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Influence of Ceria Oxide as filler Material on e-glass fiber/epoxy Reinforced Hybrid Composites

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ABSTRACT

This paper describes the mechanical characterization of particulate filled hybrid composites. The work is carried out to know the influence of filler material and to fabricate a new class of composites. The filler material is varied based on weight fraction i.e. 1%, 2% &3%. The mechanical properties such as Tensile, Flexural & Rockwell hardness are compared with unfilled composite. The testing is conducted as per the ASTM standards. The rare earth material is used as the filler material. Among the four different class of composites, the composite C3 had better results.

Key Words: *GFRP, Mechanical Properties, Epoxy resin (Lapox-L-12, Hardner K-6), Ceria oxide as filler material, Tensile strength, Flexural strength.*

1. INTRODUCTION

Composite materials are defined as the binding of two or more materials that in turn result in the different properties than parent materials. Fiber reinforced plastics have been widely used for manufacturing aircraft and spacecraft structural parts because of their peculiar physic mechanical properties such as high specific strength and high specific stiffness. Another significant application for fiber reinforced polymeric composites (especially GFRP) are engaged for producing PWB (printed wiring board). The use of polymer composite materials is becoming increasingly important. For that reason, studies on the mechanical properties of these composites are very significant. Many have been published concerning the mechanical properties of the PMC with a variety of fillers including organic and inorganic fillers. Strength, hardness and wear are been improved by addition of silicon carbide, alumina, and titanium carbide. [1,2]. Glass fiber epoxy composites erosion wear resistance improved by graphite particles. [3] Wear resistance is be increased in glass vinylester composites by adding filler as fly ash. [4] .The impact strength of bamboo epoxy laminate with addition of filler censopher [5]. Mechanical strength of glass fiber reinforced composites is improved by addition of coal ash as filler. [6]. In the present work an attempt is made to study the effect of ceria oxide as a filler material in epoxy glass fiber reinforced composites.

2. MATERIALS AND METHODS

2.1 Materials

Materials used in this experimental work are as follows:

1. E-glass fiber plain weave mat (200GSM)
2. Lapox resin, L12
3. Hardener, K6
4. Ceria oxide as filler material

2.2 Specimen preparation

Fabrication of laminates in the present work the traditional method is adopted i.e. Hand layup, as shown in the figure 1. The material s used are Mat type 200 GSM Glass Fiber. The matrix material used is one of the family member of Epoxy with a medium viscosity (LAPOX L-12) and hardener (K-6), both manufactured by ATUL India Ltd, Gujarat, India. This combinations of matrix and hardener is selected based on two priority i.e. it is having good resistance to alkalis and adhesive. Based on volume fraction, the calculations were defined as for 60-40 (60% Glass Fiber – 40% Epoxy Resin) combination showed a better result. Filler materials i,e ceria oxide were added to different combination by keeping Epoxy percentage constant (40%). Based on literature review , the amount of filler added was 1, 2, & 3 % , the details are as shown in Table 1. After fabrication of the specimen, the specimens were cutted according to ASTM standards for different test to obtain the strength of materials.

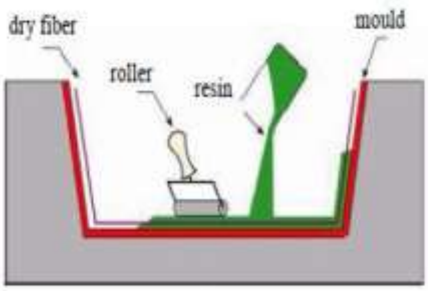


Figure 1: Hand lay-up Technique

Table 1: Nomenclatures of composite material fabricated

Sl. No	Specimen code	Glass fiber content %	Epoxy	Filler content in %
1	C1	60	40	---
2	C2	59	40	1
3	C3	58	40	2
4	C4	57	40	3

3. EXPERIMENTAL SETUP

Following tests were conducted in the present work;

- Tensile test
- 3-point bending test
- Rockwell hardness test

3.1 Tensile strength:

The test is being conducted as per the tensile test standards for composite Materials (ASTM D3039). The displacement velocity is been kept constant at 2mm/min. the cross section area is been calculated based on initial breadth and width of specimen. The output parameter is obtained a stress strain curve, from this the ultimate stress, percentage of elongation, break load and yield stress is calibrated. Three trials are conducted for each laminate.

Figure 2: Tensile testing setup

3.2 Flexural strength

Definition of Flexural strength states that "The ability of the material to withstand bending forces applied perpendicular to its longitudinal axis". The combination of compressive and tensile stress, are induced by the flexural load.

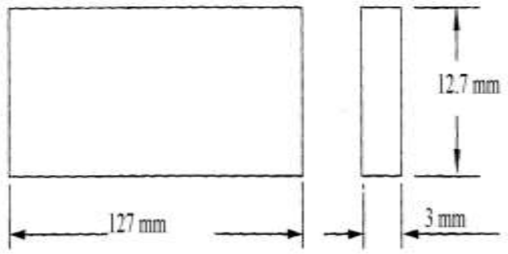


Figure 3: Flexural Test under ASTM Standard D790

The test is been conducted with the help of UTM of capacity (1-100kN) as it gives better result for composite materials. Test was performed at a crosshead speed of 2 mm/min considering a beam span of 50 mm. The output result is a load Vs displacement curve, from this result the ultimate stress and break load is calibrated. Three trials are tested for each laminate.

Figure 4 : Flexural testing setup

3.3 Rockwell hardness test

The hardness test was completed utilizing a Rockwell hardness analyzer. First, the specimen was cleaned and made free from impurities and irregularities. The test was performed on the side that had the best smooth and homogeneous surface at 24ºC ,with the specimen thickness of 2.5mm. The example was put on a hard, level surface. The durometer was held in a vertical position with the purpose of the indentor at least 12mm away. The pressure foot was applied to the specimen without stun, keeping the foot parallel to the surface of the example. Hardness values were taken from 3 samples of different composition .The mean value of the results was calculated.

Figure 5 : Rockwell hardness test setup

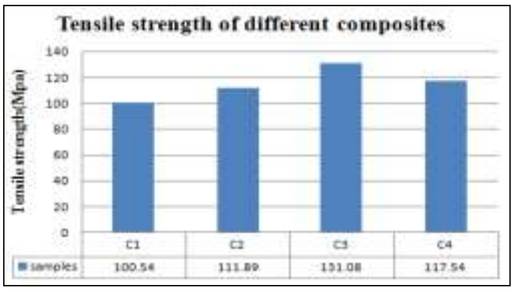
4. RESULTS AND DISCUSSION

4.1 Mechanical Properties

Mechanical properties of these kind of composites rely on matrix, isolated powder and as well as on interface between fiber and matrix. The mechanical properties are also influenced by other factors like type of filler, amount of filler, dissemination of filler in the matrix, processing parameters and kind of bonding between matrix and filler. From the fabricated composites, the test samples are prepared as per ASTM standards and are tested to assess their tensile and flexural strength. The results accomplish by conducting these tests are given below.

4.2 Tensile Strength

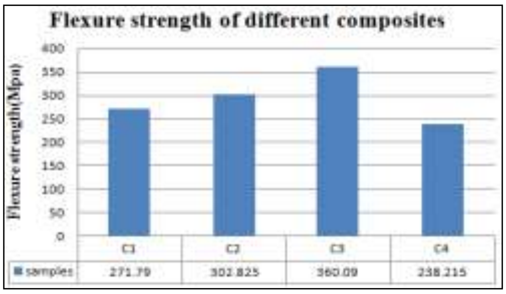
The effect of ceria oxide content on the tensile strength of the composite is shown in graph 1. It is observed that the tensile strength varies from 100.54MPa to 131.08MPa. The tensile strength increases for the composite C3 and thereafter it decreases. Increase in ceria oxide corresponding increase in tensile strength, due to the good interfacial bonding between the ceria oxide and the matrix. As the filler content is further increased the composite transforms into brittle and hence the tensile strength decreases.



Graph-1: Comparison of Tensile strength for different composites

4.3 Flexural Strength

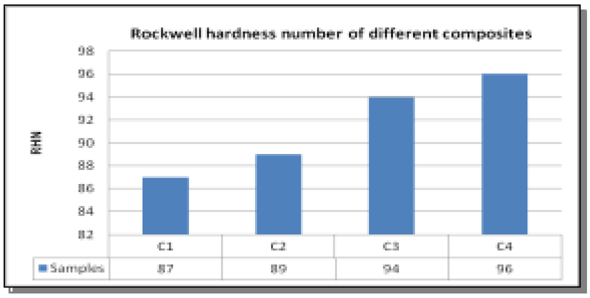
The flexural strength of the composite is examined from 3-point bend test. The flexural strength for various composites is shown in figure. The flexural strength of the composites varies from 271.795MPa to 360.09 MPa and the maximum value is obtained for composite C3 on further addition of ceria filler material in the epoxy matrix, the flexural strength decreases.



Graph-2: Comparison of Flexure strength for different composites

4.4 Hardness Number

Resistance to indentation is known as Hardness of material. On occasion hardness refers to resistance of Resistance to indentation is known as Hardness of material. On occasion hardness refers to resistance of material to scratching or graze. Hardness may be measured from a small sample of material without destroying it. Hardness is not primary property and its value depends on the blend of yield strength, tensile strength and modulus of elasticity. The test conducted on Rockwell hardness machine, as per the ASTM standards the specimen prepared as per ASTM E10, the chart 3 shows the comparison with unfilled composite and filled hybrid composite. The hardness is increased by corresponding increase in the hard reinforcement weight percentages in the composites.



Graph-3: Comparison of Rockwell hardness number for different composites

5. CONCLUSION

In the present work glass fiber reinforced with ceria oxide as fillers were used for preparation of sample laminates by using hand layup technique. The flexural strength and tensile strength were tested.

The conclusions drawn from the present work are.

The tensile strength of the composites varied from 100.54MPa to 131.08 MPa and the maximum is obtained for composite C3 with ceria oxide as filler material.

The flexural strength of the composite varies from 271.795 to 360.09 MPa. The maximum flexural strength is obtained for the composite C3 with ceria oxide as filler material.

The Rockwell hardness number of the composites varies from 87 to 96 RHN and the maximum is obtained for composite C4 with ceria oxide as filler material.

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