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The effects of alkali-silane treatment and filler materials on the tensile and water absorption properties of hemp fibre reinforced polypropylene.

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Abstract

Research was undertaken to determine the effects that multi-walled carbon nanotube and glass flakes have on treated fibre composites. The fibre chosen was initially kenaf fibre to expand on work done by Asumani *et al.* [1], however, due to a number of complications, the fibre was changed to hemp. The previous research investigated the effects of a treatment using NaOH and Silane on kenaf fibre reinforced polypropylene and the current work uses the same treatment on hemp fibre reinforced polypropylene. The properties that were investigated were tensile strength, tensile modulus as well as water absorption.

Hemp fibre was purchased in long strands. The fibres were then manufactured into hemp fibre mats with a density of $350 \pm 20 \text{ g/m}^2$. The fillers were mixed into the matrix using a shear mixer. It was found that the carbon nanotubes and glass flakes did not mix perfectly inside the matrix which led to agglomeration of the filler material. These agglomerates led to holes being created inside the composite as matrix cannot penetrate to the centre of the agglomerates resulting in empty space. The composite plates were manufactured using a combination of the film stacking technique and compression moulding. The process was adapted from that of Asumani *et al.* [1]. Four different fibre weight fractions were investigated, namely: 15%, 20%, 25% and 30%. Composites containing 2% carbon nanotubes and composites containing 350 nm thick glass flakes at a concentration of 8% were investigated at all fibre weight fractions. The effect of variation in filler concentration was investigated at 30% fibre weight fraction.

Tensile tests as well as water absorption tests were performed on the composites. The treated fibre composites achieved better results than the untreated fibre composites for all fibre weight fractions when analyzing the tensile strength and for 15%, 20% and 25% when analyzing water absorption properties. The 30% treated fibre composites behaved poorly in the presence of water due to the number of fibres exposed on the surface of the composite. The carbon nanotubes increased the tensile strength of the matrix. The carbon nanotubes, however, may reduce the strength of the interfacial bonding between the fibres and the matrix and so the strength remains constant with increasing fibre weight fraction. Therefore, at low fibre weight fractions there was an increase in strength relative to treated fibre composites containing no carbon nanotubes. At high fibre weight fractions there was a decrease in strength relative to treated fibre composites containing no carbon nanotubes. Glass flakes improved the tensile strength slightly, for all fibre weight fractions. The highest tensile strength achieved used 350 nm thick glass flakes at a concentration of 12%. At high fibre weight fractions, there appears to be an improvement in water absorption properties using 350 nm glass flakes at a concentration of 8%. No significant improvement on the water absorption properties resulted from the carbon nanotubes or other glass flake sizes or concentrations.