Impact Testing of E Glass Fiber Epoxy Nanoclay composites

P. Anjani Devi [1], P. Ravinder Reddy [2], K. Eswara Prasad [3]

[1, 2] Chaitanya Bharathi Institute of Technology, Hyderabad ,India
[3] JNTUH College of Engineering, Hyderabad, India

Abstract - *FRP composite materials are playing a major in transformation of the brach f materials . they possess excellent characteristic strength to weight ratio , greatly flexible and are highly rigid made them replace the usually used traditional materials . Also being lighter adds the great benefit and their availability made them find uses in variety of engineering fields and applications in several industries. In the current work , an investigation is made in which a Glass epoxy fabricated with varying percentages of Nanoclay viz , 1.5 ,3.5 and compared with unmodified epoxy composite. Three different orientations viz unidirectional, Symmetric and Asymmetric of the laminate are considered. Impact characterization of the material is performed as per ASTM D256. Scanning Electron Microscopy of the surface is also done to characterize the material property*

Key Words**: Nanoclay, impact testing, Polymer composites, ASTM , Scanning Electron Microscopy**

1. INTRODUCTION

Fiber reinforced polymers play a dominating role and they really emerged superior materials over the traditional materials and hace abundant usues in the. Suhas Yeshwant Nayak[1] et al worked on the mechanical properties of E-glass Chopped Strand Mat (CSM) of varied weight fractions viz 15%, 30%, and 45% and the matrix material used was CNSL-epoxy resin wherein Hand layup technique was employed for the fabrication of the test piece. They found a clear indication in the improvement of micro hardness by increased in fiber content. K. Krushnamurty etal[2], made investigations by using the Nanoclay to check with the mechanical properties live impact property of E Glass epoxy composite at a 3 weight percentage, the addition of Nanoclay they found the property to increase but at weight percentage of 5 , they found the properties to diminish due to the embrittlement of the matrix..Smaranika Nayak et al[3], assessed the impact property of hybrid glass composite. The composite was diffused in water and the effect of it on the mechanical property of the composite sample was tested. The hand layup technique was employed for the assessment of the impact property of the composite . Their work gave a very good result on the impact property. Sharma et al [4]. in their present work used epoxy modified with Cloisite variety of nanoclay with three different weight percentages of 1, 3 and 5 wherein the reinforcement used was unidirectional E-glass fiber nanocomposites and hand layup technique was used to fabricate the sample. Their results tests showed by adding nanoclay ,till 3 % of their wiight the hardness was found to increase and further addition diminished the property value. Bino Prince Raja D et al [5]investigated the mechanical properties of hybrid Glass Fiber out of which one of the properties was Impact property . Their work gave conclusion that the impact property enhanced b the addition of nano particles in the making of a composite material.

2. Fabrication of laminate

The materials used for testing are prepared using LapoxL12 resin and K6 as a hardener. The reinforcement employed in the making of the composite sample was unidirectional E-Glass fiber. The fiber was manufactured and supplied by Arrow Technical Textiles PVT LTD, Maharastra. The area weight of the fiber was about 650g/m2.For three different type of Nanoclay loading and three different orientations the laminates were fabricated using hand layup technique at a volume fraction of 60% fiber. The orientations of laminates considered are unidirectional, symmetric, and Quasi isotropic types. Also sonication process was employed for dispersing nanoclay into Epoxy resin. The mixture is sonicated for 45 minutes . There is a chance of captivity of air bubbles that consistently happen during sonication process. Therefore to takeoff the trapped air in the sonicated mixture , this is put to vacuum degasification for a time of about 6 hours. Later, hardener is added to epoxy-resin in the ratio of 1:10 and mixed thoroughly. Subsequently, Hand Lay-up technique is used for the manufacturing of the composites. Once fabricated the laminate is kept aside for curing for 24 hours. The manufactured samples were all subjected to post curing at 140°C for 6hours. The samples for testing cut from the laminates and the size of the samples considered is 64mm x 12.7mm x 3.2 mm as per ASTM standard.

Fig 1 Dispersion of nano clay into epoxy resin using probe sonicator

3. Impact testing

The impact test is done in the setup as per ASTM: D256 standard .the Test laminate dimension is 63mm × 12.5mm × 4 mm .The test sample will be loaded on the machine where in a pendulum hits until it the sample is fractured. This test characterizes the energy required for the fracture of the material which is measures the toughness of the test sample. Figure 2 shows the geometry and the dimensions of the sample as per ASTM standard

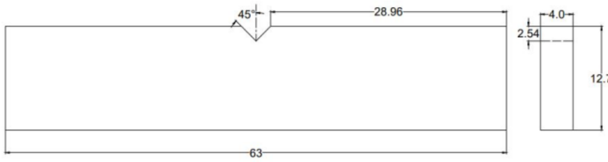

Fig 2: Geometry of the specimen

Table -1: Impact strength of the fabricated laminates

Clay Loading	Laminate	Impact strength (J)
0 % clay	Unidirectional laminate	11
	Symmetric	9
	Quasi isotropic	8
1.5%	Unidirectional laminate	17.6
	Symmetric	13.5
	Quasi isotropic	11.6
3.5%	Unidirectional laminate	18.92
	Symmetric	15.84
	Quasi isotropic	13.6

Table 1 shows the impact strength of the fabricated samples at different clay loading and different stacking sequences

Figure 3 shows the variation of the clay loading on the impact strength of the fabricated composite sample .

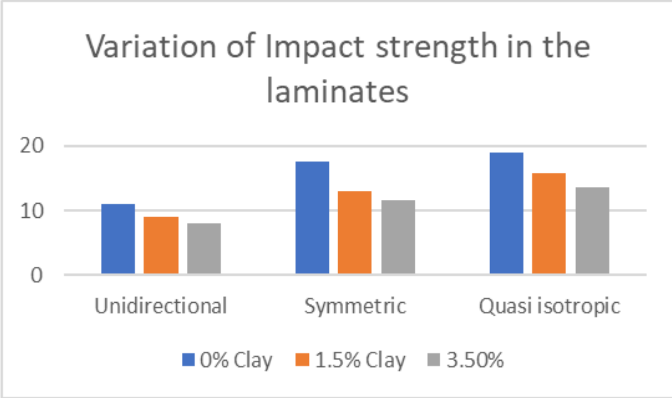

Fig 3 : variation of the impact strength in the laminates.

4. Scanning electron Microscopy

The morphological studies of the composite was done using the scanning electron microscope. The Morphology of Glass Fiber Reinforced Epoxy composite suggested that by the modification of epoxy made a good adhesion of the matrix and the fiber which indicate a superior wetting and stronger interface. The SEM studies also proved the same from the traces of the epoxy which are visible on the fiber's surface . SEM studies also revealed a very negligible fiber pullout which made it clear that the modification of the matrix had worked very well because of the formation of the very good bond with Glass fibers. Even on the fractured surface of the sample, the fibers were neatly oriented in the proper direction of the sample as it was done which indicate composite's highest degree of fiber's orientation even under the stress, that resulted in superior efficiency of fiber which helped to achieve greater mechanical strength.

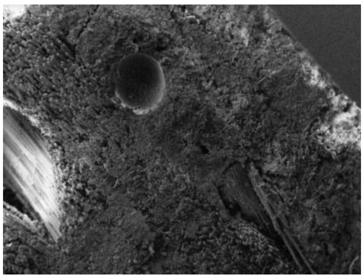

Fig 5a SEM images of Nanoclay GE sample

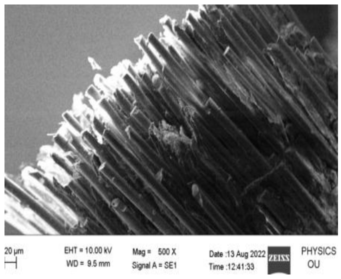

Fig 5b SEM images neat GE sample

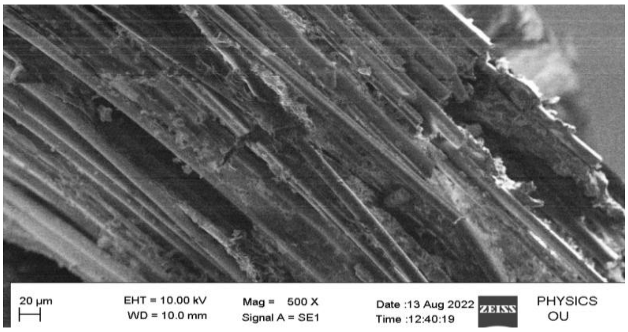

Fig 5c SEM images of fractured Nanoclay GE sample

5. Conclusion

There had been a considerable increase in the hardness of the samples when compared with neat glass epoxy. For 1.5% clay sample there was an increase of 60% for when compared with neat Glass Epoxy laminate. For 3.25 % of clay there is an increase of over 70% in the hardness when compared with the neat sample. It has been observed that the modified epoxy matrix may be considered as an excellent matrix for potential composite preparations. The substantial enhancement in the mechanical properties of the GFRMEC does indicate good adhesion between the matrix and the fibers. Hence this modified epoxy matrix may be used to develop various other composites containing different reinforcing materials and the study of their mechanical and morphological properties can be carried out.

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