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EFFECT OF COPPER NANO PARTICLES ON BANANA FIBER REINFORCED POLYSTER COMPOSITES

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ABSTRACT

Natural fiber reinforced composites offer specific properties compared to the artificial fiber composites. Natural fibers are low cost fibers with low density and high specific strength. In the present work, copper nano particles prepared by chemical method are used as filler material in banana fiber reinforced polyester composites. The composites are prepared by hand lay-up technique. The tensile strength, flexural strength and density of the composites are evaluated. The tensile strength, flexural strength and the density of the composites improved with the addition of copper nano particles. Scanning electron microscope is used to determine the size and shape of copper nano particles.

Key words: *Copper nano particles, Banana fiber reinforced composite, Tensile strength.*

1. Introduction

Fiber Reinforce Composite (FRP) materials form an economical and viable solution to the conventional materials. FRP materials with glass, carbon and armid fibers have the advantage of high stiffness and strength to weight ratio as compared to conventional materials. Despite these advantages, the use of synthetic fiber reinforced composites is restricted because of their high cost. To overcome this, natural fibers are used as reinforcements in polymers. Natural fiber composites (i.e bio-composites) are composed of natural or synthetic resins reinforced with the natural fibers. Natural fibers are recyclable, biodegradable, renewable and have high strength and stiffness. Natural fiber reinforced composites have low density combined with good mechanical properties. Most commonly used natural fibers are kenaf, hemp, flax, bamboo, banana and jute. Banana fibers reinforced phenol formaldehyde composites showed an improvement in tensile and flexural properties with increase in fiber content upto 40% [1]. Although these composites provide excellent mechanical properties, some applications demand improved mechanical properties as well as additional properties. The properties of these composites can be further improved by addition of nano particles. The nano particles act as additional reinforcements and enhance their mechanical, thermal and electrical properties. The additions of nano particles to FRP composites show a significant improvement in their properties. ZrO, ZrO_2 and CeO_2 nano metal oxides are added to epoxy to improve their density and mechanical properties [2]. Silica nano particles improved the toughness of carbon fiber/epoxy laminates [3]. The nano structures oil palm ash improved the density of epoxy nano composites. The 3 wt% oil palm ash composite showed maximum tensile and flexural strength [4]. The addition of nano clay particles to FRP composites significantly improved their tensile strength, impact strength and fatigue life [5]. Nano silicon dioxide particles in GFRP improved their stiffness [6]. The thermal conductivity of epoxy resin is increased by addition of copper nano particles [7]. Hence, in the present work copper nano particles are added to 40wt% banana fiber composite to study their effect on tensile and flexural strength.

2. MATERIALS AND METHOD

The following section highlights preparation of copper nano powder and the specimens.

2.1 Preparation of Nano Powders

Copper nano particles are prepared by using chemical method. Two solutions are prepared by mixing Cu $(NO_3)_2$ in (0.5m) ethanol and (0.4m)NaOH in ethanol. These two solutions are stirred for about 60 minutes under magnetic stirrer. After stirring, the two solutions are mixed and transferred to test tubes. These test tubes are placed in the centrifuge machine and centrifuged for about

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15minutes. After centrifuging processes, the clear solution left is poured off leaving gel of copper nano particles.

2.2 Chemical Treatment of Banana Fibers.

The raw banana fibers were purchased from the local market. The fibers are soaked in water for 24 hours and dried in sunlight. After drying, the fibers are cleaned from dust by vigorous rubbing and combing. To increase the surface roughness and to improve the adhesion properties, the fibers are treated with NaOH solution and acetic acid solution. The fibers are soaked in 5% NaOH solution for 3 hours and washed with distilled water. The obtained fibers are then soaked for 20 minutes in acetic acid solution, washed in distilled water and dried in sunlight.

2.3 Preparation of Composites

The composites are prepared by hand layup processes. Three different specimens, shown in Table-1 are prepared to study the effect of banana fiber and the effect of copper nano particles with fibers in polyester resin. All the specimens are prepared by hand layup process. Specimen S1 is prepared by pouring the resin mixed with hardener and catalyst in the mould. S2 is prepared by laying the fibers in the mould and pouring the resin mixture. Specimen S3 is prepared by immersing the fibers in the gel consisting of copper nano particles. The fibers are then laid in the mould and allowed to dry in sunlight. The polyester resin mixed with hardener and catalyst in the required proportions is poured into the mould and allowed to cure in sunlight. After curing, the composite is stripped off from the mould and tensile specimens are cut according to ASTM standard.

Table 1. Designation of Specimens.

S.No	Specimen Designation	Specimen Details
1	S1	Pure Polyester
2	S2	Polyester+40wt% Banana Fiber
3	S3	Polyester+ 40wt% Banana Fiber + 1wt% Cu Nano Particles

2. RESULTS AND DISCUSSIONS

The SEM characteristics of the nano powder, the density of the specimens, and the tensile and flexural strength of the specimens are given below.

3.1 Powder Characteristics

The SEM photograph of the copper nano particles is shown in Fig.1. It is observed that the particles are near spherical shape. Similar observations were also made by srecko et.al. [8].

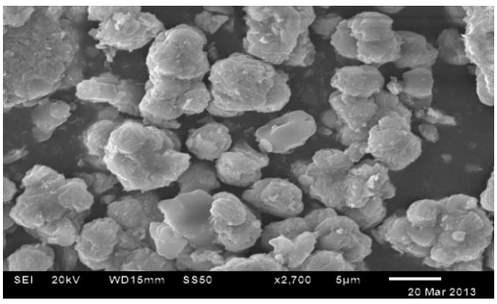

Fig.1 SEM Photograph of Copper Nano Particles

3.2 Density

The density of the neat polyester, banana fiber composite and the nano composite is shown in Fig.2. It is observed that, the addition of copper nano particles improved the density of the composite. This is due to high density of copper (8.96 g/cc) when compared to the density of polyester (1.5g/cc) and banana fiber (1.4g/cc).

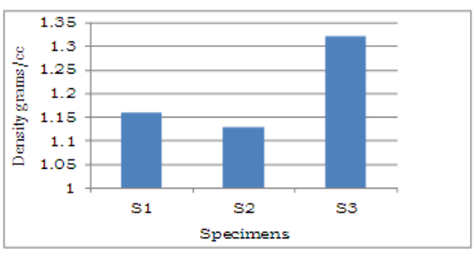

Fig.2 Density of Specimens

3.2 Tensile Strength

The tensile strength of the prepared specimens shown in Fig.3 is determined using electronic tensometer model PC2000. It is observed that, the tensile strength of the composite is more than that of the neat polyester. The fibers act as reinforcements and increase the tensile strength of the polyester resin. The presence of banana fiber in the polyester matrix can be observed from the microstructure shown in Fig.4. The tensile strength is further increase by the addition of copper nano

particles. The copper nano particles act as particle reinforcement and enhance the tensile strength.

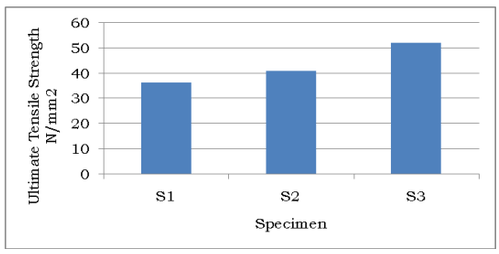

Fig.3 Ultimate Tensile Strength of Specimens

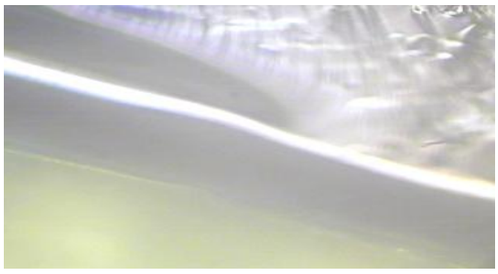

Fig. 4 Microstructure of Banana Fiber Composite

3.3 Flexural Strength

The flexural strength of the specimens determined from the three point bend test on electronic tensometer is shown in Fig.5. The addition of the banana fibers to the polyester resin increases its flexural strength. The flexural strength is further increased by the addition of the copper nano particles. The copper nano particles and the banana fibers act as the reinforcing materials and enhance the flexural strength of the composite.

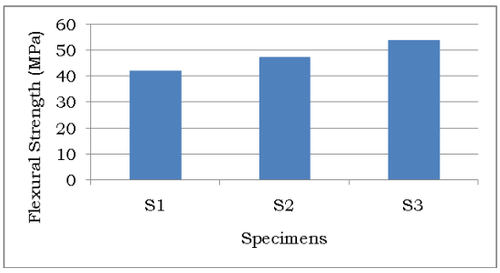

Fig.5 Flexural Strength of Specimens

4. CONCLUSIONS

- The following conclusions are drawn from the present work.
- The copper nano particles prepared by chemical method are in the form of spheres.
- The density of the copper nano composite is superior to those of banana fiber composite and neat polyester.
- The addition of the copper nano particles increased the tensile and flexural strength of the composite.

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