UNIVERSITI PUTRA MALAYSIA

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By

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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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June 2012

Chairman: Edi Syams Bin Zainudin, PhD

Faculty: Engineering

Composites of kenaf filled unplasticized poly (vinyl chloride) (uPVC) were produced by a compression moulding method. The main objective of this study is to investigate the effects of kenaf filler (KF) loading, incorporation of poly [methylene poly (phenyl isocyanate)] (PMPPIC), and electron beam irradiation (EBI) treatment on mechanical and thermal properties of KF/uPVC composites. Tensile test, flexural test, impact test and thermo gravimetric analysis (TGA) were performed to determine those properties. The results showed that the use of 30% KF content in untreated KF/uPVC composite contributed to the about 12% enhancement in tensile strength. Furthermore, the incorporation of PMPPIC coupling agent in similar composition has improved the tensile and flexural strength by about 22% and 11%, respectively. Adversely, the electron beam (EB) irradiated KF/uPVC composite without PMPPIC has failed to enhance the tensile, flexural, and impact strength of

pure uPVC matrix. However, the presence of PMPPIC in irradiated composite at 30% filler content has amplified the tensile and flexural strength. The TGA results showed KF degraded before uPVC. As the amount of KF content was increased from 10% to 40%, the thermal stability of KF/uPVC composite decreased. This occurs in both composites that incorporated PMPPIC and without PMPPIC. In conclusion, KF has the potential to be used as filler in uPVC composites as it enhanced the stiffness, mechanical strength and reduced the materials cost of the composites by about 26%. The KF/uPVC composite that incorporated with coupling agent appeared to have better tensile and flexural strength since PMPPIC induced better interfacial adhesion between KF and the uPVC. The EB irradiated KF/uPVC composite without PMPPIC has failed to improve the mechanical properties which is suggested due to the structural distortion and random chain scission (degradation) of uPVC main chain. However, the irradiated composite that incorporated PMPPIC has demonstrated better mechanical properties and this might be due to cross-linking reaction or interaction of free radicals produced in the irradiated uPVC and KF that enhanced the KF-uPVC matrix adhesion.

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

SIFAT TERMA-MEKANIKAL KOMPOSIT POLIVINIL KLORIDA BERISI SERAT KENAF

Oleh

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Komposit daripada poli (vinil klorida) tegar (uPVC) yang disi gentian kenaf dihasilkan dengan menggunakan kaedah pengacuan mampatan. Objektif utama kajian ini ialah untuk menyelidik kesan pengisian kenaf (KF), penambahan poli [metilen (polifenil) isosianat] (PMPPIC) dan perawatan menggunakan sinaran alur elektron (EBI) terhadap sifat – sifat mekanikal dan terma KF/uPVC komposit. Ujian tegangan, ujian kelenturan, ujian hentaman dan analisis terma gravimetrik (TGA) dilakukan untuk menentukan sifat - sifat tersebut. Daripada hasil penyelidikan, didapati KF/uPCV komposit yang mengandungi 30% KF telah menunjukkan penambahbaikan terhadap sifat ketegangannya sebanyak 12%. Seterusnya, dengan penambahan agen gandingan PMPPIC ke dalam komposit yang mempunyai komposisi yang sama telah meningkatkan kekuatan tegangan dan leturannya sebanyak 22% dan 11%. KF/UPVC komposit tanpa PMPPIC yang dirawat menggunakan EBI tidak meningkatkan kekuatan tegangan, lenturan dan

hentaman matriks uPVC yang asal. Walaubagaimanapun, dengan penambahan PMPPIC ke dalam komposit yang dirawat dengan EBI pada komposisi 30% KF telah meningkatkan kekuatan tegangan dan lenturannya. Keputusan TGA menunjukkan KF meluput lebih awal dari uPVC. Selain itu, kestabilan terma KF/UPVC semakin berkurang apabila jumlah KF semakin bertambah dari 10% ke 40%. Kesan ini berlaku kepada kedua – dua komposit, baik yang mengandungi PMPPIC mahupun yang tidak mengandungi PMPPIC. Secara kesimpulannya, gentian kenaf (KF) mempunyai potensi yang cerah sebagai bahan pengukuh di dalam uPVC komposit. Ini adalah kerana, dengan penambahan KF telah memberikan ketegaran dan kekuatan mekanikal yang lebih baik sekaligus mengurangkan kos komposit tersebut. KF/uPVC komposit yang mengandungi agen gandingan menunjukkan sifat – sifat mekanikal yang lebih baik kerana PMPPIC telah mendorong kepada kesempurnaan lekatan antara muka gentian dan matriks. Komposit yang dirawat dengan EBI tanpa PMPPIC tidak meningkatkan sifat – sifat mekanikal dan ini mungkin disebabkan rantaian utama uPVC telah mengalami herotan struktur dan pemotongan rantaian secara rawak. Walau bagaimanapun, komposit yang dirawat dengan EBI yang mengandungi PMPPIC telah menunjukkan sifat – sifat mekanikal yang lebih baik kerana ia mengalami tindak balas penghubung secara silang atau interaksi radikal bebas yang terhasil daripada matriks dan gentian yang telah disinar sekaligus meningkatkan lekatan gentian – matriks.

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APPROVAL

I certify that Examination Committee met on ..... to conduct the final examination of Mohd Firdaus Bin Abd Rahman on his Master of Science thesis entitled "Thermo-Mechanical Properties Of Kenaf Filled Unplasticized Poly (Vinyl Chloride) (uPVC) Composites" in accordance with the Universities and University Colleges 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 Master of Science.
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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 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 quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any degree at Universiti Putra Malaysia or at any other institution.

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