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Development and Study of Properties of Natural Fiber Reinforced Polyester Composites

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Abstracts

Fiber reinforced composites offer varied advantages in various applications. Today fiber composites aeronautically used in such diverse applications as automobiles, aircraft, space vehicles, offshore structures, containers and piping, sporting goods, electronics, and appliances. In this work, Bamboo, Jute and Grass fibers reinforced with polyester composite specimen pieces are prepared separately. Their Tensile, Flexural properties are determined using Universal Testing Machine (UTM), Chemical resistances are studied and compared and Scanning Electron Microscope (SEM) analysis is carried out. It is observed that flexural strength of the reinforced composites increases with bamboo fiber content. Through SEM analysis, the interfacial bonding between bamboo, jute, grass fibers and the matrix- polyester, is studied. The chemical resistance of Bamboo, jute and grass fiber reinforced with polyester composites to acetic acid, Nitric acid, Hydrochloric acid, Sodium hydroxide, Sodium carbonate, Benzene, Toluene, Carbon tetrachloride and Water is studied. These results have demonstrated a new approach to use natural materials to enhance the mechanical performances of composites.

Keywords: Bamboo-jute-grass fiber composites, chemical resistance, polyester resin, flexural strength, tensile strength, SEM Analysis.

Introduction

Several studies on the composites are made from polyester matrix and natural fibers like jute, wood, banana, cotton, bamboo, coir and wheat straw are reported in the literature. In the present work, bamboo, jute and grass fiber reinforced high performance polyester composites are developed and their tensile, flexural properties with fiber content (with varying ratio of bamboo, jute, grass fibers) are carried out.

Materials and methods

Materials

High performance polyester resin with curing agents accelerator and catalyst in 10:1 ratio are used as matrix. Bamboo fibers (dendrocalamus strictus) were procured from Tripura state of India in the dried form.The fibers with a thickness of 0.3 mm were selected in the mat form. The jute fibers have been procured from company (mat) is used in making the composite percentage. The grass fibers have been procured from local area.

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 is 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 laid over it and finally another thin layer of PVA is coated. Each coat is allowed to dry for 20 minutes at room temperature.

Moulding box is loaded with matrix and reinforcement in random orientation (with varying percentage) and is placed in furnance which is maintained at 100^{o}c for 3 hours to complete the curing . After curing, the plate is removed from the moulding box with simple tapering and samples are cut for tensile and flexural test with dimensions 150mmx20mmx3mm and for chemical test with dimensions 10mmx5mmx5mm. For Scanning Electron Microscope analysis samples are cryogenically cooled and fractured specimen surfaces are coated with gold covering and the interfacial bonding between bamboo, jute, grass fibers and the matrix- polyester, is studied.

Tensile and flexural load measurement

The Tensile, Flexural stress and modulii are determined using Instron 3369 UTM. The cross head speed for tensile test is maintained at 10mm/min, flexural test is maintained at 5mm/ min. The temperature and humidity for this test are maintained at 18 ^{0}C and 25% respectively. In each case 5 samples were tested and average values are reported.

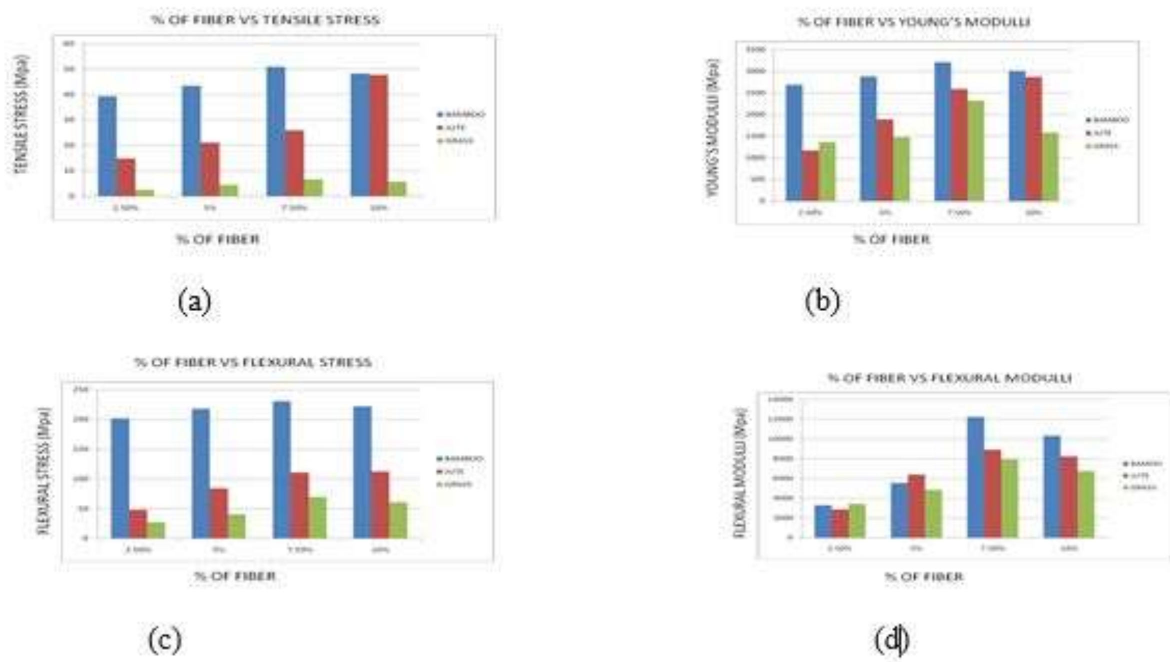

Fig. 1: Variation of Stress and modulii with % change in the ratio of bamboo, jute, grass fiber reinforced polyester composites

Chemical resistance of composites

The chemical resistance of the composites is 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 are 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 are reported.

Table-1: %change in weight of bamboo reinforced polyester composite after immersion in chemical reagents for 24 hours

Chemicals	Matrix	Composites
40 % nitric acid	+0.2269	+0.26491
10% Hydrochloric acid	+0.9765	+0.29491
8% Acetic acid	+0.3867	+2.4699
10% sodium hydroxide	-0.4361	-2.7191
20% sodium carbonate	+0.787	-3.9856
10% Ammonium Hydroxide	-0.3793	-2.9158
Benzene	-1.375	-1.347
Tolerance	-0.697	-2.350
Carbon tetrachloride	-1.136	+4.4588
Water	-1.219	-1.696

SEM analysis

To probe the bonding between the reinforcement and matrix, the Scanning Electron micrograms of fractured surfaces of bamboo, jute and grass reinforced polyester composites were recorded. These micrograms were recorded at different magnifications and regions. The analysis of the micrograms of the composites prepared

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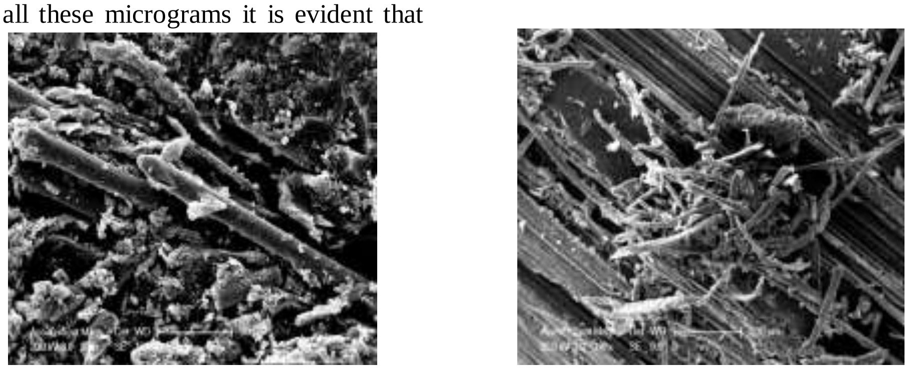
under different conditions is presented in the following paragraphs.

Untreated bamboo fiber

The micrograms of fractured surfaces of untreated bamboo fiber are presented in figure 2 (a),(b). Figure 2 (a) & (b) represents the fractograms with magnification of 100X. 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 bamboo fiber composite study indicates these properties are least for these untreated bamboo fibers.

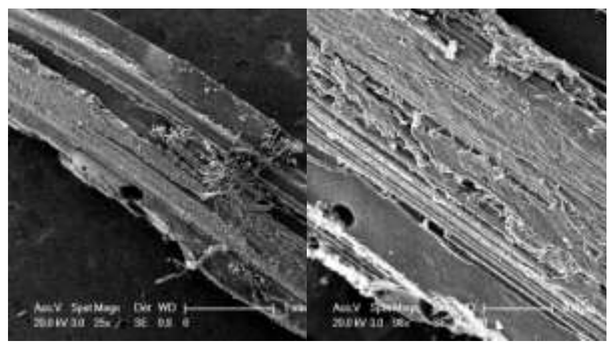


(a) (b)

Figure 2: SEM image of untreated Bamboo fiber (a) and (b) at two regions 100x magnification.

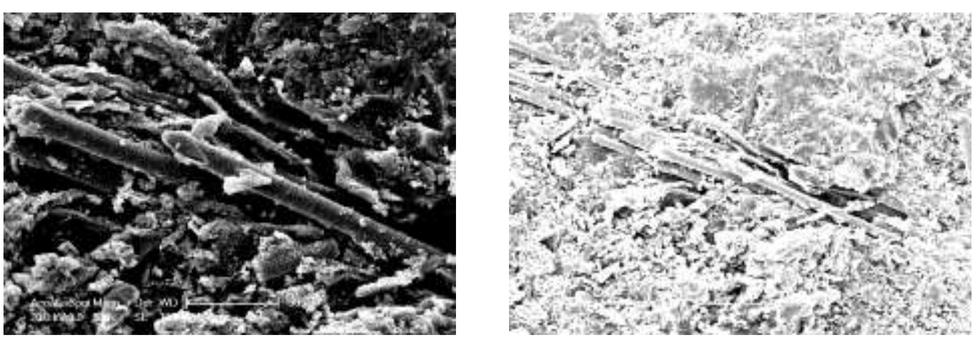
Treated bamboo fiber

The fractograms of alkali treated bamboo fiber are presented in fig 3(a) & (b). These fractograms are recorded at 100X magnifications. From these micrograms it is clearly evident that the surface of the fiber becomes rough on treatment. The elimination of hemi-cellulose from the surface of the bamboo fiber is responsible for the roughening of the surface. Here, though the bonding is improved, fiber pullout is reduced. Thus the bonding of treated bamboo is improved.



1. (b)

Figure 3: SEM image of treated Bamboo fiber (a) and (b) at two regions 100x magnification.



(a) (b)

Figure 4: SEM image of untreated jute fiber (a) and (b) at two regions 100x magnification.

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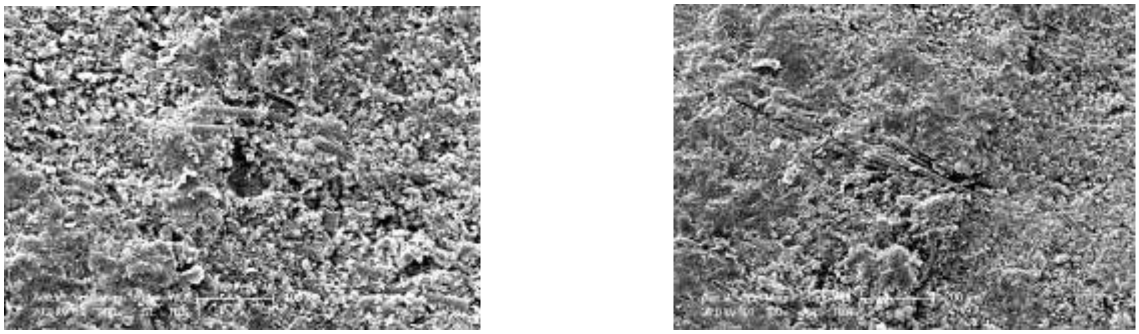
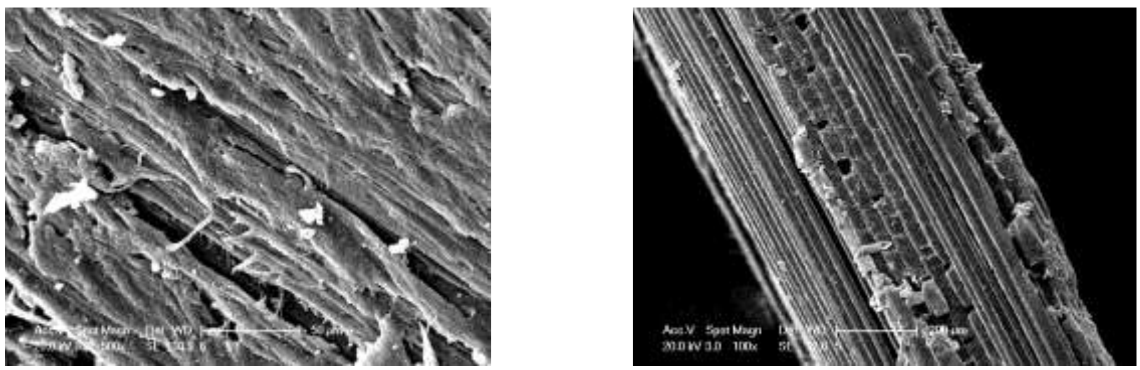


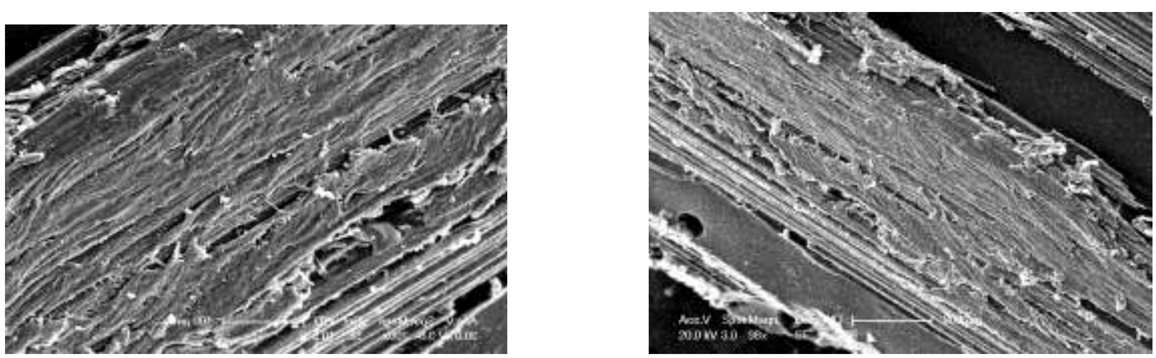
(a) (b)

Figure 5: SEM image of treated jute fiber (a) and (b) at two regions 100x magnification .



(a) (b)

Figure 6: SEM image of untreated grass fiber (a) and (b) at two regions 100x magnification.



(a) (b)

Figure 7: SEM image of treated grass fiber (a) and (b) at two regions 100x magnification.

Results and discussion

The variation of tensile, flexural stress and modulii with percentage change of bamboo, jute and grass fiber ratio is presented in figure 1. For comparison, these values for the matrix are also presented in the same figures. The minimum and maximum values of tensile stress and modulus for these composites are found to be 2.42 and 50.86MPa and minimum and maximum values of f modulus of these composites are found to be 1171.86 and 3207.95 Mpa respectively. The minimum and maximum values of flexural stress and modulus for these composites are found to be 27.16 and 230.62MPa and minimum and maximum values of f modulus of these composites are found to be 2874.29 and 12221.61 Mpa respectively

The effect of some acids, alkalis and solvents on the matrix and composite under study is presented in table-1. From this table it is clearly evident that for matrix and composite, the weight gained is observed after immersion. This is understandable as the matrix is cross linked and as a result formation of gel takes place instead of dissolution. The chemical resistance of the reinforced

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composites with treated bamboo fibers is found to be better for the chemicals mentioned.

References

1. Jindal, U.C (1986) development and testing of bamboo fibers reinforced plastic composites journal of composites 20: 19 (1986)
2. Varada Rajulu , A., Narasimha Chary, K., Rama Chandra Reddy, G. Void content, density, weight reduction and mechanical properties of short bamboo fibers/ stryrenated polyster composites.j. Bamboo & Ruttan.,2(2):95-102(2003).
3. Varada Rajulu, A., Narasimha Chary, K., Rama Chandra Reddy, G.,Meng, Y.Z. Void content, density, weight reduction and mechanical properties of short bamboo fibers/ stryrenated polyster composites.j. reinforced plastics and composites, 23(2):127-130.(2004).
4. H A Sharifah, P A Martin, T C Simon and R P Simon, Modified polyester resins for natural fiber composites, Compos. Sci. Technol. 65, 525-535, 2005.
5. H. P. S. Abdul Khalil, S. Hanida, C. W. Kang, N.A. Nikfuaad, Agro hybrid composite: "the effects on mechanical and physical properties of oil palm fiber (efb)/glass hybrid reinforced polyester composites", Journal of Reinforced Plastic Composites. 26(2) (2007) 203–218.
6. Luo S and Netravali A. N, "Interfacial and mechanical properties of environment-friendly 'green' composites made from p ineapple fibers and poly(hydyoxybutyrate-co-valerate) resin", Journal o f Materials Science, 34, 1999, pp. 3709-3719.
7. Shibata M, Ozawa K, Teramoto N, Yosomiya R and Takeishi H, "Biocomposites made from short abaca fiber and biod egradable polyester", Macromolecular Materials and Engineering, 288 (1), 2003, pp. 35-43.
8. Gassan J and Bledzki A. K, "Possibilities for i mproving the mechanical properties of jute/epoxy composites by alkali treatment of fibres", Composite Science and Technology, 59 (9), 1999, pp. 1303-1309.