Effect of Particle Loading on Flexural Properties of Coconut Shell Reinforced Cardanol Resin Composite

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Abstract - *A study on the flexural properties of coconut shell (CS) particle reinforced cardanol resin (CR) composites is presented in this paper. The coconut shell/cardanol resin composites were made as per the compression moulding procedure. These specimens were then tested in the three point bend configuration in accordance with ASTM D790. Weight fractions of coconut shell particles 0, 10%, 20%, 30% and 40 wt % were chosen to be studied. The experimental results indicated that the maximum flexural strength of 30 % coconut shell/cardanol resin increased by 46 % as compared with those of neat cardanol resin. This improvement can be attributed to the uniform distribution of particle in the matrix and high surface area of coconut shell particles.*

Key Words: Coconut shell, cardanol resin, Flexural properties, Scanning electron microscope

1. INTRODUCTION

Increasing concerns and awareness of the environment in connection to the exhaustion of earth's potential petrochemical reserves, the rising expenditure of oil and alarming surrounding climate changes, the necessity for reducing our carbon footprint and disposal of toxic waste are currently the driving force for expedition in development of materials that are sustainable, ecological and are solely created from renewable resources are generally more abundant [1]. Natural filler reinforced polymer composites are finding much interest as a substitute for glass or carbon reinforced polymer composites recently. Some advantages associated with using natural fillers as reinforcement in polymers are their non-abrasive nature , low cost, easy fabrication, high strength to weight ratio, better thermal and insulating properties, renewable, completely or partially recyclable, biodegradable and low energy consumption [2-4]. Natural fillers sequester CO_2 from the atmosphere; hence provide an advantageous contribution to the global carbon budget. The mechanical properties of polymer composites reinforced by filler particles are determined by particle size, dispersion and distribution state, interfacial adhesion, morphology and particle loading [5-7]. According to Savita Singh (et al).with higher particle loading, large number of voids results in CSP particle accumulation due to weak interfacial bonding between the matrix and the CSP particle. 20 and 30 % CSP reinforced epoxy composites have high tensile strength and low hydrophilic characteristic than 40 % CSP reinforced composite [8]. The objectives of this study are to determine the flexural properties and Morphological Characterization of random oriented coconut shell particle reinforced cardanol resin composites.

2. MATERIALS AND METHODS

2.1 Materials

The matrix material used in this investigation was CNSL were obtained from Golden Cashew Products Pvt. Ltd, Pondicherry, India. Formaldehyde, epoxy (LY 556), HY 951, and ammonium hydroxide Supplied by Merck Life Science Pvt. Ltd, Mumbai, India. The reinforcement (coconut shell) were obtained from local market of Mayiladuthurai, Tamil Nadu, India as raw form. The said shells were cleaned by water then they are powdered by grinding then dried in sun light 5 to 8 hrs.

2.2 Methods

Figure.1 shows planetary ball mill. The dried coconut shell were then breaking in to pieces and they were first ground in a ball mill to produce fiber powder and then separated by mechanical sieving in to particle form. The average size of coconut shell particle used in this study is 25μm.

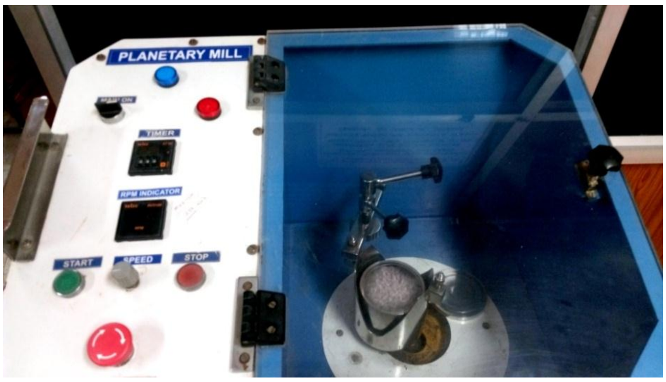


Fig -1: Planetary ball mill

2.3 Composites preparation

The prepared 25μm coconut shell particles were mixed with the prepared Cardanol resin in our earlier work, epoxy resin and hardener matrix in a ratio of 75:25. The mixture was shifted to a mould in dimension of 290 × 290 × 3 mm and was fabricated by compression moulding process, under temperature of 60°C and pressure of 100kgf/cm^2, the composite was formed. Then composites were left to cure at

60 to 70°C temperature for 24 hours in hot air oven. The different weight composition coconut shell particles, viz.,0, 10,20,30, and 40 Wt% .Figure 2 shows the Schematic diagram for cardanol rein and coconut shell particles/ Cardanol resin flexural specimens and (b) photograph image of the developed composites.

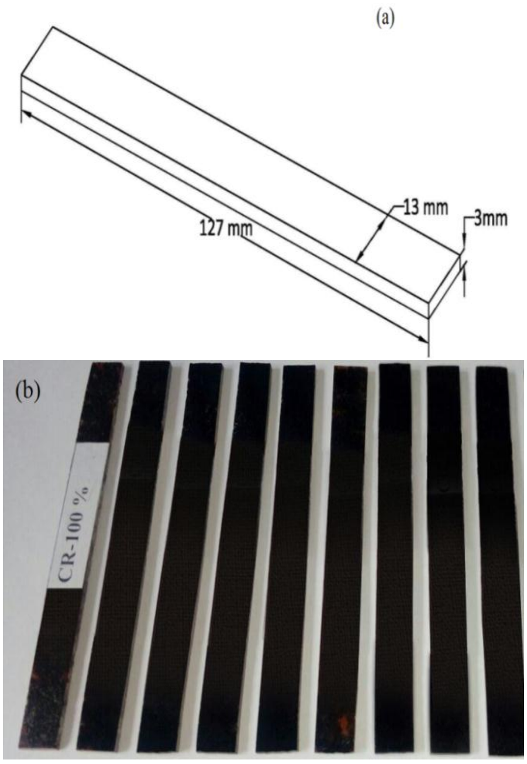


Fig -2: (a) Line diagram for Cardanol resin and CS/CR Flexural specimens and (b) Photographic view of the developed composites

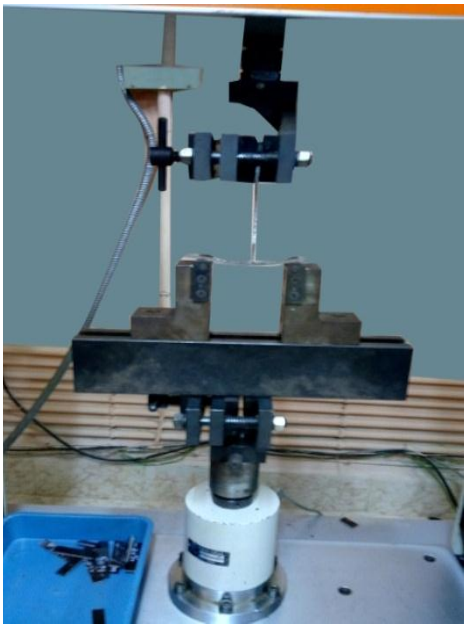


Fig -3: Loading arrangement for flexural specimen

3. RESULTS AND DISCUSSION

3.1 Flexural strength

Figure 4 shows the flexural strength and flexural modulus of coconut shell particulate composite at different particle loading. Flexural strength of coconut shell / cardanol resin composite is increased from 33.48 MPa to 46.50MPa and then decreased from 25 MPa to 44.10 MPa. This decrease is attributed to the void content or crack formation at the interface of composite, inability of the particle to support stresses transferred from the matrix and poor interfacial bonding generates partially spaces between particle and matrix materials which generates a weak structure. Cardanol resin has excellent adhesion to a large number of materials and could be further strengthened with the addition particulates. From the results it is observed that the coconut shell reinforced composite gives best results at 30 wt% particle in flexural strength when compared with the other particle loading. The flexural modulus of the composites increased with increasing particle content. The presence of coconut shell particle in matrix reduced polymeric chain mobility due to the increased stiffness of the composites.

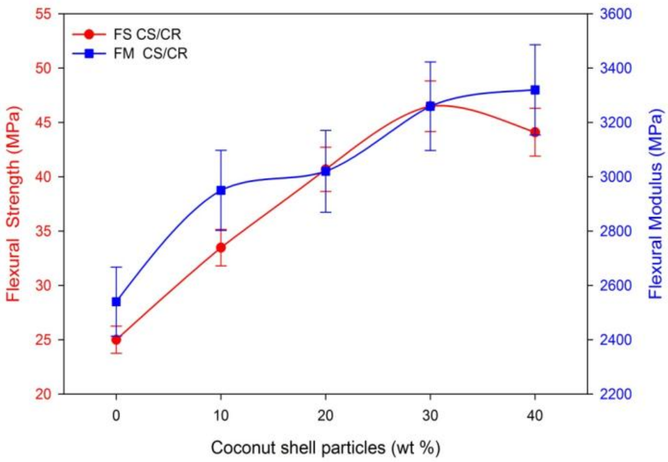
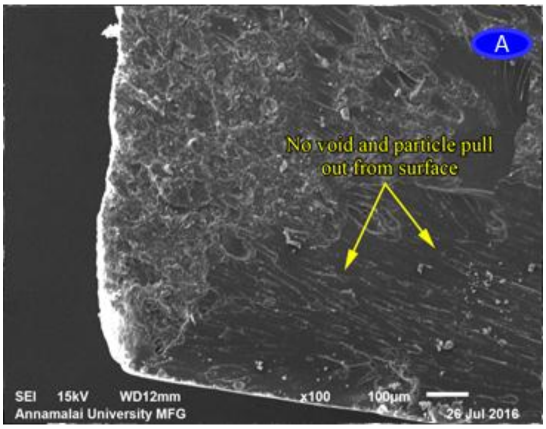


Fig -4: Effect of flexural strength and flexural modulus of CS/CR composite

3.2 Morphological Characterization

Figure 5 (a) shows the microstructure of 30 wt% flexural specimen. From the microstructure it is evident that, due to incorporation of CS particle with cardanol resin, it is found to have good interfacial bonding between particle and matrix materials. Hence no voids and micro cracks were found on the surface of the composite which has given the composite little positive strength to flexural load. But, at 40wt%, the problem occurred at the time of mixing of particle and resin due to maximum percentage of reinforcing materials. Due to improper mixing of the particle and matrix a poor interfacial bonding creates between the materials. From Figure 5 (b) it is observed that a small micro cracks and voids are also found on the surface of the composite is also a region for reduction in strength of the composite.



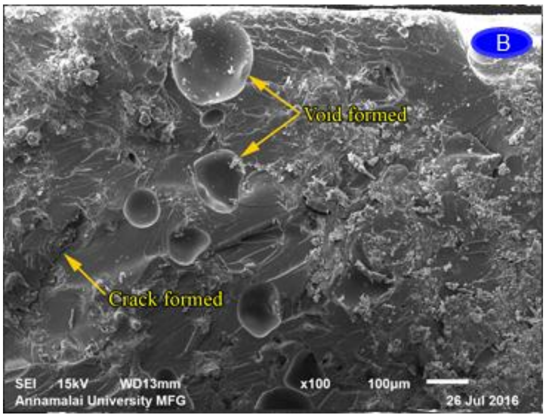


Fig -5: SEM Micrograph of fractured surface of (A) 30 wt% and (B) 40 wt% CS/CR composite flexural specimen

4. CONCLUSION

The characterization of compression moulding cardanol resin and coconut shell particles/cardanol resin composites of different weight fractions of reinforcement materials (0, 10%, 20%, 30 % and 40 %of coconut shell particles) and study of flexural strength by a universal testing machine has led to the following inferences.

1. The increase of the filler plays an important role in improving the mechanical behavior of composites. The improvements of flexural strength up to optimum particle content, that is 30 wt%, indicated better interfacial interaction and effective load transfer between particle and cardanol resin due to better dispersion. However, as the coconut shell particle content increased up to 40 wt%, coconut shell particles aggregated and the crack formation would decrease the effective cross-sectional area of the composites and induced its flexural properties reduced.
2. Additionally, the morphology of the coconut shell particles/cardanol resin composites were observed by SEM, where the formation of micro cracks, voids, and poor interfacial bonding which causes the reduction in flexural strength.

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