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Experimental Investigation of Mechanical Properties of Epoxy LY556/ E-Type Glass Fiber/ Nano Clay Nano Composite Materials

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Abstract : In this research paper clearly explained about the Epoxy LY556/Glass Fiber/Nano Clay nanocomposites consisting of an epoxy resin matrix reinforced with nano clay was investigated. This investigation describes the fabrication of nano composites, mechanical properties. The nano composites were manufactured by using hand layup technique with low weight percentages of filler material Nanoclay (0.5, 1, 1.5, and 2 wt. %) added with epoxy resin. Nano composites were subjected to tensile tests, impact testing, to analyze the mechanical properties and tensile modulus.

Keywords : Nanoclay, Epoxy/clay nanocomposites, Glass fiber, impact strength, tensile strength.

Introduction

Glass fibre reinforced epoxy composites are widely used in a number of aerospace and non-aerospace applications. Selection of reinforcements and matrix systems, as well as the nanoclay fraction is crucial in structural designing of the composite product for specific applications[1,3]. Whereas, thermal stability and mechanical properties govern the long term performance capabilities of the composites. Glass fibres are better known for their impact toughness, medium modulus, high tensile strength and thermal stability[7].

To achieve the combination of these desirable properties to satisfy application requirements, fibre hybridization has recently become an attractive approach[5]. The thermal stability of a given composite is further governed by the matrix functionality and cure temperature. Also, for a given fiber/resin system, the thermal degradation behaviour depends on the fibre fraction, since at higher temperatures of exposure it is the matrix which practically degrades [6]. The objective of this work therefore, is to study the effect, of nanoclay fraction on the mechanical and thermal behaviour of composites containing epoxy/glass fibre nanoclay nanocomposites [2,4].

In this paper it is clearly observed that the different fiber such as glass fiber and carbon fiber are reinforced with polyester resin. These composite materials were prepared in different proportion of glass fiber 10%, 15% and 20% for reinforcement with polyester resin and similarly for carbon fiber with different proportion carbon fiber 5% and 10% reinforced with polyester resin. The composite materials were prepared by oldest method hand layup technique, after fabrication composite materials were cut by water jet cutting machine as per ASTM standard[8]. To indentify the composite material strength, material undergoes mechanical characterization such as Tensile, Flexural and Impact properties for the composite materials.

In this paper work it is addresses that the influence of weight fractions on mechanical, corrosion and water absorption behaviors of natural fiber like coir-banana reinforced in epoxy hybrid composites material. Composite material were cut by ASTM standards and method by using hand lay-up technique, the specimens were prepared with the weight proportion of 0/40, 15/25, 20/20, 25/15 and 40/0 of natural fiber sandwich coir/banana fibers, and maintaining constant fiber length of 5mm[9].

In this research paper it is observed that the sisal-epoxy composites were fabricated by wet had layup technique method with varying different fiber length of 10 mm to 75 mm and different fiber loading in weight percentage of 10 % to 50 % as per the Response Surface Design. Based on results we identify the Response and Contour plots and studied with reference to the ANOVA by using Response Surface Analysis and the multi objective optimization of tensile and impact behaviors were found using Design of experiment software[10].

This paper briefly describes about the microscope technique used to investigate the structure of natural fiber. The production of natural fiber like basalt fibers on the basis of cost, strength and their cost. Natural fiber are gives good strength is equal and even less than cost of glass fiber, Though Natural fiber has good wear resistance and free from corrosion and increasing the hardness. In this research different oxide are used as a filler materials such as titanium oxide, silicon carbide and barium sulphate added to the composite matrix, it shows the increase mechanical properties[11].

This research paper described briefly about the preparation of silica fume from the high temperature furnaces, with efficient system like dust capture system, quartz vaporized are collected by bag i.e. main bag house filter used for dust collector[12].

Experimental procedure

Material preparation

The epoxy/glass fibre/nanoclay composite material was prepared by following the processes , viz, Waxing, rolling, curing,etc. The substrate was coated with wax to prevent sticking of the epoxy resin. Over the waxed layer an thin layer of epoxy resin was applied and then followed by glass fibre. The glass fibre was coated by hand laying technique with maximum of 4 mm thickness. The glass fibre was subjected to rolling to make it to adhere to the epoxy material. Again the epoxy resin was coated over the glass fiber and this process was continued till the required thickness was achieved. The composite was prepared in four conditions, viz, epoxy and glass fiber; epoxy, glass fiber with 1 % nanoclay; epoxy, glass fiber with 2 % nanoclay and epoxy, glass fiber with 3 % nanoclay [4, 5].

The prepared epoxy/glass fiber/nanoclay material was cured in room temperature for three days and remove from the substrate [6, 7].

Specimen preparation

The test specimens were cut by water jet cutter as per the ASTM standards. The water jet method was used to prevent damage and delamination of the composite material. The plain sized tensile specimens were subjected to tensile test to determine the tensile strength and the results are shown in Table.I, the tensile modulus (Young’s Modulus) is shown in Table.II and the percentage elongation is shown in Table. III.

Table 1:Tensile Strength of the Material

Sl.No	Specimen	Tensile strength (Gpa)
1	Epoxy/GF	27.63
2	Epoxy/GF/1% of Nanoclay	18.96
3	Epoxy/GF/2% of Nanoclay	17.53
4	Epoxy/GF/3% of Nanoclay	19.54
5	Epoxy/GF/4% of Nanoclay	21.03

Table II: Tensile modulus of the material

Sl.No	Specimen	Tensile modulus (Gpa)
1	Epoxy/GF	1.44
2	Epoxy/GF/1% of Nanoclay	1.77
3	Epoxy/GF/2% of Nanoclay	2.09
4	Epoxy/GF/3% of Nanoclay	1.28
5	Epoxy/GF/4% of Nanoclay	1.95

Table III: Percentage elongation of the material

Sl.No	Specimen	Elongation %
1	Epoxy/GF	6.69
2	Epoxy/GF/1% of Nanoclay	2.64
3	Epoxy/GF/2% of Nanoclay	2.96
4	Epoxy/GF/3% of Nanoclay	4.36
5	Epoxy/GF/4% of Nanoclay	3.43

Table IV: Impact Strength of the Material

Sl.No	Specimen	Impact Strength (J)
1	Epoxy/GF	22
2	Epoxy/GF/1% of Nanoclay	16
3	Epoxy/GF/2% of Nanoclay	16
4	Epoxy/GF/3% of Nanoclay	14
5	Epoxy/GF/4% of Nanoclay	15

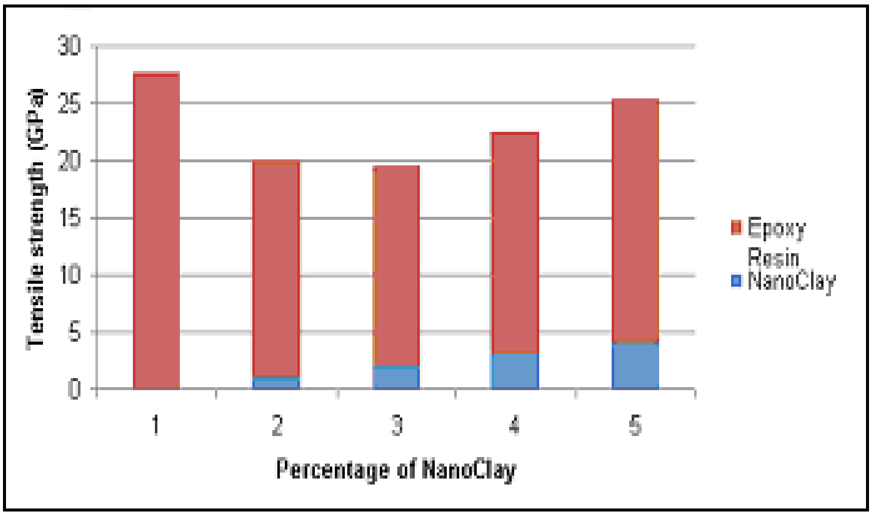

Figure.1. Tensile strength of Nanocomposite

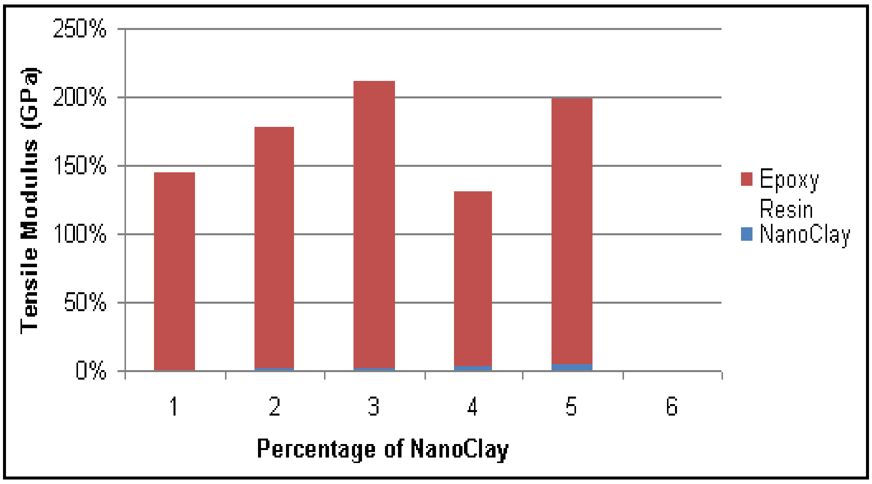

Figure.2. Tensile Modulus of Nanocomposite

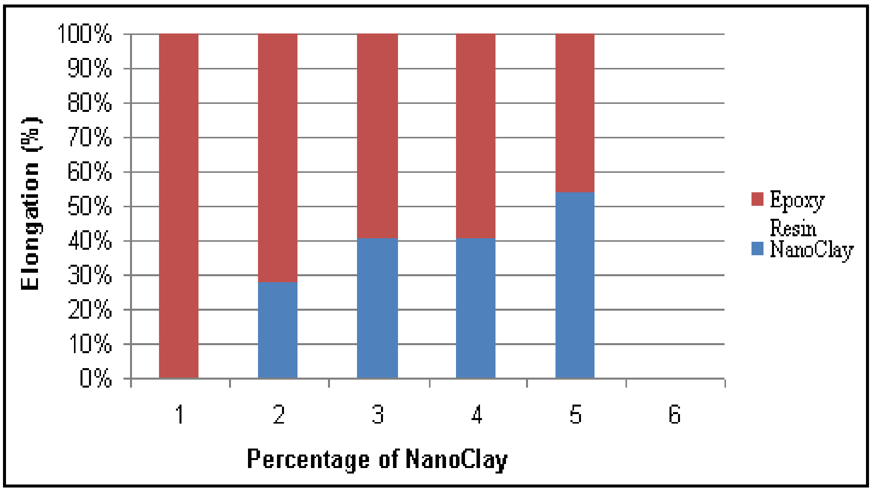

Figure.3. Percentage of elongation of the Nanocomposite

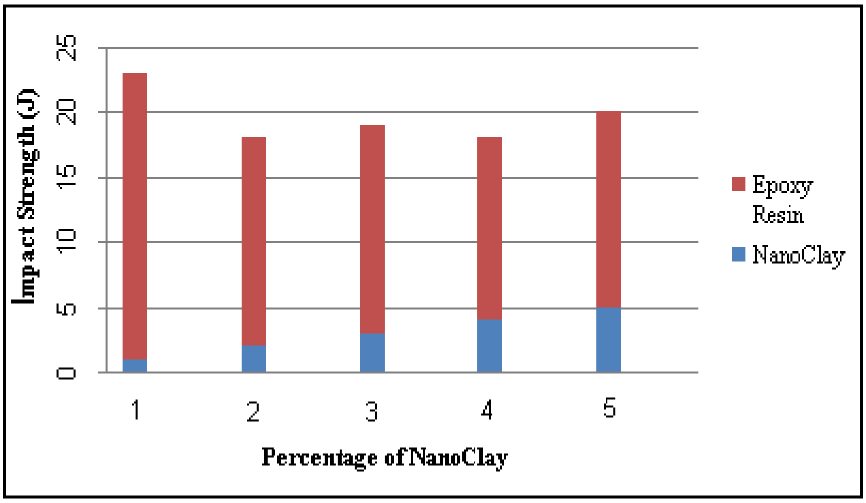

Figure.4. Impact strength of the Nanocomposite

The impact strength is shown in Table IV. The tensile properties and impact strength are shown in the histograms depicted in Figure 1 to Figure 4.

Results & Discussions

The Glass fiber reinforced –epoxy resin matrix composite in its pureform yielded 27.63 Gpa, which shows its excellent tensile strength. But the addition of nanoclay in volume fraction; epoxy, glass fiber with 1 % nanoclay; epoxy, glass fiber with 2 % nanoclay, epoxy, glass fiber with 3 % nanoclay and epoxy and glass fiber with 4 % nanoclay resulted in the loss of tensile strength. The loss in tensile strength in the nanoclay added material could be justified by the increase in the tensile modulus (Youngs Modulus). The tensile modulus being an indication of the stiffness of the material, the results indicate an increase in the stiffness of the composite material. It was observed that the tensile modulus of the epoxy, glass fiber with 3 % nanoclay possessed the least tensile modulus.

The ductility of the material reduced after the addition of the nanoclay due to the increase of the stiffness. Around 27 percent loss in the impact strength was observed after the addition of the nanoclay. But the impact strength is within acceptable limits.

Conclusion

The epoxy/glass fibre/nanoclay composite material was prepared as per ASTM specifications and tested for tensile properties like tensile strength, tensile modulus, percentage elongation and dynamic property, viz., Charpy impact was conducted. The results showed the increase in stiffness and slight reduction tensile and impact properties after the addition of nanoclay into the composite matrix. Therefore there is no major influence of the nanoclay addition on the properties of the epoxy/glass fiber composite.

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