Effect of SiC Nano powder on Multiaxial Woven and Chopped Randomly Oriented Flax/Sisal Fiber Reinforced composites

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Abstract. A study has been carried out to investigate effect of SiC Nano powder on tensile and impact properties of Multiaxial layers of Flax and Sisal fiber reinforced composites and randomly oriented chopped Flax and Sisal fiber reinforced composites. It has been observed that tensile strength and impact strength were improved using 6% of SiC Nanopowder into Multiaxial layer (+45º/-45º, 0º/90º) of Flax and Sisal where as randomly oriented chopped Flax and Sisal fiber reinforced composites are improved in its stiffnes for the same composition of fiber, epoxy and SiC Nano powder. SEM Analysis are done to analyse the distribution of SiC in both Multiaxial layers of Flax and Sisal fiber reinforced composites and randomly oriented chopped Flax and Sisal fiber reinforced composites.

1 Introduction

Natural fiber reinforced composites are alternative materials for many applications such as small wind turbine blades, automobile applications, and aerospace applications [1]. Natural fibers shows superior properties such as tensile, flexural and impact than glass fiber [2]. Low cost, light weight, easy fabrication, ecofriendly, low manufacturing cost are the advantages of natural fibers [3, 4]. But high moisture absorption is major drawback of natural fiber [7]. European cars are already using Natural fiber reinforced composites due to more favorable economic, environmental and social aspects of vegetable fiber [9]. Also they are using them in trunk liners, instrumental panels, interior roofs, and door panels. Low level of volume fraction provides higher modulus of elastity and good 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 orientation, fiber length, fiber concentration and the bonding between the fiber and matrix [10].

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1.2 Literature Review

Mechanical properties of Sisal and Flax fiber reinforced composite are increses by selecting suitable composition of fiber and resin [11].

Sisal fiber gaves good potential as reinforcement in polymer composites. Low density and high specific properits of Sisal fiber, composites taking into account, these filaments may have great applications in the automotive and transportation industry [12].

A experimental investigation on effect of orientation of alkaline treated fiber reinforced composites. The charpy impact strength in the orientation 90° yielded the maximum impact strength. The orientation 90° shows the better mechanical properties compare to 0/90° and 45° [13].

Experimental investigation has been studied on the tensile properties of Sisal and coconut spathe reinforced composites. The distinctive rate of filaments is taken, because of the low density the composites can be viewed as a helpful light weight material [14].

The mechanical properties of Sisal and Flax fiber reinforced composites are incredibly affected by alkalization trématent. Alkaline trématent was found be effective in improvement of tensile and impact properties of natural fibres.

2 Fabrication

2.1 Materials used

The raw materials used in this work are, Sisal fiber, Flax fiber, SiC Nano powder, Epoxy and Hardener

2.2 Multiaxial Layers of Flax/Sisal Reinforced with Epoxy and SiC Nano powder

Flax and Sisal fiber reinforced composites are fabricated by hand layup process into dimensions of length and breadth of 300×200mm was used to prepare the specimen. The composite specimen consists of totally 6 multiaxial woven layers of Flax and Sisal at different angles of +45°/-45° and 0°/90° as shown in table 2.1. Specimens were fabricated using hang layup by taking 17% of Flax ,17% of Sisal and 6% of SiC Nano powder as shown in figure 2. 1..

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.

Table 1. Details of multiaxial 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

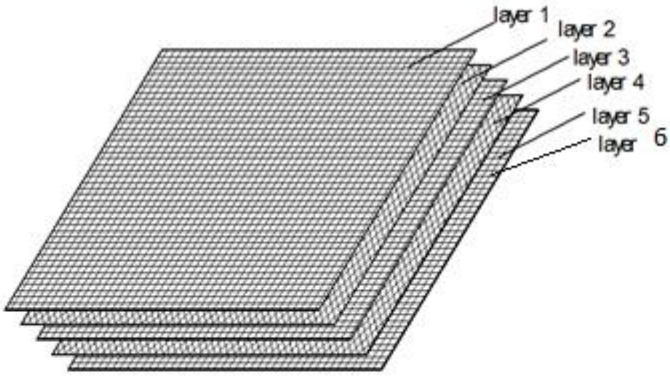


Fig. 1. Multiaxial layers of Flax and Sisal

2.3 Randomly oriented Chopped Flax/Sisal Reinforced with Epoxy and SiC Nano powder

Sisal and Flax were cut into a small length of 4 to 6 mm. Dimensions of length and breadth of 300×200mm was used to prepare the specimen. These chopped fibers are then fabricated in the ratio of 17% of Flax, 17% of Sisal and 6% of SiC Nano powder.

3 Mechanical Test

3.1. Tensile specimen

Tensile strength and young's modulus were determined by taking average value of three specimens and ASTM D3039 is used for testing tensile strength of composites. Specimens are fabricated according to ASTM Standard as shown in figure 2.

(a) (b)

Fig. 2. Fabricated Specimens for Tensile Test as per ASTM Standards
(a) Woven Flax and Sisal Fiber Reinforced Composite; (b) Randomly oriented Flax and Sisal fiber reinforced composite

3.2. Impact specimen

Impact strength of composite material is determined by by taking average value of three specimens carrying followed by ASTM Standards. ASTM E23-15b is used for testing impact strength of composites. Specimens are fabricated according to ASTM Standard as shown in figure 3.

(a)

(b)

Figure 3: Fabricated Specimen for Impact Test as per ASTM Standards (a) Woven Flax and Sisal Fiber Reinforced Composite; (b) Randomly oriented Flax and Sisal fiber reinforced

4 Result and discussion

4.1. Tensile test

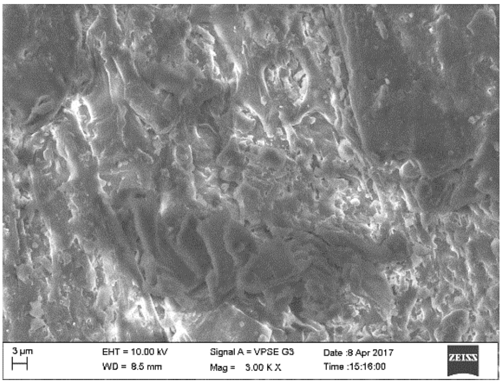
It is found that average Tensile strength of multiaxial woven Flax and Sisal fiber reinforced with epoxy and SiC is 28.13 N/mm², and average tensile strength of randomly oriented Flax and Sisal fiber reinforced composites is 13.183 N/mm². Tensile strength of composite materials increased by 53.14% for multiaxial layers of Flax and Sisal are increased.
Strain rate for multiaxial layers of Flax and Sial reinforced composites are 65% more than that of randomly oriented chopped fiber of Flax and Sisal. But stiffness of randomly oriented chopped fiber of Flax and Sisal reinforced composites are 36.12% better than multiaxial woven Flax and Sisal fiber reinforced composites.

4.3. Impact test

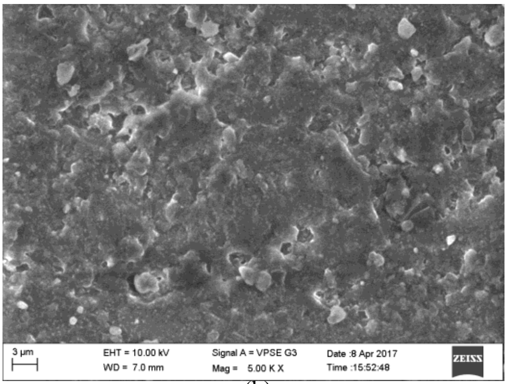
The impact strength of Flax and Multiaxial Woven Sisal fiber reinforced with SiC resulted in higher strength than the chopped fiber reinforced composites. Multiaxial layers of different angled woven fibers are ability to absorb more energy before its failure. Impact strength of composite material is improved by 62.47% by using multiaxial layers of Flax and Sisal Reinforced with SiC.

4.4 SEM Analysis

From the following Figure, Figure. a shows sample's surface topography of multiaxial Woven Flax/Sisal fiber reinforced with SiC Nano powder and figure.b for Chopped Flax and Sisal fiber reinforced composites.
The topography properties of the fabricated composite surface show the variation in mechanical properties through phase information of the fabricated composites specimens. From the SEM analysis on both composites (Woven and Chopped fiber), It is observed that distribution of fiber and resin is uniform in Woven cloth fiber composite which is resulted in improving impact strenth of composite materil. Where as in case of Chopped fiber composite the fiber and SiC are randmloy distributed and resulted in poor impact strenth but resukted in more stiffer than woven cloth fiber reinforced comosite.



(a)



(b)

Fig. 4. (a) SEM images of Woven cloth fiber composites (b) SEM images of Chopped fiber composites

5 Conclusions

Natural fibers are superior in mechanical properties and are also bio-degradable. Natural fiber are able to replace glass fiber and carbon for automobile and wind turbine blade applications. But it is very difficult by natural fiber alone. In order to increase the mechanical properties, it is very essential to use multiaxial layers of two or more than two types of natural fiber and Nano particle into it.

In this research, work has been carried out on multiaxial layers of Flax and Sisal fiber reinforced with SiC Nano powder and randomly chopped oriented Flax and Sisal fiber reinforced with SiC Nanopowder. It is found that uniform distribution of SiC into Flax/Sisal fiber improved impact strength and tensile strength by more than 50% than that of randomly oriented chopped fiber. But non uniform distribution of SiC into randomly oriented chopped fiber improved its stiffness by 36% more than that of woven cloth fiber reinforced composite.

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