

Synthesis and characterization and properties comparison of Epoxy filled pennisetum typhoides (Jowar) filler and treated Sacharum offinarum (sugar cane) fiber reinforced composites

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Keywords: treated Sacharum offinarum; Pennisetum typhoides

ABSTRACT. In the current work epoxy resin is chosen as matrix, treated Sacharum offinarum (SugarCane) fiber, Pennisetum typhoides (Jowar) filler is chosen as reinforcement. Room temperature cured Epoxy System filled with Sacharum offinarum fiber and Pennisetum typhoides (Jowar) filler is synthesised by mechanical shear mixer, then kept in a Ultra sonic Solicitor for better dispersion of Pennisetum typhoides (Jowar) filler in the matrix. Different weights of modified Pennisetum typhoides (Jowar) filler (1,2,3,4,5 gm wt) has been incorporated into the Epoxy matrix in order to study the variation of Mechanical and Thermal properties.

Mechanical properties like Flexural strength, Tensile strength and impact strength of the micro hybrid composite are studied by UTM (Universal Testing Machine). Thermal properties of micro hybrid composites are studied using Thermo Gravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC).

1. INTRODUCTION

Thermoplastics occupy only a small percentage of the advanced composite market, while other and epoxy thermoset materials contribute to more than 70 per cent. Epoxy resins the most important matrix polymer when it comes to high performance. Its combination with natural fibers gives an advanced composite with properties like low weight, good mechanical properties and tribological properties. These materials make very attractive for use in aerospace applications. A rough estimate has it that for every unit of weight reduction in aircraft, there is a considerable less considerable fuel consumption or higher load capacity and hence material offers material saving. Due to low density around 1.3g/cm³, good adhesive and mechanical properties, epoxy resins become a promising material for in the transportation industry, usually in the form of composite materials. The performance of these composites not only depends on the selection of its components, but also on the interface between fiber and resin. Sometimes it is necessary to modify the matrix and reinforcement for specific properties.

Due to low density natural fibres are widely used as reinforcing agent as it is high biodegradability. Natural fibers are largely divided into two categories depending on their origin: plant based and animal based. Therefore, natural fiber can serve as reinforcements by improving the strength and stiffness and also reducing the weight of resulting biocomposite materials, although the properties of natural fibers vary with their source and treatments.

The Fiber / Filler reinforced composites improve strength, fatigue, stiffness and strength to weight ratio by incorporating strong, stiff, brittle Fibers into a softer, more ductile matrix. The matrix material transmits the force to the Fibers and provides ductility and toughness.

2. MATERIALS AND METHODS:

Materials:

Commercially available epoxy (LY-556) and hardener (HY-951) supplied by Ciba-Geigy India Ltd. Company. Naturally available sugar cane fibers were retrieved from Regadikothuru village, Anantapur, Andhra Pradesh, India. In addition, naturally available jowar is used as a filler is also retrieved from Regadikothuru village, Anantapur, Andhra Pradesh, India.

Fiber Treatment:

Sugar cane fiber was taken in a plastic tray and a 5% NaOH solution was added into the tray and the fibers were allowed to soak in the solution for 1 hr. The fibers were then washed thoroughly with water to remove the excess of NaOH sticking to the fibers. Final washing was carried out with distilled water and the fibers were then dried in hot air

Composite Manufacturing:

Moulds are prepared for different castings that are made from resin as per ASTM standards. The pre – calculated amount of Jowar and Epoxy (resin) is mixed together in suitable beaker. Jowar is mixed with stipulated quantity of resin based on the predetermined ratio and mixed thoroughly with mechanical shear mixing for about 1 hour at ambient temperature conditions. Then the mixer is carried out through a high intensity ultra-Sonicator for one and half hour with pulse mode (50s on / 25s off). External cooling system is employed to avoid temperature during the sonication process, by submerging the beaker containing the mixer in an ice bath. Once the irradiation is completed, hardener is added to the modified epoxy in the ratio of 10:1 parts by weight. A glass mould with required dimensions is use for making sample as per the ASTM standards and it is coated with mould releasing agent enabling easy removal of the sample. In this technique sugar cane fiber is wetted by a thin layer of epoxy/ jowar and epoxy suspension in a mould. Stacking of sugar cane fiber is carefully arranged side by side all over the mould. Stacking of sugar cane fiber is carefully arranged after pouring some amount of resin against the mould, to keep the poor impregnation at bay. Left over quantity of mixture is poured over the sugar cane fiber. Brush and roller are used to impregnate fiber. The closed mould is kept under the pressure for 24 hours at room temperature. To ensure complete curing, the composite samples are post cured at 70⁰C for 1 hour and the test specimens of the required size is cut out from the sheet. The removed castings are cut into the samples in accordance with ASTM standards for further testing. Direct processing technique has been used for the above micro hybrid composites preparation.

Mechanical Tests:

In the present research work, specimens are prepared to study various tests which include tensile test, impact test and flexural test. In fact, all these samples are cut as per ASTM standards. Test specimens ASTM D638 for tensile test of dimensions of (100 x 20 x 3) mm³, ASTM D618 for flexural test of dimensions of (100 x 20 x 3) mm³ and ASTM D695 for impact test of dimensions of (150 x 150 x 3) mm³. In each case, samples were tested on UTM and its values are tabulated in the following table 1.

Thermal analysis:

The thermal characteristics of the epoxy/hybrid composites were measured using both Differential Scanning Calorimetry (DSC) and thermogravimetric Analyses (TGA) at a rate of 10°C/min under nitrogen flow.

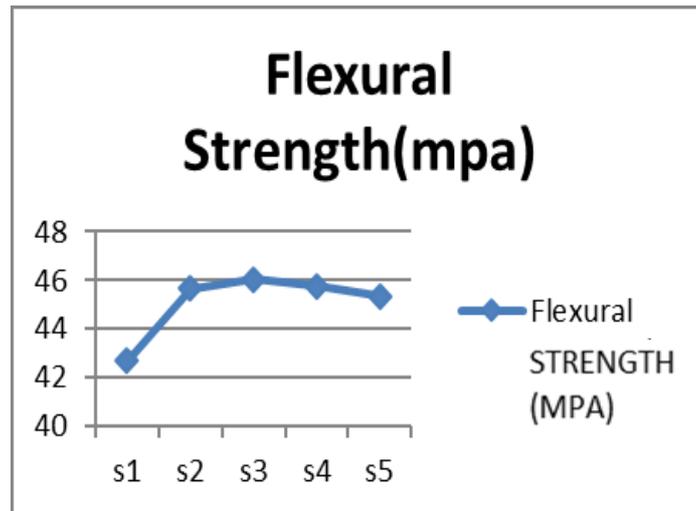


Fig 1: Flexural strength variations for different proportions

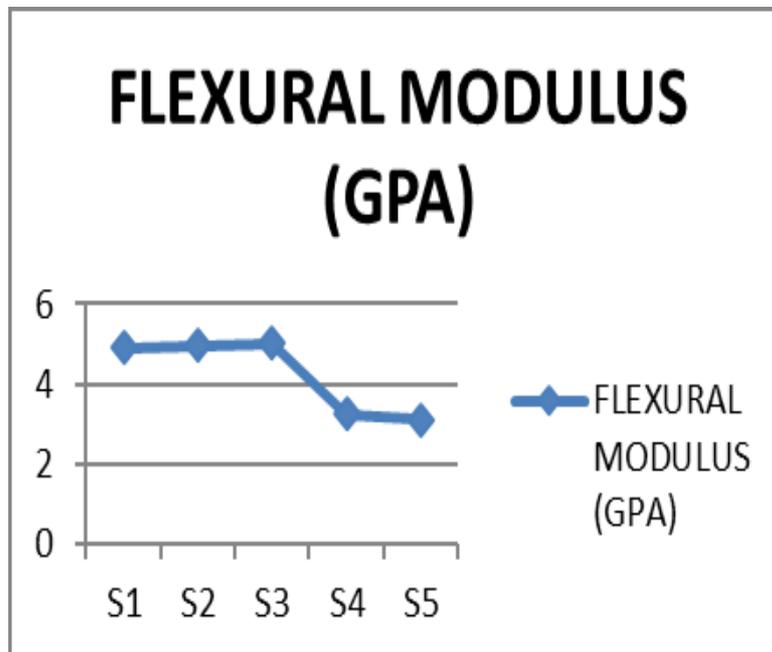


Fig 2: Flexural modulus variations for different proportions

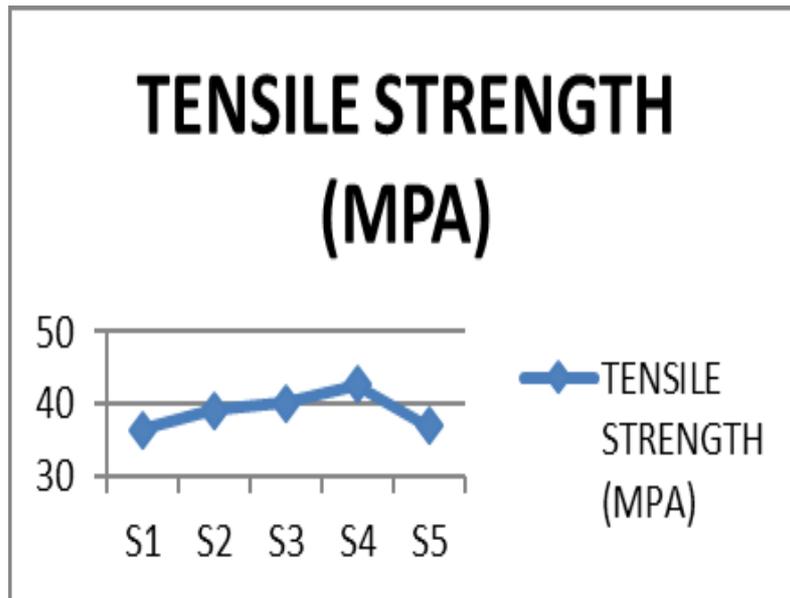


Fig 3: Tensile strength variations for different proportions

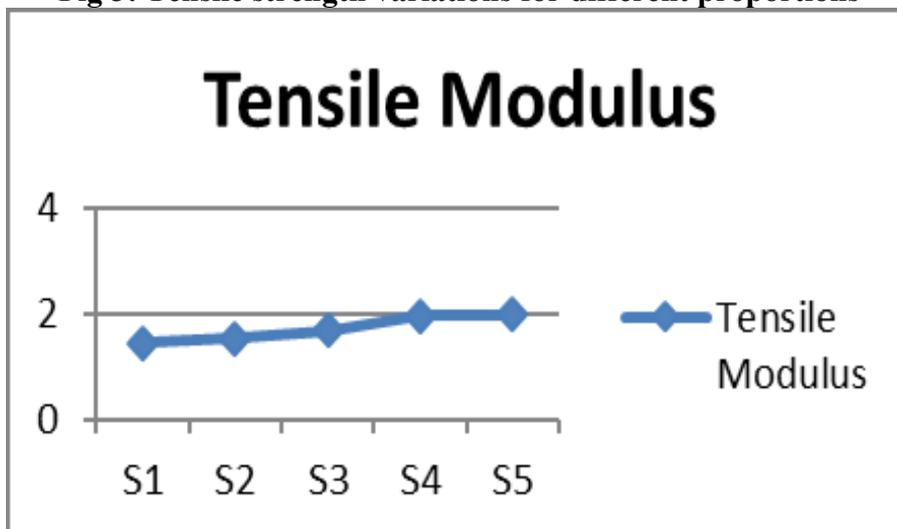


Fig 4: Tensile modulus variations for different proportions

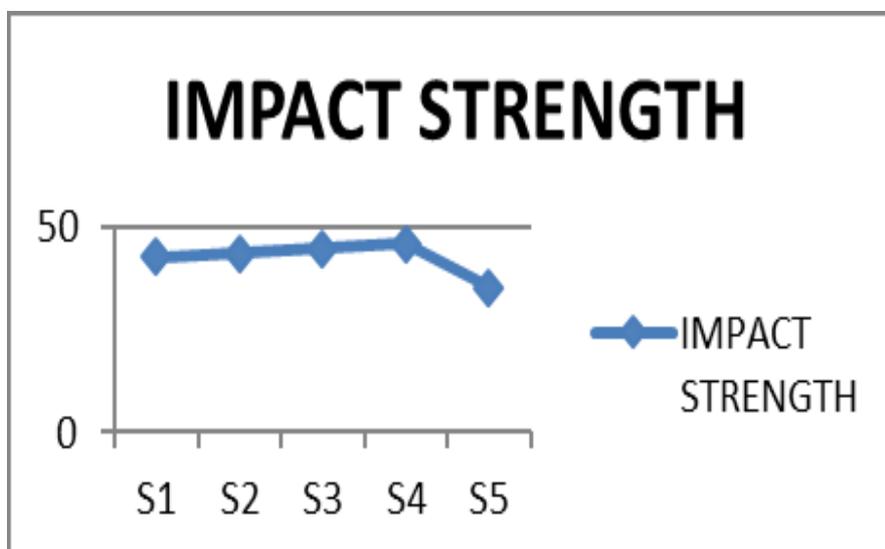


Fig 5: Impact strength variations for different proportions

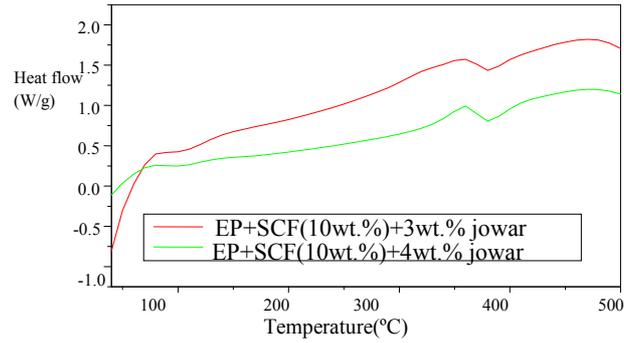


Fig 6: Differential Scanning Calorimetry (DSC) for Specimen 3 and Specimen 4

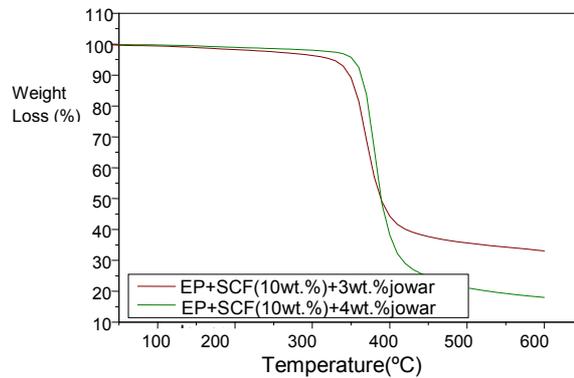


Fig 7: Thermo Gravimetric Analysis for Specimen 3 and Specimen 4

Table 1: Tensile strength, flexural strength and impact strength of treated sugar cane and epoxy/jowar hybrid composites with different proportions

Sample (wt.%)	Tensile strength (MPa)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Impact strength (J/Cm)
EP	25.32	1.135	35.25	2.452	40.69
EP+SCF(10%)+(1%) jowar	36.48	1.457	42.68	4.895	42.56
EP+SCF(10%)+(2%) jowar	39.14	1.536	45.68	4.968	43.56
EP+SCF(10%)+(3%) jowar	40.15	1.689	46.05	5.025	44.52
EP+SCF(10%)+(4%) jowar	42.69	1.956	45.78	3.245	45.86
EP+SCF(10%)+(5%) jowar	36.96	1.969	45.36	3.125	35.05
EP=Epoxy; SCF=sugarcane fiber					

3. RESULTS AND DISCUSSIONS:

Mechanical Characterization:

Experimental results of epoxy hybrid (treated sugar cane and jowar) composites are prepared with different proportions. It is obvious strength increases when increasing jowar upto 3gm impregnated with epoxy matrix. Mechanical properties (i.e. tensile, flexural and impact) increased when epoxy matrix impregnated with 2gm fiber of each as mentioned above [1]. Mechanical properties are degraded when jowar is further increased. It is observed that 3gm jowar composites were optimal tensile, flexural and impact strength than the other proportions of jowar composites. **Figures 1-5**, represents graphical variations on tensile, flexural, and impact strength properties as function of sugar cane fiber and epoxy/jowar. Thus, it is observed that the mechanical properties are degraded due to further increase in jowar weight.

4. THERMAL ANALYSIS:

Differential Scanning Calorimetric (DSC) analysis is done to the epoxy filled with jowar & sugar cane fiber reinforced composites for specimen 3 (epoxy (50gm)+ jowar (3gm)+ sugar cane fiber(2gm)) and specimen 4 (epoxy (50gm)+ jowar (4gm)+ sugar cane fiber(2gm)) which has highest flexural strength and flexural modulus. The **Figure 6** is obtained to show the glass transition temperature variations for specimen 3&4.

Thermo Gravimetric Analysis is observed From the **Figure 7** it is observed that specimen 3 (Epoxy(50gm) + jowar(3gm) + sugar cane fiber (2gm)) can resist up to 350⁰C. The weight loss takes place above 350⁰C. specimen4 (Epoxy(50gm) + jowar (4gm) + sugar cane (2gm)) can resist up to 230⁰C. The weight loss takes place above 230⁰C. The system1 specimen 3 has good thermal stability compared to specimen 4.

5. CONCLUSION

The variation of tensile strength, flexural strength, and impact strength of epoxy based sugar cane fiber and jowar hybrid composites has been studied as function of various proportions of jowar. It is observed that specimen 3 (Epoxy(50gm) + jowar(3gm) + sugar cane fiber (2gm)) hybrid composites obtained optimal tensile, flexural, and impact strength than the other specimens. The effect of tensile, flexural modulus properties has also been studied. In TGA investigation, the weight loss takes place above 350⁰C rise in decomposition temperature, and also investigation done for specimen 3 got a good glass transition temperature in DSC analysis.

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