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Characterization of coir fibre composites reinforced with CNT, glass flakes and clay particles

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ABSTRACT

Hybrid composites are composite materials used when a material is required that has more than one property benefit from its constituent materials. The current research involves the fabrication of hybrid composite materials from a type of natural fibre being coconut/ coir fibre, using vacuum resin transfer moulding (VRTM). Epoxy resin was selected as the base matrix that would be used. The second reinforcements used to fabricate the hybrid composites were carbon nanotubes (CNT), clay and glass spheres. The coir fibre was treated with Sodium Hydroxide (NaOH) to improve its bonding properties by removing the cellulose and lignin found on the cell walls. Composite specimens were fabricated using epoxy and coir fibre at 7%, 10%, 15% and 20% volume fractions. These composite specimens were then exposed to mechanical tests such as tensile, flexural and impact tests which indicated that a 15% volume fraction of coir fibre showed the optimal mechanical properties. Due to the VRTM process being a controlled process the processing conditions had to be varied to ensure that good quality composite specimens were fabricated. Functionalization was done on both the CNT and clay particles. Acid functionalization of CNT was done using Nitric acid (HNO_3) and Sulphuric acid (H_2SO_4) with the optimal functionalization time of 12 hours being selected. Clay functionalization was done using 3-Aminopropyltriethoxysilane at different ratios with the optimum ratio of 1g clay : 2g silane being used. To confirm that the functionalization treatment was successful Fourier Transform Infrared Spectroscopy (FTIR), Raman analysis and the Transmission Electron Microscope (TEM) was used. Hybrid composites were then fabricated using the optimal coir volume fraction with the CNT, glass and clay reinforcements respectively. These composite specimens were then exposed to mechanical tests such as tensile, flexural and impact tests to observe the properties of the hybrid composites. The CNT hybrid composites proved to exhibit good mechanical properties at a 1.5% weight fraction followed by glass with an 8% weight fraction and finally clay at a 4% weight fraction. Epoxy-clay and epoxy-glass composites were fabricated to observe the difference in properties between hybrid composites and normal composites. From the results obtained for the epoxy-clay and epoxy-glass composites, a 0.5% weight fraction

of reinforcement exhibited the best mechanical properties amongst both reinforcements. These composite specimens did not show an increase in properties in comparison to the hybrid composites with an average of a 10% reduction in properties as compared to the hybrid composites. A few of the test specimens had undergone an SEM analysis to observe what occurred during the fabrication and testing processes. The SEM analysis had shown that the specimens fabricated where of good quality and conditions such as agglomeration, fibre pull out, voids as well as interfacial adhesion were observed.