Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

Experimental Investigation and Analysis of Natural Composites Using Banana Fiber and Vetiver Reinforced with Epoxy Resins

Dinakaran1, S.Aravind2
[1]Assistant Professor, Department of Mechanical Engineering
,[2]Assistant Professor, Department of Aeronauticall Engineering
Dhanalakshmi Srinivasan College of Engineering and Technology, Mamallapuram

ABSTRACT

In this research, vetiver & Banana fibers composites were prepared by using hand lay-up. The characterization of vetiver was investigated. The effect of vetiver& Banana particle sizes on the rheological, thermal, and mechanical properties of the composites were determined. In addition, the effects of vetiver & Bananaparticle sizes, andvetiver& Banana contents on shear-induced crystallization layer, degree of crystallinity, and crystalline distribution were`The crystallization kinetics and spherulitic growth rate were also analysed.

Natural fiber composites are playing an important role in present area of composites among them plant fiber have a major role as a fiber reinforced material. Thermal analysis has a crucial role and play an significant factor in determining the materialistic properties of composites. In the present study, a vetiver & Banana fibers fiber composite was prepared by a simple hand lay-up method. Tensile, impact and flexural test was carried out. Thermal degradation analysis was performed with thermal gravimetric analyser and the studies show that the fibres were treated with some more chemical treatments it would have added less thermal degradation and more mechanical properties.

A composite material is a combination of two or more materials arranged in the form of layer one on one the other layer using binding material through some prescribed methods. In the Vetiver & Banana fiber hybrid composite method, the epoxy resin is used as binding material, in which one layer is formed of Nature fiber, followed by vetiver & Banana fiber . By using hand lay-up method and by changing the above arrangement of the layers, using the resin of LY 556 and hardener HY 951. Carbon fiber laminated have significantly influenced the mechanical properties.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

INTRODUCTION

Vetiver belongs to the same family as maize, sugarcane and lemon grass. In Thailand, His Majesty the King initiated and supported the use of vetiver for soil and water conservation .Normally, the vetiver leaves are cut every few months to keep vetiver row in order and left as a residue. Therefore, to help farmer gains some extra incomes from the residue has been an inspiration of our works. Nowadays, natural fibers such as flax, jute, vetiver etc. have been increasingly used as alternative fillers in polymer composites. This is due to their advantages over synthetic fibers including their low cost, less tool wear during processing, low density, biodegradability and renewability. Vetiver is one of the interesting candidates among other natural fibers to use as a reinforcing filler in polymer composite has been widely used for production of natural fiber-polymer composites because it posses many advantages, such as its good process ability, high cost performance ratio, and low processing temperature. In order to make vetiver fiber suitable for PP composites, chemical treatments of vetiver fiber must be performed. From our previous works, alkali treatment was to be an effective method to clean the surface of vetiver`

In order to prepare products from vetiver-composites, injection molding is one of the potential processing methods. The processing conditions of the injection molding can have the effect on the crystallization and morphology of the products. Hence, they govern the physical properties of the molded products. During injection molding, the molten polymer at the cavity wall is subjected to high shear stress which causes the shear-induced crystallization to take place. However, in the core of the moldings due to the low shear stress and low coolingrate, the relaxation of the molecular chains occurs which favors the quiescent crystallization.

As a result, a clear skin-core structure composed of a surface skin layer with a high molecular orientation and an inner core layer with a low molecular orientation of spherulites was observed. Understanding the crystallization occurred in the injection molded samples is highly important because it relates the morphology and hence the property of the products. Until now there are a few research papers published on the crystallization of injection molded PP composites

From our previous study, DSC curves of the core region exhibited obviously multiple and broader than those of the skin. This indicated that several crystallographic forms could be taken

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

place in the core. The lower degree of crystallinity of vetiver-PP composites compared to neat PP was also observed. The degree of crystallinity of vetiver fiber composite was found to be slightly higher than that of the vetiver powder composite.

This is possibly due to the more suitable surface topology of vetiver fiber for nucleation. In addition, the effect of processing conditions on shear-induced crystallization layer of vetiver fiber was also studied. It was found that the shear-induced crystallization layer of both and vetiver- composite slightly decreased with increasing screw speed, injection speed, and mold temperature. When compared to, vetiver- composite showed lower shear-induced crystallization layer. This may be due to the vetiver acting as an obstruction to the normal flow of the melt. As a result, the molecular orientation of vetiver fiber was less than that of leading to the thinner shear- induced crystallization layer. Moreover, slightly higher crystallinity was observed when injection speeds and mold temperatures increased.

LITERATURE REVIEW

K Arun et al (2016) conducted an experiment on fabrication and testing of vetiver and banana fibers reinforced polymer composites material. In this work, vetiver and banana fibers reinforced composites is developed and their mechanical properties suchas tensile strength, compression strength and impact strength are evaluated.Thus the vetiver-GFRP composite samples are fabricated and tested. Thehybrids composite are subjected to mechanical testing such as tensile,compression and impact test. Based on the results, the following conclusions aredrawn.

The results indicated that vetiver–Epoxy resin specimen gives tensile strength is low. The Maximum tensile force (MTF) of thevetiver–Epoxy resin composite is in the range of 24 KN. In the compression test the result indicates that very high strength 29 KN and the respectively displacement is 2.3mm. The maximum impact strength is obtained for the vetiver-Epoxy resin fiber composite and has the value of 18 joules. The microstructure of the fiber is obtained in the breaking point of tensile and impact test of specimen. To obtain the interfacial properties, internal cracks and internal structure of the fractured surfaces of the composite materials.

M K Gupta et al (2017) investigated the properties of vetiver and banana fiber reinforced epoxy composites. Vetiver fiber reinforced epoxy composites havebeen prepared by hand lay-up

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

technique followed by static compression, usingvarious fiber weight fractions (15, 20, 25 and 30%). Mechanical properties,thermal properties, water absorption properties and dynamic mechanicalanalysis of vetiver composites are investigated. The results show that theaddition of vetiver fibers in epoxy matrix up to 30 wt. % increases the mechanical, thermal and water absorption properties. The values of storage modulus and loss modulus increase with the increase in fiber content up to 25 wt. % and then decrease.

Manjunath G et al (2018) investigated the mechanical properties of vetiver and banana fiber reinforced polymer composites. The aim of this work is to studythe influence of vetiver fiber content on mechanical (i.e. tensile, flexural, impact, hardness and abrasionresistance) and thermal (i.e. TGA) properties of composites by varying the fiber and epoxy percentage.
The composite wasprepared by melt-mixing method, followed by compression molding process.The percentage of vetiver fiber is varied from 4% to 10% in steps of 2%.Similarly epoxy content is varied from 96% to 90% in steps of 2%. Detailedmechanical Properties of Vetiver Fiber Reinforced Polymer Composites havebeen studied.

B K Mallikarjun et al (2018) conducted a test on vetiver fiber reinforced epoxy composites at different orientations for tensile and compression. Aim of this work is to investigate the mechanical properties such as tensile strength and compressive strength of the vetiver fiber reinforced polymer composites. The strength analysis of the vetiver fiber reinforced polymer composites has been made with volume fraction and different combinations such as unidirectional and orientations. The specimens were prepared by hand layup technique and are as per the ASTM standards. The experimental results showed that the tensile strength of the vetiver fiber reinforced polymer composites with unidirectional gives better results as compare to orientation composites, but the compression strength is better for orientation composites.

K Joseph et al (2019) made a review on vetiver and banana fiber reinforced polymercomposites. The present paper surveys the research work published in the fieldof vetiver fiber reinforced polymer composites with special reference to thestructure and properties of vetiver fiber, processing techniques, and the physical

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

and mechanical properties of the composites. Due to the low density and high specific properties of vetiver fibers, composites based on these fibers may have very good implications in the automotive and transportation industry. Moreover, reduced equipment abrasion and subsequent reduction of re-tooling costs will make these composites more attractive. The use of vetiver fibers as a source of raw material in plastic industry not only provides a renewable resource, but could also generate a non-food source of economic development for farming and rural areas.

MATERIALS AND METHODS

Banana fiber is multiple celled structures. The lumens are large in relation to the wall thickness. Cross markings are rare and fiber tips pointed and flat, ribbons like individual fiber diameter range from 14 to 50 microns and the length from 0.25 cm to 1.3 cm, showing the large oval to round lumen. The ‘‘pseudo-stem’’ is clustered, cylindrical aggregation of leaf stalk bases. Banana fiber at present is a waste product of banana cultivation and either not properly utilized or partially done so.A high cellulose content and low microfibril angle impart desirable mechanical properties for bast fibers. Lignins are composed of nine carbon units derived from substituted cinnamyl alcohol; that is, coumaryl, coniferyl, and syringyl alcohols. Lignins are associated with the hemicellulosesand play an important role in the natural decay resistance of the lignocellulosic material.

Fig 3.1 Banana fiber

VETIVER

vetiver is perennial bunch grass of the poaceae family, native of india. Vetiver is most closely

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

related to sorghum but shares many morphological characteristics with other fragrant grasses, such as lemongrass, citronella, and palmarosa.and the biological name of the vetiver is chryosopogan ziaznioides. Vetiver grows of 150 centimeters (5 feet) high and form clumps as wide. Under favorable conditions, the erect culms can reach 3m in height. The stems are tall and the leaves are long, thin, and rather rigid. The flowers are brownish-purple. Unlike most grasses, which form horizontally spreading, mat-like root systems, vetiver"s roots grow downwards, 2meters (7 ft) in depth.

The vetiver bunch grass has a gregarious habit and grows in tufts. Shoots growing from the underground crown make the plant frost and wildlife resistant, and allow it to survive and heavy grazing pressure. The leaves can become up to 300 centimeters (10 ft) long and 8 millimeters (0`3 in) wide. The panicles are 15 centimeters (12 in) long and have whorled, 25 millimeters (1 in) to millimeters (2 in) long branches the spikelets are in pairs. And there are three stamens.

Fig 3.4 vetiver

METHODOLOGY

The various proportions of composites were fabricated using hand layup method. The mechanical behavior of specimens are investigated such as Impact test (Izod and Charpy), Tensile test , flexural test and Compression testing. The specimen undergoes Scanning Electron Microscope (SEM) test for obtaining the microstructure on the surface of composites. Finally the results were discussed and concluded.

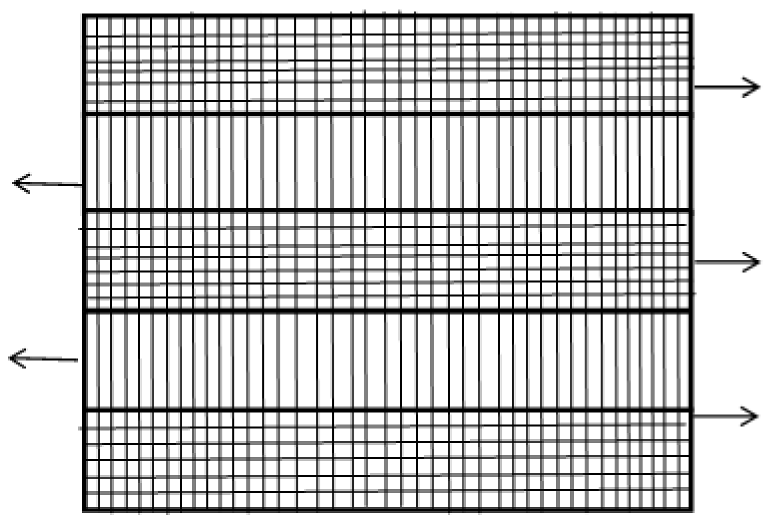
Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

Raw materials used in hand lay-up method

Table 3.1 Materials used

Matrix	Epoxy
Reinforcement	vetiver &banana fiber

Block diagram



TESTING METHOD

IMPACT TEST

The charpy test, izod test and other impact testing determines material toughness or impact strength in the presence of a flaw or notch and fast loading conditions. This destructive test involves fracturing a notched specimen and measuring the amount of energy absorbed by the material during fracture

CHARPY IMPACT TEST

The charpy impact test, also known as the charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.


Fig 4.1.1 Before test Fig 4.1.2 After test

TENSILE TEST

According to ASTM D3039 / D3039M standards for composites, the specimens were prepared for tensile test. Fiber configuration and volume fraction are two important factors that affect the properties of the composite. The test process involves placing the test specimen in the testing machine and slowly extending it until it fractures. During this process, the elongation of the gauge section is recorded against the applied force.

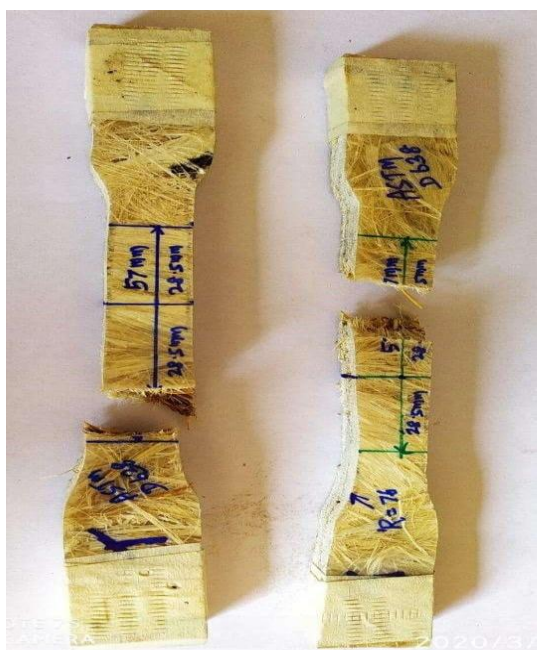


Fig 4.2.1 Before test Fig 4.2.2After test

FLEXURAL TEST

The material properties of four laminates with different skin/core/production method are compared in order to identify their mechanical properties. In this study, 3-point flexural beam tests following the ASTM standard C393 are carried out on each of the four laminates and the results are compared.


1Before test Fig 4.3.2 After test

RESULT AND DISCUSSION

TENSILE TEST

The tensile test is carried out to determine the effectiveness and behavior of a material when a stretching force is applied on it.

Specimen	**Load (p)** kN	**Width of the specimen (b)** mm	**Length of specimen (L)** mm	**Ultimate load in** kN	**Breaking load in** kN	**Ultimate stress in** Kpa
Specimen-1	30	15	165	20	4	10
Specimen-2	30	15	165	30	4	12

Table 5.2

5.1. CALCULATION OF TENSILE STRENGTH

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

Length of the specimen l= 200mm Width of the specimen b= 15mm Ultimate load = 30 KN

Breaking load = 10 KN Reduced cross section = 500 mm^2

Area of cross section = l x b

= 165 x 15 = 2475 mm^2

Reduction of area for convenience= 2475– 500 =1975 mm2

Cross sectional area = 1975 mm^2

Ultimate stress = ultimate load / cross sectional area

= $30 \times 10^3 / 1975$

Ultimate stress = 15.18 N/mm^2

Breaking stress = breaking load / cross sectional area

= $10 \times 10^3 / 1975$

Breaking stress = 5.06 N/mm^2

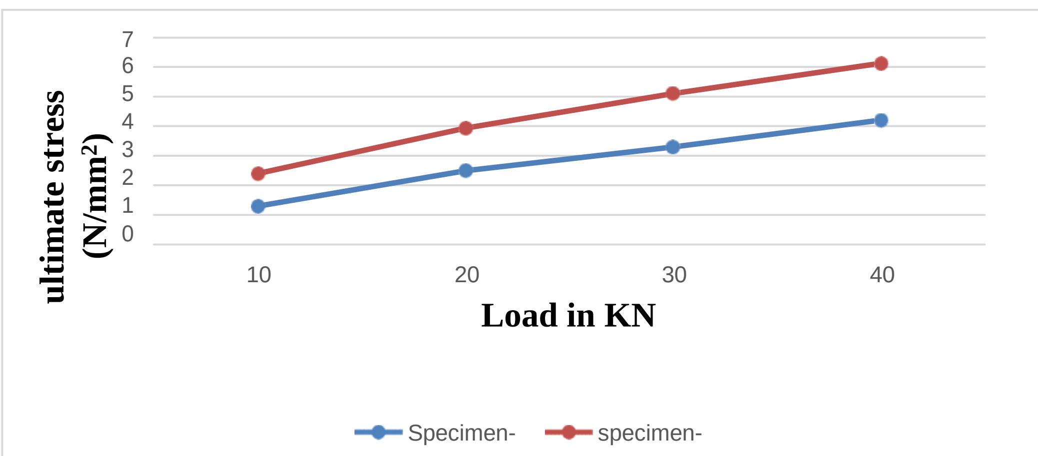


Fig 5.1 variations in tensile strength on different compositions

IMPACT TEST

The izod test, charpy test and other impact testing determines material toughness or impact strength in the presence of flaw or notch and fast loading conditions.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

Table 5.3 Impact Test Results

Specimen	Energy Absorbed J)
Specimen-1	2
Specimen-2	3

CHARPY IMPACT TEST

Length of the specimen l= 75 mm Width of the specimen b= 10 mm Height of the specimen h= 10 mm Cross sectional area a= 172 mm^2

Impact strength= energy absorbed/ cross sectional area

= 02/172

Impact strength =0.001J/mm^2 (or) 11.62J/m^2

CHARPY IMPACT TEST

Length of the specimen l= 75 mm Width of the specimen b= 10 mm

Height of the specimen h= 10 mm Cross sectional area a= 172 mm^2

Impact strength= energy absorbed/ cross sectional area

= 03/172

Impact strength =0.01749 J/mm^2 (or) 17.44J/m^2

FLEXURAL TEST

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

specimens	**Observed values (N/ mm$^{2)}$**
Specimen 1	11
Specimen 2	12

Displacement = 10mm Load of specimen 1= 11N Load of specimen 2=12 N

Flexural test for specimen 1= Load/ Displacement

= 11/10

Flexural test =1.1J/mm^2

Flexural test for specimen 2= Load/ Displacement

= 12/10

Flexural test =1.2J/mm^2

SEM TEST RESULTS

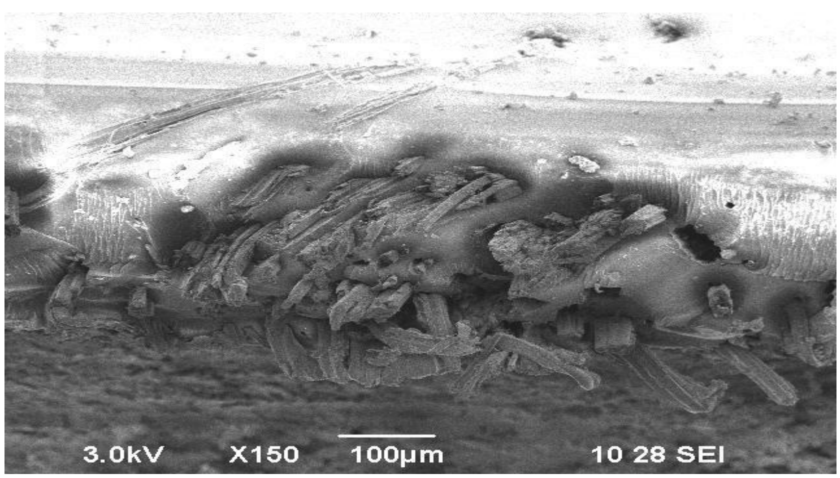


Fig 5.4.1 SEM image for specimen 1

Fig 5.4.1 reveals the surface structure of specimen 1 (Epoxy (80 wt %), Vetiver fiber (10 wt %)

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

,banana fiber (10 wt %) and Hardener (30 wt % of Epoxy). From the figure it isclear that the fiber and the epoxy resin are evenly distributed throughout the entire specimen and it shows the fine link between the matrix and reinforcing fiber.

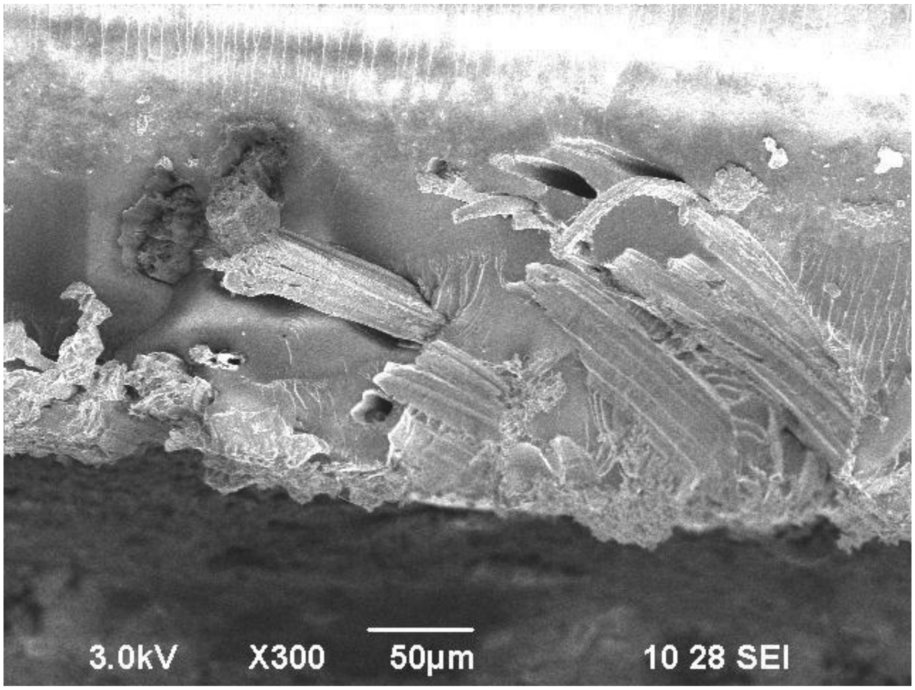


Fig 5.4.2 SEM image for specimen 2

Fig 5.4.2 reveals the surface structure of specimen 2 (Epoxy (70 wt %), Vetiver fiber (15 wt %) ,Banana fiber (15 wt%)and Hardener (30wt % of Epoxy). From the figure it isclear that the fiber and the epoxy resin are evenly distributed throughout theentire specimen and it shows the fine link between the matrix and reinforcingfiber.

CONCLUSION

Thus the Vetiver and Banana composite samples are fabricated and tested. The hybrids composite are subjected to mechanical testing such as tensile,compression and impact test. Based on the results, the following conclusions are drawn. The results indicated that vetiver and Banana –Epoxy resin specimen gives tensile strength is low. The Maximum tensile force (MTF) of the vetiver and Banana–Epoxy resin composite is in the range of 12 KN.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 24, Issue 2, 2020, Pages. 1930 - 1943
Received 20 October 2020; Accepted 04 December 2020.

REFERENCES

[1]. Gopinath, M.Senthil kumar and A.Elayaperumal, “Experimental Investigations on mechanical properties of jute fibre reinforcement composites with polyester and epoxy resin matrices”, procedia Engineering, vol. 97, pp. 2052-2063, 2016.

[2]. Alok singh, savitha singh and Adithya kumar, “study of mechanical properties and absorption behaviour of coconut shell powder-epoxy composites”, international journal of materials science and applications, 0205.12,2017.

[3]. N. Anupama sai priya, P. Veera raju and P. N. E. Naveen, “Experimental testing of polymer reinforced with coconut coir fiber composites” International journal of emerging technology and advanced engineering, 2250-2459,2018

[4]. Somnuk U., sutapan W., suppakan N, “Effect of processing conditions on shear-induced crystallization of injection molded vetiver grass-polypropylene composites. Australian polymer symposium , new Zealand, p9,2016`

[5]. Ruksakulpiwat Y, somnuk U., sutapan W., sutapan N., “Effect of particles sizes of vetiver grass on shear-induced crystallization of injection molded vetiver grass –polypropylene composites. Congress of science and technology of Thailand, pp 221. 2013.

[6]. M K Gupta & R K Srivastava, “Properties of vetiver fiber reinforced epoxy composite”, Dec 2016.

[7]. Manjunath G. Prasad,A. G. Girimath, sharath Rao,A. J.vinekar, D.c. patil,S.N Mathad ,“Investigation of mechanical properties of vetiver fiber reinforced polymer composites”, Jan 2017.