

# Development and Properties of Hybrid Composites

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## Abstract

The Flexural and tensile properties and Scanning electron Microscope analysis of Aramide/Onion/Glass fibers Reinforced Epoxy Hybrid composites were studied. The effect of alkali treatment of the Aramide/Onion/Glass fibers on these properties was also studied. These properties found to be higher when alkali treated glass fibers were used in the hybrid composites. The elimination of amorphous hemi-cellulose with alkali treated leading to higher crystallinity of the Aramide/ Onion/Glass fibers with alkali treatment may be responsible for these observations. The author investigated the interfacial bonding between Aramide/Onion/Glass reinforced epoxy composites. The effect of alkali treatment on the bonding between Aramide/Onion/Glass composites was also studied.

**Keywords:** Aramide fiber, Glass fiber, Onion fiber, Epoxy resin, SEM Flexural properties, Chemical resistance, Tensile properties, Hybrid composites.

## INTRODUCTION

Several studies on the composites made from epoxy matrix and natural fibers onion, jute, wood, banana, sisal, cotton, coir and wheat straw were reported in the literature. Jindal (1) reported the development of bamboo fiber reinforced plastic composites using araldite (CIBA CY 230) resin as matrix. Though bamboo is extensively used as a valuable material from times immemorial (because of its high strength and low weight), the studies on this fiber reinforced plastics re meager. In the present work, the aramide, onion & glass fiber reinforced high performance epoxy hybrid composites were developed and their Flexural and tensile properties with fiber content were studied. The author investigated the interfacial bonding between aramide, onion, glass reinforced epoxy composites. The effect of alkali treatment on the bonding between aramide, onion, glass composites was also studied.

## MATERIALS AND METHODS

### Materials

High performance epoxy resin LY 556 and the curing agent hardener HY 951 system were used as the matrix. Onion fiber were procured from local area. Some of these fibers were soaked in 1% NaOH solution for 30 min. to remove any greasy materials and hemi-cellulose, washed thoroughly in distilled water and dried under the sun for one week. The fibers with a thickness of 0.3mm were selected in the mat form. The glass chopped strand mat was used in making the hybrid composite percentage.

### Preparation of mould

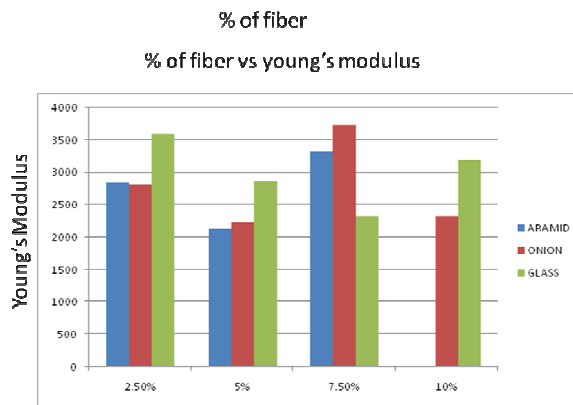
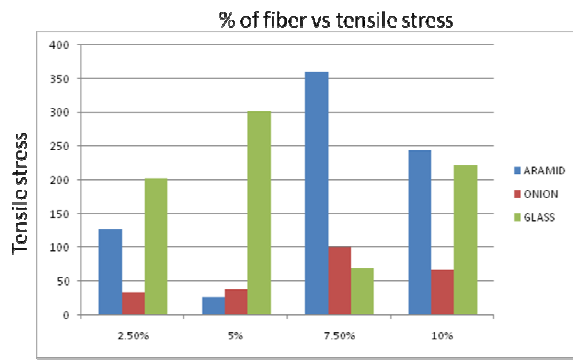
For making the composites, a moulding box was prepared with glass with 200mmx200mmx3mm mould (length x width x thickness)

## PREPARATION OF THE COMPOSITE AND THE TEST SPECIMENS

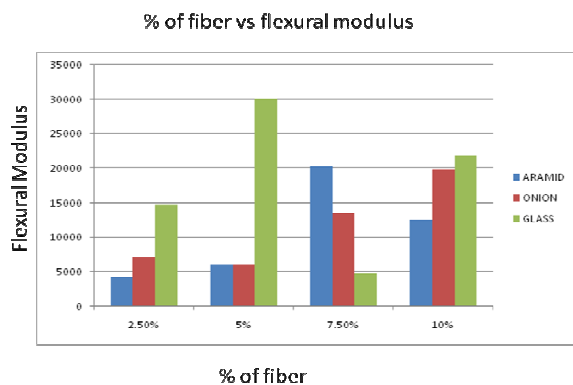
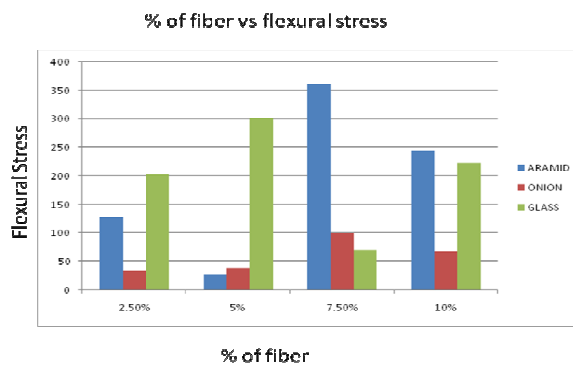
The mould cavity was coated with a thin layer of aqueous solution of poly vinyl alcohol (PVA) which acts as a good releasing agent. Further a thin coating of hard wax was laid over it and finally another thin layer of PVA was coated. Each coat was allowed to dry for 20 min at room temperature. A 3mm thick plate was made from the epoxy and hardener taken in the ratio of 100 and 10 parts by weight respectively. Then the moulding box was loaded with the matrix mixture and onion & glass fiber in random orientation (with varying percentage) and was placed in a vacuum oven which was maintained at 100°C for 3 hours to complete curing. After curing the plate was removed from the moulding box with simple tapering and it was cut in to samples for flexural test with dimensions of 150mmx20mmx3mm are cut as per ASTM specifications. For comparison sake the specimen for matrix material were also prepared in similar lines. For Scanning electron microscope analysis the cryogenically cooled and fractured specimen surfaces were gold coated and the fractures surface was observed using scanning electron microscope.

## TENSILE AND FLEXURAL LOAD MEASUREMENT

The tensile and flexural modulus were determined using M/S Instron 3369 Model UTM. The cross head speed for flexural test was maintained at 10mm/min respectively. In each case 5 samples were tested and the average values are reported.



**The variation of Stress with the ratio of Aramide, onion, Glass fiber Reinforced Epoxy composites**



**The variation of Flexural modulus with ratio of Aramide, Glass, onion fibers reinforced Epoxy composites**

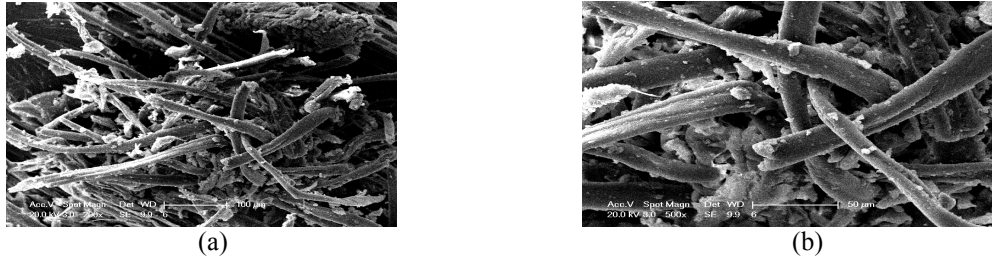
**SEM ANALYSIS**

To probe the bonding between the reinforcement and matrix, the Scanning electron micrograms of fractured

surfaces of aramide, onion, glass reinforced epoxy composites were recorded. These micrograms were recorded at different magnifications and regions. The analysis of the micrograms of the composites prepared under different conditions is presented in the following paragraphs.

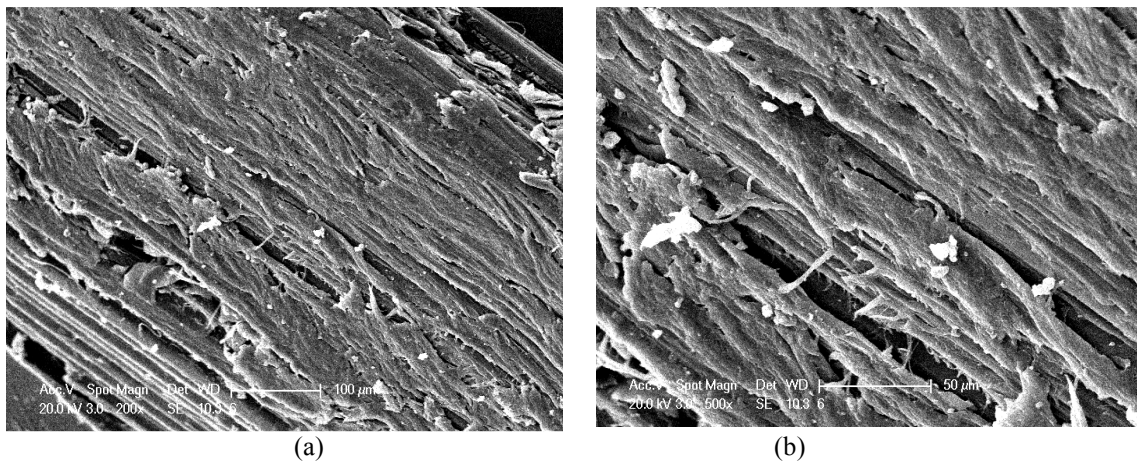
### UNTREATED ONION FIBER

The micrograms of fractured surfaces of untreated onion fiber are presented in figure 2 (a),(b),(c&d ). Figure 2 (a)&(b) represents the fractograms at two regions with a magnification of 100X. Figure 2(c)&(d) and the fractograms at these regions at magnification of 200X. From all these micrograms it is evident that fiber pullout is observed, indicating a poor bonding between the fibers. When the interfacial bonding is poor, the mechanical properties of the composites will be inferior. All the mechanical properties of the glass/onion fiber composites studied indicate that these properties are the least for these composites with untreated onion fibers. The poor adhesion is indicated in figure 2 supports this observation.



**Fig: SEM of untreated Onion fiber (a) and (b) at two regions 100x magnification**

The fractograms of alkali treated bamboo fiber are presented in fig 3(a),(b).these fractograms were recorded at two different regions and 100X and 200X magnifications. From these micrograms it is clearly evident that the surface of the fiber becomes rough on alkali treatment. The elimination of hemi-cellulose from the surface of the bamboo fiber may be responsible for the roughening of the surface. Here, though the bonding is improved, fiber pullout is reduced. Thus the alkali treatment improved the bonding. This is in accordance with the mechanical properties of these composites.



**Fig: SEM of treated Onion fiber (a) and (b) at two regions 100x magnification**

### CHEMICAL RESISTANCE OF COMPOSITES

The chemical resistance of the composites was studied as per ASTM D 543-87 method. For chemical resistance test, the acids namely concentrated hydrochloric acid (10%), concentrated nitric acid (40%) and glacial acetic acid (8%), the alkalis namely aqueous solutions of sodium hydroxide (10%), ammonium hydroxide(10%) and sodium carbonate (20%) and the solvents- Benzene, carbon tetra chloride, toluene and water were selected. In each case, ten pre-weighted samples were dipped in the respective chemicals under study for 24 hours, removed and immediately washed thoroughly with distilled water and dried by pressing them on both sides by filter papers. The final weight of the samples and % weight loss/gain was determined. The resistance test was repeated for ten samples in each case and the average values reported.

Chemicals	Matrix	Composite
40 % nitric acid	+0.2876	+0.27541
10% Hydrochloric acid	+0.9365	+0.35491
8% Acetic acid	+0.3365	+2.4679
10% sodium hydroxide	-0.4761	-2.2191
20% sodium carbonate	+0.747	-3.7756
10% Ammonium Hydroxide	- 0.3243	-2.9985
Benzene	-1.321	-1.346
Toluene	-0.491	-2.340
Carbon tetrachloride	-1.124	+4.4858
Water	-1.112	-1.634

## CONCLUSION

The hybrid composites of onion/glass fiber reinforced epoxy were made and their Flexural properties and SEM analysis studied. The effect of alkali treatment of the bamboo fibers on these properties was studied. These hybrid composites were found to exhibit good Flexural properties. The hybrid composites with alkali treated onion fibers were found to possess higher flexural properties. The elimination of amorphous weak hemi-cellulose components from the Bombay fibers on alkali treatment may be responsible for this behavior.

## RESULTS AND DISCUSSION

The variation of Flexural strength with the ratio of percentage glass/onion fiber in these composites is presented in fig-1, fig-2. In this case also the hybrid composites are found to have good Flexural properties. In the case of maximum strength, the values vary between 60 to 213 MPa. The Flexural strength of these composites are found to be enhanced when alkali treated bamboo fibers were used in the hybrid composites. Similarities observation was made by Varada Rajulu et al (2-9) and Srinivasulu et al(10) in the case of some onion composites and polymer coated onion fibers.

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