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Technical Report

Mechanical properties of randomly oriented short *Sansevieria cylindrica* fibre/polyester composites

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ABSTRACT

The tensile, flexural and impact properties of randomly oriented short *Sansevieria cylindrica* fibre/polyester (SCFP) composites are described for the first time in this work. Composites were fabricated using raw *S. cylindrica* fibres (SCFs) with varying fibre lengths and weight percents of fibre. When the length of the SCFs was increased, the tensile, flexural and impact properties of the composite were increased up to a 30-mm fibre length, and then a curtailment in properties occurred for higher fibre length composites. SCFP composites showed a regular trend of an increase in properties with fibre weight percent until 40% and afterwards a decrease in properties for composites with greater fibre weight percent. Tensile tests revealed that the tensile strength was about 76 MPa, the Young's modulus was 1.1 GPa and the elongation at break was between 7% and 8.3%. The flexural strength and modulus were estimated to be around 84 MPa and 3 GPa, respectively. Impact tests exhibited a strength of approximately 9.5 J/cm^2. The analysis of the tensile, flexural and impact properties of short SCFP composites displayed a critical fibre length and optimum fibre weight percent of 30 mm and 40%, respectively. Scanning electron microscope (SEM) studies were carried out to evaluate the fibre/matrix interactions. The experimental tensile strengths were compared with the theoretical predictions and found to be in good agreement with Hirsch's model. An X-ray diffraction (XRD) analysis of the composites exposed the presence of cellulose IV with a crystallinity index of 60% and crystallite size of 68 nm.

1. Introduction

Natural fibre-reinforced polymer composites have gained attention among materials scientists and engineers in recent years due to the need to (i) develop an environmental friendly material and (ii) partly replace currently used synthetic fibres in fibre-reinforced composites. The benefits of natural fibre composites include high specific strength and modulus, low cost, light weight and recyclability. Therefore, natural fibre-based composites have good potential for use as structural materials. Several authors have reported the use of natural fibres such as palmyra [1], sisal [2], banana [3], oil palm [4], henequen [5], jute [6], hemp [7] and wood pulp [8] as reinforcements in polymer matrixes.

Polyester matrixes possess exceptional adhesive properties, high rigidity, dimensional stability and exceptional heat and fire resistance due to a highly cross linked aromatic structure. The modification of polyester resins by the inclusion of fibres, particulate fillers or elastomeric materials enables them to overcome high brittleness, cure shrinkage and the major drawbacks that prevent the widespread application of resins [9]. Polyester resin generates chemical bonding with lignocellulosic reinforcement, leading to strong forces between the fibres and the resin. Thus, a high compatibility in the system between the vegetable fibres and polymer is achieved. It has been reported that hemp fibre is a potential reinforcement for polyester matrixes [10].

In recent years, polymer composites reinforced with short, natural fibres have gained importance due to the advantages they impart during processing, their low cost and their high strength [11]. The properties of short fibre composites are strongly influenced by the fibre length, fibre orientation and fibre weight percent [9]. Velmurugan et al. [1] studied the mechanical properties of randomly oriented short palmyra fibre-reinforced composites and identified the critical fibre length and optimum fibre weight percent of short palmyra fibre polyester composites as 50 mm and 53%, respectively.

In tropical countries, fibrous plants are available in abundance, and *Sansevieria cylindrica* is a wild plant found in various parts of tropical Africa and Asia. Presently, it is used as a plant for decoration [12]. Sreenivasan et al. [13] analysed the microstructural,

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