Studies on Particulate CowBone /SnailShell Hybrid Reinforced Epoxy Composite

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Abstract- The purpose of this work aimed at discovering filled epoxy with superior properties using naturally occurring particulate: cowbone, snail shell and hybrid (combination of cowbone and snail shell). The tensile and impact of cowbone, snail shell and hybrid reinforced composites were evaluated. The reinforcement(cow bone and snail shell) were ground separately and sieved using 38 microns sieve shaker.Cow bone and snail shell particles reinforced with epoxy (CBRPC and SSRPC) was prepared by varying the cow bone and snail shell particles from 0-25 wt% with 5 wt% intervals.

The test specimens were prepared using epoxy resin with different compositions and prepared in accordance with ASTM standard. The reinforcement by high strength fibers provides the polymer substantially enhanced mechanical properties and makes them more suitable for a large number of diverse applications. The results revealed that mechanical properties did not increase uniformly with additions in filler but exhibited maximum properties at specific percentages of filler additions.From elemental composition analysis of both cowbone and snail shell, it was discovered that snail shell has larger percentage composition of calcium compare to cowbone. Manganese oxide and chlorine are also present in snail shell which is outright absent in cowbone.

Keywords Snail shell, Cow bone, Hybrid, Particulate, Composites.

INTRODUCTION

Composite materials are any combination of two or more different materials at the macroscopic level or it can also be defined as two inherently different materials that when combined together produced a material with properties that exceed the constituent materials [1].

The past few decade have seen outstanding advances in the use of composite materials in both mechanical and structural applications. There can be little doubt that, within engineering circles, composites have revolutionized traditional design concepts and made possible an unparalled range of new and exciting possibilities as viable materials for construction.
The reinforcing fibers are the primary load carriers of material, with the matrix component transferring the load from fiber. Reinforcement of the matrix material may be achieved in a variety of ways. Reinforcement may also be in the form of particles. The matrix material is usually one of the many available engineering plastics/polymers. Selection of the optimal reinforcement form and material is dependent on the property requirements of the finished part[2].
In several years composite materials, plastics and ceramics have been the reigning emerging materials. In developing countries, harvest season are often accompanied with residues that are of environmental menace and in some cases hazardous. Many of these materials as fillers. Research is proceeding to develop composites using various recycled waste [4]. It is an established fact that polymers have several physical limitations such as low stiffness and low resistance to impact on loading. Hence, polymers do not usually have requisite mechanical strength for application in various fields. The reinforcement by high strength fibers provides the polymer substantially enhanced mechanical properties and makes them more suitable for a large number of diverse applications [6].

The use of composites as substitutes for metals is very vital to the success of many industrialized nation.

Engineers, scientists, research and development institutes, and many more have been intervening on its improvement. In fact statistics have shown that the use and development of composites for the past 30 years have increased by over a 100%. The interest in natural fiber-reinforced polymer composite material is rapidly growing both in terms of their industrial applications and fundamental research [5].

The number of applications of composites (particularly polymeric composites reinforced with synthetic fibers such as glass, carbon and aramid) has grown steadily due to their unique properties of high stiffness and strength-to-weight ratio[2]. High performance synthetic fiber reinforced polymer composite have been used in such diverse applications such as composite armoring design to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial driver shafts, and paper making rollers[3].

Materials Used

The materials used are : Cow bone, Snail shell, epoxy resin and hardener.

Preparation of Cow bone /Snail shell composite

The snail shell and cow bone were washed using NaOH, dried and pulverized separately. They were sieved using sieve shaker and 38 microns was selected as the particle size. The unsaturated epoxy resin was weighed using an electronic weighing machine. The snail shell and cow bone particulates were weighed based on the weight percentage of the particulate to be added to the epoxy resin. Pouring of the particulate into the petri dish containing the epoxy resin was stopped when the desired weight of particulate necessary for a particular formulation was achieved. The process was repeated for other weight fractions of particulate needed. A measured amount of hardener was added. The mixture was poured into a mold already coated with paper tape which acted as our poly vinyl alcohol (PVA) and allowed to cure. This procedure was repeated for all samples produced with changes in the particle percentages. After curing, the samples were stripped from the mold. Desired tests were carried out on produced composites.

RESULTS AND DISCUSSION

Table 1: Result of Mechanical Tests on 0wt% Cow Bone, Snail Shell and Hybrid Reinforcement

Reinforcemen	Young modulus	Impact strength(J)	Ultimate tensile strength(MPa)	Tensile strain(mm/mm)
Cow Bone	226.039	5.100	260.020	0.039
Snail Shell	226.039	5.100	260.020	0.039
Hybrid	226.039	5.100	260.020	0.039

Table 2: Result of Mechanical Tests on 5wt% Cow Bone, Snail Shell and Hybrid Reinforcement

Reinforcement	Young modulus	Impact strength(J)	Ultimate tensile strength(MPa)	Tensile strain(mm/mm)
Cow Bone	195.820	5.300	204.840	0.038
Snail Shell	218.710	4.210	100.100	0.019
Hybrid	275.610	6.610	43.930	0.019

Table 3: Result of Mechanical Tests on 10wt% Cow Bone, Snail Shell and Hybrid Reinforcement

Reinforcement	Young modulus	Impact strength(J)	Ultimate tensile strength(MPa)	Tensile strain(mm/mm)
Cow Bone	281.340	5.080	150.080	0.020
Snail Shell	222.180	3.520	89.180	0.015
Hybrid	222.890	9.380	70.120	0.013

Table 4: Result of Mechanical Tests on 15wt% Cow Bone, Snail Shell and Hybrid Reinforcement

Reinforcement	Young modulus	Impact strength(J)	Ultimate tensile strength(MPa)	Tensile strain(mm/mm)
Cow Bone	247.150	4.670	68.340	0.018
Snail Shell	191.450	4.410	158.270	0.027
Hybrid	139.010	12.910	25.840	0.008

Table 5: Result of Mechanical Tests on 20wt% Cow Bone, Snail Shell and Hybrid Reinforcement

Reinforcement	Young modulus	Impact strength(J)	Ultimate tensile strength(MPa)	Tensile strain(mm/mm)
Cow Bone	288.080	5.220	90.740	0.013
Snail Shell	374.050	5.380	80.690	0.008
Hybrid	89.030	12.020	52.650	0.014

Table 6: Result of Mechanical Tests On 25wt% Cow Bone, Snail Shell and Hybrid Reinforcement

Reinforcement	Young modulus	Impact strength(J)	Ultimate tensile strength(MPa)	Tensile strain(mm/mm)
Cow Bone	227.020	4.870	102.410	0.015
Snail Shell	194.410	8.380	159.820	0.013
Hybrid	10.880	10.240	96.52	0.012

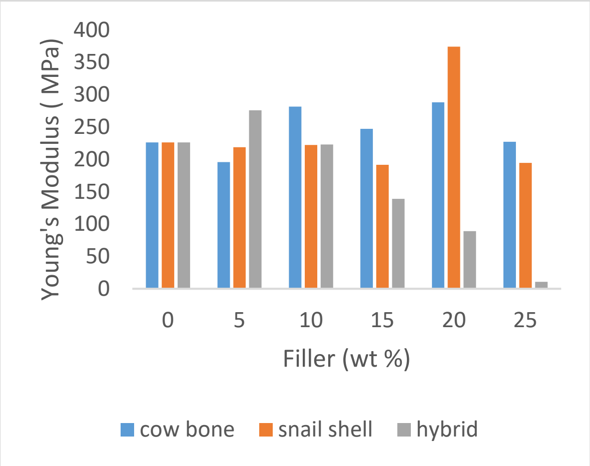

Figure 1: Graph of Young Modulus against Filler Concentration

The Young's modulus for the cow bone and groundnut shell showed a wavelike pattern while the hybrid decreased steadily in Figure 1 above. The ultimate strength of a composite depends on the weakest fracture path throughout the material. Hard particles affect the strength in two ways. The tensile strength is highest at 20% of snail shell, this could be due to absence of void or porosity and good interfacial bond while the lowest is at 25% of hybrid, which could be due to poor stress transfer between the particle matrix interface.

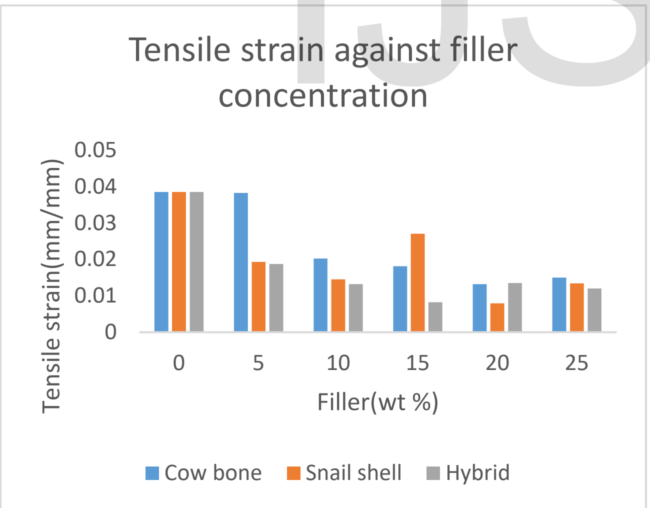

Figure 2: Graph of Tensile Strain against Filler Concentration

Again from the figure 2, the Tensile strain at maximum load seems to follow a similar trend as that of the UTS because stress and strain have always shown to be proportional. Here, it is seen that the 5wt% snail shell reinforcement has the highest strain and also the 15wt% hybrid reinforcement showing the least strain, while the cow bone showed its maximum strain at 15wt% filler concentration. This graph shows that additional filler concentration to the 5wt% snail shell reinforcement and the 15wt % cow bone reinforcement will not improve the strain.

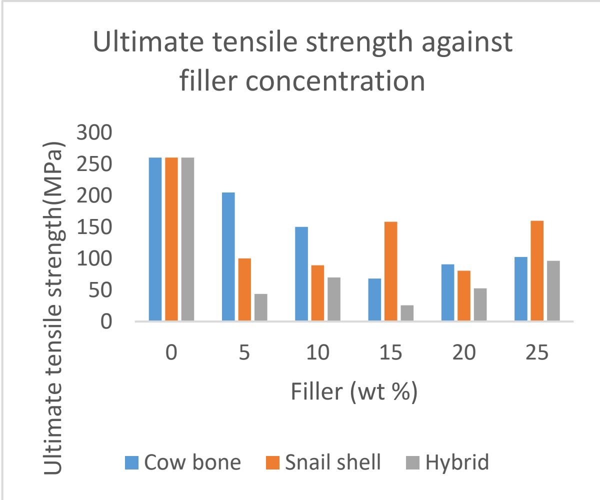

Figure 3: Graph of Ultimate Tensile Strength against Filler Concentration

The figure 3 shows the graph of ultimate tensile strength of all composite samples against their corresponding percentage reinforcement. It was observed that the snail shell composite at 5wt% filler concentration shows the highest tensile strength, while the hybrid sample of 15wt% filler concentration showed the least ultimate tensile strength, while the cow bone showed its maximum UTS at 15wt% filler concentration. The ultimate strength of a composite depends on the weakest fracture path throughout the material. The better tensile strength at lower filler content most especially for snail and cow bone could be attributed to good interfacial bond, better dispersion of the reinforcement in the epoxy resin matrix and better wettability.

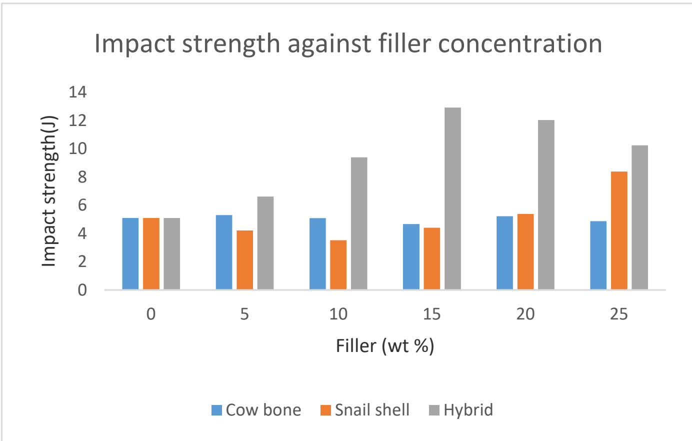

Figure 4: Graph of Impact Strength Against Filler Concentration

Fig. 4shows the amount of energy the samples can absorb prior to fracture. It was observed that the cow bone and hybrid samples can only absorb maximum energy at 15% filler concentration. However, the maximum amount of energy absorbed was by the hybrid at 15% reinforcement. The impact strength of the snail shell increased uniformly as the filler concentration was increased. For the cow bone and hybrid, the impact strength reduced after 15%. An increase in concentration of filler reduces the ability of matrix to absorb energy and thereby reducing the toughness, so impact strength decreases.

CONCLUSION

The tests carried out are impact and tensile tests using various proportions of reinforcement. It was seen that properties of epoxy can be greatly improved by these reinforcements.

From Fig. 1, it can be seen that the snail shell sample of 20% reinforcement showed the highest stiffness before shattering relative to other samples the tensile test was performed on. Therefore, the snail shell reinforcement of 20% can be used in place of pure epoxy where stiffness is a major concern. From figures 2 and 3, it can be seen that the performance of all the composites being tested were very poor when subjected to tensile loading, it can be seen that tensile strength and strain of the pure epoxy reduced when it was reinforced. This implies that the use of these composites should not be considered in applications that would subject it to tensile loading. From Fig.6 it can be seen that the hybrid sample of 15% reinforcement showed to absorb the highest amount of energy before shattering relative to other samples the impact test was performed on. Therefore, the hybrid reinforcement of 15% can be used in place of pure epoxy where impact strength is a major concern. This implies that the hybrid reinforcement of 5% can be used in place of the pure epoxy for applications where surface hardness is a major consideration. In conclusion, these composites can be used in place of pure epoxy depending on the filler content and also area of application.

REFERENCES

[1]Callister, D. W. (2007):*Materials science and Engineering*- An introduction. 7th edition. pp 580-607.

[2]Daramola,O.O.,Adediran, A.A.,AdePuyi,B.O and,Adewole, O.(2017): Mechanical Properties and Water Absorption Behaviour of Treated Pineapple
Leaf Fibre Reinforced Polyester Matrix composites.Leonardo Journal of Sciences, Issue 30,pp 15-30

[3]Deepa, B. (2011): Structure, Properties and Recyclability of Natural Fiber Reinforced Polymer Composites. Recent Development in Polymer Recycling. pp.101-120.

[4]Njoku, R.E,Okon,A.E, and Ikpaki, T.C.(2011):Effect of variation of particle size and weight fraction on the tensile strength and modulus of periwinkle shell reinforced polyester composites. Nigerian Journal of Technology. Vol.30(2).pp.55-60

[5] Oladele I. O. and Adewole T. (2013): Influence of Cow Bone Particles Size Distribution on the Mechanical Properties of Cow Bone-Reinforced Polyester Composites. Hindawi Publishing Corporation Biotechnology Research International Volume 2013, pp.1-5

[6]Rufai,O.I., Lawal,G.I., Bolasodun,B.O.,Durowaye,S.I, and Etoh,J.O.(2015): Effect of cow bone and Groundnut Shell Reinforced in Epoxy Resin on the Mechanical Properties and Microstructure of the Composite. International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering Vol:9. pp.6-10