

**THE EFFECT OF PALM KERNEL SHELL HYBRIDIZATION
AND SURFACE TREATMENTS ON PROPERTIES OF
NATURAL RUBBER COMPOSITES**

by

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In the name of Allah, the Most Gracious and Merciful

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LIST OF ABBREVIATIONS

NR	Natural rubber
SMR L	Standard Malaysian Rubber L
CB	Carbon black
HNT	Halloysite nanotube
CaCO ₃	Calcium carbonate
FTIR	Fourier Transform Infra- Red
SEM	Scanning Electron Microscopy
PKS	Palm kernel shell
NR/PKS	Palm kernel shell-filled-natural rubber
ASTM	American Standard of Testing and Materials
Phr	part per hundred rubber
AMEO	3-aminopropyltrimethoxysilane
M _H	Maximum torque
t ₉₀	Cure time
t _{s2}	Scorch time
M100	Modulus at 100% elongation
M300	Modulus at 300% elongation
TGA	Thermo Gravimetric Analysis

DTG Derivative- Thermo Gravimetric

E_B Elongation at break

**KESAN PENGHIBRIDAN DAN PERAWATAN PERMUKAAN
TEMPURUNG ISIRUNG KELAPA SAWIT KEATAS SIFAT-SIFAT
KOMPOSIT GETAH ASLI**

ABSTRAK

Dalam kajian ini, ciri-ciri pematangan, sifat mekanik, sifat terma, kebolehbidegrasi komposit telah dikaji. Pertama, kesan muatan tempurung isirung kelapa sawit kepada sifat-sifat komposit getah asli (NR) telah dikaji. Komposit getah asli/tempurung isirung kelapa sawit telah disediakan dengan menyebatkan tempurung isirung kelapas sawit dari muatan pengisi 0 hingga 20 phr ke dalam matrik getah asli menggunakan mesin penggiling bergulung dua bersaiz makmal. Keputusan menunjukkan bahawa masa skorj (t_{s2}), masa pematangan (t_{90}), kekuatan tensil, pemanjangan pada takat putus, hayat fatig, kestabilan terma menurun dengan peningkatan muatan pengisi tempurung isirung kelapa sawit, manakala tork maksimum (M_H), dan modulus pada 100% (M100) dan 300% (M300) pemanjangan menunjukkan trend meningkat dengan peningkatan muatan pengisi. Pengimbas mikroskopi elektron (SEM) menunjukkan bahawa peningkatan muatan PKS melemahkan interaksi antara pengisi dan getah matrik. Kedua, kesan agen gandingan silana (3-aminopropiltrimetiloksilana) kepada sifat-sifat komposit NR/PKS telah dikaji. Keputusan menunjukkan berlaku peningkatan dalam sifat-sifat yang dikaji disebabkan oleh peningkatan interaksi getah -pengisi di dalam komposit NR, yang telah terbukti dalam pengkajian SEM dan FTIR. Ketiga, kesan pra-perawatan permukaan menggunakan natrium hidroksida telah dikaji. Tork maksimum, masa skorj, dan masa pematangan menunjukkan trend penurunan pada PKS yang telah dirawat dalam komposit getah asli. Kekuatan tensil, pemanjangan pada takat putus, modulus pada 100% (M100) dan 300% (M300) pemanjangan, hayat fatig, dan

interaksi getah-pengisi semua menunjukkan trend penurunan. Kestabilan terma bagi komposit juga berkurangan. Walau bagaimanapun, sifat-sifat mekanikal pengisi PKS yang telah dirawat dalam komposit NR telah meningkat berbanding PKS tanpa dirawat di dalam komposit NR. Kemudian, kesan penggantian sebahagian PKS oleh pengisi komersial juga telah dikaji. Nisbah PKS/pengisi komersial telah dihadkan kepada 20 phr. Penggantian pengisi komersial telah memberi penguatan yang lebih baik kepada komposit getah asli. Akhir sekali, kesan cuaca dan penanaman telah dikaji. Ujian pencuacaan semulajadi dan penanaman didalam tanah telah dijalankan selama enam bulan. Dari keputusan yang diperolehi, kemerosotan dalam sifat-sifat komposit NR/PKS diperhatikan untuk kedua-dua ujian yang telah dijalankan. Tahap kemerosotan dalam sifat-sifat tensil komposit NR/PKS menunjukkan kesan pendedahan foto-oksidasi dan biodegradasi terhadap komposit. Spektra FTIR selanjutnya mengesahkan berlakunya foto-oksidasi dan biodegradasi.