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Investigation on tensile strength of silicon carbide epoxy polymer nanocomposite

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Abstract— **In this work, the tensile properties of silicon carbide nano composites were reported. The matrix material used in this work is thermoset polymer of epoxy resin. The reinforcement is glass fiber of Woven Roving Mat (WRM) and Chopped Strand Mat (CSM). The Nano composite laminates are prepared by hand layup method, by varying the nanoparticles Silicon carbide (Sic) 0, 1, 2 and 3 Wt. % respectively. The dispersion of Silicon carbide in resin was studied using Scanning Electron Microscope (SEM). The addition of silicon carbide improved the tensile strength of composites.**
Keywords: Silicon carbide; Glass fiber; Tensile Strength; Scanning Electron Microscope.

I. INTRODUCTION (*HEADING 1*)

Composite materials has their major applications in the field of aerospace and automobile industries. Polymer composites is of two type's thermoset and thermoplastic. Epoxy resin, a thermoset polymer is widely used nowadays. The addition of nano particles will improve the mechanical properties of the polymer composites. Silicon carbide can be used as nano particles, which has high hardness, high strength and it has excellent thermal and low thermal expansion. When it combines with the advantages of fiber composite materials it lead to high mechanical properties like tensile, impact, compression, etc.[4]. Tensile test delivers information on the safety and integrity of materials, components and products, helping manufacturers confirm that their finished products are fit-for-purpose and prepared to the highest quality.

Homogeneity, dispersion and size of the particle will strongly influence the performance of the nano composites [6].

Nano particles with Epoxy resin glass fiber composite will be paid more attention [1,2]. Nano particle has the capability of improving the tensile and other mechanical properties of polymers. The present paper focusses on Investigation on tensile strength of silicon carbide epoxy polymer nanocomposite with 1, 2 and 3 Wt. % nano particles. Scanning Electron Microscope (SEM) is used to analyse the bonding of nano composites prepared.

II. EXPERIMENTAL PROCEDURE

A. Material and Sample prepareation

We have used Epoxy resin LY556 with hardener HY951 as the matrix phase of our polymer composite. Then we used glass fiber of woven roving mat and chopped strand mat as reinforcement phase. In addition to this two phases, silicon carbide is used as Nano particles. In order to improve the strength of the composite, Silicon carbide is mixed with the matrix phase. Mixing of silicon carbide (sic) with epoxy resin is the first step in the fabrication process. The silicon carbide was mixed with the epoxy resin and the mixture is stirred for 120 mins at 800 rpm using high speed mechanical stirrer.

The mould of galvanized iron of dimensions (320*320) was fabricated. Then poly vinyl alcohol (PVA) is applied on the mould, which act as a releasing agent. Chopped strand mat and woven roving mat are laid alternatively for about six layers.

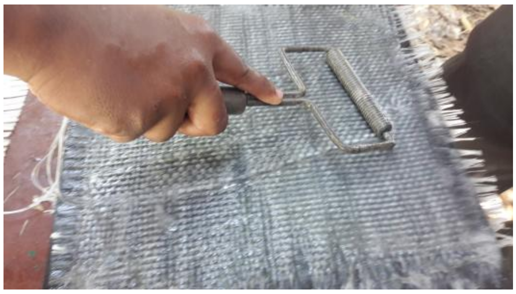

Fig.1 Fabrication process

The roller was then used to apply the resin uniformly to the entire part of the mould and also the roller helps to remove the air bubbles. Then the laminates in the mould is allowed to dry for about 48 hours. Post 48 hours, the laminates where separated from the mould. Totally four laminates were prepared, by varying the weight percentage composition of silicon carbide nano powder such as 0,1,2,3 percentages respectively. The entire process is carried out by hand layup technique [4, 5].

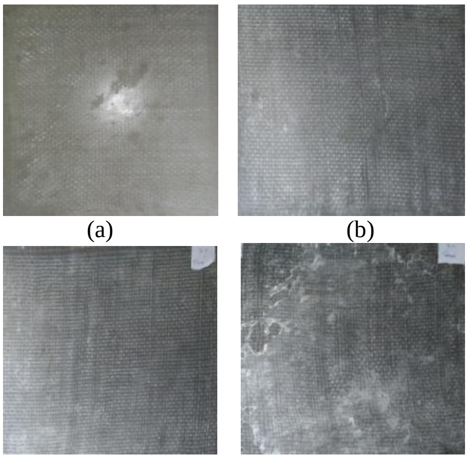

Fig.2 Finished samples having (a) 0%, (b) 1%, (c) 2% and (d) 3% Silicon carbide.

B. Characterization techniques

In order to study the rate of dispersion of silicon carbide on resin and also to study the rate of bonding of the reinforcement, the SEM test was carried out. One part of the sample is taken from the prepared laminates and test is carried out. The surface of the specimen were coated with thin gold film to increase the conductance for SEM analysis.

Fig.3 Scanning Electron Microscope

The model of Scanning Electron Microscope we used is JSM-6610LV. The voltage limit of this type is 0.3-30KV. It has a magnification range of ×5 to ×300000. We can use upto 200mm diameter of specimen. The scanning electron microscope shows the bonding between the matrix and the reinforcement phase in the laminates and also the rate or amount of dispersion of Sic in Epoxy resin can be verified. Since the Fiber Reinforced Polymer (FRP) is non-conducting, a thin gold film is coated on surface of the specimen to be tested. This provides a better conductance and better images can be produced.

C. Testing

Tensile test

Tensile test is performed to evaluate the bonding strength between the matrix and reinforcement phase and also to find the ultimate load for varying percentage of nano particles. The specimen is cut to a dimension of 200×25 for performing tensile test. The upper and the lower part of the specimen is clamped to a holder and the tensile load is acted on the specimen gradually by applying hydraulic load on it. Then the specimen tends to elongate up to a certain limit, until it reaches the ultimate load.

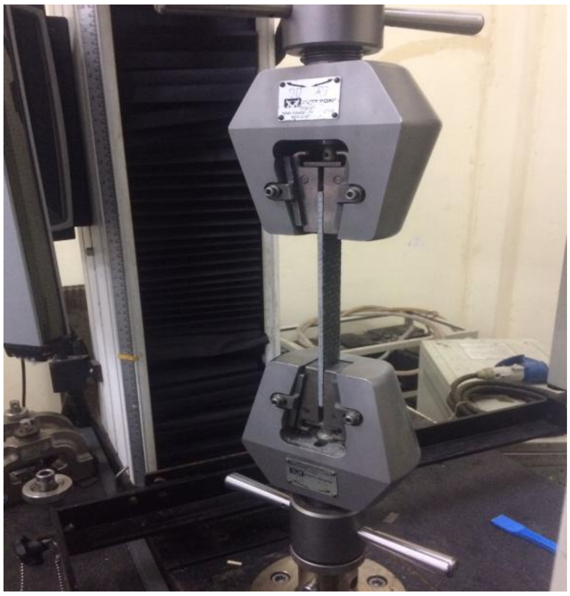

Fig.4 Tensile test

III. RESULT AND DISCUSSION

1. TENSILE TEST:

Tensile test is conducted to evaluate the tensile load of the specimens prepared. When the bonding is more between the matrix and the reinforcement, higher tensile values can be obtained. The entire fabrication process is done by hand layup technique. Totally 4 samples are prepared by varying Wt. % of nano particles, they are 0, 1, 2 and 3%. Tensile test results shows that the tensile strength of the specimen gradually increases with increase in percentage composition of nano particles. The specimen with zero percentage nano particles has the maximum load of 10448.67 N, whereas the specimen with one percentage of nano particles has a maximum load of 11664.26 N. This proves that the Maximum load increases with increase in percentage of nano fillers. The table below shows the various specimens about their tensile properties. [3]

Table.1

S L. N O	SAMPLE PERCEN -TAGE (Wt. %)	MAXIM-UM LOAD (N)	ELONG-ATION @ BREAK (%)	TENSILE STRESS (MPa)	YOUNG`S MODULUS (MPa)
1	0	10448. 6	2.97218	105.8495	3100.28
2	1	11664. 2	3.24446	116.5762	4786.54
3	2	12187. 2	3.28049	116.7696	5903.61
4	3	12322. 6	4.65274	122.1495	6025.13

Fig.5 tested specimens of 1 and 3 Wt. %

2. Scanning Electron Microscope

The SEM images are to analyze the structure of the nano composites and also to clarify the dispersion rate of Sic with the resin. Figure 6 shows the SEM image of the nano composites. In matrix phase some clusters are present but the Sic nano particle is dispersed homogeneously is clearly visible. The below SEM image shows that the bonding between the Fiber and resin is good and addition of nano particles improves the bonding between fiber and resin.

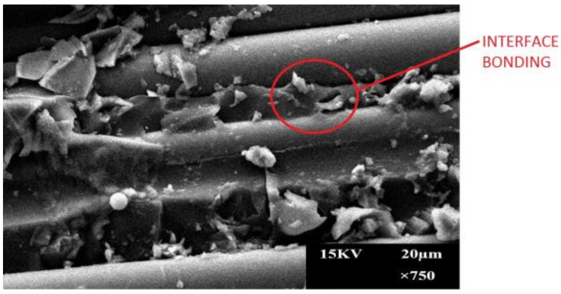

Fig.6 SEM image of 3% Sample

IV. CONCLU SION

The nano composite laminates were successfully prepared by varying the weight percentage of Sic by 0, 1, 2 and 3% respectively. The prepared samples were subjected to tensile test, the result of the tensile test clearly shows that by increasing the weight percentage of Sic, the tensile strength gradually increases with addition of Sic. The tensile strength of 1 Wt. % specimen is 116.5762 MPa, whereas the 3 Wt. % is 122.15 MPa. The SEM images clearly shows that the nano particles are evenly distributed over the epoxy resin. By increasing the Wt. % of Sic the tensile strength has increased and also better bonding is acquired. These composite laminates has huge applications in automobiles and air craft components. [6]

V. REFERENCES

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