UNIVERSITI TEKNOLOGI MARA

MECHANICAL AND WEAR PROPERTIES OF FUNCTIONALISED CARBON NANOTUBES MODIFIED KENAF COMPOSITES

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ABSTRACT

Natural fibres reinforced polymer composites have been gaining great attention in several applications due to its eco-friendly nature, sustainability, stronger and cost effective. Among all natural fibres available, kenaf fibre has been identified as an attractive option for reinforcing fibres due to its availability, high aspect ratio and superior toughness properties. However, limitation arise with respect to the mechanical properties when kenaf fibres and epoxy resin are used. The combination of these materials has been reported to have poor-matrix interfacial addition due to hydrophilic kenaf fibres and hydrophobic epoxy resin in nature. In addition, majority of epoxy systems are degraded by their brittleness property, low impact strength and low fracture toughness. The objective of this study is to improve the properties of the kenaf fibres reinforced composites by incorporating carbon nanotubes (CNT) in epoxy matrix and hybridised with glass fibres. Moreover, the study was focused on the functionalisation of CNT surface via concentrated acid and amino silane. This surface modification aims to enhance the dispersibility of CNT into epoxy matrix and improve the interfacial adhesion bonding between three phases (CNT/epoxy/kenaf fibres) composites. In this study, the modified epoxy with 0.5, 0.75 and 1.0 wt% pristine CNT (PCNT)/ acid treated (ACNT)/silane treated (SCNT) was impregnated with kenaf fibres to fabricate the kenaf fibres reinforced composites system. The woven glass fibres (G) plies were placed at top and underneath kenaf fibres (K) in fabrication of hybrid G/K fibres composites system. The effect of CNT addition and functionalised CNT on the longitudinal and transverse tensile, flexural, compressive, impact and wear properties of kenaf and hybrid G/K composites were studied. Several types of analytical methods such as X-Ray Diffractometer (XRD), Transmission Electron Microscopy (TEM), Fourier Transforms Infrared Spectroscopy (FTIR) and Scanning Electron Spectroscopy (SEM) were used to examine these composites. FTIR tests showed the presence of Si-O and Si-OH functional groups on silane treated CNT surface at peak 803 and 1070 cm^{-1}, respectively. This results in improved dispersion and interfacial bonding between CNT and epoxy resin as shown in TEM and SEM micrographs. The inclusion of SCNT improved the mechanical properties of kenaf and hybrid glass/kenaf composites. The maximum improvements were achieved at 1.0 wt% of SCNT loading. For example, the 1.0SCNT-modified kenaf composites were improved about 43.39% for longitudinal tensile strength, 28.2% for transverse tensile strength, 21.1% for flexural strength, 20.15% compressive strength and 130.6 % for impact strength when compared to kenaf composite. In addition, the 1.0SCNT-modified hybrid glass/kenaf composites were improved about 48.78% for longitudinal tensile strength, 19.36% for transverse tensile strength, 11.36% for flexural strength, 7.73% compressive strength and 24.45% for impact strength when compared to hybrid G/K composite. However, the inclusion of SCNT did not improve the wear properties due to rougher worn debris produced that induced the three-body abrasive wear effect, thus increased the wear rates of the kenaf composites. When hybridised with glass fibres, the kenaf composites showed improvement of 40.0% for longitudinal tensile strength, 86.9 % for transverse tensile strength, 155% for impact strength and 49.1% for flexural strength. In contrast, there is insignificant improvement in compressive and wear properties due the premature failure of the specimens when subjected to compressive load and glass fibres were easily pulverised when exposed to abrasive roller.

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TABLE OF CONTENT