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EXPERIMENTAL INVESTIGATION ON IMPACT BEHAVIOR BY VARYING PERCENTAGE ADDITION OF SiC PARTICULATE FILLERS IN GLASS VINYL ESTER COMPOSITES

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ABSTRACT

Characterization of engineering properties is a complex issue for fiber- reinforced composites due to their inherent anisotropy and in homogeneity. In terms of mechanical properties, advanced composite materials are evaluated by a number of specially designed test methods. In this study the incorporation of SiC fillers on Impact behavior of Glass-Vinyl ester (G-V) composites has been investigated. The composites are assessed by using Izode Impact test apparatus. The properties like Impact strength, energy consumed at break, type of failures were investigated as per ASTM standards. From the experimental investigation, it is found that the Impact strength of G-V composites increased with increasing the SiC content.

Keywords: *impact, polymer composites, fillers*

1. Introduction

Polymers and their composites find use in many engineering applications as alternative products to metal based ones. In recent years, much research has been devoted to exploring the potential advantage of thermo set matrix for composite applications [1]. One such matrix is vinyl ester, have found a place in the family comprising the thermo set engineering polymers because of their displaying excellent mechanical properties with good chemical/corrosion resistance. A notable advance in the polymer industry has been the use of fiber and particulate fillers as reinforcements in polymer matrix [2, 3]. Particulate fillers are of considerable interest, not only from an economic view point, but as modifiers especially the physical properties of the polymer. It is well documented in the literature that majority fillers have a positive influence on mechanical properties. Furthermore, it is known that the shape, size and volume fraction of any filler will influence this modifying effect on the properties [3]. Unal and Mimaroglu, [4] evaluated the mechanical properties of nylon 6 by adding one or a combination of more than one filler and by varying the weight percentage. They observed that the tensile strength and modulus of elasticity of nylon 6 composites increased with increasing filler weight percentage. Most of the above findings are based on either randomly oriented or unidirectionally oriented fiber composites. In this study, the mechanical behavior of G-V composites with the addition of SiC particulate fillers of 20μm and 40μm size has been investigated. Influence of addition of SiC fillers in G-V composites has been studied here against plain G-V composites. Mechanical properties like tensile, flexural, impact and hardness are investigated according to the ASTM standards on both plain G-V and SiC filled G-V composites. The cause for failure in G-V composites due to mechanical testing has been observed using Scanning Electron Microscopy (SEM).

2. Experimental procedure

Mechanical properties of a composite material refer to the elastic and strength properties of the material under tensile, shear, or compression loading. Other properties, such as fracture toughness and flexural strength and stiffness, are also useful in characterizing the performance of a composite material. The mechanical properties, including tensile strength, tensile modulus, elongation at break, and flexural strength were investigated with a J.J. Lloyd Universal testing machine in accordance with ASTM D 638 and D 790 respectively. Impact test has been conducted on Izode impact testing machine in accordance with ASTM D 256. Rockwell hardness with R and M scale and Shore D tests has been conducted on GV composites.

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Table 1: Details of Glass Vinyl ester composites with and without SiC fillers

Material Name	Filler size (μm)	Matrix (wt %)	Filler (wt%)	Sample code
G1	0	50 ± 2	0.0	G1
G2	20	45 ± 2	5.0	G2
G3	40	45 ± 2	5.0	G3

Table 2. Physical property of SiC particle used in GV composite.

Filler	Shape	Size (μm)	Density (g/cm^3)
Silicon carbide	Tetrahedral	20-40	3.1

3. Results and Discussion

The results obtained from Mechanical characterization of Glass vinyl ester composites with and without SiC fillers are presented in this study in four different sections. The first section will deduce the tensile property, second section deduces flexural property, third section reveal about impact strength and fourth section will imply on the hardness of the materials.

Tensile property

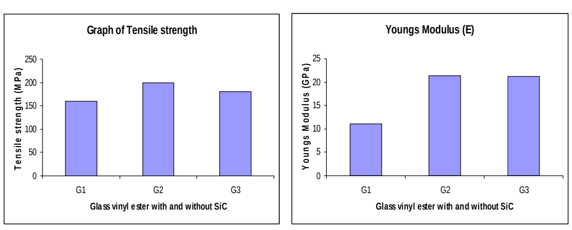

Fig. 1 Tensile strength of Glass vinyl ester composites with and without SiC fillers

Fig 1 shows the tensile properties of Glass vinyl ester composites with and without SiC fillers in which the GV with SiC fillers shows maximum tensile strength i.e. 190.55 MPa Young's Modulus 21.39 and Elongation at break is 3.55mm.

Flexural property

The results of flexural strength have been shown in following graphs.

From Fig 3, it is revealed that Flexural strength is more for SiC filled composites compared to plain GV composites.

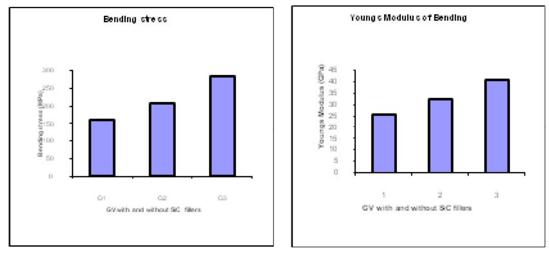

Fig. 3 Flexural strength and Young's Modulus of GV composites with and without SiC fillers

Impact strength

The results of impact test on GV composite with and without SiC fillers is given in Table 3.

Table 3. Impact strength of GV composite with and without SiC fillers.

Material	Impact strength (Joules)
G1	3.2
G2	5.4
G3	6.6

The result shows the impact strength of GV composites with SiC fillers is high compared to plain GV composites. The presence of SiC fillers creates tough bond between the matrix and reinforcements and hence the impact strength is high for SiC filled GV composites.

Hardness

Hardness of GV composites with and without fillers is shown in Table 4. The results shows GV with SiC fillers have high hardness compared to plain GV composite in all the three type of hardness tests. This is due to the presence of hard SiC particles creating hard region within the GV composite.

Table 4. Hardness results of GV composites.

Material	Rockwell R- scale	Rockwell M- scale	Shore D
G1	90	30	85
G2	98	37	93
G3	109	61	94

4. Scanning Electron Microscopy

Tensile test results

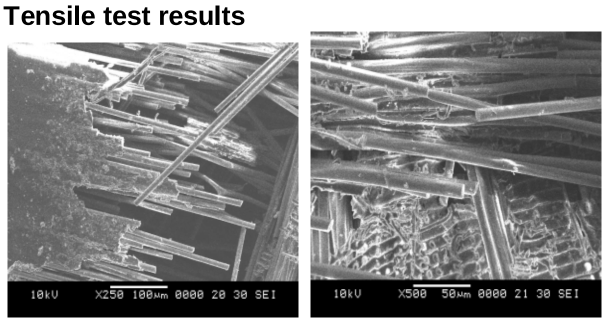

Fig. 4 SEM micrograph of fracture of fibers in GV with SiC filled composites in tensile loading.

Fig 4 shows the SEM micrographs of GV composites with SiC fillers in tensile loading. The figures depict that due to the interaction of SiC fillers with the matrix and fibers there is a tough bond between the matrix and reinforcements. Since the SiC fillers offers good bonding between vinyl ester matrix and due to its hardness, the GV composite carried more load compared to plain GV composite.

Flexural test results

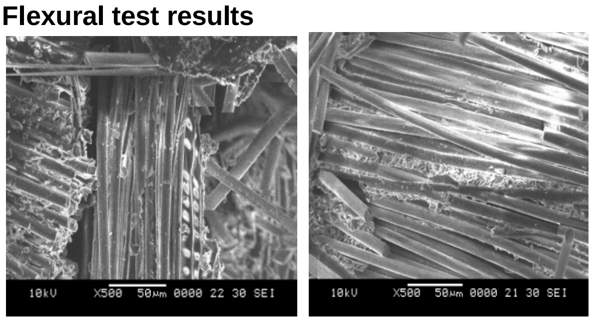

Fig. 5 SEM pictures of GV composites subjected to three point bending test.

Fig 5. Shows failure of GV composites with the addition of SiC fillers in which failure mechanism that we can observe from figure is fiber pull out and due to interaction of SiC fillers there is good bonding between matrix and reinforcements.

Impact test results

SEM pictures shows influence of SiC fillers in GV composites subjected to impact test. The impact energy has been increased due to the addition of SiC fillers in GV composites due to the improved bonding between matrix and reinforcements.

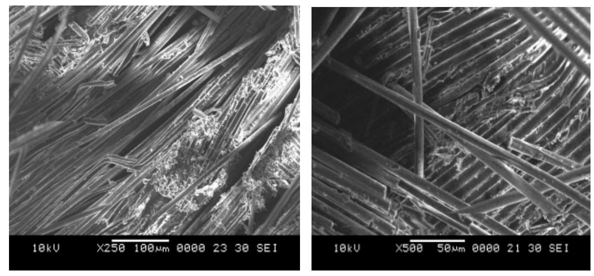

Fig 6. SEM pictures of GV composites subjected to impact test.

5. Conclusions

This work points to the fact that upon introduction of SiC fillers in E-glass reinforced GV composites, improved in the mechanical properties, thus emphasizing the importance for the need to introduce fillers into glass reinforced GV composites.

Addition of fillers increases tensile strength, modulus, flexural strength, impact strength and hardness of Glass Vinyl ester composites.

The tests showed linear elastic behavior and brittle fracture for the test samples along with fibers in a composite fail at different stress levels as the applied tensile load increases.

Correlating the tensile and flexural test results and SEM observations of the fractured surface of the SiC filled GV composites, it is verified that the interfacial adhesion between fiber/matrix, which leads to, improved mechanical properties

SEM observations throw further light on features such as fiber bridging, matrix rollers, inclined fracture of fibers and disorientation of transverse fibers and also showed the good interfacial adhesion between polyester matrix and fibers.

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