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Effect Of TiO_2 On Polymer Fiber/Foam Reinforced Nano Composites

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Abstract— **In this work the impact strength of TiO_2 Nano polymer composites where investigated. The matrix material used in this work as thermoset polymer of epoxy resin and reinforcement as woven roving mat, chopped strand mat (glass fiber) and synthetic foam. The composite laminates were prepared by hand lay-up method with varying weight percentage of (0, 1, 3) wt. % of nanoparticles TiO_2 on epoxy resin. The additional of nanoparticles titanium dioxide (TiO_2) improved the impact strength. The dispersion of TiO_2 epoxy resin were analyzed using Scanning Electron Microscope (SEM). The impact strength of the laminates was tested using Izod and Charpy methods. The addition of 1 wt. % of TiO_2 has increased the impact strength of 27.35% as compared to without nano samples. The fractured surface were analyzed using Scanning Electron Microscope.**

Keywords— Glass fibre, Epoxy resin, Titanium oxide, Impact strength, Scanning electron microscope.

I. INTRODUCTION

Composite materials have played a major application roll in automobiles and aircraft etc. Thermoset polymer of epoxy resin is widely used in automobile components. The addition of nanoparticle will improve the toughness and impact strength [1]. Material made by two (or) more phases. The combination of a matrix and a reinforcement which when combine gives properties superior to their properties of the individual components. The reinforcement is a fibres and is used to fortify the matrix is a term of strength and stiffness.

The main advantages of composite materials are their high strength and stiffness, weight reduction in the finished part [2-3]. The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. Composite materials are becoming more important in the construction of aerospace structures. The composite laminates are having good wear properties and hardness [4]. The composite materials are used in aircraft parts such as fairings, spoilers, and flight controls, for their less weight over other materials. Large aircraft structures are made with composite fuselage and wing structures and the repair of these advanced composite materials requires an in-depth knowledge of composite structures, materials, and tooling. Composite materials are used for engineering applications under hard working condition. The nanoparticles have unique wear properties and high strength to ensure safety and economic efficiency.

The present paper focused on effect of titanium dioxide on epoxy fiber/foam reinforced nano composite filled with varying wt. % of TiO_2 by hand lay-up techniques. By adding 1 % of TiO_2 has increased the impact strength of about 27.35% and 3% increased about 47.62% in composite laminates as compared to without nano sample. The fractured surfaces were analyzed using Scanning Electron Microscope.

II. EXPERIMENTAL PROCEDURE

A. Materials and sample preparation

The matrix material was thermoset polymer of epoxy resin LY556 with hardener HY951. The reinforcement used was glass fiber in the form of woven roving mat, chopped strand mat and synthetic foam. The nanoparticles used in this study were titanium dioxide (TiO_2). The primary fabrication process involved dispersion of nanoparticles TiO_2 into the epoxy resin. For preparing nanoparticle composite both resin and TiO_2 with desired proportion were mixed using mechanical stirrer for about 120 minutes at constant speed before adding the hardener in epoxy resin in the respected ratio. Before starting the fabrication polyvinyl alcohol (PVA) releasing agent is applied in the moulding board uniformly. It was used to separate the moulding board and composite laminate after fabrication. Now the mixture (consists of epoxy resin, TiO_2 and hardener) is applied over the reinforcement material (woven roving mat, chopped strand mat and foam) which has been cut to a size of (300mm×300mm). Two layer of WRM, two layer of CSM and one layer of synthetic foam are used to prepare a sample of composite laminate in that each mat is kept one over the other by applying prepared mixture by rolling operation using a roller over a moulding board. The composite laminates are removed from the moulding board after curing two days.

Fig. 1. Fabrication of nano composite

B. Impact testing

The impact test was performed on Izod and Charpy impact test apparatus for epoxy nanoparticles composite laminates to study the impact behavior of the samples. The impact test apparatus has a LCD digital display for show the impact energy level. It reads impact energy range from 5J to 25J. The Izod impact test apparatus is shown in the Fig.2. The prepared composite laminates are placed on the testing apparatus, and then the samples are subjected to impact load through the hammer placed in the apparatus. The samples 0, 1, 3 wt. % of composite laminates are tested one by one in the apparatus.

Fig.2. Izod impact test apparatus

C. Structure analysis

Scanning Electron Microscope (SEM) was used to determine how the nanoparticles are uniformly distributed and to check the dispersion of nanoparticles in epoxy. The model of SEM we used is JSM 6610LV. Scanning Electron Microscope (SEM) operating at an acceleration voltage of 0.3 to 30kV and it has the magnification of 5X to 300000X and resolution of 3.0nm (30kW HV mode) is shown in the Fig.3. The surfaces of composite laminates were coated with a thin gold film to increase the conductance for SEM observation. SEM is a technique to visualize the dispersion of nanoparticles within the matrix and the bonding of fiber and foam into the epoxy resin and to study the structure of nanocomposits [5]. After the impact test is conducted the composite laminates are viewed through Scanning Electron Microscope for fracture analysis.

Fig. 3. Scanning Electron Microscope

III. RESULTS AND DISCUSSION

A. Izod impact test

The impact test was performed to study the impact strength of the epoxy nanocomposits. The composite laminates are placed on the testing apparatus as shown in Fig.2. The samples are subjected to impact load. The samples 0, 1, 3 wt. % of composite laminates are tested one by one in the apparatus. The Izod impact testing results are tabulated below in table.1. By adding 1 wt. % of TiO_2 has increased the impact strength of about 27.35% and 3 wt. % increased about 47.62% in composite laminates as compared to without nano sample. The Izod impact tested sample is shown in the Fig.4.

Table. 1. Izod impact test result

Sample (wt.% of TiO_2)	Break Energy (Joule)	Impact Strength (kJ/m^2)	Percentage of impact strength increased (%)
0	4.2405	44.7457	0
1	5.7960	56.9854	27.35
3	5.6294	66.0559	47.62

Fig.4. Izod impact tested sample (1 wt. % of TiO_2)

B. Scanning electron microscope (SEM)

Scanning Electron Microscope (SEM) is a technique used to study the structure of Nano composites and to view the dispersion of TiO_2 with the matrix epoxy resin. The SEM images of Epoxy/nanoparticles TiO_2 are showed in Fig.5. In the matrix medium some small agglomerates are present but the homogeneous dispersion of nanoparticle TiO_2 is clearly visible. The below SEM images of 1 wt. % of composite

laminates shows the homogenous distribution of nanoparticle TiO_2 in the matrix medium epoxy resin and it mainly shows about the proper interface bonding between fiber and matrix epoxy resin. By increasing wt. % of TiO_2 will improve the bonding of fiber and matrix medium because of good interface bonding the impact strength were increased.

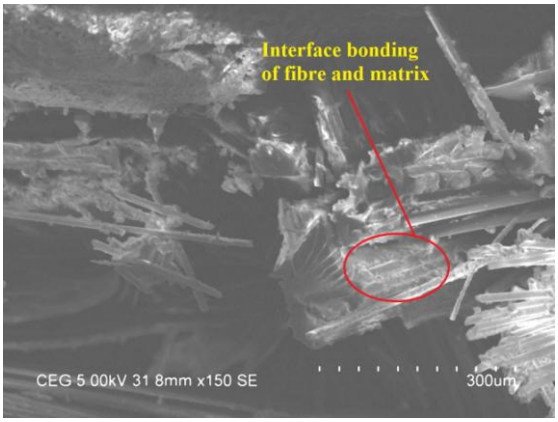

Fig. 5. SEM images of 1 wt. % of composite laminates

IV. CONCLUSION

The Nano composite laminates are successfully prepared by varying weight percentage of 0, 1, and 3. The prepared samples were subjected to Izod impact test, the results of Izod impact test increased by adding 1 wt. % of TiO_2 will increase the impact strength of 27.35% and 3 wt. % increase 47.62% of impact strength as compared to without nano sample. The SEM images of 1 wt. % of samples shows the random distribution of nanoparticle TiO_2 over epoxy resin and also shows the good interface bonding with fiber and matrix medium epoxy resin. By increasing the wt. % of TiO_2 will increase the impact strength of composite laminates and this samples are have good interface bonding with fiber and matrix. The tough laminates can be used for aircraft and automobiles applications.

V. REFERENCES

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