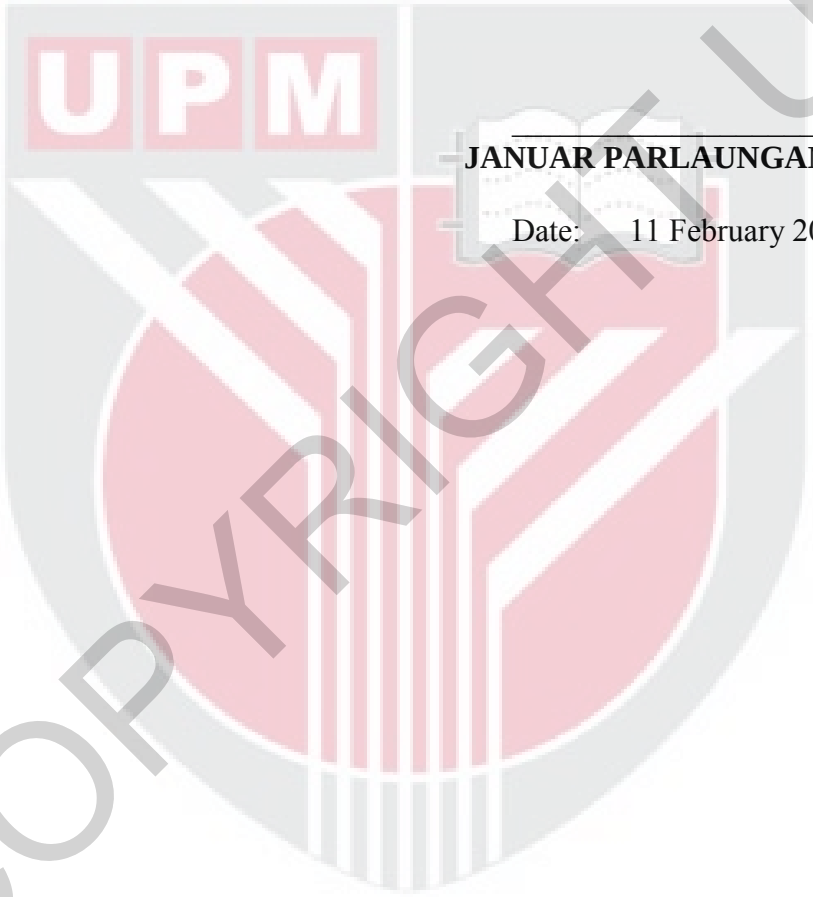
Date:

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 previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or any other institutions.



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Date: 11 February 2011

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