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Mechanical Property of Glass Fiber Reinforcement Epoxy Composites

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Abstract: ***The present work describes the development and mechanical characterization of new polymer composites consisting of glass fibre reinforcement, epoxy resin and filler materials such as TiO2 and ZnS. The newly developed composites are characterized for their mechanical properties. Experiments like tensile test, three point bending and impact test were conducted to find the significant influence of filler material on mechanical characteristics of GFRP composites. The tests result have shown that higher the filler material volume percentage greater the strength for both TiO2 and ZnS filled glass epoxy composites, ZnS filled composite show more sustaining values than TiO2.***

Keywords: fillers, polymer composites, strength of composite.

1. 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 TiO_2 and ZnS and evaluation of materials property.

1.1. Specimen Preparation

The method that is used in the present work for manufacturing the laminated composite plates is hand lay-up as shown in Figure.1 which is the oldest method that was used to get the composite materials. The type of Glass Fiber mat selected to make specimens was, Mat–330GSM. The matrix material used was a medium viscosity epoxy resin (LAPOX L-12) and a room temperature curing polyamine hardener (K-6), both manufactured by ATUL India Ltd, Gujarat, India. This matrix was chosen since it provided good resistance to alkalis and has good adhesive properties. Based on volume fraction the calculations were made for 60-40 (60% Glass Fiber – 40% Epoxy Resin) combination showed a better result. Two filler materials TiO_2 and ZnS were added to Mat 60-40 combination by keeping Epoxy percentage constant (40%). Based on literature survey the amount of filler added was 1, 2, & 3 % of Tio_2 and 1, 2, & 3% of ZnS, the details are as shown in Table 1. After preparation of the specimen the specimens were tested in tensile test, three point bending test, impact test to obtain the strength of materials.

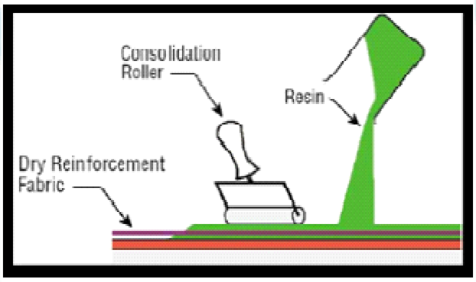

Figure 1: Hand lay-up Technique

Table 1: Filler Material Specimen Detail

Mat -330GSM				
Sl. No	*Glass fibre content %*	*Epoxy*	*Filler content in %*	
			TiO_2	ZnS
01	60	40	--	--
02	59	40	1	1
03	58	40	2	2
04	57	40	3	3

Table 2: Test specimen detail

Test specimens	*ASTM*	*Size*
Tensile test specimens	D-3039	250x25x4 mm.
Impact Test Specimens	D-256	55x10x10 mm.
Bending test specimens	D-790	110x25x6 mm.

1.2 Experimental Setup

Following tests were conducted in the present work;

- Three Point Bending test
- Tensile Test
- Impact Test (Charpy)

The tests were conducted using calibrated Universal Testing Machine (UTM). Different tests were conducted, such as three point bending test, tensile test and impact test carried (Charpy type) on Impact machine**.**

2. Results and Discussion

2.1 Effect of Filler on Bending Characteristics

The load displacement of the tested specimen is g is given on figure 2.

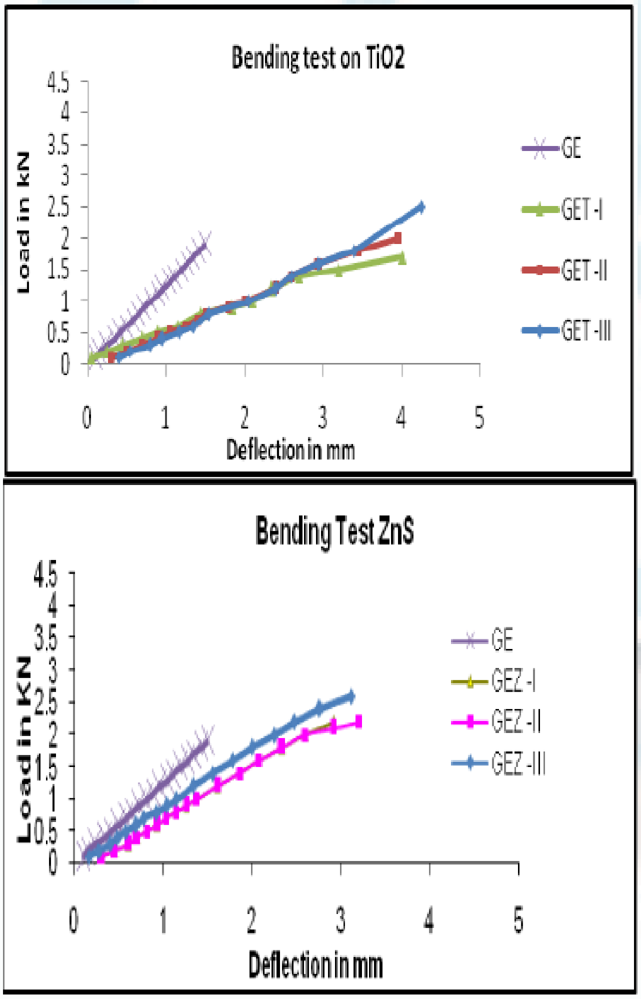

Figure 2: Load –displacement for TiO_2 & ZnS

It can be observed that the bending load bearing strength of composite increases with the addition of filler. The addition of TiO2 as the filler material to glass/epoxy composite makes the material harder than normal glass/epoxy composite, this leads to bear more bending load than the normal composite material. Basically the glass epoxy composite itself is a brittle material and further addition of TiO2 as filler made the material still harder and hence the bending strength increased with addition of filler content. Also it can be observed that there is a sharp yield in case of TiO2 filled composite.

The addition of ZnS leads to increase in the bending strength compared to normal GFRP composites. As observed from the graph, there is no sharp yield in the case of ZnS filled composites. Since ZnS is a ductile material, the addition of filler had enhanced the bending strength of composites and there is proportional deformation with respect to load.

2.2 Effect of filler on Tensile Characteristics

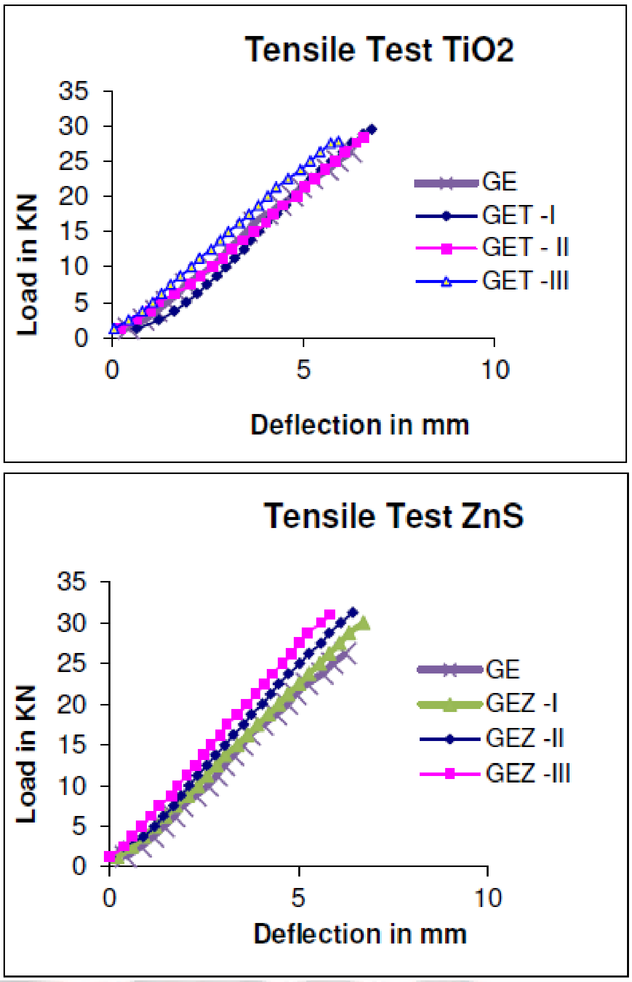

Figure 3: Load- Displacement for TiO_2 and ZnS

Comparison of the load-deformation relations as shown in the Figure 3.From the graph it can be observed that filled composites bear more load than unfilled glass epoxy composites, damage mechanism in composite materials during tension involves various combinations of damage modes are matrix cracking, debonding, ply failure and fiber breakage occurs during testing. As seen in the graph, unfilled glass epoxy composite bear less load than 1% volume fraction filler, maximum load is for 3% volume fraction where as 2% volume fraction is moderate for both the filler materials (TiO2& ZnS).

2.3 Effect of filler on Impact Strength

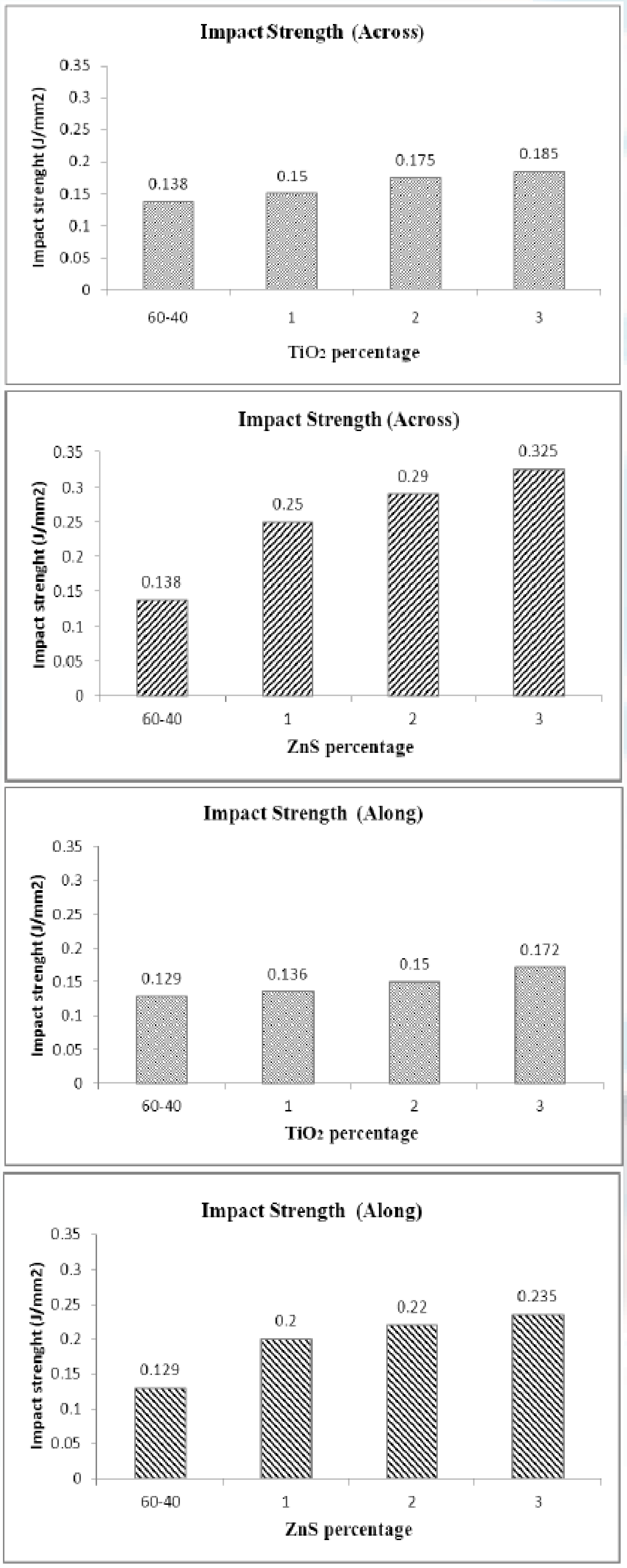

Figure 4: Comparison of Impact strength against volume fraction of specimens along and across the notch

It is observed that decrease in the impact strength with increased percentage content of filler. It is also very clear that the impact strength of the test specimen with the notch grooved across the laminates is higher than that of specimens with the notch along the laminates irrespective of percentage of content.

3. Conclusions

- Tensile, Bending and Impact strength increases with addition of filler material.
- ZnS filled composite shows significantly good results than TiO2 filled composites.
- ZnS filled composite shows more tensile load in comparison with unfilled and TiO2 filled composites.
- Impact toughness notch across the laminates is higher than that of along the notch.
- Impact toughness value for unfilled glass composite is more than filled composite.
- TiO2 and ZnS filler material makes material harder and brittle which is the reason for reduction in impact toughness value.
- ZnS filled composite shows significantly higher values than TiO2 filled composites.

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