Study Of Mechanical And Morphological Properties On Glass Fiber Reinforcement Polyester Composite With Graphene

Merlis Baby[1], Niranjan Hiremath[2], Shivasaranayya Swamy [3], Dr.Manjunatha L.H[4]

[1] M.Tech Scholar, [2,3,] Assistant Professor and [4]Professor
School of Mechanical Engineering
REVA University
Bangalore, India

ABSTRACT:

Composite materials are preferred mostly because of their high strength and light weight. The present work studies the mechanical properties such as tensile and bending strength of a polyester and glass fiber reinforced composites with and without the addition of graphene. In order to determine the static mechanical properties of the composite, tensile and bending tests of the polymer matrix composite is carried out. The tensile and bending test are carried out in the Universal Testing Machine.The percentage of graphene is varied and the tests are carried out in order to find out the optimum amount of graphene needed. Also scanning electron microscopic analysis is conducted to study the uniform distribution of graphene. The SEM study indicated that there is an uniform distribution of graphene in the composite material and also it is observed that the tensile and bending strength increases with the increase in graphene content.

Keywords: *Graphene, Mechanical properties, Morphology, Glass fiber reinforced composites*

1. INTRODUCTION

Composite materials gained much popularity in the modern society because of their unique properties like high strength and light weight nature. The usage of composite materials started in the early centuries, where brick, a combination of straw and mud were used for the construction purposes. A rapid boom in the field of composites started in 1940s, when the airplanes, helicopter and many other military vehicle preferred for a high strength light weighed materials Most of modern structures are made with the composites. Hence it is necessary to find out the mechanical properties of every composites. The glass fiber reinforced composites are widely used nowadays in aircraft and automotive industries.The basic tests like tensile and bending tests give the tensile and bending strength of the material respectively. Identifying the tensile and bending strength enables us to use the material according to its application. Also the SEM study helps to ensure the uniform distribution of the constituents. The SEM analysis is carried out in different magnifications.

2. METHODOLOGY AND EXPERIMENTATION

The hand lay up method has been used for fabrication of composites. Hand lay-up is the most common and less expensive method. It requires minimum number of equipments[1] . Both the large and small specimens can be prepared using this method. The mould is coated with the releasing agent, then the resin mixed with hardener and

catalyst is allowed to pour. After that the fibres are arranged manually. A roller is used to ensure the uniformity and smoothness of the surface. The prepared specimen is allowed to dry in atmospheric temperature.

The specimens are subjected to tensile, bending and SEM test in order to find out their mechanical and surface morphological properties[1].All the materials used in this work are commercially available. Polyester which is having a density of 1.37 g/cm^3 is used as the resin to bind the fibres. The fibres used are glass fibres of density 2.5 g/cm^3. The nano particle used is graphene which is an allotrope of carbon. Graphene is a good conductor of electricity and it has a density of 0.2 g/cm^3. Other allotropes of carbon like carbon nanotubes are used to increase the strength but they are expensive [3]. Graphene is used in the proposed work because of its novelty and economic feasibility.The constituents are taken in three different proportions for the fabrication. The percentage of constituents taken are enumerated in the table 1. The graphene is used upto 5 % because above that may cause the coagulation of graphene instead of uniform distribution.[4]

Table 1: Specimen Configuration

CONSTITUENTS	GRAPHENE %	GLASS FIBER %	POLYESTER %
Specimen 1	0	20	80
Specimen 2	2	20	78
Specimen 3	5	20	75

The tensile test specimens are fabricated according to ASTM D-3039 [5]. The length of the specimen is 250mm, breadth is 25 mm and the thickness is 3 mm. The line diagram representing the tensile specimen is shown in figure 1.

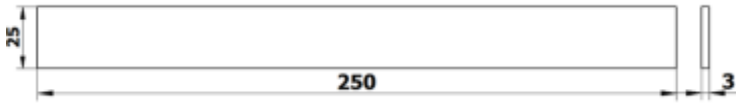

Fig 1: Line diagram for tensile test specimen

The bending specimens were manufactured according to ASTM D- 790 [6]. The length of the specimen is 125mm, breadth is 12.7 mm and thickness 3mm. the line diagram representing bending specimen according to standard is shown in Fig 2.

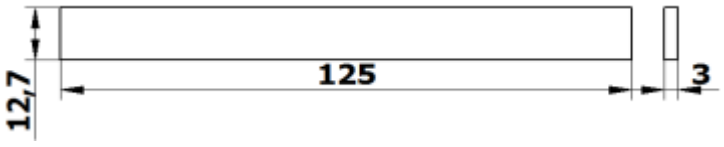

Fig 2: Line diagram for bending specimen

3. RESULTS AND DISCUSSION

The fabricated specimens were subjected to tensile and bending tests to find of the tensile and bending strength respectively. The results of tensile tests are shown below in the figures 5, 6 and 7 for three different compositions.

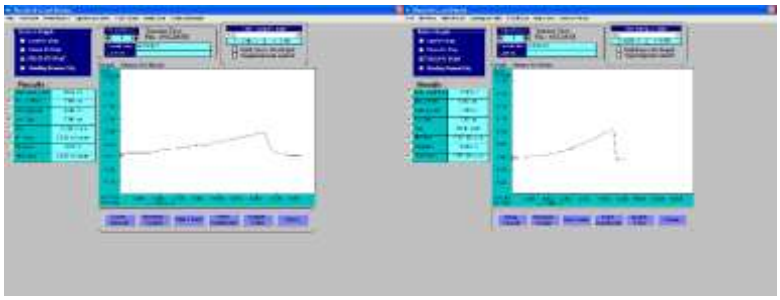

Fig 3: Tensile result for specimen 1 **Fig 4: tensile result for specimen 2**

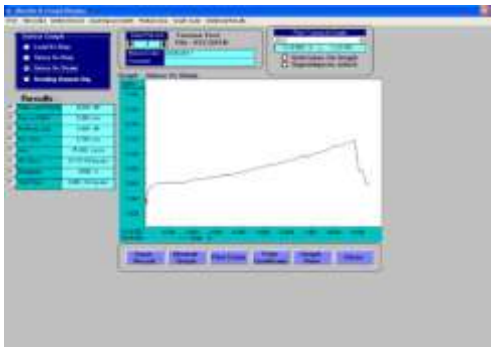

Fig 5: Tensile result for specimen 3

It is evident from the graphs that the peak load for specimen 1, specimen 2 and specimen 3 are 6600 N, 7760 N and 8840 N respectively. The tensile strength is calculated as follows

$$\text{Tensile strength } (\sigma_t) = \frac{\text{Load at failure (P max)}}{\text{cross-sectional area (A)}} \text{ MPa}$$

The Cross sectional Area = w*t = 25*3 = 75mm^2

Tensile strength for specimen 1 = 6600 / 75 = 88 N/mm^2

Tensile strength for specimen 2 = 7760 / 75 = 103.46 N/mm^2

Tensile strength for specimen 3 = 8840 / 75 = 117.86 N/mm^2

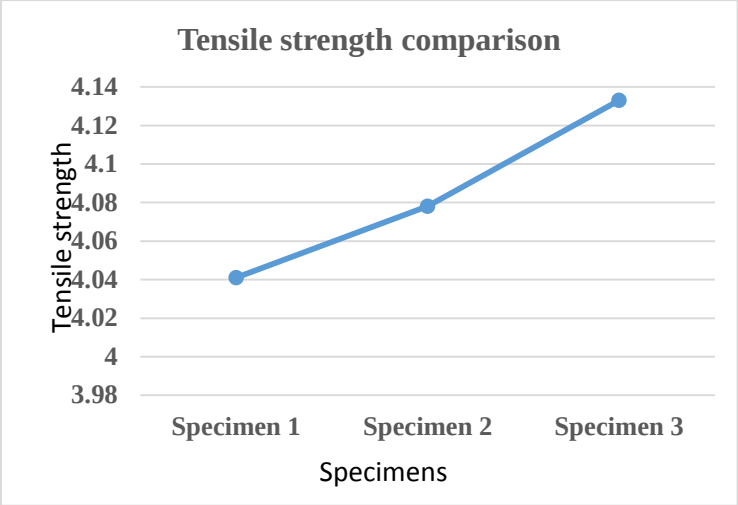

Fig 6: Tensile strength v/s Specimens

It is observed from the graph 6 that the tensile strength is high for specimen 3 and least for specimen 1. Thus it can be concluded that the tensile strength of the material is increased with the addition of graphene upto 5 % of its total mass.

The results of bending test are shown below in the Fig 7, 8 and 9 for specimen 1, specimen 2 and specimen 3 respectively.

Fig 7: Bending result of specimen 1

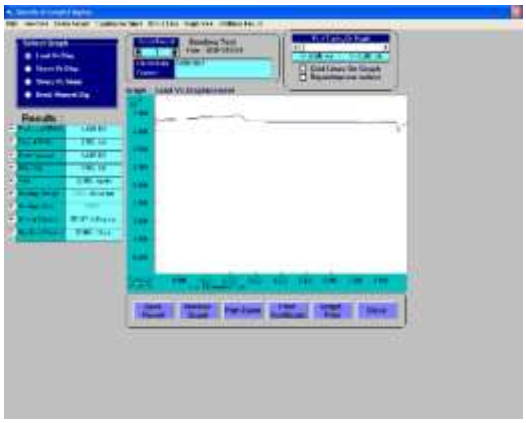

Fig 8: Bending result of specimen

Fig 9: Bending result for specimen 3

It is observed from the graph that the peak loads for specimen 1, specimen 2 and specimen 3 are 4400 N, 4440 N and 4500 N respectively. The bending strength is calculated as follows

Bending strength = $3PL/2bd^2$

P = Load in kN,

b = breadth = 12.7 mm,

L = span length = 70 mm,

d = Thickness = 3mm

The bending strength for specimen 1 = 4.041 kN/mm^2

The bending strength for specimen 2 = 4.078 kN/mm^2

The bending strength for specimen 3 = 4.133 kN/mm^2

A gradual increase is visible in bending strength with the increase of percent of graphene up to 5 % of the total mass.

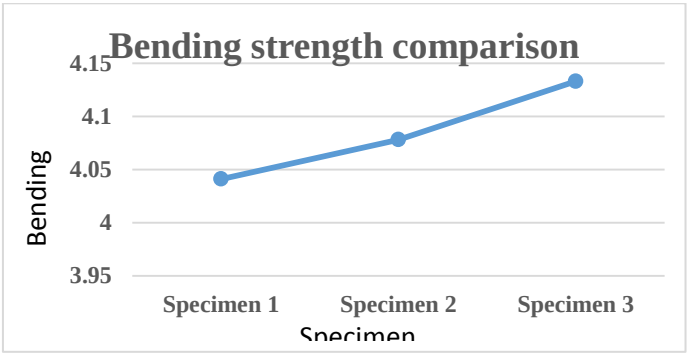

Fig 10: Bending strength v/s Specimens

It is clear from the line chart that the bending strength is high for specimen 3 and least fore specimen 1. Thus it can be concluded that there is an increase in the bending strength of the composites with the addition of graphene up to 5 %.

The surface morphology is studied for specimen 2 and specimen 3 in which the graphene is added. The results for both the composition are shown in Fig 11 and Fig 12.

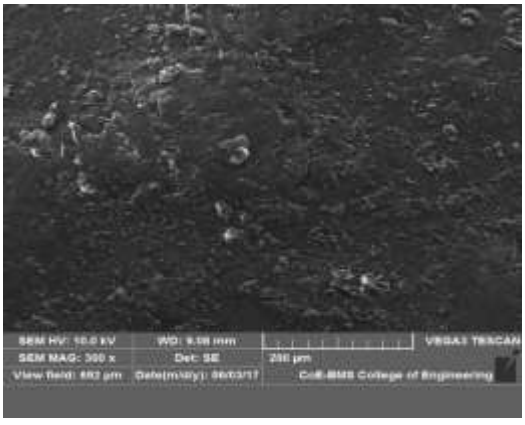

Fig 11: SEM results for specimen 2

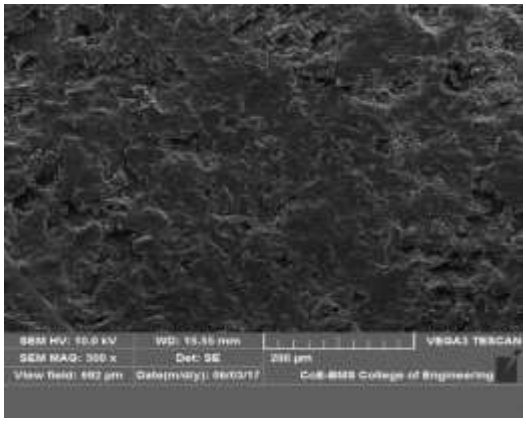

Fig 12: SEM results for specimen 3

It is observed that a more uniform distribution of graphene happened in specimen 3 where graphene is added in 5 %.

4. CONCLUSION

The tensile and bending strength of specimen 3 is showing appreciable result than other two configurations. Also observed to be uniform distribution of graphene is visible in the specimen 3 from SEM analysis. Therefore it can be concluded that with the addition of graphene the strength of the glass fiber reinforced polyester composite can be increased. It is preferable to add graphene up to 5 % weight fraction to increase the overall strength. Further the study can also be extended for addition of graphene in natural fibres can also be carry out.

5. REFERENCES

1) Uma Devi, S. S. Bhagawan, Sabu Thomas, "Mechanical Properties of Pineapple Leaf Fiber-ReinforcedPolyester Composites", 1997 John Wiley & Sons, Inc. J Appl Polym Sci 64: 1739 – 1748, 1997
2) S. Mazurkiewicz, R. Porębska, "The methods of evaluation of mechanical properties of polymer matrix composites", ISSN (1897-3310) Volume 10 Special Issue 3/2010
3) R. Hemanth, M. Sekar , B. Suresha, "Effects of fibers And fillers on mechanical properties of thermoplastic composites", Indian Journal of Advances in Chemical Science 2 (2014) 28-35
4) M. Bastiurea, M.S. Rodeanu, D.Dima, M.Murarescu, G. Andrei, "thermal and mechanical properties of polyester composites with graphene oxide and graphite", Digest journals of Nanomaterials and biostructures, (2015) pp. 521-533.
5) Prof. Dr. Muhsin J. Jweeg , Asst. Prof. Dr. Ali S. Hammood and Muhannad Al-Waily, "Experimental and Theoretical Studies of Mechanical Properties for Reinforcement Fiber Types of Composite Materials", International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS Vol:12 No:04
6) I Wayan Surata, I Gusti Agung Kade Suriadi, and Krissanti Arnis, "Mechanical properties of rice husks fiber reinforced polyester composites", International Journal of Materials, Mechanics and Manufacturing, Vol. 2, No. 2, May 2014.