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Experimental Study on Jute Fibre and Graphene Reinforced with Epoxy Resin

Simhadri chakradhar[1], Santosh Madeva Naik [2], Thangellapally Vinay chary [3], Pamarthi Pavan Kumar [4]
[124]Mechanical Engineering, Hyderabad Institute of Technology and Management, Hyderabad 501401, Telangana, India
[2]Assistant Professor Mechanical Engineering, Hyderabad Institute of Technology and Management, Hyderabad 501401, Telangana, India
Email: chakradharsimhadri1998@gmail.com[1],santoshn.mech@hitam.org[2], vinaychary836@gmail.com[3], pavanzmail@yahoo.com[4]

Abstract- Far from many years we been using the different types of materials or metals for different purposes. But the problems are faced by using these metals led to many destruction activities due to the poor physical properties of the metals. This affects played a major role in the development of the new composite materials. Recently, the attention is given to polymer matrix composites (PMCs) has increased drastically. Environment friendly green composites were manufactured from a starch-based dispersion type biodegradable resins and cellulose nanofibers such as jute fibre. This chapter mainly focus on the manufacturing of the polymer composites reinforced by natural fibres with epoxy resin and mixed with Nano particles such as graphene by hand layup method, because of the graphene unique features gives high strength with the mixture of required amount will give more advantage then compared with the old type metals or materials. In this Tensile, Rockwell tests are conducted to determine the strength of the produced material.

Index Terms – Jute fibres, Epoxy resin, Polymer matrix composites, Graphene, Synthetic fibres, Natural fibres.

1. INTRODUCTION

Past from many years until recently there were many researches went by to bring new materials which consist of desirable mechanical properties to fulfil the requirements of human needs and comforts. And still many researches are proceeding further to bring new changes in terms of new materials which may be either composite fibre materials or the composite metals. Initially the word composite means combining the two or more different materials to the microscopic level to form a single component is known as composite materials. This is mainly done due to bring out the new mechanical properties. Since the early 1960's there has been an augmenting enthusiasm for materials that are stiffer and more grounded yet lighter in fields as flying and consistent change by selecting a fitting blend of fortification and frame work material. Composite material frame work results in an execution of impossible by the individual constituents. They even offer massive advantages in the manufacturing the products.
The most commonly used composite materials are made up of glass fibre reinforced with epoxy resin of other materials, which is mostly utilized in everywhere in our day to day life for example glass fibre sheets used in the home roof tops and etc. the reason for selection of the material is because of its mechanical properties such as light in weight, high strength, long life span.

2. METHODOLOGY

The composite specimen is fabricated according to the ASTM standards. Here we had taken three cases with different Compositions according to standard, that is

For case 1 the composition is
5%graphene+20%jute+75%epoxyresin
Case 2:
5%graphene+15%jute+80%epoxyresin
Case 3:
5%graphene+10%jute+85%epoxyresin
And the procedure is preceded by following Hand layup method.

Table 1 - Jute + graphene + epoxy resin composition

S/N	Reinforcement	Matrix	Method of fabrication
1	Graphene (5%) +Jute (20%)	Epoxy resin (75%)	Hand layup process
2	Graphene (5%) +Jute (15%)	Epoxy resin (80%)	
3	Graphene (5%) +Jute (10%)	Epoxy resin (85%)	

2.1 Hand layup technique
This is the process which was followed from method and we can say it's an old method followed which is still in usage and it is similar to casting process.

- Initially take a mold of required dimensions according to ASTM standards

- And apply some non-sticky material on the base of the mold so that the specimen does not stick the base of the mold.
- Later take the epoxy resin with hardener according to the requirements with 10:1 ratio.
- Later mix the graphene with calculated quantity, and mix it in the epoxy resin.
- Later cut the jute fiber with required sizes and place it in the mold and apply the resin on the jute strip and keep another layer and apply the resin on that layer and repeat the process up to the last layer and finally press the layer with some roller so that the resin is distributed equally.
- Finally place some weight on the mold in order to make sure the shape of the materials is in proper shape.

3. EXPERIMENTATION

3.1Tensile test

For tensile test according to ASTM D3039 standards is selected. The standard testing specimen is rectangular shape and the cross section of the material is 250*25*3mm^2 that is the length is 250mm, width is 25mm and its thickness is 3mm, respectively. The whole testing is conducted on the advanced setup that is computerized universal testing machine having the capacity of (0-100kN) and the procedure is followed below. Initially take the specimen and arrange it in between the jaws of the machine by adjusting the jaws and fix the specimen by tightening the jaws with the help of fitting tools.
And later start the set up by pulling the upper jaw with the help of buttons or by executing program in the computer.
And after the specimen is stretched and broken record the readings as below.

Fig. 1 - Tensile test specimen

Fig. 2 - Rockwell test before conducting test

3.2 Rockwell hardness test

The hardness measurement is carried out on the special machinery called Rockwell hardness tester. The specimen which has to be tested has to be placed on the anvil and below the indenter which is made up of steel. The capacity of the machinery is 100 kg. The procedure of the Rockwell test is as shown below. Initially the specimen is held in between the anvil and indenter. And the dial is brought to zero before dropping the lode on it. And drop the lower or minor lode on the specimen by just pulling the lever and repeat the same process on different cases specimens

4. RESULTS AND DISCUSSION

4.1 Tensile test results

Table 2 - Final results of all three specimens

s/n	Polymer matrix composite	Tensile load (KN)	Breaking load (KN)	Tensile strength (MPA)	Youngs modulus (GPA)
1	5%G + 75%E + 20%J	0.0835	0.00684	11.3	0.30373
2	5%G + 80%E + 15%J	1.326	0.642	17.69	1.21998
3	5%G + 85%E + 10%J	0.499	0.00559	6.5	1.98570

Table 3 - Case 1: - 5%G + 75%E + 20%

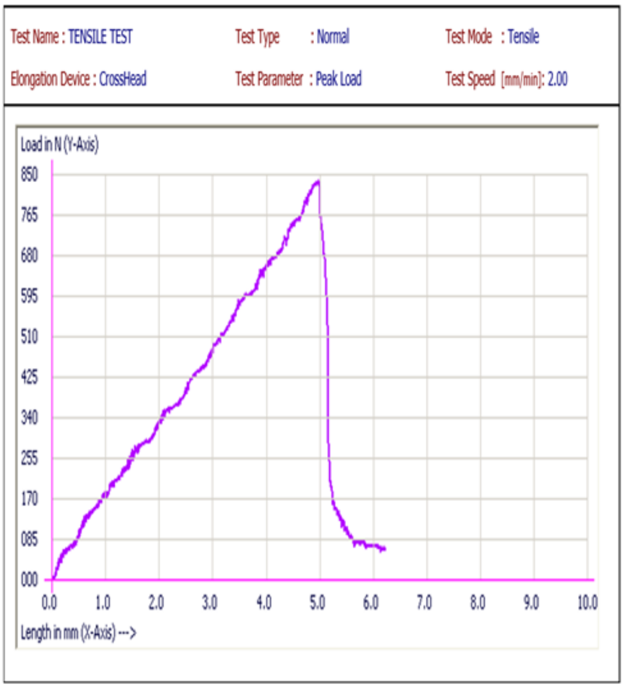
Sample Details :

Sample No.	CS Area (mm²)	Peak Load (N)	%Elongation	Break Load (N)	UTS (N/mm²)	Youngs Modulus (N/mm²)
000002	75.00	835.00	3.67	6.84	11.13	303.73

Summary Report :

	CS Area (mm²)	Peak Load (N)	%Elongation	Break Load (N)	UTS (N/mm²)	Youngs Modulus (N/mm²)
Min	75.00	835.00	3.67	6.84	11.13	303.73
Max	75.00	835.00	3.67	6.84	11.13	303.73
Avg	75.00	835.00	3.67	6.84	11.13	303.73
Std Dev.	0.00	0.00	0.00	0.00	0.00	0.00
Variance	0.00	0.00	0.00	0.00	0.00	0.00
Median	75.00	835.00	3.67	6.84	11.13	303.73

Graph 1- Case 1, load v/s displacement



Graph 2 - Case 1, stress v/s strain

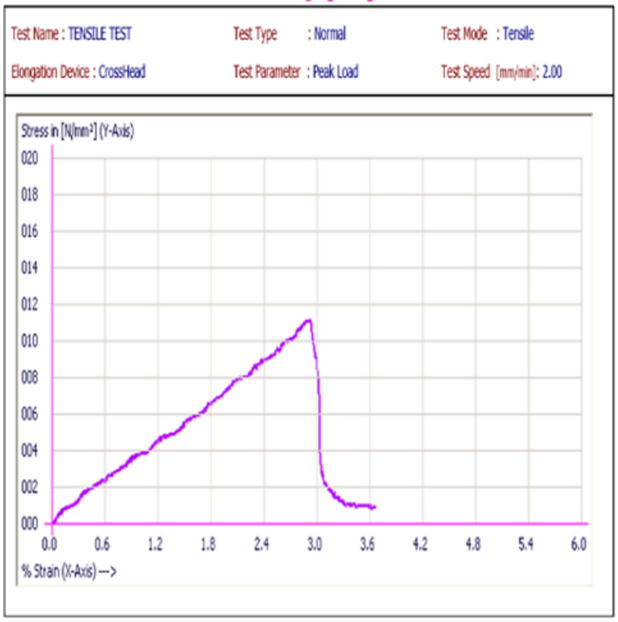


Table 4 - Case 2 - 5%G + 80%E + 15%J

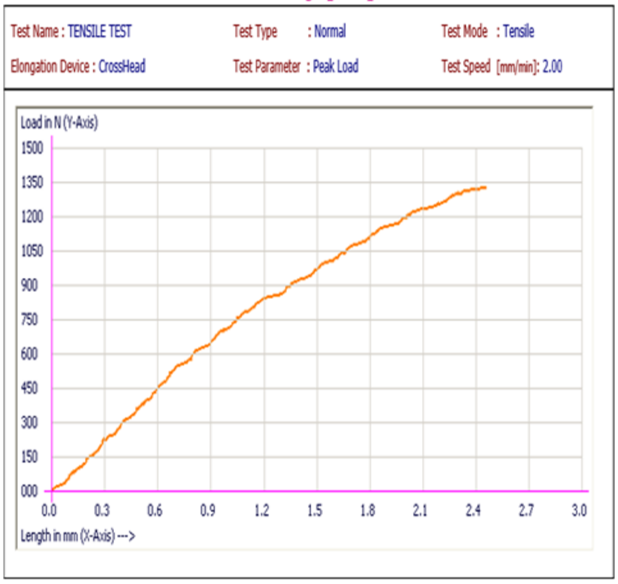
Sample Details :

Sample No.	CS Area (mm²)	Peak Load (N)	%Elongation	Break Load (N)	UTS (N/mm²)	Youngs Modulus (N/mm²)
000001	75.00	1,326.00	1.45	642.14	17.68	1219.98

Summary Report :

	CS Area (mm²)	Peak Load (N)	%Elongation	Break Load (N)	UTS (N/mm²)	Youngs Modulus (N/mm²)
Min	75.00	1326.00	1.45	642.14	17.68	1219.98
Max	75.00	1326.00	1.45	642.14	17.68	1219.98
Avg	75.00	1326.00	1.45	642.14	17.68	1219.98
Std Dev.	0.00	0.00	0.00	0.00	0.00	0.00
Variance	0.00	0.00	0.00	0.00	0.00	0.00
Median	75.00	1326.00	1.45	642.14	17.68	1219.98

Graph 3 - Case 2, load v/s displacement



Graph 4 - Case 2, stress v/s strain

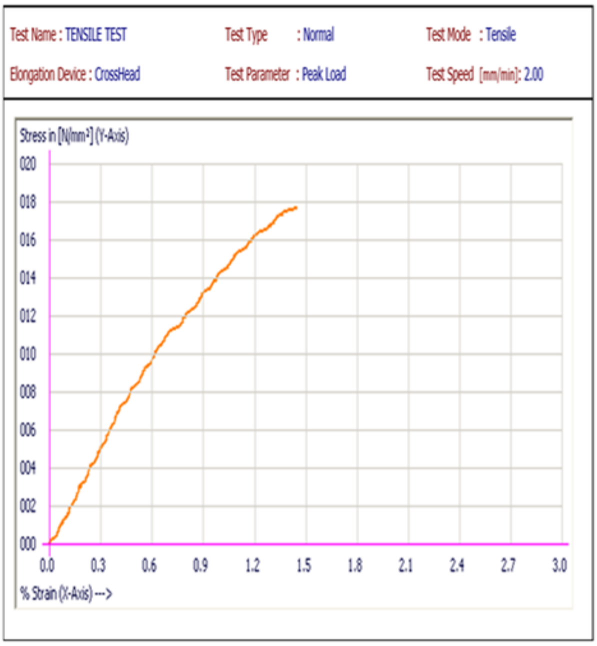


Table 5 - Case 3, 5%G + 85%E + 10%J

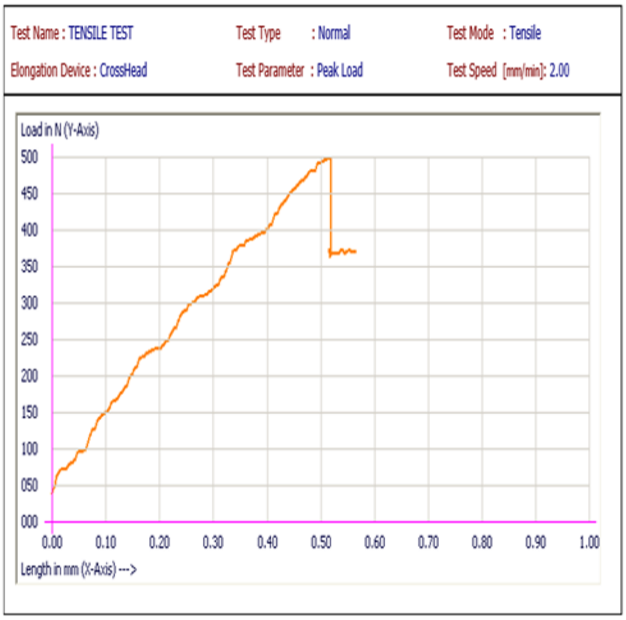
Sample Details :

Sample No.	CS Area (mm²)	Peak Load (N)	%Elongation	Break Load (N)	UTS (N/mm²)	Youngs Modulus (N/mm²)
000001	75.00	499.00	0.34	5.59	6.65	1985.70

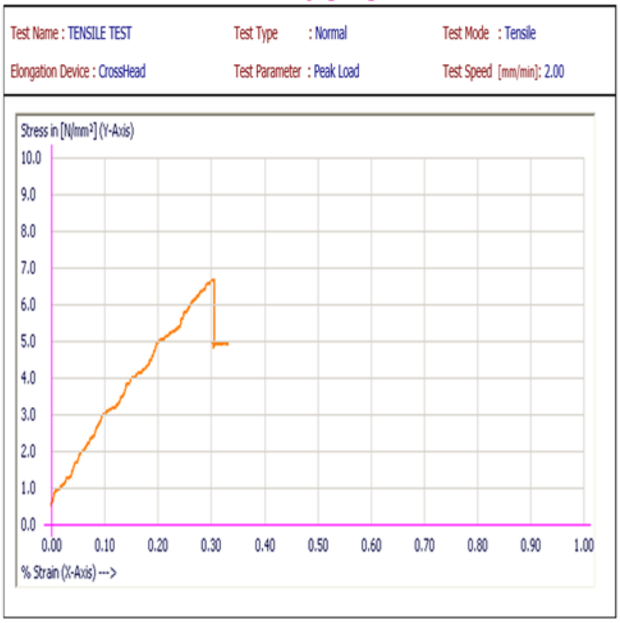
Summary Report :

	CS Area (mm²)	Peak Load (N)	%Elongation	Break Load (N)	UTS (N/mm²)	Youngs Modulus (N/mm²)
Min	75.00	499.00	0.34	5.59	6.65	1985.70
Max	75.00	499.00	0.34	5.59	6.65	1985.70
Avg	75.00	499.00	0.34	5.59	6.65	1985.70
Std Dev.	0.00	0.00	0.00	0.00	0.00	0.00
Variance	0.00	0.00	0.00	0.00	0.00	0.00
Median	75.00	499.00	0.34	5.59	6.65	1985.70

Graph 5 - Case 3, load v/s displacement



Graph 6- Case 3, Stress v/s strain



4.2 Rockwell Hardness Test Results:

CASE 1: - 5%G + 75%E + 20%J
Trial 1: - 64
Trial 2: - 62
Trial 3: - 60
Avg = 62

CASE 2: - 5%G + 80%E + 15%J
Trial 1: - 45
Trial 2: - 47
Trial 3: - 45
Avg = 46

CASE 3: - 5%G + 85%E + 10%J
Trial 1: - 59
Trial 2: - 60
Trial 3: - 59
Avg = 59.333

4.3 Discussion:

From the above results its was observed that we could able to bring maximum mechanical properties with the usage of the material like Jute fibre which is having low mechanical properties then compared with any other material on earth.

5. CONCLUSION

Addition of the SiC particles to the Al6061 alloy leads to enhancement in both tribological and mechanical properties. Since Al6061 belonged to heat treatable series, it could be certainly implemented for stir casting and pressing technique. Thus this casting technique can be successfully adopted for the casting of AMC unless the process parameters are strictly followed. Stir casting technique is reliable and economical in comparison to other processing methods. The Equal channel angular pressing is successfully implemented, i.e. imposing of high strain when passed through the ECAP channel leading to grain refinement which in turn enhances the materials property.

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