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Effects of Coir Fiber Loading on the Physio-mechanical and Morphological Properties of Coconut Shell Powder Filled low Density Polyethylene Composites

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Abstract

Coconut shell filled composites were prepared from recycled low density polyethylene polymer matrix containing up to 15 % weight of coconut shell powder as filler. The effect of coir fiber loading on the properties of the composites was then investigated. It was shown that the values of tensile strength, flexural strength and hardness increased up to 7.1MN/m^2,18.0GPa and 92.7 respectively. Impact energy decreased with increase in fiber length. With the introduction of fiber length from zero to 10mm, a decrease in density and increase in water absorption was observed.

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Keywords: coir fibre; coconut-shell; filler; LDPE; matrix

1. Introduction

Composites with light-weight; high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, wood etc. A unique feature of composites is that the characteristics of the finished product can be tailored to a specific engineering requirement by the careful selection of matrix and

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the reinforcement type. Frequently, strong materials are relatively dense, also, increasing the strength or stiffness generally result in a decrease in impact strength [1-4]. The amount of waste is ever increasing due to increase in population, developmental activities, change in life style and socio-economic conditions. Water sachet polyethylene are widely used polyethylene in developing countries especially Nigeria. Sachet water factories licensed and unlicensed are found in many streets in cities, towns and villages of Nigeria [5]. Over the last few years, different kinds of waste materials have been successfully utilized as fillers in polymer composites for various applications. This not only reduces the production cost but also offers an opportunity for utilization of waste materials thereby reducing environmental pollution [6]. Reinforcement of polymer such as polyethylene with natural fibers/particulates to form polymer composites has gained attention due to their low cost, availability, low density, acceptable specific properties, biodegrability and recyclable nature. Coconut shell is an important filler for the development of new composites as a result of its inherent properties such as high strength and high modulus [7]. M. Ashok Kumar *et al.* [8] have studied the utilization of Coconut Fiber (CF)/Sawdust reinforced Epoxy hybrid composites on mechanical properties and found that the hybridisation of carbon fiber and saw dust was similar to Epoxy/CF hybrid composites. An attempt is made in this work to use the agro-based coconut shell particles as reinforcement of polyethylene matrix. In the current study, the effects of coir fiber length on physical and mechanical properties of a coconut shell powder reinforced recycled low density polyethylene (RLDPE) composite has been investigated.

2. Experimental

The coconut shell was dried in open air and grinded into powder after which the powder was sieved in accordance with BS 1377:1990 standard using a 425µm sieve size. The pelletised polyethylene waste was sun-dried and shredded in a plastic crusher machine. Composition of coconut shell powder, coir fiber and shredded pure water sachet (RLDPE) were weighted accordingly and melt mixed for a period of 30 minutes at temperature of 180°C using a two-roll mill.

Characterization

Scanning electron microscopy analysis was conducted to study the morphological features of the various layers of the polymeric samples using an ultra-high vacuum and high resolution FEI Xl-30 scanning electron microscope. Densities and the percentage water absorption of the compacted samples of known weight were determined. The hardness property of the samples produced was determined using a Hardness tester Model 5023-A with supporting table Model 5019. Tensile test of the composites was carried out using the Hounsfield Tensometer Tensile Machine and the ASTM standard dimension was observed. The flexural strength was calculated using the equation [9]

$$\text{Flexural Strength}=\frac{3\text{PL}}{2bd^2}\,(MPa)$$

Where, P = maximum load applied on test specimen (N)
L = support span/gauge length (mm)
b = width of specimen tested (mm)
d = thickness of specimen tested (mm)

3. Results and discussion.

It is well known that the dispersion and interface interaction of nanofillers in a polymeric matrix are two key factors for polymer composites. Figure 1 shows the SEM images of fractured surfaces of the fabricated composites. It clearly indicates well-dispersed materials within the matrix. The homogeneous dispersion can be attributed to the melt mixing using the two-roll mill. Furthermore, it is clear that the composites have a rough fracture surface due to the embedding in the matrix which indicates the strong interaction between the filler and matrix. Therefore, the significant improvement in mechanical properties of the composites is expected owing to the well oriented dispersion throughout the matrix and the strong interaction between the fillers and the matrix.