Investigation on Mechanical And Tribological Behavior of Epoxy-Sio_2/Cocount Coir Hybrid Nano Composites

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Abstract- *The composite materials reinforced by natural fibers has improved remarkably for several industrial applications such as brake pads and wind turbine blades. Composites high strength-to-weight ratio have made progress as compared to conventional materials. Hybrid polymer matrix composites showed significant improvement in mechanical, tribological properties. In this project, Epoxy was used as the matrix material and coir as a reinforcement and SiO_2 as hybrid reinforcement. The composites were fabricated by Compression Moulding technique by varying the weight percentage of SiO_2 as 1 %, 3%, and 5 %. The coconut coir fibers were randomly oriented along the matrix. The mechanical properties such as tensile test, impact test, and tribological properties were evaluated as per the ASTM standard. Based on the test results, the composite having 3 weight percentage of SiO_2 exhibited high tensile strength, high impact energy, and less wear..*

Keywords- Epoxy, coirfiber, sio_2, compression moulding

I. INTRODUCTION

Hybrid composites are those composites which have a combination of two or more reinforcement fibres.The **hybrid composites** are sio_2.cocount coir fibre reinforced epoxy (which combines strength and impact resistance).A composite material can be characterized as a mixture of two or more materials that results in preferable properties than those of the individual components. As opposed to metallic combinations, every material holds its different synthetic, physical, and mechanical properties. The two constituents are reinforcement and a matrix. The principal points of interest of composite materials are their high strength and stiffness, combined with low density when compared with bulk materials. Strength and stiffness provided by the reinforcing phase.

The reinforcement is harder, stronger and stiffer than the matrix in most of the cases. The reinforcement is usually a fibre or a particulate. Particulate composites have dimensions that are approximately equal in all directions. They may be spherical, platelets, or any other regular or irregular geometry. Particulate composites are much weaker and less stiff than continuous fibre composites, but they are usually inexpensive. Particulate strengthened composites ordinarily contain less reinforcement (up to 40 to 50 volume per cent) because of handling challenges and brittleness.

The SIO_2-epoxy composite is a two-phase composite where epoxy is the matrix and SIO_2 particles constitute the dispersed phase. The matrix is usually referred to the phase that is continuous and surrounds the dispersed phase. obtain dispersion under the sonication process.

Epoxy resin is a class of thermoset materials that extensively used in structural and composite applications because the unique property they deliver is unattainable by other thermoset materials. A wide variety of physical forms, i.e., low viscosity liquid to high melting solid is available in the market. Epoxy system consists of two parts. One part is resin and the other is hardener. When mixed together the resin and hardener activate, causing a chemical reaction which cures the material. Epoxy resin has greater bonding and physical strength than polyester resin. Slow curing property is shown by most of the epoxies. This is widely used as adhesives, coatings encapsulates, casting materials, potting compounds and binders. Resin and fibre are combined to form complex composite, used inaerospace and recreational industries. Epoxy resins are formulated to generate specific physical and mechanical properties. Epoxy resin provides a unique balance of chemical, mechanical properties.

The coir fibre is relatively waterproof and is one of the few natural fibres resistant to damage by saltwater. It must not be confused with coir pith, or formerly cocopeat, which is the powdery material resulting from the processing of the coir fibre. Coir fibre is locally named 'copra' in some countries, adding to the confusion.Brown fibre is obtained by harvesting fully mature coconuts when the nutritious layer surrounding the seed is ready to be processed into copra and desiccated

coconut. A well-seasoned husker can manually separate 2,000 coconuts per day. It is a natural fibre with brown and silky shine and hence called The Golden Fibre. It is the cheapest vegetable fibre procured from the bast or skin of the plant's stem.It is the second most important vegetable fibre after cotton, in terms of usage, global consumption, production, and availability.It has high tensile strength, low extensibility, and ensures better breathability of fabrics. Therefore, jute is very suitable for agricultural commodity bulk packaging.The removal of this material is also simple when compared to that of the other derivations of the fibres that requires less man efforts and the cost of the removal of the material is also less when compared to others. It helps to make best quality industrial yarn, fabric, net, and sacks. It is one of the most versatile natural fibres that have been used in raw materials for packaging, textiles, non-textile, construction, and agricultural sectors.Bulking of yarn results in a reduced breaking tenacity and an increased breaking extensibility .when adding coir fibre 10-20mm size dispersive type.

Silica/Epoxy composites is one of the most widely used polymer matrix composites. Adding of silica particles leads to an improvement in mechanical electrical and thermal properties. Epoxy and its composites are widely used in coatings, potting, adhesives, encapsulation of semiconductors, laminates. Adding silica to epoxy matrix enables lower shrinkage on curing, reduction in coefficient of thermal expansion, enhancement in thermal conductivity and other mechanical properties. Silica/epoxy composite material is a widely used material due to their ability to sustain mechanical as well as thermal loading.

II. PROBLEM IDENTIFICATION ANDOBJECTIVE

Generally, epoxy are used corrosion resistance coating but very low wear properties.so can not use for brake pad and wind turbine blade application but using epoxy wind urbine prover wear resistance so adding some parentage coconut coir fibre and nano sio_2 adding coconut fibre improve structural resistance. sio_2 adding wear resistance it add percentage level.

To fabricate polymer hybrid nanocomposites by means of compression moulding technique adding various percentages of nano sio2 into epoxy/coconut coir fibre composite. investigates mechanical properties such as that tensile wear, impact and tribological properties like wear test carrying find the optimum best solution.

III. EXPERIMENTALSET UP AND FABRICATION

Investigated different mechanical properties by various types of reinforcement. There are many researches which have already taken place on Polymer Matrix Composites with Silica as reinforcement. The usual particle size of SiO_2 taken by the researchers variesfrom100to300nm.In this study three component epoxy resin system was used which consisted of epoxy resin(LY-556),Hardener(HY-951) and Nano silica particles with much lesser particle size in the range of **20-30nm.**Mechanicalpropertieslike tensile strength, flexural strength, also microstructure analysis was done. To make a desired proportion of epoxy and nanoparticles epoxy is added with various weight percentageofSiO_2 i.e.1wt%,3 wt%,5wt%. In order to remove the absorbed moisture nano SiO2 particles in the powder for mispreheated in the muffle furnace at 100°C for 2hrs. And then mixed with epoxy which is also slightly heated to reduce viscosity. To form a homogeneous mixture of SiO2 and Epoxy, a sonicator is employed. And the frequency set minimum range for 15 min.Whichismaintaineda80°Cfor uniform dispersion of nanoparticles. Then adding coconut coir fiber (10-20mm size) is followed by mechanical stirring of the mixture using a stirrer with four blades inclined at 45° with the axis of shaft. Mechanical stirring is done for 30min with a gradual increase in speed till 400rpm so that a proper vortex is formed so that a uniform dispersion takes place. Once the mixture reaches to the room temperature, hardener (HY-951) is mixedintheratioof10:1.Shoulder Die is preheated and then a coat of mould relief agent(pal) is applied on the inner surfaces of the die to facilitate easy removal of sample after curing. Under the compression of die compression molding technique. Then die is left for 10 to 12 hrs curing at room temperature and then the samples are removed from the die.

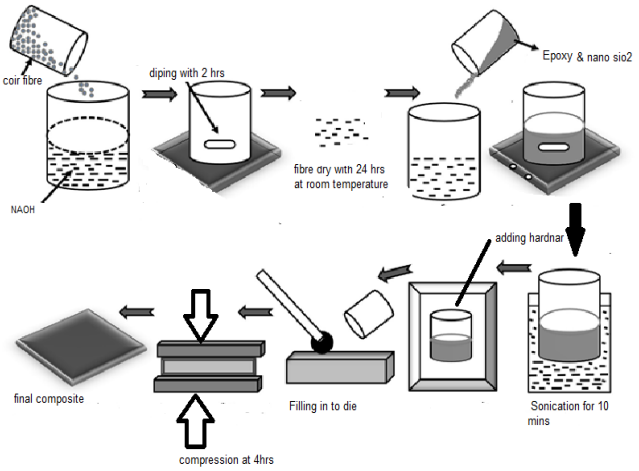


Figure.1. fabrication of composite

IV. RESULTS AND DISCUSSION

Tensile tests measure the force required to break the material and also measures the elongation produced at the breaking force. The tensile test give stress strain graphs which can be used to calculate tensile strength, modulus of elasticity, percent elongation at yield, percent elongation at break etc. Tensile test were carried on UTM machine, at government college of technology, Coimbatore.Tensile test specimens, as shown in figure 2, were developed according to ASTM D638 tensile sample specification for polymer and plastic materials

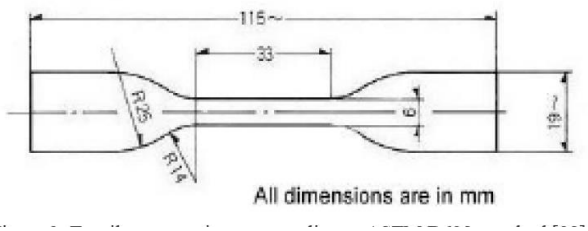


Figure2.Tensile test specimens according to ASTM D638 standard

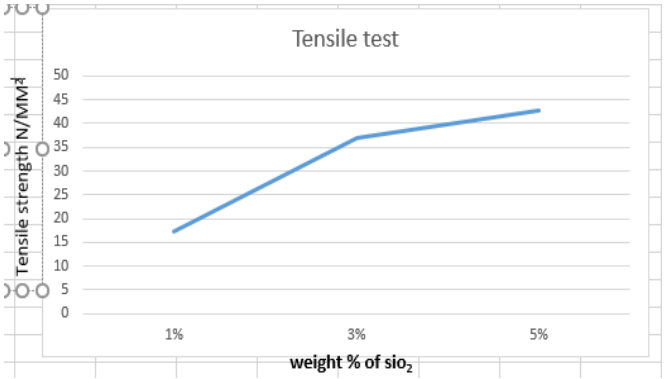
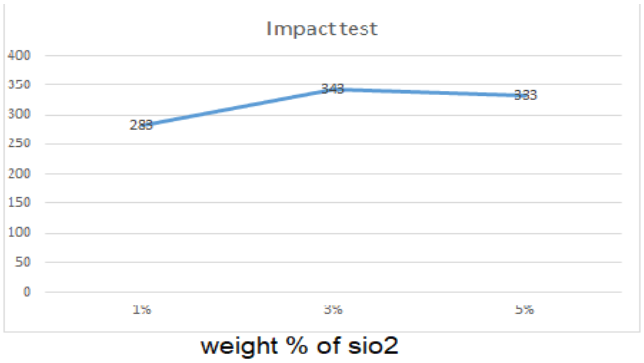


Figure3:Tensile stress variation in nano silica PMC with different weight percentage of nano SiO2

Impact test is done to evaluate the energy absorption capability of the material when a sudden load is applied. Izodand Charpy test gives the results for the impact testing. Energy absorbed by the specimen is estimated by change in potential energy at the height when pendulum was lifted up for releasing and after striking the specimen the height it raised to Impact testing (IZOD test) of the polymer samples were done on Izod and Charpy Impact Tester, strength material lab in government college of technology, Coimbatore.Izod impact test results show an increase in impact strength till 3 wt% of SiO2 nanoparticles, this show that there is a proper interaction between the matrix and reinforcement of nano silica particles as shown in figure 4. And also it implies that there is no change in the ductility of epoxy till 3wt% loading of nano SiO2. But further increase in the percentage loading of nano SiO2 may result in increase in brittle character which will result in subsequent reductionin impact properties



Dry sliding wear test has been carried out in pin-on-disc machine as per ASTM G99 standard. This ASTM standard is fixed for polymeric samples. The disc of the machine is made up of stainless steel with negligible amount of surface roughness. The specimen is held tight with the help of a sample holder and screws and perpendicular to the rotating disc with four screw fasteners, and load is applied with a lever attachment. Other parameters, like time of rotation, speed in RPM and track diameter have to be fixed manually prior to each experiment. Here, the load has to be provided manually by placing discs of desired weight prior to each experiment. An AC motor helps in rotating the disc, while the flat sample surface remains fixed and unmoved.

Wear test all the parameters are constant.

Speed =500rpm
Track diameter=80mm
Time =5mins

Wear test result show that wear rate increases normally up to 3% then decrease after then increase. low wear rate 3% of sio_2

Figure 5. wear test

% of sio_2	Speed (rpm)	Load (KN)	Track distance (mm)	Time (min)	Wear rate	Co efficient friction	Tensile Strength (N/mm^2)	Impact test (kj/cm^2)
1	500	20	80	5	326	0.44	42.57	283.66
3	500	20	80	5	179	0.51	37.56	343.57
5	500	20	80	5	275	0.654	12.5	333.24

Figure 6.over all result

The overall result shows that 3% of sio_2 suitable wind blade appication and brake pad all so.

V. CONCLUSION

The composites were fabricated by Compression Moulding technique by varying the weight percentage of SiO_2 as 1 %, 3%, and 5 %. The coconut coir fibers were randomly oriented along the matrix. The mechanical properties such as tensile test, impact test, and tribological properties were evaluated as per the ASTM standard. Based on the test results, the composite having 3 weight percentage of SiO_2 exhibited high tensile strength, high impact energy, and less wear.3% sio2 composite are suitable for low volume application .and result shows that 3% of sio_2 suitable wind blade appication and brake pad.

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

REFERENCES

[1] Abhijit Pattnayak, N.Madhu, Aum Sagar Panda*, Manas Kumar Sahoo, Kalyani Mohanta,A Comparative study on mechanicalpropertiesofAl-SiO2compositesfabricated sing ricehusk silica in crystalline and amorphous form as reinforcement, Materials Today: Proceedings 5 (2018) 8184–8192

[2] Kishore Kumar Mahato∗, Krishna Dutta, Bankim Chandra Ray, Assessment of mechanical, thermal and morphological behavior of nanoAl2O3 embedded glass fiber/epoxy composites at in-situ elevated temperatures, Composites Part B 166 (2019) 688–700

[3] Anisha Christy, Rajesh Purohit, R. S. Rana, Development and Analysis of Epoxy/nano SiO2 Polymer Matrix Composite fabricated by Ultrasonic Vibration assisted Processing,Materials Today: Proceedings 4 (2017) 2748–2754

[4] Prashant Gupta, Madhu Bajpai,Development of Siliconized Epoxy Resins and Their Application as Anticorrosive Coatings,*Advances in Chemical Engineering and Science*, 2011, 1, 133-139 doi:10.4236/aces.2011.13020 Published Online July 2011

[5] Enqiu He, Shijie Wang, Yunlong Li, Quan Wang,Enhanced tribological properties of polymer composites by incorporation of nano-SiO2 particles: A molecular dynamics simulation study, Computational Materials Science 134 (2017) 93–99

[6] Fairuz I. Romli, Ahmad Nizam Alias,Factorial Study on the Tensile Strength of a Coir Fiber Reinforced Epoxy Composite, AASRI Procedia 3 (2012) 242 – 247