Influence of Sea Shell Addition in Preparation of Epoxy Based Polymer Composites

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Abstract

Seashell is an organic substance which is abundantly available in the seashores. The contents in the seashell are an attractive thing to utilize it as reinforcement in the polymer composites. The present work focuses on the preparation of the seashell powder and utilization of the same as reinforcement with glass fibres in the preparation of the composite. The composition with three different rages is used for the synthesis. The prepared seashell powder was subjected to SEM and EDAX analysis and the prepared composite samples are subjected to physical and mechanical testing as per ASTM standards. Interesting elemental fixtures are found in the chemical composition of the seashell followed by significant results in hardness and tensile tests were recorded.

Keywords*: Seashell, polymer composite, SEM, EDAX*

1. INTRODUCTION

Composite materials are one of the most significant inventions of the material sciences. Composite materials are used in furniture, packaging, assembly boards, paneling, fencing, kitchen to civil constructions, automobile and marine industries, military purposes and even space or aircraft manufacturing. So, composites are a versatile and valuable family of materials that can be used in many fields with high quality and low cost applications. Currently, synthetic fiber-reinforced thermoplastic composites are widely used because of their excellent mechanical properties and durability [1]. Composite materials produce a combination property of two or more materials that cannot be achieved by either fiber or matrix when they are acting alone. Fiber-reinforced composites were successfully used for many decades for all engineering applications. Glass fiber-reinforced polymeric (GFRP) composites were most commonly used in the manufacture of composite materials due to their low cost, high tensile strength, high chemical resistance, and insulating properties. The matrix comprised organic, polyester, thermo stable, vinylester, phenolic and epoxy resins. Suitable compositions and orientation of fibers made desired properties and functional characteristics of GFRP composites was equal to steel, had higher stiffness than aluminum and the specific gravity was one-quarter of the steel. The various GF reinforcements like long longitudinal, woven mat, chopped fiber (distinct) and chopped mat in the composites have been produced to enhance the mechanical and tribological properties of the composites [2-3]. Glass fiber reinforced unsaturated polyester resin (UPR) composite materials have become the alternatives of conventional structural materials, such as wood and steel in some applications, because of its good mechanical properties. Mechanical properties of fiber-reinforced UPR composites depend on the properties of the constituent materials, the nature of the interfacial bonds, the mechanisms of load transfer at the inter-phase and the adhesion strength between the fiber and the matrix [4].

Fibre reinforced composites have been widely explored in many literature in view of its lightness and improved modulus these materials have demonstrated in many engineering application. Application of polymer materials in many engineering application have enhanced the corrosion resistance and improved strength of

many structures as witnessed in construction and building industries. Key of the factors that influence the properties of these composites are determined by fibre loading and orientation. According to Biswas, et al. [5], fibre loading enhances the strength of polymer composite and this property also determines the mechanical and corrosion wear behaviour of any reinforced composites.

With growing environmental awareness, ecological concerns and new legislations, bio fiber reinforced polymer composites have received increasing attention during the recent decades. In late 1980s researchers are more concentrated on producing the product from natural fiber reinforced biodegradable polymer composites to avoid global environmental problems. But as compared to polymers natural fibers cost is more and have low strength and stiffness [6]. Jute is the second common natural fiber cultivated in the world next to cotton. Jute fiber is obtained from two herbaceous annual plants, white corchoruscapsularis (white jute) originating from Asia and corchorusolitorius (Tossa jute) originating from Africa [5]. Natural fillers (NF) reinforced materials offer many environmental advantages, such as reduced dependence on non-renewable energy/material sources, lower pollution and greenhouse emission. Natural fillers (flax, hemp, etc.) represent an environmentally friendly alternative to conventional reinforcing fibers (glass, carbon). Advantages of natural fillers over traditional ones are their low cost, high toughness, low density, good specific strength properties, reduced tool wear (non-abrasive to processing equipment), enhanced energy recovery, Recently, there is a growing interest in agricultural waste and plant as a substitute for wood-based raw materials [3].

Among the various fillers, sea shell could be very interesting material as filler in biodegradable polymer composites, due to its good thermal stability compared to other. The sea shell can be easily crushed into chips or particles; the sea shell is mainly composed of calcium carbonate (CaCO3) in two forms Calcite and aragonite or a mixture of them with some organic compounds. Advantages of natural fillers over traditional ones are their low cost, high toughness, low density, good specific strength properties, reduced tool wear (non-abrasive to processing equipment), and enhanced energy recovery[5].

2. RAW MATERIALS USED

Epoxy LY556 resin used as a matrix material, which is mixed with seashell and E-glass fibre as reinforcements. Regular hand layup process is adopted to synthesis the composite.

Investigation has made by using the untreated seashell particulates without removing any organic content and the orientation of the fibre is irregular. The main intension of this is to identify the behaviour of the seashell particulates in the polymer composite with respect to mechanical and physical properties.

The collected seashell was first cleaned with normal water and kept for drying under normal atmospheric temperature. The shells were manually crushed into fine pallets type irregular particulates. The crushed seashell is further subjected to sieving analysis and segregated to different particulate size and out of all 850µm size particulates of seashell is taken for the use as reinforcement. The E-glass fibre is taken as second reinforcement to prepare the polymer composite.

Figure 1.1: Sieve analysed seashell grain particles of 850µm

3. EXPERIMENTAL DETAILS

3.1 Synthesis of Composites:

The segregated grain particles of 850µm size is taken with E-glass fibre with a composition range of

Composition 1: Epoxy resin – 40% + Seashell – 35% + Glass Fibre – 25%

Composition 2: Epoxy resin – 40% + Seashell – 45% + Glass Fibre – 15%

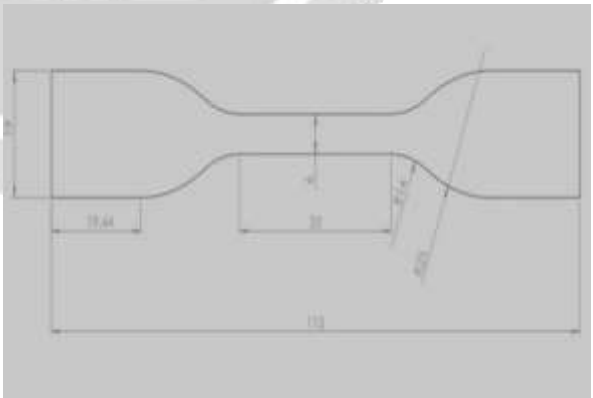
Composition 3: Epoxy resin – 40% + Seashell – 40% + Glass Fibre – 20%

are used for the synthesis of the composite. Steel metallic die of 200×200×6 mm dimensions is used to compress the composite using hydraulic cold press. Initially the mixture of resin along with hardener is prepared with a ratio of 10:1 and kept ready. Then, a coating is performed all over the die followed by the chopped glass fibre and seashell powders were laid one by one in layer form. 3 layers of fibre and 3 layers of seashell mixture is fixed for all the composition. The mixed and layered composite is then kept in a cold hydraulic press and squeezed between two platens at 5bars and keep the load for 24hours. Further after 24 hours the composite is removed from the die and marked for the cutting which is taken to multiple testing's.

Figure 3.1: Prepared Polymer Composite

3.2 Tensile specimen

The prepared composite were marked and sliced as per the ASTM D638 standard using a normal wood cutter. The sliced tensile specimens were subjected to tensile strength test using computerized Universal Testing Machine having a maximum load capacity of 2KN. The tests were conducted for three different specimens of the same composition and an average value of the same is recorded. The standard dimension and the sliced composite samples are shown in Figure 3.2



(a) (b)

Figure 3.2: (a) Sliced Tensile Specimen (b) ASTM D638 standard dimension

3.3 Hardness specimen

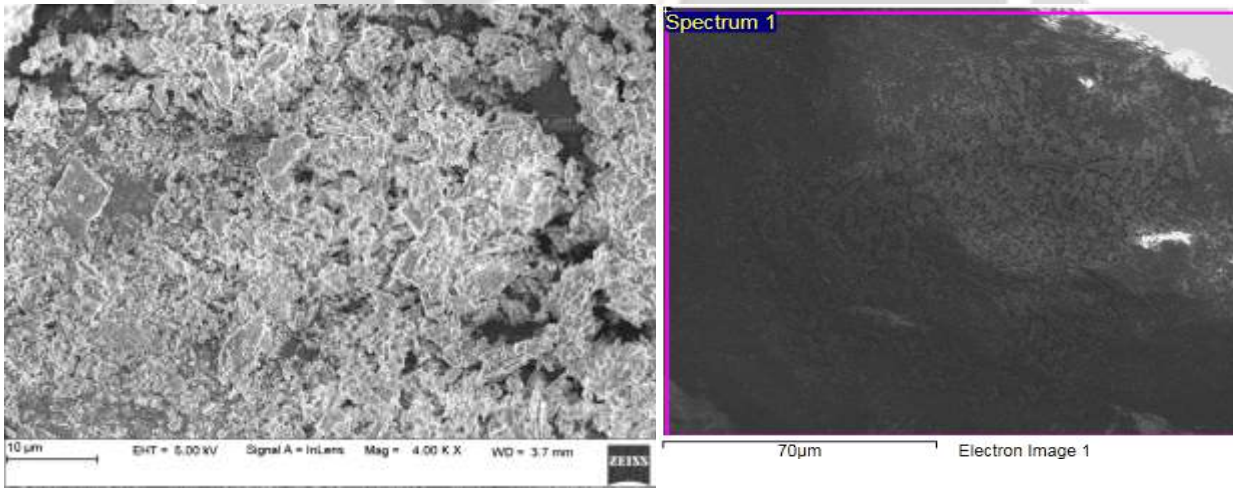
The prepared specimens were sliced to adequate sizes for the hardness testing and an average of three samples were recorded for the testing. The sliced hardness specimen is shown in Figure 3.3

Figure 3.3: Sliced Hardness Specimen

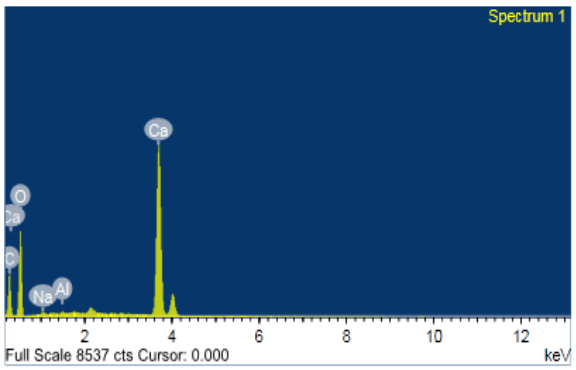
4. RESULTS AND DISCUSSION

4.1 Microscopic analysis

Microscopic analysis of the prepared sea shell powder was performed by using SEM and analysis. The main aim is to identify the elemental contents present in the sea shell mixture. From Figure 4.1 (a) the micrograph of sea shell powder are represented. Before examining the prepared powders are subjected to sieving analysis and equal sizes were segregated and none of the particles were found in spherical form. So as in the micrographs it can be observed the sharp edges of the sea shell with lots of irregularities. The major advantages of this may found in the synthesis of composite. The EDAX analysis has also been done to identify the elemental content in the powder which shows the presence of O, Na, Al, Ca, C and Si in adequate quantity.



(a) (b)



Elem...	Weight%	Atomic%	Compd%	Formula
O K	41.19	54.81	56.64	O2C
Na K	0.35	0.32	0.00	
Al K	0.19	0.15	0.00	
Ca K	32.58	17.31	0.00	
C	15.46	27.41		
Totals	89.76			

(c) (d)

Figure 4.1:(a) SEM image of sea shell powder (b-c) EDAX spectrum region (d) Elemental weight %

4.2 HARDNESS TEST

The composites prepared with variable composition were sliced to the required dimensions and taken for hardness testing. Brinell hardness tests were conducted on the prepared samples with a load of 187.5 kgf in 5 different locations was noted and an average value was tabulated in graphical form as shown in Figure 4.2.

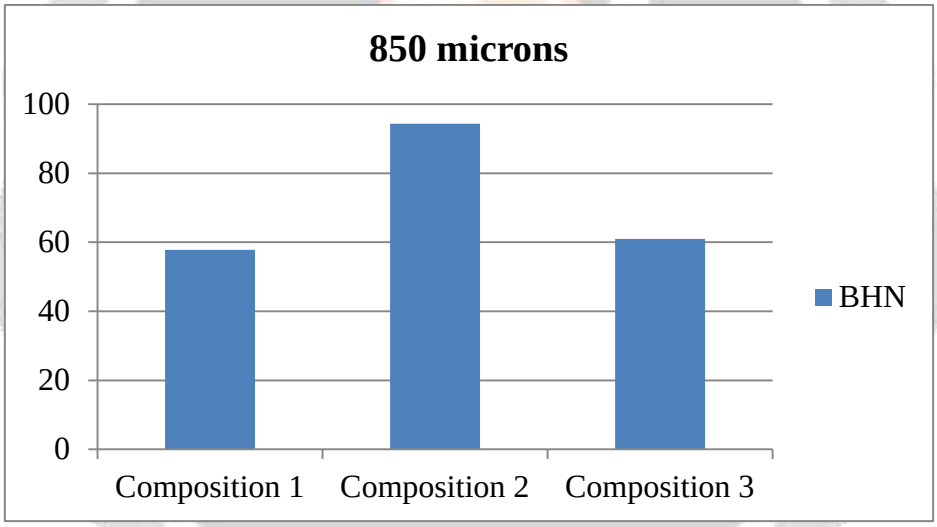


Figure 4.2: Hardness comparison of 850 micron particulate seashell

The prepared composite in the composition indicated shows a significant result in the hardness where, in each case the sea shell percentage is gradually increased by lowering the glass fiber composition. The irregular shape of the seashell mixture combines with the glass fiber has bonded in homogeneous manner and as the sea shell percentage increases the hardness also increases. But as the particle size varies the hardness is getting varied because of the over particle sizes chosen. The optimum size of the seashell particle can be chosen as less than 800 micron size.

4.3 TENSILE TEST

The prepared composite was sliced for tensile specimen as per ASTM D638 standard. The specimens with different particle size and different composition ratios were tested under computerized universal testing machine with maximum capacity of 2KN for all the three compositions mentioned three trial specimens were taken and an average value is recorded. The composition 1 and composition 3 shown a significant increment in the tensile strength where as in composition 2 since the sea shell percentage is more the agglomeration of the particulates happened which leads to the decrement in the strength of the compsite.

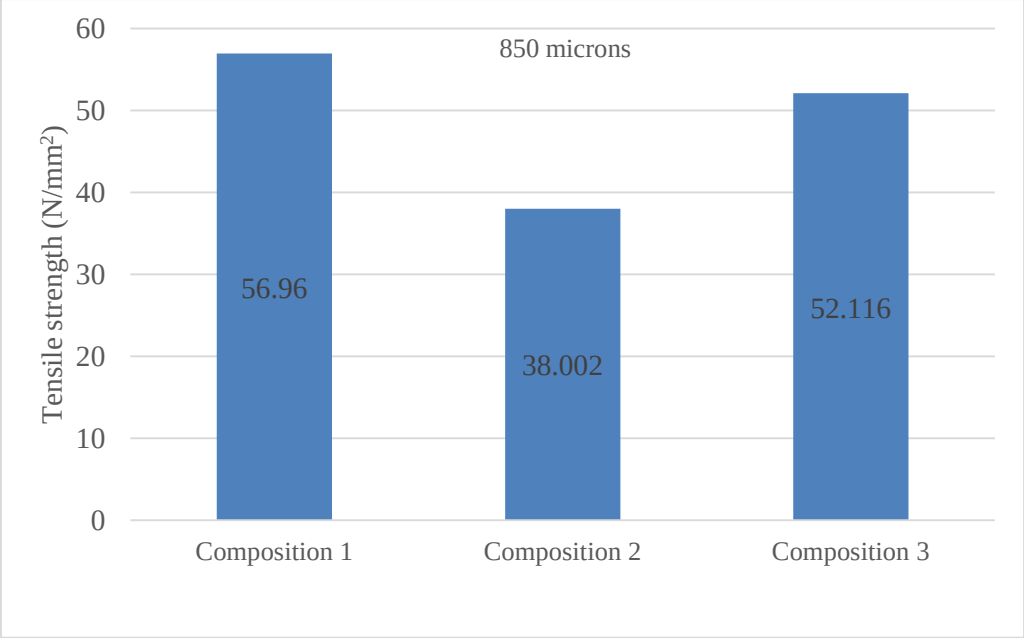


Figure 4.3: Tensile strength comparison of 850 micron particulate seashell

5. CONCLUSION

- Synthesis of the composite using seashell, glass fibre and epoxy resin was completed successfully
- Preparation of specimens for hardness and tensile strength test asper the ASTM standards is completed successfully
- Characterized the prepared seashell powders with SEM and EDAX.
- Evaluated the physical and mechanical properties of the prepared composite and found significant results.

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