Original Research Article

EFFECTS OF SOME ADDITIVES ON THE TENSILE STRENGTH AND YOUNG MODULUS OF EPOXY RESIN.

Abstract: Epoxy resin was mixed with bone powder, PMMA and Animal hair at 0%, 0.01%, 0.05%, 0.1%, 0.5%, 1.5% and 5.0% levels. The tensile strength and the modulus were determined using Instron Universal Testing Machine. The results showed that as the filler load increases, modulus increases in the order: 848.472> 907.4847>939.6108Mpa for PMMA, Bone powder and Animal Hair respectively. On the other hand, as the filler load increases, the tensile strength of the composite decreases in the order: 49.9766>42.7583>234.7440Mpa for Bone powder ,PMMA and Animal Hair respectively. The poor tensile strength of the composite could be attributed to the presence of cross-linking in the epoxy resin, a thermoset. This cross-linking prevents the filler from having maximum surface interaction with the matrix.

Keywords: Epoxy resin, tensile strength, young modulus.

Comment [DM1]: Young's Modulus

INTRODUCTION

In order to fulfill the requirements of polymer industry in Nigeria, many developers usually blend polymers together in order to reach an optimum balance of properties. This approach allows high flexibility in property adjustment and avoids development of new macromolecules which is generally long and expensive compared to polymer alloying [1]. A vigorous development of polymer composite and extensive utilization of polymer materials in technology has led to intense research and development of new polymer composites [2]. The intensive use of polymers has led to the development of materials for specific applications, namely composites [3].

A composite is the combination of two or more materials in which one of the materials is the reinforcement phase (fibres, sheets or particles) and the other is matrix phase (polymer, metal or ceramic). Fibre reinforced composites are composed of filler fibres and a matrix. A matrix is a material that binds together the reinforcing fibres of a composite. It is either a thermoset or a thermoplastic. Composites have some advantages over the conventional counterparts which include the ability to meet diverse requirements with significant weight savings as well as strength to weight ratio. The tensile strength of composites is four to six times greater than that of a steel or aluminium [4]. They are less noisy while in operation and provide lower vibration transmission than metals. Thus, these improved properties have led to some applications like the use of fibre reinforcement material in orthodontic treatment [5]. Fibre reinforced composites can be used in the construction of bridge decks [6]. Animal hair reinforcement composite materials have found application in the automobile, aerospace and sports equipment [7-9]. Animal hair is strong. Cortex Keratin is responsible for this property and its long chain is compressed to form a regular structure [10-11]. Polymethyl metacrylate (PMMA) is a transparent thermoplastic, often used as a lightweight or shatter-resistant alternative to glass. It is used as a graft template and as femoral window plug in total hip template [12-14].

This work is aimed at producing animal hair composites, PMMA composites and PMMA composites that can offer a high strength-to-weight ratio, corrosion and termite resistance. Animal hair composites are cost competitive and are very attractive alternative to convention materials. In Nigeria today, large number of cows are slaughtered every day and their hairs are burnt. The windscreen of a care which is used as PMMA in this research work is usually disposed by combustion. This combustion increases the amount of carbon monoxide in the atmosphere, thus causing global warming, it is against this backdrop that we decided to convert these waste materials

Comment [DM2]: Conventional materials

into useful materials by using them as fillers to produce composites. As part of efforts towards ensuring environmental sustainability, a continuing interest has attached to developing a new class of composite materials using reinforcing agents like animal hair, bone powder and PMMA into a polymeric resin. These reinforcing agents are environmentally friendly.

Experimental

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Materials and Method

Comment [DM4]: Materials and Methods

The following materials were used:

Beaker – 250cm^3 Pyrex

Sieve – (425Nm)

Blender (corona model)

Mould – (Aluminum and Teflon)

Stirring rod

Weighing balance (Adventurer ohaus)

Instron Universal Testing Machine (Model No: 336)

Comment [DM5]: Please write Materials and Methods section in detail sentences with figures

COLLECTION OF MATERIAL

Animal hair and bone were obtained at Kwata slaughter in Awka, Awka South LGA while PMMA was collected as a broken windscreen of a Toyota Camry's car in the mechanic workshop at Awka. Analytical grade Epoxy resin (355 A- bisphenol class of epoxy resin), harder (355 4B, an amine class hardner), Polyvinyl alcohol were bought from Onitsha main market all in Anambra State, Nigeria.

SAMPLE PREPARATION

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The cow hair was taken to the laboratory. It was washed with detergent and sun-dried for two weeks so that it will become brittle. It was ground into powdered form using manual grinder (coronal model) and sieved with 425μm size sieve, 0.01g, 0.05g, 0.01g, 0.5g, 1.5g and 5g of the filler were weighed and kept for composite making. The mould was first cleaned with Acetone to remove dirt and other contaminants. It was coated with polyvinyl alcohol and allowed to dry in open air. The filler was added to the epoxy resin matrix in different proportions. However, no filler was added in the case of the standard (control). The ratio of epoxy to hardner was 100:50. In order to prepare 0.01% of animal hair powder epoxy composite, 0.01g of animal hair powder was weighed and mixed with 99.99g of epoxy resin. In like manner, composite made of 0.05%, 0.1%, 1.5% and 5.0% of PMMA and bone powder were prepared. The mixture was stirred for 2-5 minutes. It was cast into the mould which has been previously coated with polyvinyl alcohol. It was allowed to cure at room temperature for 24hrs, after which the samples were removed from the mould. They were kept for mechanical tests.

RESULTS AND DISCUSSION

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The results of the effect of additives of tensile strength of animal hair composite, Bone powder composites and PMMA composites is shown in figure 1 while the result of the effect of additives on the modules of the same composites is shown in figure 2.

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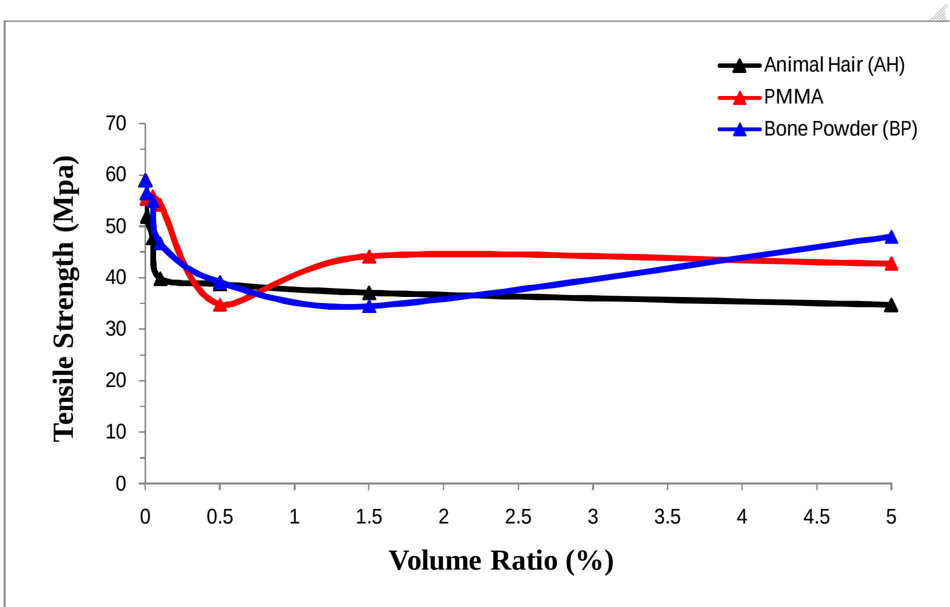

Figure 1: Graph of Effect of different filler on Tensile Strength of Epoxy Composite.

From fig. 1, it is evident that as the filler load increases the tensile strength of the composites decreases. The poor tensile strength of the composites could be attributed to the presence of cross-linking in the epoxy resin, a thermoset. This cross linking prevents the filler from having maximum surface interaction with the matrix, thereby resulting in poor mechanical property such as tensile strength of the composite.

However, among the three fibres used (bone powder, PMMA and animal hair), the bone powder imparts the highest tensile strength at 5% filler load even though it is below 0% filler load (control). The reason for the differences observed with the different fillers is the chemical compositions of the individual fillers. Animal hair powder is a protenousfibre which contains an amine group. The bone power contains collagen which is a protein, and calcium phosphate $Ca_3(PO_4)_2$ which is a mineral. The PMMA powder contains silica (SiO_2) which is capable of forming three dimensional structure.

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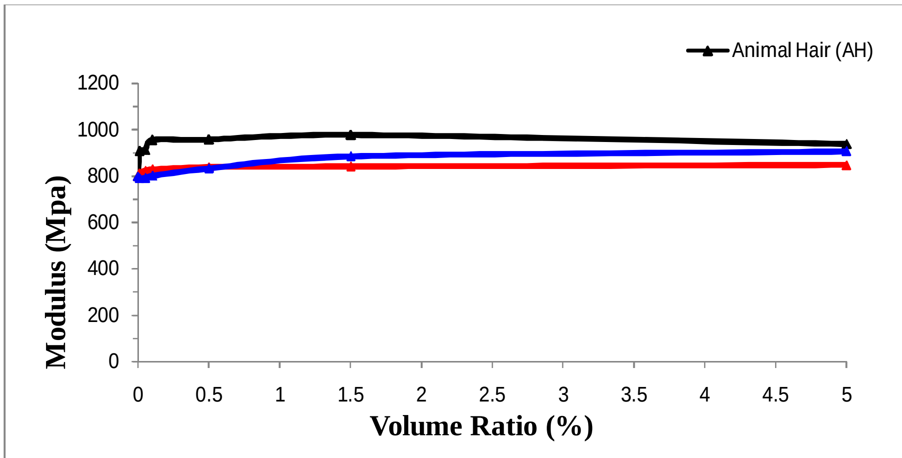

Figure 2: Graph of Effect of different filler on Modulus of Epoxy Composite.

In fig. 3, it is observed that as the filler load increases, the young modulus of the composites increases in the order: PMMA>BP>AH. This is as a result of the strong covalent bond that is formed between the filler and the matrix. PMMA contains about 99% Perspex. PMMA based composites could be used in orthopedic surgery to fix prosthetic components There is the presence of carbonyl group and-amine group in animal powder epoxy-composites. These reactive functional groups improve the compatibility between the animal hair fibre and matrix leading to an increase in interfacial adhesion between the filler and the matrix. This is why fibre reinforced composites could be used in the construction of bridges. Its application can also be found in automobile and railway interior, as well as boat.

CONCLUSION

The tensile strength of the composite at 0% load (i.e without filler) is 58.8973Mpa. As the filler load increases, the tensile strength of the composites decreases below the standard. However, among the three fillers used (bone powder, PMMA and animal hair), bone powder impacts the highest tensile strength 97.976Mpa at 5% filler load even though it is still below the standard. The modulus (the modulus of the composite is the ability of the composite to resist deformation of the composite) at 0% filler load is 800.579Mpa. As the filler load increases, the modulus of the PMMA, BA and AH-epoxy composites increases above the standard in the order: 842.2472>907487>939.619Mpa respectively. This decrease in the tensile strength of the composite is as a result of the presence of cross-linking in epoxy resin which prevents the filler from having maximum surface interaction with the matrix. On the other hand, the increase in modulus is as a result of the strong covalent bond that is formed between the filler and the matrix.

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