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SYNTHESIS AND CHARACTERIZATION OF POLYESTER COMPOSITES REINFORCED WITH PALMYRA NATURAL FIBER

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Abstract

The natural fiber is a best replacement for synthetic fiber which is reinforced with polymer composites for advanced engineering application. The main purpose of this paper is to study the tensile and flexural properties of untreated and treated palymra natural fiber reinforced polyester composites. Palmyra fibre is used as a reinforcement and the polyester resin is used as a matrix. Composites plates were fabricated through hand layup moulding techniques. The treated palymra fiber composites yields excellent tensile and flexural properties. Tensile tests revealed that the ultimate strength is about 48MPa, and elongation break at 6 %. The flexural strength is estimated to be around 64MPa respectively. The mechanical properties of materials prepared from a chemical treated with potassium permanganate palmyra are found to be much stronger than those of untreated fiber. Surface morphologies of fracture surfaces of composites were reported using electron microscopy scanning (SEM).

Keywords: Palmyra fibre; Tensile strength; Flexural strength

Introduction

Enhanced research into the production of new automotive, marine time, aerospace, sports, civil and domestic products is stimulated by economic and environmental concerns. Composites of these are the ones that depend mostly on sustainable natural resources to mitigate more environmental stress.

Natural fibres have some benefits when compared with synthetic fibres, such as low density, cheaper specific properties and reduced health risks. Composite material scientists from around the world have concentrated on seed-fiber composites (cotton, coir), bast fibres (hemp, flax, kenaf, jute), leaf-fiber (sisal) stem-fibers, fiber-based (bananas, indian mallows), grass (elephant grass, bamboo, wild cane, golden cane) etc. [1-10]. Bledzki et al. (2002) investigated the mechanical properties of Wood fiber polymer composites. Results revealed that the hard wood composites shows the better strength when compared to soft wood fiber composites [11]. Srinivasababu et al. (2014) investigated the chemically treated thysanolaena maxima fiber polymer composites. Chemical treatment thysanolaena maxima fiber composites exhibits ultimate tensile strength of 82.39 MPa and flexural strength of 78.51 MPa than the other composites investigated in the work[12]. Idicula et al. (2006) investigated banana/sisal hybrid fiber reinforced polyester composites by varying the fiber volume fraction as a function of filler concentration and for several fiber surface treatments [13].Ramaniah et al. (2011) studied the mechanical properties of typhaangustifolia fiber /polyester composites. The result revealed that the mechanical properties of composites increased with increase in fiber content [14]. Ratna Prasad et al. (2011) studied the flexural properties of wildcane grass fiber /polyester composites. The result showed that the flexural strength of composites increases with increase in fiber loading and wildcane grass fiber composite exhibits ultimate flexural strength than other polymer composites [15]. In view of the aforementioned considerations, this paper deals with composites of raw palmyrafibre and processed palmyrafibre. Due to its less cost, green nature and much lower energy demand for manufacturing, Palmyra is a desirable natural fibre for use as reinforcement in composites. The aim of this paper is to fabricate the treated and untreated palmyrafibre composites and to analyze the mechanical properties of the manufactured composite

2. Material and Methods

Palmyra Natural Fibre

Palmyra fibre is one of the natural palmyrafibre extracted from the stem of the palmyra. Palmyra fibre is used as reinforcement. Readily available, low cost and low weight is the advantage of palmyrafibre. It is made from a palmyra waste stem.

2.1 Materials used in Fabrication Process

Unsaturated polyester resin are obtained from Prasanafibre glass Ltd., Madurai, India. The accelerator used for the investigation is Cobalt Napthanate and the catalyst Methyl Ethyl Ketone Peroxide (MEKP) is added as 1% with the resin to fabricate the composite palte.

2.2 **Fabrication of Composite**

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Palmyra fiber was placed in a mould measuring 300 x 300 x 3 mm3 for making composite plate with untreated and treated fiber at random fiber orientation.A method of hand lay-up has been introduced to prepare randomly mixed fiber with the composites.The wax is used as releasing agent to remove easily the composite plate from the moulddie.A sufficient volume of polyester resin mixture and randomly mixed fibres have been filled with the mould beginning and finishing with resin layers. Split 30mm palmyrafibre and 47gm palmyrafibre weight. The palmyrafibre has been immersed in 0.5 percent of the permanganate of potassium in acetone for half an hour. A compressive pressure (100kPa) was applied on the mould during curing and the composite specimens were cured for 24 hours. Eight hours after removal of the mould, the specimens were cured at 70 °C only.

2.3 Tensile Test

Tensile strength of the composite laminates prepared was evaluated using UTM (Tinius Olsen H50K) as per standard ASTM D3379-75 (165mm x 10 mm x 3 mm), with a cross head speed of 1 mm/min. A tensile examination involves positioning and tensioning the specimen in a machine. The test method involves putting the test specimen in the test machine and using stress until it breaks down. [15-18].

2.4 Flexural Test

Three-point flexural test was carried out in Tinius Olsen H50K equipment as per ASTM D790-10 standard (127mm x 13 mm x 3 mm) with a cross head speed of 2 mm/min. Testing requires inserting the test specimen in and using force on the universal testing system until it cracks and splits [18-20].

Results and Discussion

3.1 **Mechanical properties of single palmyrafibre**

The suitability of palmyrafibres as a reinforcement must be tested before the composites are made. Table1 explicitly shows that rather than coir fibre, Palmyra fibre has greater tensile strength than other available fibres. The modulus of tensile is much greater than that of the fibre of rice, grass elephant and banana fibre. The elongation is also slightly smaller at intervals than

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that of coir fabric. Palmyra fibre density is smaller than for untreated fibre such as coir fibre, which constitutes an attractive parameter in the manufacture of lightweights.

Table 1 Comparison between the properties of palmyra fibres with other natural fibres

Fibres	Density in(kg/m^3)	Diameter (um)	Tensile Strength (MPa)	TensileModulus(GPa)	Elongation (%)	References
Palmyra	1090	70-130	180-215	7.4- 604	7-15	Present work
Elephant grass	817	70-140	185	7.4	2.5	10
Coir	1150	100-460	252	8-20	15-40	6
Banana	817.53	70-400	185	7.40	2.50	12

3.2Tensile Test

Tensile test is done on the composite specimen prepared as it was clearly evident that with treated fiber content in the polyester matrix exhibits better tensile strength than untreated fiber. This is due to the fact that the polyester resin transmits and distributes the applied stress to the palmyra fibers resulting in higher strength. Therefore, the composite can sustain higher load before failure compared to the unreinforced polyester. The ultimate tensile strength for treated palmyra fiber composites is 48MPa and elongation is 6%. As the load increases, the deformation begins to increases.. Figure1 Shows tensile strength of composites compared with treated and untreated Palmyra Fibre.The SEM analysis of the fractured tensile specimen is shown in Figure 2. The fiber pull-out is visible, the treated with palmyrafibres is found to be some fracture in it. Intra-fabric delamination is also found to be more prevalent in potassium permanganate treated with palmyrafibres. Fiber pull-out occurs primarily due to weak bonding between the palmyra and the polyester. The fibre strain values in this area may have decreased and this contributes to a fibre pull-out in this region [15-18].

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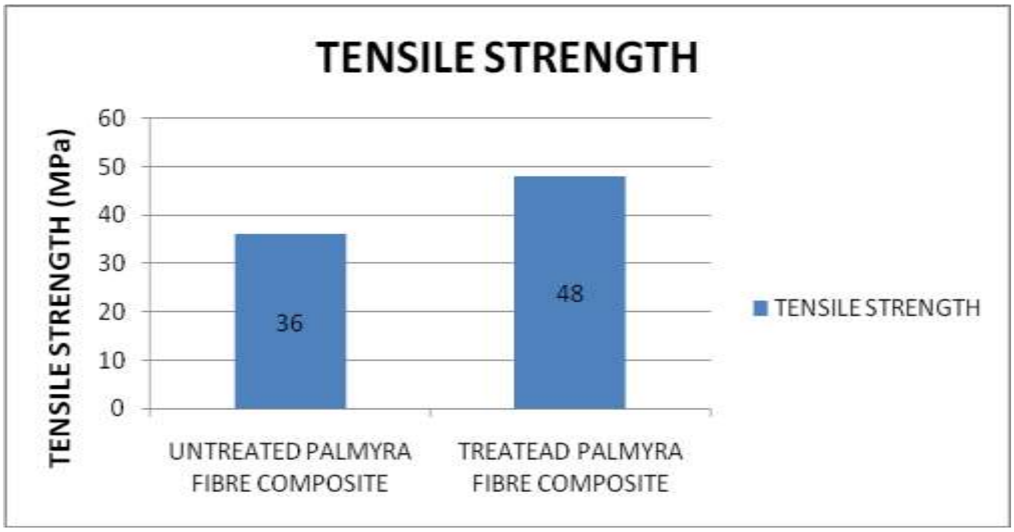

Figure 1Tensile strength of treated and untreated Palmyra Fibre

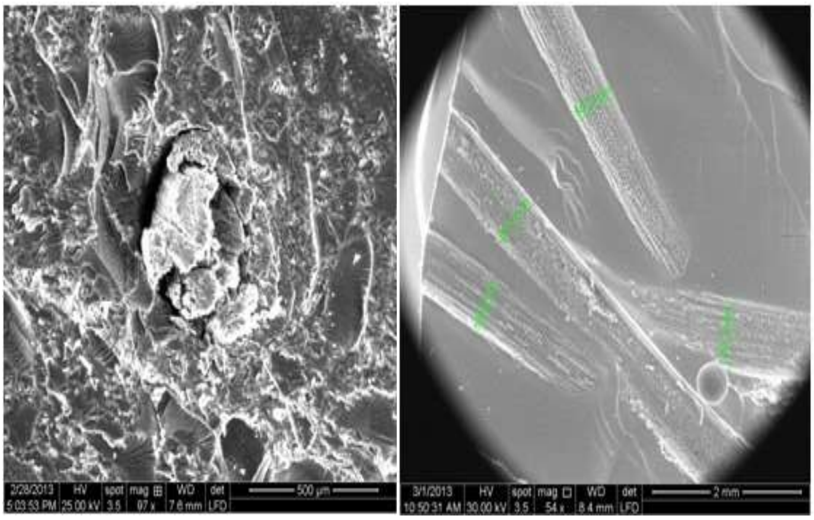

Figure 2 SEM micrograph of the tensile fractured specimen

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3.3 Flexural Test

The flexural or bending test is performed out to analyze the flexural behaviour of the palymra composites. The contribution of flexural deformation plays a vital role in the structural configuration of palymracompositesIt displays the effect of fibre treatments on the flexural properties of short palmyrafibre composites. Treated palmyrafibre composites are found to show higher flexural strength compared to untreated palmyrafibre composites, indicating that the chemical treatments performed on palmyra improve stress transfer from the matrix to the fibre.. In the flexural test point load is applied at center of the material. When the point load is applied, the specimen bends and subjected to bending moments. Bending stresses are induced in the cross section. During testing, when the load attains, the composite specimen suddenly breaks. Figure 7 shows the composite specimen after testing. Figure 3 shows Flexural strength of composites are compared with treated and untreated Palmyra Fibre. Figure 4 displays the SEM fractography of flexural fractured specimen. Due to the flexural load, the cross-sectional delamination of the composite is found. Because of the uniform spread of fiber in the composite sample, there are very few voids in the specimen. Fiber pull-out in the micrograph is very clear, since there is very weak link between the fibre and the matrix. More pull-out in the compression area is found by the greater stress concentration, while it is shown to be much lower in the flexural region [16-20]

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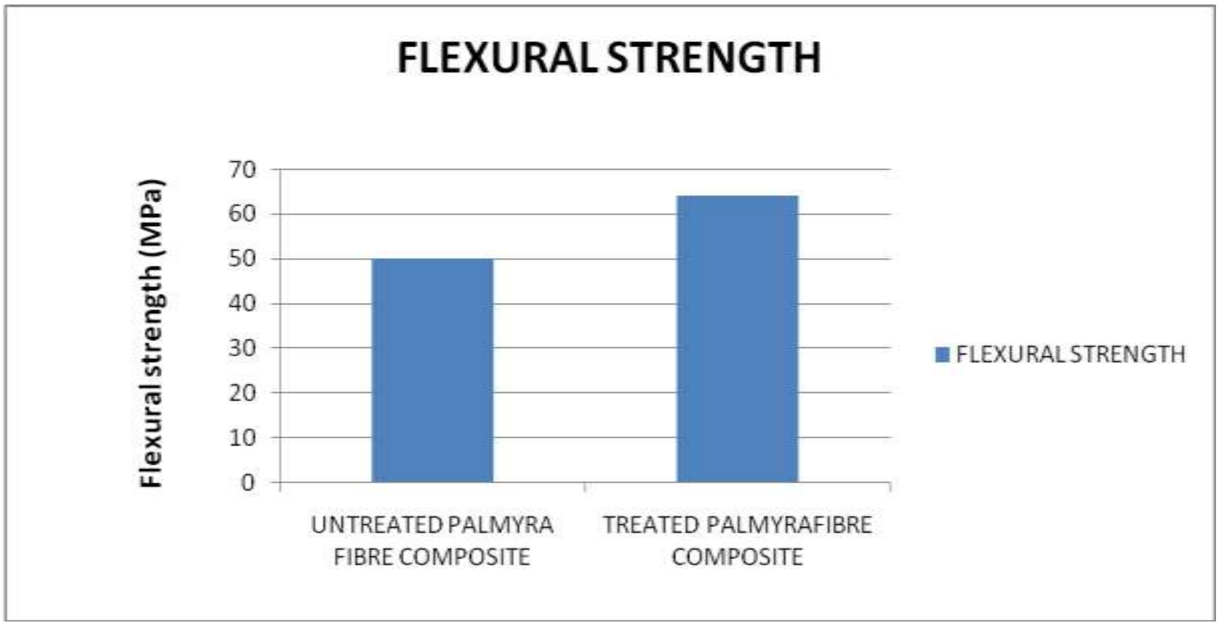

Figure 3 Flexural strength of composites are compared with treated and untreated Palmyra Fibre

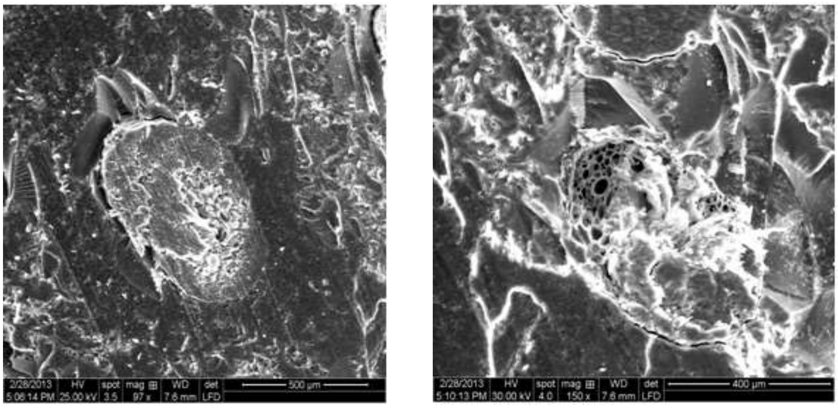

Figure 4 SEM micrograph of the flexural fractured specimen

4 Conclusion

In this research paper work,Palmyra natural fiber reinforced polyetser composites were fabricated and analyzed their mechanical properties. The following conclusions can be drawn.

- The tensileproperties of treated Palmyrafiber composites exhibits good tensile strength and elongation at break compared to other composites.
- The treatedPalmyrafibercomposites exhibits superior flexural propertycompared to other natural fiber polymer composites.
- Due to chemical treatment with potassium permagante in palmyrafibre, the tensile strength is increased from 36.MPa to 48 MPa and flexural strength is also increased from 50 MPa to 64 MPa.
- Therefore, the fabricated composites can be suggested for various automobile, home appliances, civil constructions and sports application such as helmet, car door panels, table tennis bat, electronic plastics manufacturing, house appliances and civil structures like fiber concrete, pipes, fiber door and windows.

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