ISSN: 2582-6271

Vol.1 No.3; 2020

FABRICATION, MECHANICAL AND PHYSICAL PROPERTIES OF AGBA (PRIORIA BALSAMIFERA) SAWDUST REINFORCED POLYESTER COMPOSITE

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ABSTRACT

Agba sawdust/unsaturated polyester resin composites have been fabricated using 0wt%, 10wt%, 20wt% and 30wt% of sawdust. The unsaturated polyester resin (UPR) was mixed with treated agba sawdust to produce the composites. The effect of filler loading on mechanical and physical properties of the composites was studied. The results showed that both tensile and flexural strengths of the composites decreased with increasing filler contents. This is as a result of increase in the interfacial area which worsens the interfacial bonding between the sawdust and the polyester. The tensile and flexural moduli of the composites have their peaks at 20wt% sawdust. There was a sharp drop in moduli at 30wt% filler. The water absorption test result showed increasing percentage water absorption as the sawdust content increases. The progressive increase in percentage water absorption is as a result of hydrophilic nature of sawdust.

KEYWORDS: Absorption, mechanical properties, unsaturated polyester resin, mould, sawdust

1. INTRODUCTION

Natural fibre reinforced composites have attracted great interests in recent times as candidate materials for structural applications. The excellent properties of natural fibres have been their low costs, lower density, biodegradability, availability and lower abrasiveness [1 - 3]. Natural fibres contain three main components which are cellulose, hemicellulose and lignin, in which cellulose has the greatest percentage [4]. The cellulose is responsible for the good mechanical properties of the fibre. The major unit of cellulose macromolecule is anhydro-d-glucose, which consists of three hydroxyls (-OH). The hydroxyls form hydrogen bonds in the macromolecule itself and equally with hydroxyl groups from moist air which can reach 3- 13% [5]. Despite these attractive properties of natural fibres, they have common problem of poor interfacial bond between the fibre and the matrix (polymer) [6]. This problem leads to poor mechanical properties of the composites. To reduce this drawback, surface treatment of the fibres is done. The surface modification could be physical or chemical method [7]. The corona and cold plasma electric discharge are the most common physical methods but are not cost effective. Chemical treatments such as isocyanate, alkali treatment (mercerization), grafting agents and silane coupling agents have been proven to improve fibre-matrix adhesion [8 – 10].This study aims at studying the effect of varying the weight percentage of chemically treated Agba (Prioria balsamifera) sawdust on the mechanical and Physical properties of agba sawdust reinforced polyester composites.

2. MATERIALS AND METHODS

2.1 Materials

The agba sawdust was sourced from a timbre market in Ogugu, Nigeria. The surface modification reagents used were sodium hydroxide, citric acid and silane coupling agent. The unsaturated polyester resin, methyl ethyl ketone peroxide (MEKP) and cobalt naphthenate were bought from a vendor in Nigeria.

2.2 Methods

2.2.1 Sawdust Preparation

Sawdust particulates were sourced from a timber market in Ogugu, Nigeria. The particulates were oven dried at 60oC for 1day (24 hours), then sieved to particle size of 150 micrometre. Chemical treatments of the sawdust were done using 0.4M of NaOH, citric acid and silane solution respectively. The solutions were added into a beaker containing the sieved sawdust and stirred well with stirring rod. This was kept for 1 hours at room temperature while it was been stirred. The sawdust was later thoroughly washed with distilled water in order to remove excess of the chemical treatment reagents sticking to the sawdust and was later dried in an oven to remove traces of moisture.

A

B

Plate 1: (a) sawdust particulate and (b) Oven

2.2.2 Composite Fabrication

The various weight percentages of the treated agba sawdust were measured and added to the polyester resin, stirred well, 1% cobalt naphthenate and 1.5% methyl ethyl ketone peroxide were added and thoroughly stirred. A release agent was applied on the mould. The components were poured into

ISSN: 2582-6271

Vol.1 No.3; 2020

aluminium mould of dimensions 300mm x 300mm x 5mm. The samples were prepared with different sawdust contents, 0, 10,20 and 30 (v/v%). The samples were allowed to cure at room temperature for 24 hours. The samples were demoulded, trimmed and cut for mechanical tests.

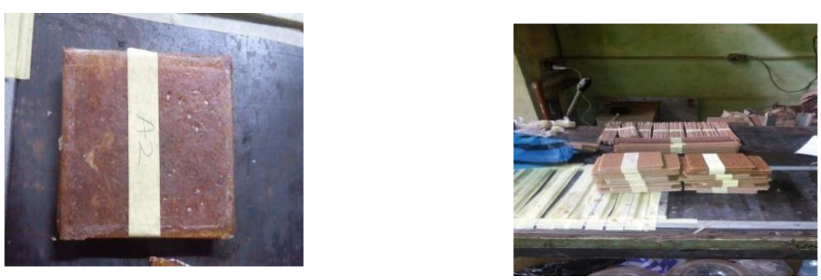
A B

Plate 2: (a) Clean mould and (b) fabricated sawdust composite in a mould

2.2.3 Mechanical Test

(a) Tensile test

The composite tensile samples were tested as per ASTM D3039 using computerized Testometric Model Universal Testing Machine at a crosshead speed of 50mm/min and strain rate of 3mm/min. The specimen dimensions were 150mm x 20mm x 5mm (plate 2b). Three test specimens were tested to failure for each sample group.



A B

Plate 3: (a) sawdust composite panel and (b) test specimens

ISSN: 2582-6271

Vol.1 No.3; 2020

(b) Flexural test

The composite flexural specimens were tested according to ASTM D 790 test standard using Universal Testing Machine.

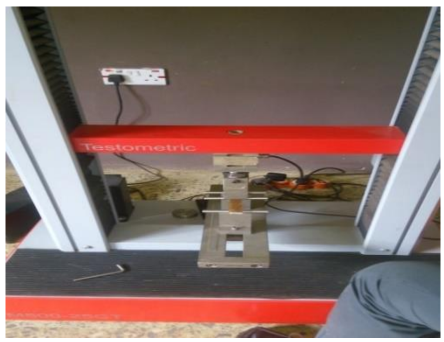


Plate 4: Universal Testing Machine

3. RESULTS AND DISCUSSION

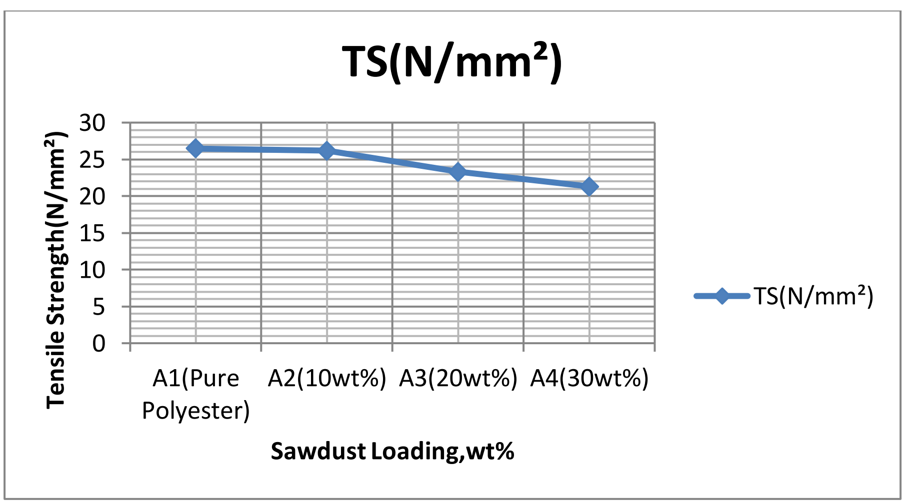


Figure 1: Tensile strength of agba sawdust/ UPR composite

ISSN: 2582-6271

Vol.1 No.3; 2020

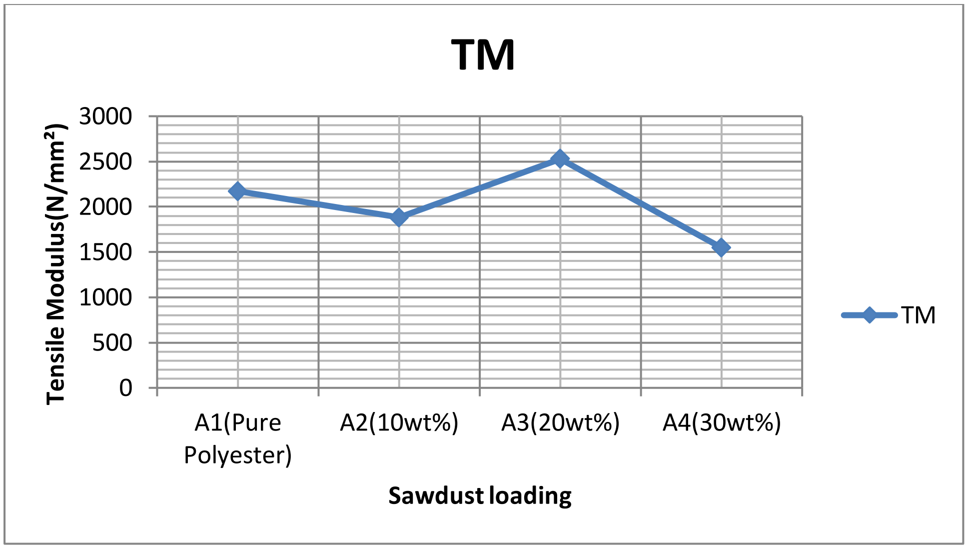


Figure 2: Tensile Modulus of agba sawdust/UPR composite

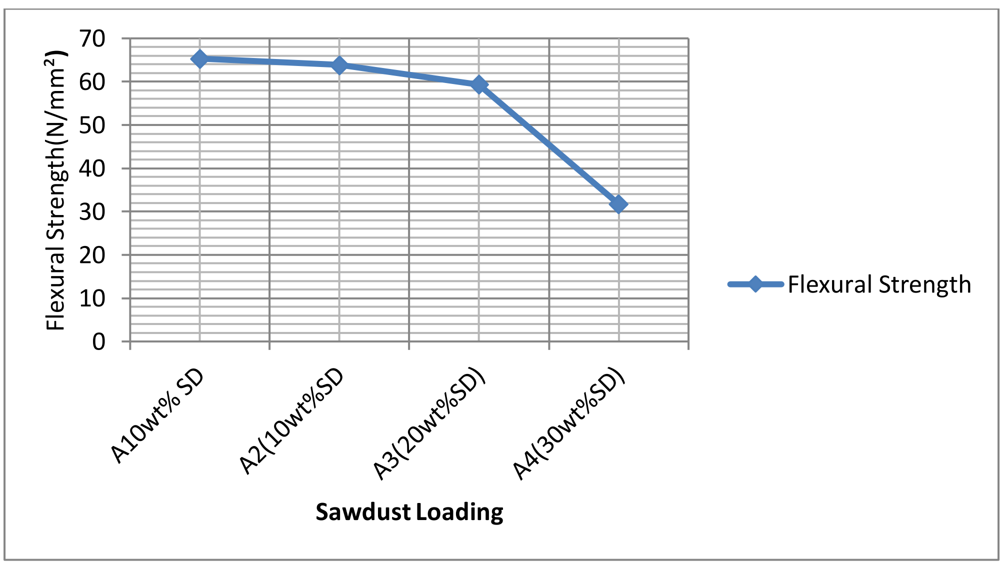


Figure 3: Flexural strength of agba sawdust/UPR composite

ISSN: 2582-6271

Vol.1 No.3; 2020

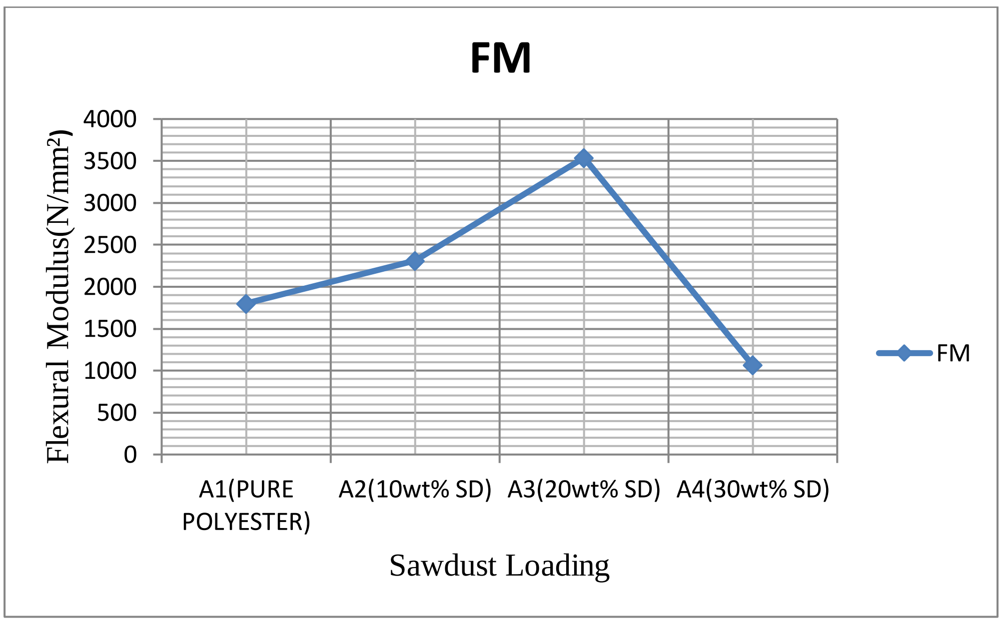


Figure 4: Flexural modulus of sawdust/ UPR composite

ISSN: 2582-6271

Vol.1 No.3; 2020

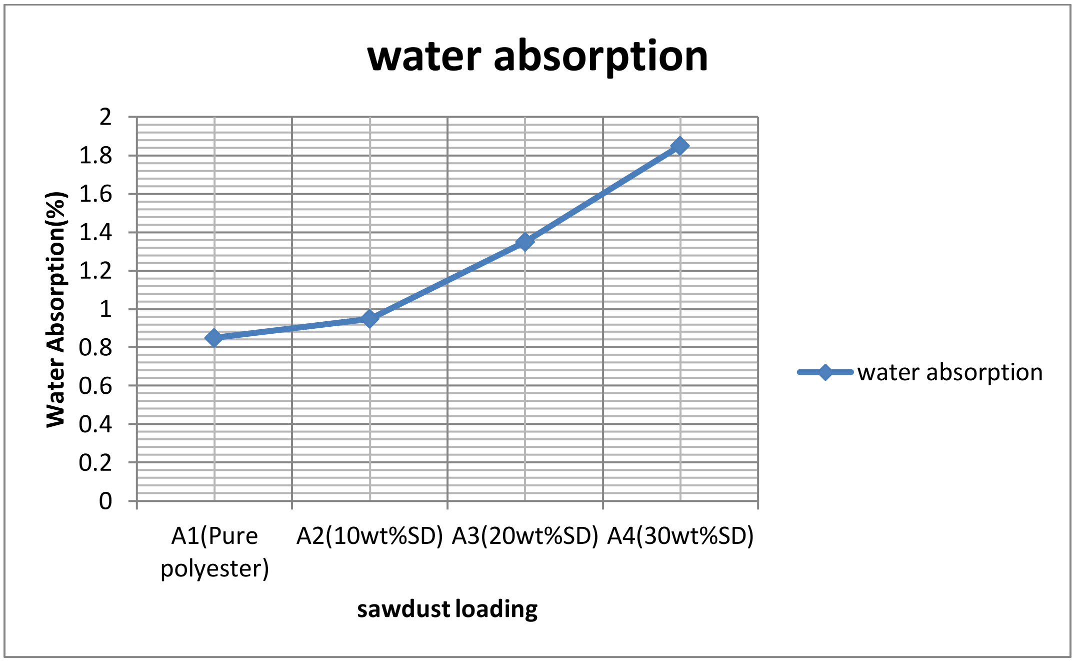


Figure 5: Water absorption of agba sawdust/ UPR composite

Figure 1 shows the tensile strength of the composite as the sawdust filler is varied from 0 – 30 wt%. The unreinforced (pure) unsaturated polyester resin shows a tensile strength of about 27 N/mm2. As the sawdust is being loaded from 10–30 wt%, the tensile strength decreases progressively. The decrease in tensile strength of the composite is as a result of increase in the interfacial area which worsens the interfacial bonding between the sawdust and the polyester [11 - 13]. Figure 2 shows the tensile modulus (Young's Modulus) of the composite. The unfilled composite has a flexural modulus of about 2200 (N/mm2). The addition of 10wt% brought about a decline in the flexural strength, but the 20wt% loading increased the tensile modulus to about 2600 N/mm2, an increase to 30wt% drastically reduced the modulus to 1500 N/mm2. The result shows that the 20wt% sawdust has the best tensile modulus and this as a result of better mechanical interlocking between the sawdust and the matrix (polyester resin) [14-16]. Figure 3 is a graph of flexural strength of the composite. The test gave the flexural strength of the unfilled polyester as 65 N/mm2. Increase in the sawdust resulted in a progressive decrease in the flexural strength of the composite as observed in the tensile strength. The progressive reduction in the flexural strength is as a result of poor interfacial bonding between the filler and the matrix [17-19]. Figure 4 is the graph of flexural modulus of the composite. The flexural modulus increases as the sawdust increases up to 20wt%, but was drastically reduced when 30wt% sawdust was added. The maximum flexural strength is about 3600 N/mm2. The drastic reduction is as a result of larger voids between the particulates and the matrix [20-

ISSN: 2582-6271

Vol.1 No.3; 2020

21]. Figure 5 is the graph of percentage water absorption of the composite. The graph shows that the water absorption increases as the volume of the sawdust increases. The increase is as a result of the hydrophilic nature of the sawdust [22-23]. The more the sawdust content, the more the hydophilicity and the consequent high-water absorption.

4. CONCLUSION

A study on the effect of agba sawdust loading on mechanical and physical properties of treated agba sawdust reinforced polyester composite was carried out. The result shows that both the tensile and flexural strengths of the composites decreased as the sawdust filler content increased. The tensile and flexural moduli of the composite have their peaks at 20wt% sawdust loading. The water absorption increases as the filler content increases. This is as a result of the hydrophilic nature of sawdust. The surface treatment has been reported as a way of reducing the water absorption, improving adhesion between the filler and the matrix. Green filler such as agba sawdust is an alternative and important reinforcement for manufacturing composites as it can cut down the cost of raw material with better performance in composites.

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Vol.1 No.3; 2020

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