

Mechanical Properties and SEM Analysis of Flax/Sisal/Sic Nano Powder Reinforced Hybrid Composites

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ABSTRACT

Natural fibre are those which are made naturally such as Flax, Jute, Hemp, cotton, hair, wool coir and etc. Because of many advantages Natural fibre are replacing glass fibre and carbon fibre such as its biodegradable nature so that it helps to dump it into the open space after it takes retirement, and its ease of availability, low weight, and better strength in multi axial reinforcement with adding Nano powder particles with it.

In this research work mechanical behavior of SiC Nano powder/flax/sisal fibre reinforced epoxy based hybrid composites and its fabrication has been studied. Work has been carried out to investigate the flexural properties, tensile strength, hardness, and impact strength of the composites. It has been observed that impact strength is improved with the increase in the weight fraction of natural fibers to certain extent. The morphology of composites is studied by using Scanning Electron Microscope (SEM).

Keywords: Flax, Sisal, SiC nanopowder, Scanning Electron Microscope.

1. INTRODUCTION

Natural fibre reinforced composites are alternative materials for some engineering applications such as aerospace applications, small wind turbine blades, and automobile applications [1]. Natural fibre show shows superior properties such as tensile, flexural and impact than glass fibre [2]. The main advantages of natural fibers are of low cost, light weight, easy production and friendly to environment [3,4]. On the other hand, there are some drawbacks such as their poor mechanical properties and high moisture absorption. The reinforcement can be synthetic (e.g. glass, carbon, boron and aramid) or of natural sources (e.g. curaua, sisal, jute, piassava, hemp, coir, flax and banana). Nevertheless, some composite components (e.g. for the automotive sector), previously manufactured with glass fibers are now produced with natural fibers. Applications including door panels, trunk liners, instrument panels, interior roofs, parcel shelves, among other interior components, are already in use in European cars due to the more favorable economic, environmental and social aspects of the vegetable fibers [4]. Low level of volume fraction of fibers provided not only higher modulus of elasticity and mechanical strength under tensile and flexural loadings but also have values of apparent density, apparent porosity and water absorption [5,6]. The addition of sic can improve the stiffness by maintaining its low density [8]. The strength of short fiber composites depends on the type of fiber matrix, fiber length, fiber orientation, fiber concentration and the bonding between the fiber and matrix [10].

2. MATERIALS USED

The main advantages of natural fibres are their availability, biodegradable, renewable, environmental friendly, low cost, low density, high specific properties, good thermal properties and enhanced the energy recovery, low energy consumption, non-abrasive nature and low cost. These fibres are low-cost fibres with low density and high specific properties which are comparable to synthetic fibres. The raw materials used in this work are, Flax fibre, Sisal fibre, SiC Nano power Epoxy, Hardener

3. METHODOLOGY AND FABRICATION TECHNIQUES

In this research it composites are fabricated by hand layup process. Flax and Sisal were cut into the dimensions of length and breadth of 300×200mm was used to prepare the specimen. The composite specimen consists of totally 6 woven layers. A measure quantity of resin and SiC are taken and which is get mixed with hardener in the ratio of 10:1. The layers of fibres were fabricated by adding the required amount of epoxy resin, 17% of flax, 17% of Sisal and 6% of SiC Nano powder is used. The six 6 layers of different fibres (flax and Sisal) are fabricated using hand layup process. The epoxy resin applied is distributed to the entire surface by means of roller. The air gaps formed between the layers during the processing were gently squeezed out, the processed wet composite were then pressed hard and excess resin is removed. Then it is dried by keeping it in atmospheric conditions for 24 hours to get the perfect samples as shown in figure 1.1,

Table 1.1: Details of Multi-axial Layers of Flax and Sisal

Layers	Angle	Fiber Specification
Layer 1	0°/90°	Sisal
Layer 2	+45°/-45°	Flax
Layer 3	0°/90°	Sisal
Layer 4	+45°/-45°	Flax
Layer 5	0°/90°	Sisal
Layer 6	+45°/-45°	Flax

Figure 1.1: Multi-axial layers of Flax and Sisal

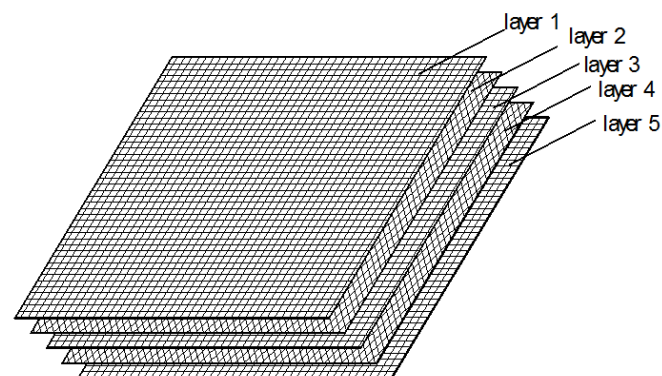


Figure 1.2: Fabricated Flax/Sisal/SiC Nano powder/Epoxy reinforced hybrid composite

After composite materials dried completely, unwanted surfaces are to be removed using secondary operations and also cut the materials as per the required ASTM standards.

4. MECHANICAL TEST

4.1. Tensile specimen

Tensile strength of the specimen is determined by carrying tensile test on UTM followed by ASTM Standards. The standard used for tensile strength is ASTM D3039. It has been fabricated according to the ASTM Standards.

Type of test: Tensile strength

Standard: ASTM D3039



Figure 1.3: Specimens for Tensile Test

4.2. Flexural specimen

Flexural strength of the specimen is determined by carrying tensile test on UTM followed by ASTM Standards. Three-point bending test of composite sample is carried out in ASTM D 790 test standard. A uniaxial load was applied through both the end.

Type of test: 3-point Flexural Test

Standard: ASTM D 790



Figure 1.5: Specimens for Flexural Test

4.3. Impact specimen

The energy absorbed by the material is found by Charpy testing followed by ASTM Standard of ASTM E23-15b as shown in figure 4.



Figure 1.6: Specimen for Impact Test

5. RESULT AND DISCUSSION

5.1. Tensile test

It is found that tensile strength of woven flax/sisal reinforced with Epoxy/SiC Resin are given unfavorable results. Woven cloth fiber based flax /Sisal reinforced hybrid composites are given average maximum Tensile stress about 28 N/mm², Maximum Tensile force about 2445N and will have maximum Tensile strain 2.718%.

Table 1.2: Tensile Test Results

Specimen	Tensile stress(N/mm ²)	Maximum force(N)	Maximum Tensile strain(%)
1	29.697	2413.50	2.25917
2	28.121	2362.17	3.39795
3	26.522	2494.51	2.49137

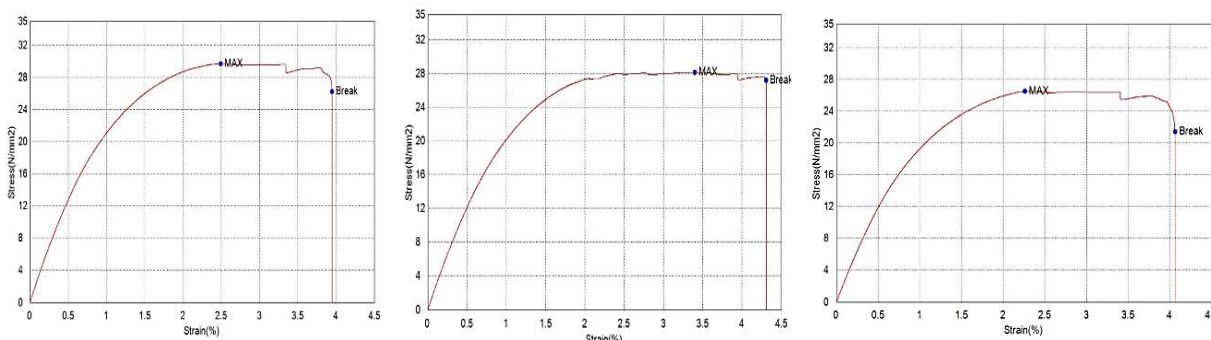


Figure 1.7 : Stress vs strain diagrams for Tensile test

5.2 Flexural test

Table 1.3 shows the details of flexural results for three number of specimens. From the below graph of stress vs strain it is observed that average flexural stress of material is 63 N/mm².

Table 1.3: Flexural Test Results

Specimen	Flexural stress(N/mm ²)	Maximum force(N)	Maximum strain(%)
1	58.29	71.0328	5.87025
2	60.56	80.05060	4.95108
3	70.01	93.0627	4.58747

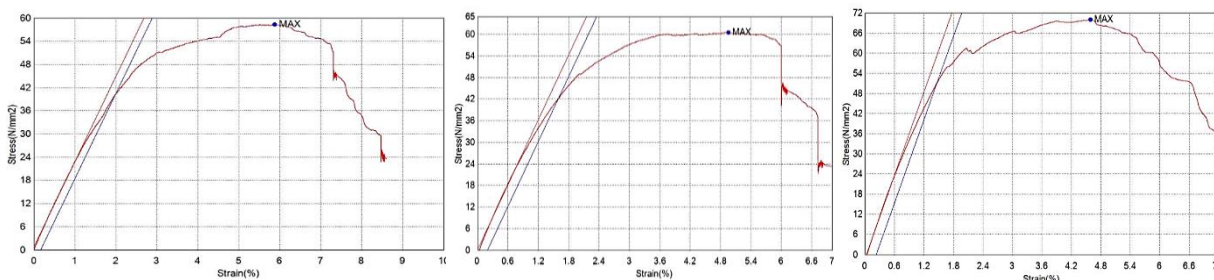


Figure 1.8: Stress vs Strain diagram of Flexural test

5.3. Impact test

Impact test is conducted to analyses the energy absorbed by the specimen for sudden applied load. The impact test is done by charpy impact test machine. From the table 1.4 it is observed that average impact strength of composite material is 137.66 KJ/m².

Table 1.4: Impact test Results

Specimen	Impact strength(KJ/m ²)
1	142.05
2	99.43
3	170.45

5.6. SEM Analysis

The following Figure 8. shows sample's surface topography of flax/Sisal reinforced with SiC nanopowder/epoxy resin after fabrication. The SEM test shows the various of mechanical properties through phase distribution information. Figure shows that phase of flax/Sisal/SiC nanopowder/epoxy reinforced epoxy composite. It is observed that due to hand layup process, Sic and epoxy resin are taken uneven surfaces which may reduce tensile and flexural properties comparatively but it is proven that this uneven surfaces of Sic and resin may increase impact strength of material.

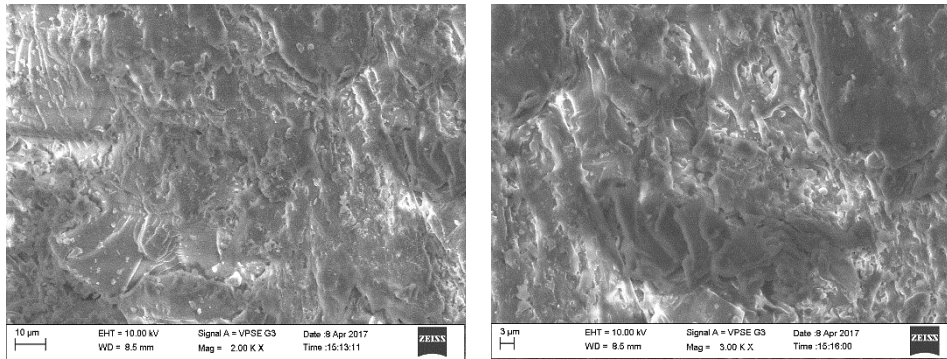


Figure 1.9: SEM Images of Flax/Sisal reinforced with

6. CONCLUSION

Natural fiber reinforced composites form one such class of materials which not only possess superior mechanical properties but are also bio-degradable in nature. Natural fiber reinforced composites can be a potential candidate where they can replace the conventional material system of wind industry. But it is not possible to completely replace the synthetic fibers by natural fibers only, in order to get better properties, it is essential to use some amount of Nanopowder such as SiC to improve its mechanical properties with low density.

From this research it is found that adding 6% of SiC Nanopowder in Epoxy which improves the impact strength of material up to 137.66 KJ/m^2 , Tensile strength up to 28 N/mm^2 , and flexural strength 63 N/mm^2 with maintaining low material density.

7. References

- [1] Aakash Sirshti, Senthil Dr.P.V (2014), Studies on Material and Mechanical Properties of Natural Fiber Reinforced Composites, The International Journal Of Engineering And Science (IJES), Volume- 3, Issue-11, pp-18-27.
- [2] Abdul Gafur, Jahangir A. Khan, Mubarak A. Khan, Rabiul Islam (2010), Mechanical, Thermal and Interfacial Properties of Jute Fabric-Reinforced Polypropylene Composites: Effect of Potassium Dichromate, Materials Sciences and Applications, pp-350-357.
- [3] Ahmed F. Hamzah, Mohammed S. Hamzah, Najim A .Saad (2013), Study of Fatigue Behavior of Composite Materials with the Basis of Polyphenylene Sulfide (PPS) Reinforced with Glass Fiber and Carbon, International Journal of Engineering and Technology Volume-3 No. 4, pp-467-474.

- [4] Alagarraja1.K, Dhamodharan.A ,Gopinathan.K, Mathan Raj.R, Ram Kumar.K (2014), Fabrication and Testing of Fibre Reinforced Polymer Composites Material, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), pp- 27-34.
- [5] Alberta Latteri, Gianluca Cicala, Giuseppe Cristaldi, Giuseppe Recca (2010), University of Catania – Department of Physical and Chemical Methodologies for Engineering, Composites Based on Natural Fibre Fabrics, volume- , pp-317-339.
- [6] Ashish Chauhan, Balbir Kaith, Priyanka Chauhan (2012), Natural Fiber Reinforced Composite: A Concise Review Article, Chemical Engineering & Process Technology, Volume-3, Issue-2, pp-1-2.
- [7] Ashok Kumar.M, Dasaratha.H, Mohana Reddy.Y.V, Ramachandra Reddy.G, Thimmapuram Hemanth Babu, Vasanth Kumar Reddy.G, Vishnu Mahesh.K.R (2011),Fabrication and Performance of Natural Fibers: Sansevieria cylindrica, waste silk, jute and drumstick vegetable fibres (Moringa Oleifera) reinforced with rubber/polyester composites, International Journal of Fiber and Textile Research, pp-15-21.
- [8] Chandramohan.D, Marimuthu.K (2011), a review on natural fiber, volume-8, Issue-2, pp-114-204.
- [9] Debiprasad Gon, Kousik Das, Palash Paul, SubhankarMaity(2012),Jute Composites asWood Substitute, International Journal of Textile Science Vol-6, pp-84-93.
- [10] De Rosa.M, Marra.F, Pulci.G, Santulli.C, Sarasini.F, Tirillo.J, Valente.M (2011), Post-impact mechanical characterization of E-glass/basalt woven fabric interply hybrid laminates, eXPRESS Polymer Letters Vol-5, No.5, pp- 449–459.