PREPARATION AND MECHANICAL CHARACTERIZATION OF EPOXY BASED COMPOSITE DEVELOPED BY BIOWASTE MATERIAL

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Abstract

Increasing concern about environment has made scientist and engineers very eager in their search for environmental friendly materials. So lot of research is going on today in the field of material science to develop newer materials. Natural fibers are getting much attention of researchers, engineers and scientists as reinforcement in the polymer matrix to develop natural fiber reinforced polymer composites. In the present work an attempt has been made to develop natural fibers reinforced polymer matrix composite. Advantages of using natural fibers are density reduction, cost savings and less weight to strength ratio. Composites with 10, 20 and 30 wt % coconut shell powder epoxy composites have been fabricated using Hand layup technique. Mechanical properties of these composites have been analyzed in detail.

Keywords – *Epoxy based Composites, Hand layup technique, Tensile strength, Flexural strength.*

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1. INTRODUCTION

Increasing concern about environment and depleting conventional materials, lot of research is going on in the field of material science to develop environment friendly material. Natural fibers and bio waste have become an interesting material to be used as reinforcement in polymer matrix to develop green composites. Application of high-performance composites using natural fibers is increasing in various engineering fields. Composites materials comprising one or more phase(s) belonging to natural or biological origin are called green or bio-composite [1-4]. Generally, polymers are classified into two types: thermoplastics and thermosetting. In thermoplastic most common matrices are polypropylene (PP), polyethylene, and poly vinyl chloride (PVC). In thermosets the most commonly used matrices are epoxy, phenolic and polyester resins [5,6]. Lot of work has been reported on manmade fibres such as glass and carbon, as well as on natural fibres like jute, hemp, cane, banana, palmyara and flax fiber polymer composites in the last decade. These investigations reported effect of different variables in NMT (natural fiber thermoplastic mat) and GMT (glass fiber thermoplastic mat) [7], the influence of fiber/matrix modification and hybridization with glass fibers [8], the effect of fiber treatment on bonding between matrix and fibre [9], the effect of surface treatment on interface by glycerol triacetate, thermoplastic starch, methacryl oxypropyl, trimethoxy-silane and boiled flax yarn [10], effect of matrices such as PP and PLA on the composite properties [11], influence of processing parameters and materials used [12-13]. Buttler [14] presented the possibility of using flax fiber in composites for coachwork and bus industry. Effects of surface modification on the mechanical and biodegradability of jute/Biopol and jute/PA (Poly Amide) composites have been investigated by Mohanty et al [15]. Epoxy / hemp fiber reinforced composites, have been studied the effect of fiber architecture on the impact properties of composites [16], Kunanopparat et al. [17, 18] studied the possibility of wheat gluten as a matrix for developing hemp fiber reinforced composites. They reported the effect of thermal treatment and plasticization on the mechanical properties. Hybrid composites of wood flour/kenaf fiber and PP were developed to study the hybrid effect on the composite properties [19]. Thermoforming has also been proved to be a successful method for the preparation of kenaf fiber reinforced PP sheets [20].

2. MATERIALS AND METHODS

2.1 Materials

Raw materials used in this experimental work are as follows:
1. Coconut Shell Powder
2. Epoxy resin, AY 103
3. Hardener, HY 951

2.2 Composite Preparation

In the present work 10, 20 and 30 wt % coconut shell powder dispersed Epoxy (E-CSP) composites have been prepared using Hand layup technique. Wooden mold of 150 X 60 X 10 mm^3 is used for the preparation of these composites. Waxed Mylar sheet is used to cover the mould for easy withdrawal and better surface finish of prepared samples. Firstly the coir powder was thoroughly cleaned three times using the distilled water to remove all the surface impurities. It was dried in sunlight for 18 hours. Mixture of epoxy and hardener in a ratio of 10:1 stirred for 2 hours.

Than the mixture was poured in the mould and then a layer of coir fibres was laid in three steps for homogeneous dispersion. For uniform distribution of fibres and removal of trapped air, mould was pressed from the upper side cover with the help of roller. After curing duration of 24 hours composites were removed from the mould, cut with a diamond cutter according to ASTM standard for different tests.

3. RESULT AND DISCUSSION

3.1 Mechanical Properties

Mechanical properties of these type of composites depend on matrix, dispersed powder and as well as on interface between fibre and matrix. The mechanical properties are also influenced by other factors like type of filler, amount of filler, distribution of filler in the matrix, processing parameters and kind of bonding between matrix and filler.
Samples prepared by this method had a cross sectional dimension of (2.00 X 3) mm^2, the length of the gauge section was kept 15 mm. Tensile tests were performed at room temperature. Stress–strain data were recorded up to a failure of samples. Three samples were tested to obtain a good error estimates.

3.1.1 Tensile Properties

Stress-strain curves of epoxy and composites are shown in Figure 1. Tensile strength increases from 17 MPa of epoxy to 29, 48 and 40 MPa in case of E-10CSP, E-20CSP and E-30CSP composites respectively (Fig 2). Young's modulus was calculated from the slope of the linear region of plots for composites. For Epoxy, E-20CSP and E-30CSP, the values are 360, 960 and 1220 MPa, respectively. Considerable increase in tensile strength and modulus in composites can be explained on the basis of better interaction and homogeneous distribution of CS powder in the epoxy matrix. It seems that at higher content agglomeration and inhomogeneous distribution of filler is taking place which results in the decreases in tensile strength and modulus.

Elongation at break decreases from 21% in case of epoxy to 14, 12 and 11% for E-10CSP, E-20CSP and E-30CSP composites respectively. This decrease in the elongation at break in the composites may be attributed to the brittle nature of the coconut shell powder particles which acts as defects from macroscopic point of view. With the increase in the filler content in the polymer matrix mechanical properties improve upto a certain limit, beyond that they start deteriorating. Poor adhesion between matrix and filler is also a one of the factor responsible for this decrease.

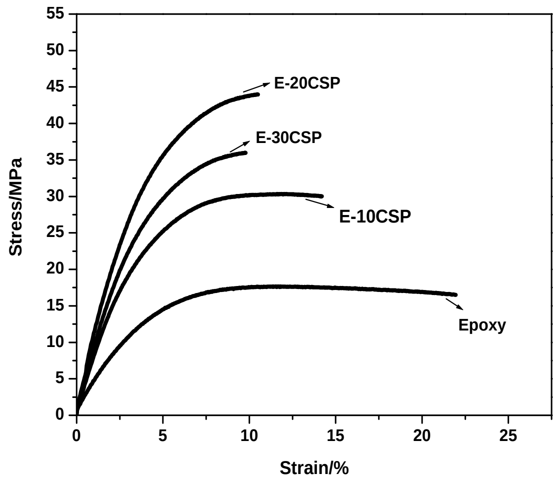

Fig 1 Stress-strain curve for Epoxy and composites

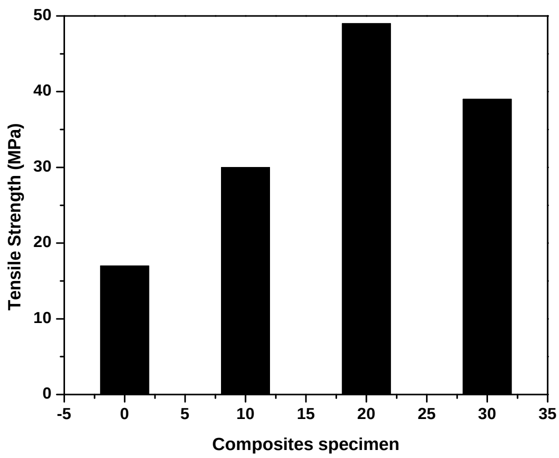

Fig 2 Tensile strength of Epoxy and composites

3.1.2 Flexural Strength

Flexural strength is equally important for structural application purposes. To determine the flexural strength of composites a three-point bending test was carried out. The rectangular samples for bend test were cut by using diamond cutter. It was found that flexural strength increases form 35 MPa in case of epoxy to 59, 78 and 67 in 10, 20 and 30 wt % composites respectively (Fig 3).

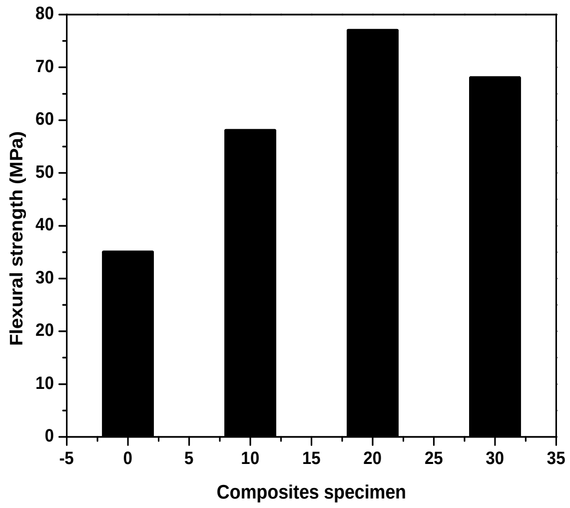

Fig 3 Flexural strength of Epoxy and composites

3.2.3 Hardness

Hardness values of epoxy and composites are shown in Figure 4. From the figure it can be seen that hardness increases with the increase in filler content in composites. This is because of the hard coconut shell powder particles dispersed in the matrix, which make the surface more resistant to externally applied load.

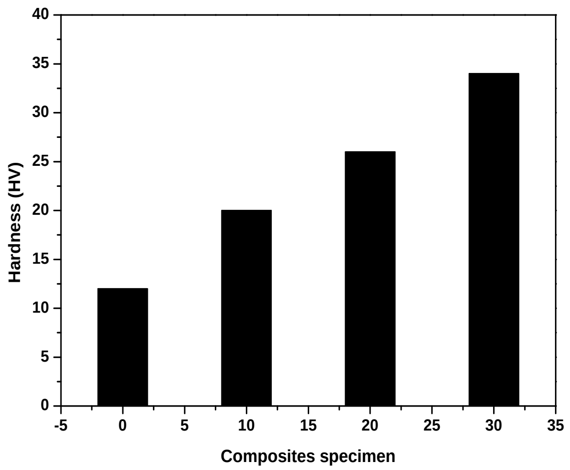

Fig 4 Hardness of Epoxy and composites

4. CONCLUSION

Epoxy reinforced with 10, 20 and 30 wt % coconut shell powder filler composites have been successfully prepared by hand layup technique. After detailed study on mechanical properties of composites it is concluded, that composites exhibit better mechanical properties than epoxy. Tensile tests were performed at room temperature. Tensile strength increases upto 20 wt % of filler reinforcement beyond that it decreases. Value of Young's modulus increases significantly which indicates greater resistance to the applied load in composites. Composites show better resistance to abrasion and wear as hardness increases from 13 HV of epoxy to 35 HV in E-30CSP composite. To make it useful for various industrial applications, further improvement in mechanical properties is required by optimizing the processing parameters and filler treatment for better adhesion with the matrix.

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