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The Effect of 3-aminopropyltrimethyoxysilane (AMEO) as a Coupling Agent on Curing and Mechanical Properties of Natural Rubber/Palm Kernel Shell Powder Composites

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Abstract

This research is conducted using palm kernel shell powder (PKS) as filler in natural rubber. The effect of 3-aminopropyltrimethoxysilane as coupling agent on composites were studied at different palm kernel shell loading i.e, 0. 5, 10, 15 and 20 phr. The palm kernel shell was crushed and sieved to an average particle size of 5.53 µm. The palm kernel shell filled natural rubber composites were prepared using laboratory size two roll mill. The curing characteristics such as scorch time, cure time and maximum torque were obtained from rheometer. The palm kernel shell powder filled natural rubber composites were cured at 150^{o}C using hot press according to their cure time. Curing characteristics, tensile properties, rubber-filler interaction and morphological properties of palm kernel shell powder filled natural rubber were studied. Scorch time and cure time show reduction but tensile strength, elongation at break, modulus at 100% (M100) and modulus at 300% (M300) increased with the presence of 3-aminopropyltrimethyloxysilane. Rubber-filler interaction studies showed that rubber filler interaction in natural rubber filled with palm kernel shell powder improved with incorporation of 3-aminopropyltrimethyoxysilane.

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*Keywords:*Palm kernel shell; 3-aminopropyltrimethoxysilane; Tensile strength; Morphology

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1. Introduction

Natural rubber with chemical name 1,4 cis-isoprene can crystallize on stretching or cooling due to its microstructure microstructure consisting entirely of cis form of isoprene. The higher degree of crystallinity of rubber, the higher is the gum strength. The ability of natural rubber to strain crystallized affect the magnitude of gum strength for example good tensile strength and tear strength. The intrinsic high gum strength can be utilized to its advantage by incorporating large quantity of cheap fillers to reduce compounding cost [1]. Moreover, fillers also added to modify and improve specific properties desired [2]. Nowadays, natural fillers have become widely known among rubber technologists because of their advantages. Due to global demand for environmental friendly products, immense research works have been carried out to investigate the use of natural fillers in rubber composites and their potential to be marketed. Natural fillers are environmentally friendly, fully degradable, readily, abundantly available, cheap and have low density [3]. However, the disadvantages of natural fillers are their polarity. Hydrophilic nature of natural fillers results in incompatibility with natural rubber which is hydrophobic [4]. Other problems with natural fillers are their tendency to form agglomerates during processing and also poor resistance to moisture. This problem retards the potential of natural fillers to be used as reinforcing filler in composites [5].

The incorporation of cellulosic fillers into polymers will result in poor dispersion due to strong hydrogen bonding that hold the fiber or filler together [4]. The solutions to this drawback are by incorporating silane coupling agents or by using surface treatment methods to improve the degree of wetting of natural filler by polymer and promotes interfacial adhesion [6]. Coupling agent has bi- functional groups that form linkages between natural filler and polymer matrix that resulted in better interfacial adhesion between them [7]. There are abundance of natural fiber and filler resources such as rattan, wood flour, betel, pineapple leaves, kenaf, bamboo, etc in Malaysia. Palm oil was one of them. Palm oil was harvested from palm oil tree and after that the palm trees are burnt off, disposed or turned into biomass fuel [8]. This action can lead to serious environmental and health problems such as haze, water pollution and respiratory diseases. There are a few research has been done to study the possible application from waste of palm oil [9–12]. The aim of this research is to use palm kernel shell as potential filler in rubber and polymer industry. The objective of this work is to study the curing and mechanical properties of palm kernel shell filled natural rubber composites as function of filler loading and silane (3-aminopropyltrimethyoxysilane) as coupling agent.

2. Experimental

2.1 Materials and chemicals

Table 1 shows the materials, their suppliers and amount used in this study. The palm kernel shell (PKS) used in this work belongs to the species of *Elais Guineensis*. The palm kernel shell were collected, grounded and sieved into average particle size of 5.53 μm. Table 2 shows the elemental composition of PKS in this study.

Nomenclature

CBS	n-cyclohexyl-2-benzothiazolsulfenamide
TMTD	tetra-methyl-thiuramdisulphide
BKF	2,2- methylene-bis-(4-methyl-6-tert-butylphenol)
AMEO	3-aminopropyltrimethoxysilane
RRIM	Research Institute of Malaysia Rubber