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Effect of Filler Volume Fraction on the Tensile Properties of Cocoa-Pod Epoxy Resin Composite

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ABSTRACT

Particulate filled polymer composites are becoming attractive because of their low cost and wide applications. To determine, the possibility of using agricultural waste materials, as reinforcing fillers in thermosetting polymer composite, the effects of cocoa-pod filler (CPF) volume fraction on the tensile properties of Epoxy composite was investigated, different filler concentrations (viz. 5 to 30 weight %) were fabricated, test results shows that tensile strength, load at break, of the composite decreases with filler concentration while elastic modulus of the composite increases with increase in filler concentration. With decrease in tensile properties, cocoa pod filler (CPF) can be use as non- reinforcing filler in Epoxy composite.

Keywords: *cocoa-pod, epoxy composite, reinforcing filler, tensile properties.*

1. INTRODUCTION

In developing countries, harvest season are often accompanied with tones of residues that are of environmental menace and in some cases hazardous. Many of these materials could be utilized in developing composite material as fillers.

Research is proceeding to develop composites using various recycled wastes [1], especially in developing composites using most environmentally friendly agro-wastes as reinforcing fillers and thermosetting polymers as matrixes. Recent investigations of polymer-based composite materials have opened new routes for polymer formulations and have allowed the manufacture of new products with optimal properties for special applications [2, 3]. In most cases, these composites improve the product design and reduce the material and energy consumption. A number of natural occurring fillers and fiber in composite have been studied in the past. These include wood fillers [4], wheat straw, almond husk, ash rice husk [5, 6], pineapple leaf, [7] coconut fruit fibers, Wood base filler derive from oil palm wood flour [8] etc. These fillers introduce some advantages compared to traditional inorganic fillers, including their renewable nature, low density, nonabrasive properties, reasonable strength, and stiffness [9]. Luo and Netravali [10] studies the tensile and flexural properties of pineapple fiber, Belmeres et al [11], studies sisal, henequen, and palm fiber, and found that they have similar physical, chemical, and tensile properties, epoxy composite reinforced with the use of cotton fiber along with glass fiber [12] have also been investigated.

Using natural filler to reinforce the composite materials offers the following benefit in comparison with mineral filler [13, 14], strong and rigid, light weight, environmental friendly, economical, renewable and abundant resource. However they have the disadvantage of degradation by moisture, poor surface adhesion to hydrophobic polymers, non-uniform filler sizes, not suitable for high temperature application among others [11].

This work is part of a comprehensive study of the utilization of cocoa-pod with potential application in polymer composite fabrication. The objective of this research therefore, is to investigate the effect of filler volume fraction on the tensile properties of cocoa-pod epoxy resin composite

2. MATERIALS AND METHODS

2.1 Sample Preparation

The cocoa pod was obtained from harvested cocoa-pod husk during the harvest season in south west Nigeria. A rip pod is yellowish in color, which turns dark brown when expose to sun light or humid hot environment in the farm waste dump. The cocoa-pod was dried in an oven at 80^0C until a constant weight was observed, after which the sample was grinded into powder with the use of an electric blender. The grinded powder was later sieved with BS/ISO 3310 into particle size of 38 µm. This was used for all the different percentage compositions.

Epoxy resin and hardener were supplied by a local supplier in Lagos Nigeria; the resin used was epoxy resin 3554A with a density of 1.15 g/cm3. The weight ratio of the resin and hardener was 100:50.

2.2 Methods

The weight ratio of resin to hardener was 100:50. After being thoroughly mixed with the filler, the resin was poured onto the cavity of a steel mold, previously coated with a mould releasing agent they were allowed to cure, at room temperature for 24hours. Composites with amounts of Cocoa-Pod Filler (CPF) ranging from 0, 5, 10, 20, and 30 wt. % were manufactured. The composite were analyzed using a Universal

Instron testing machine model 3369, in accordance with ASTM Test Method D638-03.

3. RESULTS AND DISCUSSION

Figure 1 shows the mean tensile strength with increase in percentage of filler volume fraction. There was however a reduction in mean tensile strength of 35% during initial stage of filler loading and continue to 73% reduction in tensile strength at 30% filler loading. As the filler loading increased, there is increase in the interfacial area, the worsening interfacial bonding between filler (hydrophilic) and matrix polymer (hydrophobic) decreased the tensile strength.

Figure 1: Shows Tensile strength of material against increasing filler volume

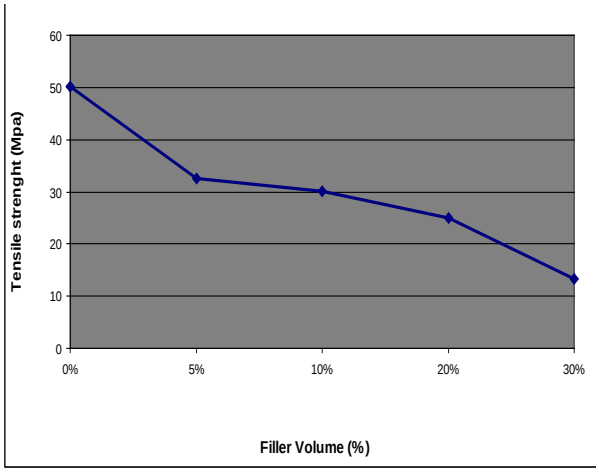

Figure 1

The graph of Modulus plotted against filler volume fraction is shown in figure 2, from the graph, it was observed that modulus increases with increase in filler volume fraction

Figure 2: Shows Modulus of material against increasing filler volume

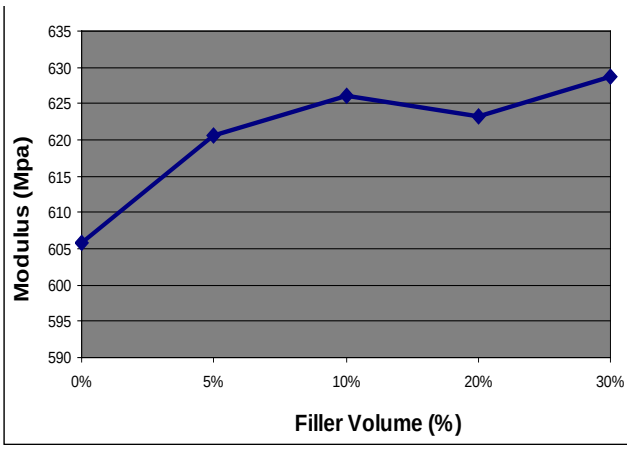

Figure 2

Figure 3 shows the graph of load at break plotted against filler volume fraction. It was observed that there was a decrease in load at break as filler volume fraction increases, 71.3% reduction was recorded at 30% filler loading

Figure 3: Shows load at break against increasing filler volume

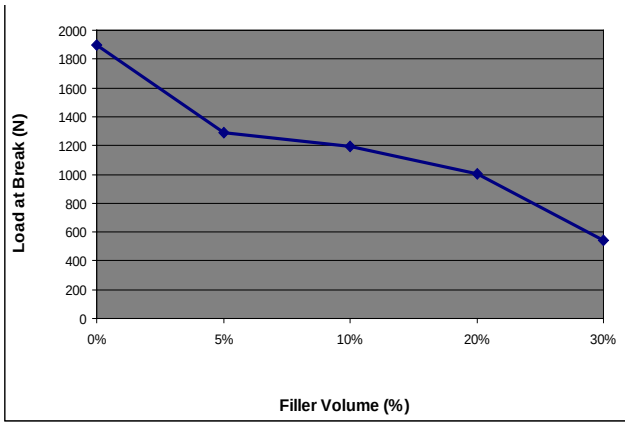

Figure 3

4. CONCLUSION

There was a reduction in the tensile properties of cocoa-pod epoxy resin composite. At 30% of filler volume fraction, the tensile strength reduces by 73% with 3.76% increase in modulus.

Cocoa-pod can thus be classified as non - reinforcing filler in epoxy composite

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