International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-6, Issue-7)

Research Article | **July 2017**

Mechanical Properties of E-Glass Fiber Reinforced Epoxy Composites with SnO_2 and PTFE

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Abstract:

Machining of the composites materials may be was troublesome on do as of those anisotropic also non homogeneous structures from claiming composites what's more of the helter skelter abrasiveness about their reinforcing constituents. In this study of the mechanical properties about e glass/ epoxy composite materials for fillers (SiO_2 Also PTFE) need focused on with explore the materials included of the grid assistance moving forward those mechanically operating properties of a composite. Those recently produced composites are described to their mechanical properties in elasticity test eventually tensile strength test and Flexural test. Those effects of Different mechanical characterization tests would account here. Those tests result bring demonstrated that higher the filler material volume rate more excellent those quality to both SiO_2 also PTFE loaded glass epoxy composites, SnO2 loaded composite hint at a greater amount manage values over PTFE.

Keywords: PTFE (Poly Tetra Fluro Ethylene), Epoxy composites, strength of composite.

I. INTRODUCTION

Fiber reinforced plastics have been widely used for manufacturing aircraft and spacecraft structural parts because of their particular mechanical and physical properties such as high specific strength and high specific stiffness. Another relevant application for fiber reinforced polymeric composites (especially glass fiber reinforced plastics) is in the electronic industry, in which they are employed for producing printed wiring boards. Composite materials are constituted of two phases: the matrix, which is continuous and surrounds the other phase, often called as reinforcing phase. Epoxy resins are widely used as matrix in many fiber reinforced composites; they are a class of thermoset materials of particular interest to structural engineers owing to the fact that they provide a unique balance of chemical and mechanical properties combined with wide processing versatility. Within reinforcing materials, glass fibers are the most frequently used in structural constructions because of their specific strength properties. The present study focuses on mechanical property of GFRP laminated composites with filler material SiO_2 and PTFE and evaluation of materials property.

The tensile, flexural and impact properties of pineapple leaf fiber (PALF) and sisal reinforced polyester composites are improved by the incorporation of a small amount of glass fibers in these composites, showing positive hybrid effect [2]. The mechanical properties of the composites are improved due to the addition of glass fiber along with Palmyra fiber in the matrix and decrease the moisture absorption of the composites [3]. Glass/sugar palm composites are found to have an increase in tensile, flexural, and impact properties with increasing fiber content and the weight ratio of glass/sugar palm fibers [4]. The tensile properties of the flax/glass fiber reinforced hybrid composites were improved with the increasing of glass fiber content. The interlaminar shear strength and the interlaminar fracture toughness of flax/glass fiber reinforced hybrid composites were higher than those of GFRP [5]. Experimental study on untreated woven jute fabric-strengthened polyester composites shows the capability of this renewable wellspring of normal fiber for utilization in various consumable products [6]. The market scenario for composite applications is changing due to the introduction of newer biodegradable polymers. Composite materials reinforced with natural fibers, such as flax, hemp, knead and jute, are gaining increasing importance in automotive, aerospace, packaging and other industrial applications [7]. Hybridization of glass fiber with Oil palm
empty fruit bunch (OPEFB) resulted in composites having a superior mechanical performance. A positive hybrid effect is observed in the elongation property. Thus, glass and OPEFB hybrid fiber reinforcement in Phenol formaldehyde (PF) resin resulted in a cost effective and a lightweight composite having good performance qualities. These composites may find applications as structural materials where higher strength and cost considerations are important [8],Vasishth A et al. [9] studied the Rheological Properties of viscosity of Industrial Lubricants.
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II. PREPARATION OF SAMPLE

2.1. MATERIALS USED

2.1.0. Materials used for E-glass fiber

The matrix material used in this study was diglycidly ether of bi-phenol -A (DGEBA) based epoxy resin in the trade name of LY 556 while the hardener was tri-ethylene tetra amine (TETA) in the trade name of HY 951 mixed in proportion of 100:10, both manufactured by Huntsman. The epoxy resin was superior in mechanical properties and had better resistance to degradation by water and other solvents.

2.1.1. Fiber: E-glass

The E-glass fibers were Chopped Strand Mat (CSM) and Woven roving mat (WRM) used as reinforcement (Figure.1). The composition of glass fiber consisted of oxygen (42.84%), silica (28.57%), calcium (17.27%) and aluminum (9.09%) in the highest concentration among constitutes, while the concentration of modifying and other oxides were below 1%. E-Glass is a low alkali glass with a typical nominal composition of SiO_2(54%), Al_2O_3(14%), CaO+MgO(22%), B_2O_3(10%) and Na_2O+K_2O less than 2%. Some other materials are also present as impurity.

(a) (b)

Figure. 1. E- Glass Fibers (a) CMS and (b) WRM

2.1.2. Poly Tetra Fluro Ethylene [PTFE]:

PTFE is a fluorocarbon solid, as it is a high-molecular-weight compound consisting wholly of carbon and fluorine. PTFE is hydrophobic neither water nor water-containing substances wet PTFE, as fluorocarbons demonstrate mitigated London dispersion forces due to the high electro negativity of fluorine. PTFE has one of the lowest coefficients of friction of any solid. The coefficient of friction of plastics is usually measured against polished steel.

III. EXPERIMENTAL TESTS

3.1. Tensile Test

The machine comprises of a loading unit (or straining unit), control panel, Hydraulic system, pendulum dynamometer, load indicating system and load-elongation recording system. Tensile test is conducted by gripping the tests specimen between the upper and middle crosshead. Compression and Bending tests are conducted between the middle crosshead and the lower table.

Figure. 2. UTM Test Rig

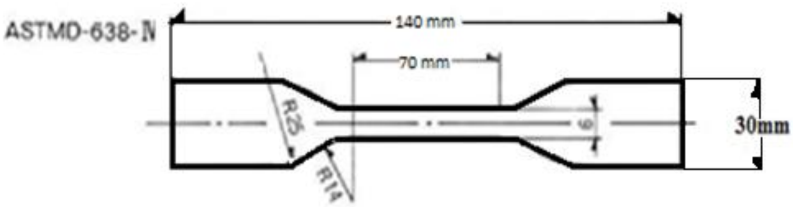

Figure 3. Tensile test specimen specifications as per ASTMD

Figure 4. Sample with glass fiber + epoxy resin before tension test

Figure 5. Sample with glass fiber + Sno2 + epoxy resin before tension test

Fig 7. Sample with glass fiber + PTFE+ epoxy resin before tension test

Fig 8.Sample with glass fiber + epoxy resin after tension test

Figure 6. Sample with glass fiber + epoxy resin + Sno_2 after tension test

Figure 9. Sample with glass fiber + PTFE + epoxy resin after tension test

3.2. FLEXURAL TEST:

A flexure test is more affordable than a tensile test and test results are slightly different. The material is laid horizontally over two points of contact (lower support span) and then a force is applied to the top of the material through either one or two points of contact (upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample.

ASTM D 790 flexural tests:

Figure.10. UTM for Flexural test

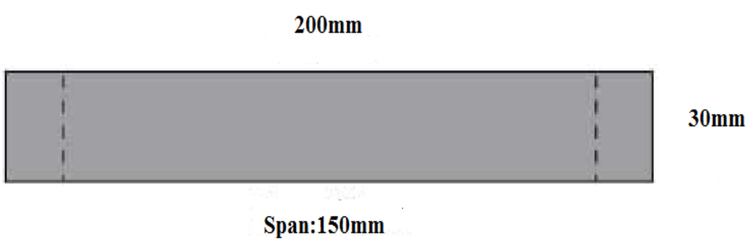

Figure. 11. Specimen dimension for flexural test

Figure 12. Specimen during flexural test

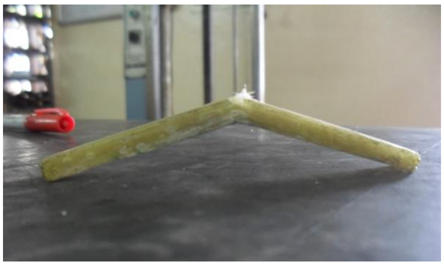

Figure 13. Specimen after flexural test

Figure 14. Sample with glass fiber + epoxy resin before flexural test

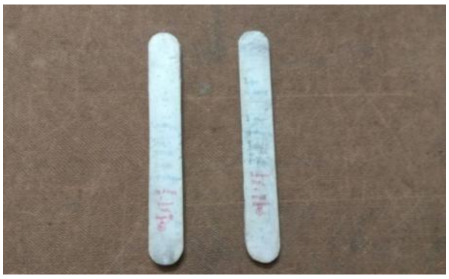

Figure 15. Sample with glass fiber + Sno2 + epoxy resin before flexural test

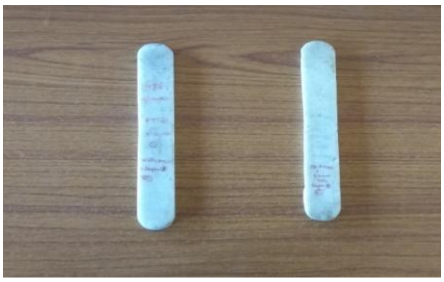

Figure 16. Sample with Fiber + epoxy resin + PTFE powder before flexural Test

IV. RESULTS AND DISCUSSIONS

The results obtained from experimental and theoretical studies of few Mechanical properties of E-glass composite material are calculated. The experimental work included the study of E-Glass fiber composite materials for difference volume fraction of Doping material by keeping the Volume fraction of fiber constant. Figure. 17 to 22 show the Tensile and Flexural strength of E-Glass Fiber with different Doping materials testing for four samples for each Doping material type with volume fraction of fiber Constant. And, the best combination of Doping material with Composites is identified. Finally the best material properties are doped in SnO_2 and results for the combination is obtained which are shown in Figure 23 and 24 for tensile and flexural tests respectively.

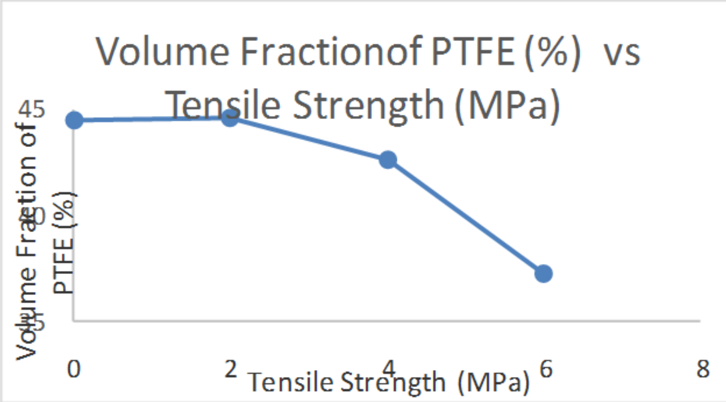

Figure 17. Volume Fraction of PTFE (%) vs Tensile Strength (MPa)

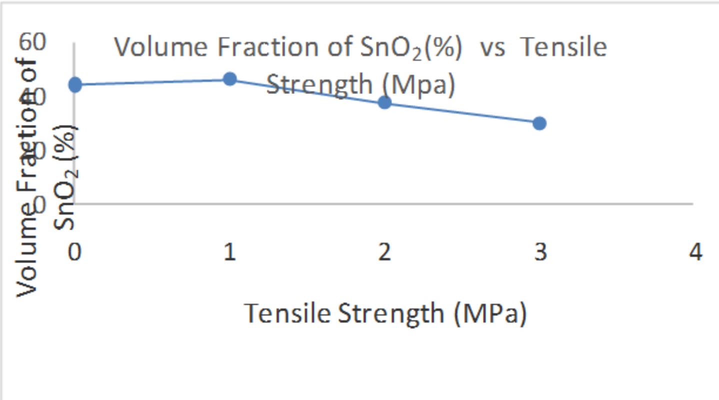

Figure 18. Volume Fraction of SnO_2 (%) vs Tensile Strength (MPa)

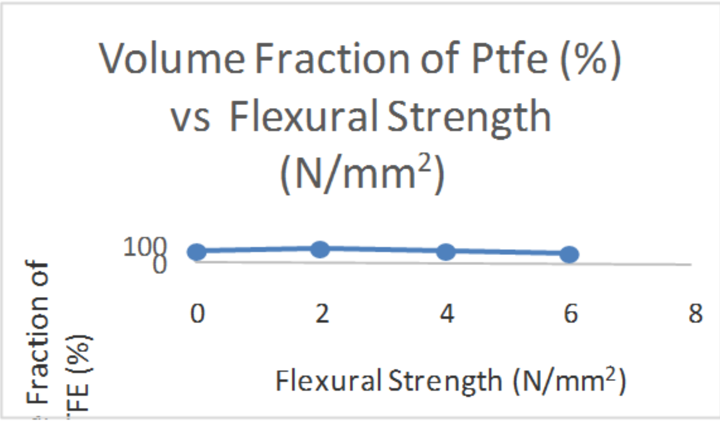

Figure 19 Volume Fraction of PTFE (%) vs Flexural strength (N/mm^2)

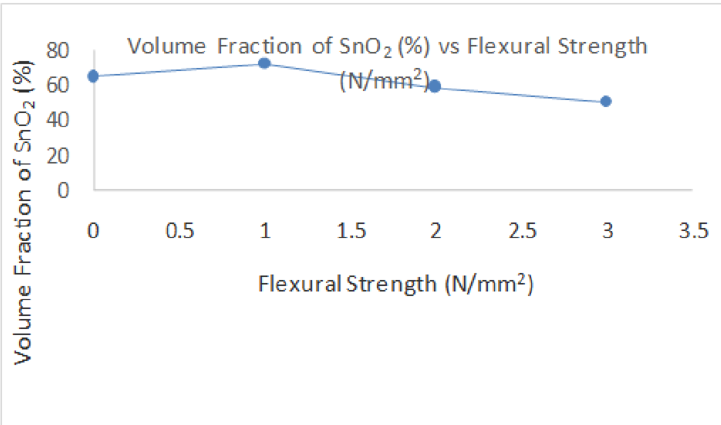

Figure 20. Volume Fraction of SnO_2 (%) vs Flexural Strength

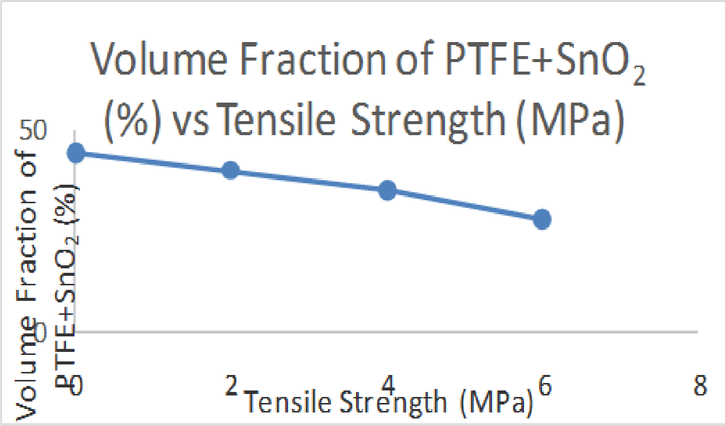

Figure 21 Volume Fraction of PTFE + SnO_2 (%) vs Tensile Strength (MPa)

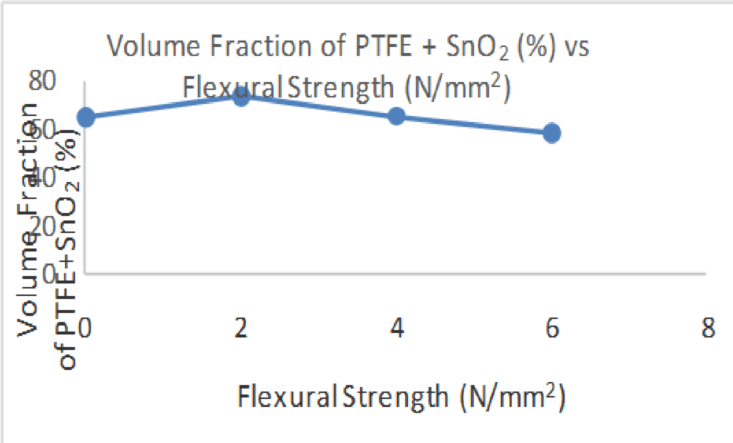

Figure 22 Volume Fraction of PTFE + SnO_2 (%) vs Flexural Strength (N/mm^2)

V. CONCLUSIONS

The successful fabrication of a new class of epoxy based composites reinforced with E-glass fibers reinforced epoxy composites with and without doping SnO_2 powder have been done. It has been observed that form this work that the best modulus of elasticity is maximum for E glass fiber composite materials in any direction i.e 22 GPa which is greater than the short and woven e glass fiber composite material. The decrease in strength in other forms of composites are may be due to poor fiber- matrix adhesion. However, the flexural strength is found to be more in long E-glass fiber i.e 18 GPa than the short and woven E glass fiber composite material. The lowest value of flexural strength is observed for short fiber i.e. this may be due to insufficient matrix material compared to volume fraction of fibers which results in lower flexural strength of the long e glass fiber composites.

Further it has been observed that the mechanical properties like the elasticity of modulus i.e 22 GPa to 25 GPa and flexural strength i.e 18 GPa to 22 GPa are improved with SnO_2 nano powder in E glass long fiber. Possible use of these composites such as in storage devices, preferred insulating materials for several electrical applications, especially printed circuit boards, bushings, GIS spacers, generator ground wall insulation system and cast resin transformers

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