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Filler Improvement on Izod Impact Test Strength of Sisal Fiber Reinforced Novel Graphene Nanoparticles for Automotive Applications

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ABSTRACT

Aim: The study's research improves and compares the Izod impact strength of Sisal fiber-reinforced polymer with epoxy composites to sisal fiber composites with graphene filler. **Materials and method:** Sisal fiber 220 gsm, resin (LY559), and hardener (HY951) of resin, and hardener of epoxy matrix composites are utilized as reinforcement materials with filler graphene. The hand lay-up technique was used to create the laminate. The total number of samples calculated with g-power 80% for both experimental and control groups are 40; i.e., 20 per group. Fabricated the composite with sisal fiber without filler and also fabricated the composite with sisal fiber and novel graphene nanoparticles as filler of 4 wt%. The samples were all tested and had to be done using an Izod impact testing machine. According to the V-shaped double-notched testing was done using the izod impact testing machine. **Result:** When comparing the results acquired through fabrication victimization of sisal fiber with graphene composites to those obtained during victimization graphene, the result obtained during fabrication victimization graphene has accrued. Using the SPSS computer code evaluated and compared, the sisal fiber with 4% graphene will rise by 2.15J, 4.9J. The mean significant variation of 0.001 ($p<0.05$) with and without filler. **Conclusion:** Within the scope of this investigation, graphene composites containing 4% sisal fiber exhibit considerably greater Izod impact strength than sisal fiber composites without filler.

Keywords: Izod impact strength, Sisal fiber, Epoxy resin, Composites, ANOVA, Novel graphene nanoparticles, Hardener, Resin, Flexibility.

INTRODUCTION

Graphene-coated sisal fibre In contrast to fibre composites, the Izod impact test of sisal fibre composites enhanced with graphene has improved. Sisal fibre composites enhanced with graphene were used to improve the izod impact test's performance (Sheshama et al. 2017). In comparison to nano clay, silica nanoparticles, and carbon nanotubes, graphene is a tough filler. It's useful in the automotive and aerospace industries. Costa researched Evaluation of izod impact and bend properties of epoxy composites reinforced with mallow fibers.Epoxy composites reinforced with 10, 20 and 30% vol% of natural fiber, the mallow fiber were investigated mechanical properties associate with izod notch toughness and flexural resistance.In this 30% is highest izod impact test. (Costa et al. 2020). Shelly reported that addition of compatibilized nanoclay to GFRCs for improved izod impact strength and tensile properties GFRCs reinforced with silinized unwashed nano clay (3X) showed 27% improvement in izod impact strength. (Shelly, Nanda, and Mehta 2021). Singh,

Nanda and Mehta reported that addition of nanoclay and compatibilized EPDM rubber for improved impact strength of epoxy glass fiber. (K. Singh, Nanda, and Mehta 2017).

There are around 42 articles published in science direct and 101 articles published in google scholar for the past five years. Asenjan researched mechanical and high velocity impact performance of a carbon and glass fiber (Asenjan, Sabet, and Nikoomanesh 2020). Pontes improved Izod impact test of epoxy and polyester matrix composites reinforced with hemp fibers with a maximum izod impact strength (Pontes et al. 2018). Moraes (Moraes et al. 2017) reported the improvement of izod impact test in polyester matrix composites reinforced with jute fiber; the results show a remarkable increase in the notch toughness with an increased layer of mauve blankets and jutes (Moraes et al. 2017). Margem improved the izod impact test in composites reinforced with malva fibers in this amount ranging from 0% to 30% in volume of continued aligned malva fibers and results show improvement by the addition of malva fiber (Margem et al. 2014). Moraes (Moraes et al. 2017) is the best study as it reported higher stronger composite preparation.

Because no combination of sisal and graphene has been identified from the literature, the impact of novel graphene nanoparticles filler is examined in an oxidative situation, according to the literature review. This new material was carried out with the expertise of The major objective of the study is to use novel graphene nanoparticles to increase the izod impact strength of sisal fibre, which will improve attributes such quality strength, durability, flexibility, lightweight, and conductivity. The izod test is also used to evaluate the relative toughness and impact toughness of the composites.

MATERIALS AND METHODS

Composite plates were prepared using the hand layup technique at the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Science, carried out this research work. This project did not work with human samples. This work is about composite materials. There are two groups. Group:1 control group and Group:2 experimental group in control group sisal without filler and in experimental group sisal with novel graphene nanoparticles to comparing the with and without filler, And the sample size is N= 20 and the G-Power used in this process is 80%, Alpha=0.05%, and Cl as 95% which suggests the data is statistically significant pre-test power analysis (Sarker et al. 2018).

The dimensions of standard specimen ASTM D256 are 63.5×12.7×3.2mm (2.5×0.5×0.125). Sisal fiber (natural fiber) and novel graphene nanoparticles (filler), liquid solutions like (resin and hardener). Every material is purchased from fiber region shops in Chennai. The matrix and reinforced material and the fabrication process we have discussed. In this paper, we are using sisal fiber used as a base material and epoxy and hardener used as a matrix material. In this project, graphene is used as a filler to improve izod impact strength. Graphene is mixed with epoxy and hardener for fabricating the laminates. sisal fiber with graphene we have done fabrication to increase properties like quality strength, durability strength, flexibility, lightweight, and conductivity. This project did not work with human samples.

Sample preparation group:1 Sisal fiber without filler (0%) prepared by the process of fabrication. Epoxy (LY556) and Hardener (HY951) were used during the matrix preparation phase. Polypoxide and epoxy resin are both terms for the same material. Epoxy (LY556) is a resin with excellent mechanical, thermal, and dynamic properties and outstanding chemical resistance. It's also impregnable. The epoxy and hardener were combined in a ratio of 10:1 during the fabrication process and fabricated plate drying 24 hours at a temperature of 80°C to prepare a plate. And the same process is followed for sisal fiber with filler. And the material is 6cm and 1.5cm (length and width) in the control group of 20 samples.

Sisal fiber is 4M long 220GSM. The fabrication by hand and using some fabricated metal plates. Epoxy resin is used to connect the fibers in a string. We'll need a mold with dimensions for this. After that, we need to put the sisal fiber in a bi-directional matte in the mold and then add the resin matrix, evenly distributed on sisal fiber in the mold. Since we're using a six-layer matte in this experiment, repeat the process six times more. Then, using the roller, apply pressure to it to expel the trapped air within the mold. After that, the mold was weighted and allowed to dry for 24 hours before being cut into samples according to izod impact strength. Similarly, the amount of 2 percent, 4 percent volume fraction graphene composites material prepared and cut into specimens. The specimens used for izod testing as shown below.

Izod impact test specimen ASTM D256, izod impact test minimum value is 300J/m and maximum value is 500J/m, velocity of izod impact test is 2gh, angle of the hammer is 45°, impact speed is 3.5 (±10%) m/sec.

A test specimen having a V-shaped notch is fixed vertically,and the specimen is broken by striking it from the same side as that of the notch by the use of the hammer. The fracture energy is determined from the swing up an angle of the hammer and its swing down angle. The izod impact value (kJ/m^2) is calculated by dividing the fracture energy by the width of the specimen.

Statistical Analysis

Using SPSS software in one way analysis to get the significance value, standard deviation data, description data, ANOVA Analysis test, multiple comparison and G graph. The software defines relationship dependent and independent variables. Independent variables are novel bi-directional sisal and graphene (filler). Dependent variables are izod impact strength. The data is calculated from the SPSS analysis.

RESULTS

Table 1 Shows the impact test values of two different groups. Table 2 presented the data collected from the izod impact test. Sisal fiber without filler izod impact value is 2.15J and sisal fiber with 4% of graphene is 4.89J. And the addition of epoxy and graphene sisal with 4% increased maximum izod impact strength is 4.89J. It is observed that the descriptive data of sisal fiber without filler and sisal with 4% of graphene filler the mean values are 2.15J and 4.89J. By using the spss software it displays ANOVA analysis with a significance level of 0.001 ($p<0.05$) and the izod impact strength of statistical expectations using one way ANOVA results.

Table 1 furnishes impact test observations. Table 2 gives descriptives about statistics of groups. Table 3 furnishers anova output. Table 4 Independent sample T-test for izod impact strength for sisal fiber without filler and with filler. There is significant mean difference between two groups that is value of significance 0.001, $p<0.05$

Figure.1 infers the error bar and mean values of two different groups performed on izod impact testing on x-axis considered as groups and y-axis considered as impact test taken to know the simple bar chart of izod impact strength values.

DISCUSSION

Graphene is a hard filler that improves an izod impact strength and stability while also making the material lighter by replacing sisal fiber with epoxy instead of epoxy graphene. sisal without filler and with filler is the whole volume of a fraction by raising 25% the maximum percentage by comparing the without filler and 4% of graphene. When comparing 0 and 4 percent, the maximum percentage increased in the 4th group. By comparing the previous results this is increased by adding the graphene.

Similar conclusions may be seen in this study the mishra and biswas concluded that mechanical properties of jute and epoxy composites having 50% silver control by weight in this izod and charpy impact tests reflects that the composites with bleached silvers have higher impact strengths. In this study the izod impact strength of fibers containing a 40% volume graphene has greatly increased in this analysis. The improvement in Izod impact strength with the increase of filler content up to 40% is attributed to a decline in the matrix content, which contributes to a drop in bonding strength and therefore a decrease in Izod impact strength (Jin and Park 2008). Due to particle aggregation in the resin matrix the izod impact strength of sisal fiber containing 40% volume fraction graphene has significantly reduced (Monti et al. 2021). The resin mixture’s strength has been reduced as result of particle accumulation, and the composite's brittle structure has improved. The composite was easily shattered due to its fragile nature.

(Mishra and Biswas 2013) Singh conducted the influence of carbon nano fillers on mechanical performance of epoxy polymer based on tests taken the tensile, compressive, charpy, izod tests with different ratios 0.5,1.0,2.0,3.0 and minimum value with epoxy is 0.18 and maximum izod impact energy with nanofiller is 0.28 (Singh, Srivastava, and Prakash 2015). Aradhana compares the mechanical and thermal properties in

graphene oxide and reduced graphene oxide filled epoxy nanocomposites adhesive impact strength increased with decreasing notch depth from 2.4 to 0.5mm (Aradhana, Mohanty, and Nayak 2018). Costa in this evaluation of izod and impact bend properties of epoxy composites reinforced with mallow fiber and results shows that izod absorbed energy 1.93J/m and 34.67J/m for the samples of plain epoxy and 30% incorporated mallow fiber respectively (Costa et al. 2020).

Fiber density, fibre thickness, fibre diameter, sisal fibre orientation, matrix to reinforcement element ratio, fabrication phase, stacking sequence, and the presence of filler elements all influence the mechanical properties of composite materials. Increase the Izod impact strength of composites and explore sisal with various fillers to boost mechanical properties in applications such as vehicles and geotextiles. This has applications in aerospace, automobile, and civil engineering.

The limitations of this study are: the composite fabrication by hand lay-up approaches allows some air gaps and increases the moisture absorption. The untreated natural fiber may lead to delamination due to insufficient surface quality of fibres with resin matrix. The original fibre qualities may degrade over time. The scope of the future is chemically treated sisal with graphene and Sisal without filler may be tested.

CONCLUSION

Nano polymer sisal fiber composite fabricated with novel graphene nanoparticles as filler sisal/epoxy hybrid composite. The novel graphene nanoparticles sisal/epoxy hybrid composite yielded 25% higher impact strength than conventional sisal/epoxy hybrid composite.

DECLARATION

Conflict of interests

No conflict of interest in this manuscript.

Author Contribution

Author SS engaged in gathering data, data interpretation, and writing of manuscripts. Author AV was engaged in the study's development and data interpretation.

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TABLES AND FIGURES

Table 1. The values of Izod impact strength without and with filler and Izod impact test of without filler and Izod impact test of sisal with 4% of graphene.

S.No	Izod impact test of sisal without filler	Izod impact test of sisal with 4% filler
1	2.95	3.95
2	3.14	3.64
3	2.64	4.89
4	2.56	3.92
5	2.8	4.29
6	3	4.23
7	3.3	3.30
8	2.8	4.39
9	2.6	3.50
10	3.1	4.89
11	3	3.2
12	2.7	4.23
13	2.9	4.63
14	3	4.71
15	2.7	4.62
16	2.2	4.41
17	2.8	3.86
18	2.651	3.79
19	2.15	4.50
20	2.62	3.93

Table 2. Izod impact strength of mean, std. Deviation, std. Error: the comparison of sisal fiber without filler and with filler compared with 0% and 4% is the maximum amount increased is 4.89by using SPSS analysis

Descriptives								
Izod Impact								
Samples	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
					Lower Bound	**Upper Bound**		
Sisal Fiber Without Filler	20	2.7805	.28847	.0645	2.6455	2.9155	2.15	3.30
Sisal With 4% Of Graphene	20	4.1440	.50273	.1124	3.9087	4.3793	3.20	4.89
Total	40	3.4623	.80023	.1265	3.2063	3.7182	2.15	4.89

Table 3. It is observed that the descriptive data of sisal fiber without filler and sisal with 4% of graphene..

ANOVA

Izod impact	**Sum of Squares**	**df**	**Mean**	**F**	**Sig.**
Between Groups	18.591	1	18.591	110.677	.001
Within Groups	6.383	38	.168	-	-
Total	24.974	39	-	-	-

Table 4. Independent sample T-test for izod impact strength for sisal fiber without filler and with filler.There is significant mean difference between two groups with p=0.001<0.05.

Samples		Levens test for Equality of variance		T-test for equality of means						
		F	sig	t	df	Sig (2-tailed)	Mean Difference	Std.Error Difference	95% Confidence interval of the diffrence	
									Lower	Upper
Izod Impact	Equal variances assumed	8.127	.001	-10.52	38	.001	-1.36350	.12961	-1.62587	-1.10113
	Equal variances not assumed	-	-	-10.52	30.28	.001	-1.36350	.12961	-1.62809	-1.09891

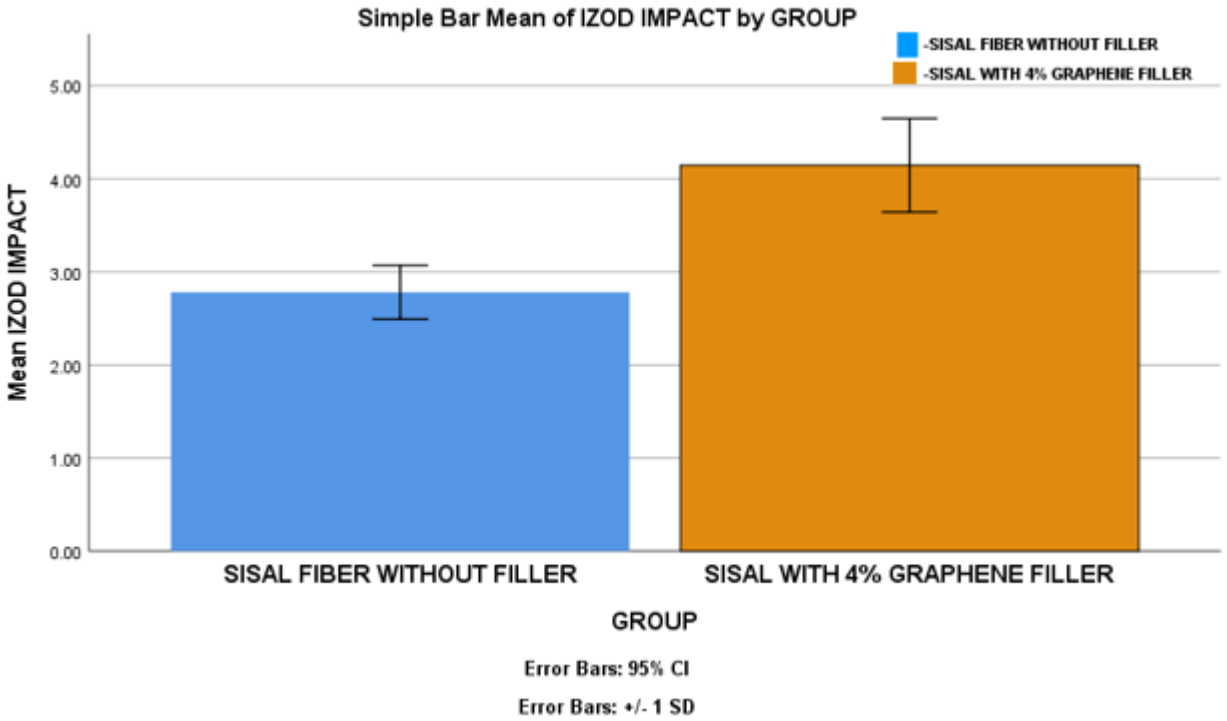

Fig. 1. Represents the mean Izod impact strength sisal without filler and with filler by varying sisal without filler blue is 0%, sisal with graphene 4% is yellow with an accuracy of ±1SD. The bar chart determines the difference between the groups. The X-axis is a group and the Y-axis is the mean izod impact strength. And sisal fiber with graphene 4% has increased.