MORPHOLOGICAL AND MECHANICAL PROPERTIES OF BIO WASTE COCONUT/BAEL SHELL POLYMER COMPOSITE

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Abstract

Morphology and mechanical properties of coconut and bael shell particles reinforced epoxy composites were evaluated to assess the possibility of using it as a new material in engineering applications. Coconut and bael shell filled composites were prepared from epoxy polymer matrix containing up to 20 wt% coconut and bael shell fillers. The effects of coconut shell particle content on the mechanical properties of the composites were investigated. Scanning electron microscopy (SEM) of the composite surfaces also studied. The maximum flexural strength of the both the composites are obtained for 15 wt%. This work has shown that coconut shell particles can be used to improve properties of epoxy polymer composite to be used in eco-buildings.

Keywords: *Bael, Coconut, SEM, Flexural, Epoxy*

1. Introduction

Bio fillers (BF) have an outstanding potential as reinforcement in thermoplastics. The growing environmental awareness throughout the world has triggered a paradigm shift towards designing materials compatible with the environment. These bio fillers possesses many environmental advantages such as low cost, low density, lower pollution, high toughness, good thermal properties, reduced tool wear and biodegradability [1-6] over conventional reinforcing fillers (glass, carbon) [7-8].

Many researchers have directed their work on bio waste like bamboo, jute, hemp, oil palm shell, coconut coir used as reinforced in polymer composite (Varghese et al. [9] and Geethamma et al. [10] and also reported their several applications[11]. Among the various agricultural waste coconut and bael shell could be very interesting material as filler in biodegradable polymer composites, due to its good thermal stability compared to other agricultural waste [12-13].

Coconut (Cocos nucifera) and Bael (Aegle marmelos) is a member of palm family. Their shells are hard lignocellulosic bio-waste. A lot of research has been done on bio fiber reinforced polymer composites but research on coconut and bael shell particles fillers based polymer composites is very rare. The present investigation deals with fabricate and characterization two new type of polymer composite in which Coconut and Bael shell are used as reinforcement and study their mechanical and morphological properties.

2. Materials and Methods

The experiment started with the procurement of the coconut shell and wood apple shell specimens, resin, hardener, mould and roller. The coconut and wood apple shells were procured from a local grocer. These shells were cleaned then grounded to form a powder with the particle size -90 to +45 microns using ball milling machine. The true density of coconut and bael shell is 1.60 g/cm^3 and 1.068 g/cm^3. Epoxy resin LY556 with the density of 1.2 g/cm^3 and hardener HY951 were procured from a local supplier. The resin used was epoxy resin LY556 with the density of 1.2 g/cm^3. The weight ratio of the resin and hardener was 10:1.

Table1. The proximate analysis of coconut shell and bael shell

Properties	Coconut shell (%)	Bael shell (%)
Moisture content at 110^{o}C	5.6	6.6
Ash content at 725^{o}C	2.72	0.85
Volatile content at 925^{o}C	74.14	73.34
Fixed carbon	17.54	19.21

Mixing of the epoxy/coconut and wood apple shell particle was carried out by hand layup technique. The epoxy is firstly mixed using casting technique with coconut shell powder (5%,10%,15% and 20% vol% by weight) until it is homogeneously mixed before the catalyst is added to initiate the polymerization reaction. The above mixture was stirred for 5-7 minute by a glass rod to obtain uniform dispersion of particle and then poured in to the mould. The dimension and shape of mould were made according to the size and shape of samples as per ASTM standard D 790-97 for flexural testing. During the application of pressure some polymer squeezes out from the mould. This has been taken care off during pouring. The samples were kept in the moulds for curing at room temperature for 24 hour until the mixture was hardened. When the composite was hardened it was removed from the moulds and cut for flexural test with a diamond cutter according to ASTM standard. Similarly Bael shell shell particle composite were prepared.

3. Results and Discussions

The density of composite materials in terms of volume fraction is found out from the following equations 1.

$$s_{ct} = \frac{W_0}{(W_o) + (W_a - w_b)} \quad (1)$$

Where "ρ_{ct}' represents specific gravity of the composite, W_0 represents the weight of the sample; W_a represents the weight of the bottle + kerosene, W_b represents the weight of the bottle + kerosene + sample.

Table 2.Density of coconut and bael shell composite

% of filler	True Density of coconut shell (gm/cm^3)	True Density of Bael shell (gm/cm^3)
5	1.245	1.189
10	1.272	1.188
15	1.285	1.187
20	1.299	1.181

Flexural test were carried out on a universal testing machine INSTRON H10KS with maximum load 250 kN. It is reported in ASTM D 3039/D [14] that five specimens per test condition should be carried out for testing the polymer matrix composite materials and all tests were carried out according to the above mentioned standard. Three different filler contents by weight were used namely 5%, 10%, and 15% and 20 % by weight.

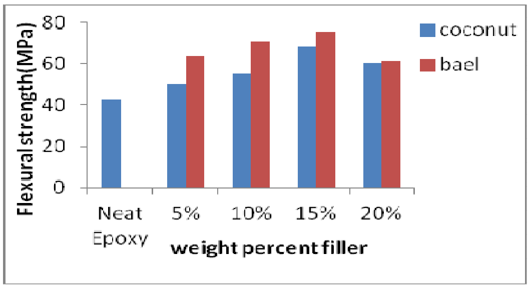

Figure 1 Flexural strength of composites

Morphological studies of the CS/BS composites were carried out using a Philips XL30 SEM (Philips, UK). The deposited CS/BS particles were detected using backscattered secondary electrons (BSE) with a 15 keV electron beam, at magnification of 300x, a spot diameter of 5 µm, take off angle of 15°, and with an acquisition time of 60s. Morphology studied indicates that the tendency of filler-matrix interaction improved with the increasing filler in polymer matrix.

Figure 2 SEM microstructure of Bael shell particles

4. Conclusions

The following conclusions are drawn from this study.

A new set of composites with bael and coconut shell powder as filler material are successfully fabricated.
The maximum flexural strength is obtained for both the composite prepared with the 15wt % reinforced particulate filled epoxy composite

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