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Investigation of Mechanical Properties of Zinc Oxide Nano Particle Using Kenaf Fibre

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ABSTRACT

In this project, Natural Fiber reinforced Polymer Composites (NFPC) in transportation diligences have become inexorable due to light weight, superior properties, less cost of production and suitability to many products. Interfacial bonding between the fiber and matrix plays a vital role in deciding the mechanical characteristics of composites. The current aerospace and automotive industries are looking to change the conventional materials which are high density material to composite material for reducing the overall weight of the vehicle to increase its performance.This work aims to investigate the mechanical and physical characterization of kenaf fiber and zinc-oxide Nano particle reinforced hybrid epoxy composites through experimental studies. Hybrid composites were fabricated by compression moulding technique with a composition of 25, 30, 32 wt. % kenaf fibers to the epoxy resin with 74, 68, 65% weight ratio with 1, 2, 3 %g of Nano particle. Hybrid composites were fabricated by hand lay-up technique with a composition of 25, 30, 32 wt.% kenaf fibers to the epoxy resin with 74, 68, 65% weight ratio with 1, 2, 3 %g of Walnut shell powder. The fabricated hybrid composites were subjected to mechanical studies as per ASTM standards. Composites of various compositions with are fabricated using Compression moulding and hand lay-up technique. It has been observed that there is a significant effect of fiber loading and orientation on the performance of zinc- oxide Nano particles and kenaf fibers reinforced epoxy-based hybrid composites. The developed hybrid composites undergo different kinds of tests. The result shows hybrid composites having good strength, stiffness, hydrophobicity and also it gives maximum thrust force, torque and least delamination, surface roughness.

INTRODUCTION

In comparison to synthetic fibres, natural fibres have been used as potential reinforcement in composite manufacturing sectors to effectively decrease carbon dioxide emissions in the environment and create lighter weight automotive, maritime, and aircraft parts, as well as used as a construction material for structural and non-structural components. These fibers have several benefits, namely high specific strength, relatively inexpensive, light- weight, renewability, biodegradability, lack of related health concerns, and simplicity of surface modification, widespread availability, and relatively low abrasiveness (. Additionally, natural fibers have demonstrated superior features such as minimum tool wear, good thermal conductivity, low energy consumption, and adequate tensile strength compared to synthetic fibers. Natural fiber composites also have superior mechanical characteristics to glass fiber composites. All- natural fibers are comprised of cellulose, hemicellulose, lignin, and pectin. Furthermore, natural fibers such as kenaf, hemp, and jute are primarily composed of cellulose and lignin. Cellulose is a semi-crystalline polysaccharide hydrophilic component comprised of a linear chain of anhydrous glucose units containing alcoholic hydroxyl groups. As a result, all-natural fibers are hydrophilic.

On the other hand, natural fibers have several drawbacks, including low transverse and compressive strengths and significant temperature and moisture sensitivity. The effectiveness of fibre-reinforced composites is determined by the fiber–matrix interface and the capacity of the matrix to transfer stress to the fiber. The experimental work done by Kumar and Sekara indicated that the primary impediments to using natural fibers in plastics had been their low compatibilitywith the matrix and their inherent high moisture absorption, which can contribute to dimensional changes in the fibers, as well as propagation cracks in the composite and deterioration of mechanical properties. The surface of the natural fiber has polar hydroxyl groups; these hydroxyl groups have trouble forming wellbonded interphase with the relatively nonpolar polymer matrix (Akil et al., 2011). Additionally, it was shown by Wambua et al.

That the integration of nanoparticles into the polymer matrix is frequently associated with agglomeration, mainly due to insufficient dispersion induced by the bias of fiber to form hydrogen bonds with one another (Wambua et al., 2003). A crit- ical property of plant fibers is their capacity to absorb significant amounts of moisture from the environment because of the hygroscopic nature of cellulose. This absorption results in weight and dimension changes and also changes in strength. Another way to overcome the hydrophilic and poor performance of natural fiber reinforced polymer composite is by employing nanoparticles in surface treatment. Soltani et al. have measured the impact of zinc oxide nanoparticles (ZnONPs) on the water repellence and dimensional beech wood stability. The results show that the ZnONPs used to adjust wood significantly enhances dimensional stability and decrease wood hygroscopicity. Furthermore, Wang et al. (Wang et al., 2012) have impregnated TiO_2 in Wood composite; as a result of this inorganic modification, the hygroscopicity of wood was considerably decreased, and its dimensional stability was enhanced consequently. An efficient way of evaluating the influence of nano- CaCO3 on the structure and characteristics of holocellulose fiber polypropylene biomass composites was performed by. The results demonstrated that the nano-CaCO3 had a notable impact on the structure and characteristics of the composites. Wang et al. reported that by incorporating inorganic components into the natural fibers and their polymer matrix composites, the natural fibers could be functionalized with improved characteristics in terms of water repellence and resistance to biodegradation. Wegner et al. also stated that the favorable properties of these modified materials, including absorbing the broadband UV, bio-degradability resistance, eco-friendly characteristics, and resistance to high temperature, provide a way for natural fiber lignocellulosic materials to enhance their efficiency and function.

LITERATURE REVIEW

1. Effect of Silver Nanopowder on Mechanical, Thermal and Antimicrobial Properties of Kenaf/HDPE Composites Vikneswari Sanmuham 1 , Mohamed Thariq Hameed Sultan , A. M. Radzi 4,* , Ahmad Adlie Shamsuri 2 , Ain Umaira Md Shah 2 , Syafiqah Nur Azrie Safri 2 and Adi Azriff Basri 1.This study aims to investigate the effect of AgNPs on the mechanical, thermal and an timicrobial activity of kenaf/HDPE composites. AgNP material was prepared at different contents, from 0, 2, 4, 6, 8 to 10 wt%, by an internal mixer and hot compression at a temperature of 150 ◦C. Mechanical (tensile, modulus and elongation at break), thermal (TGA and DSC) and antimicrobial tests were performed to analyze behavior and inhibitory effects. The obtained results indicate that the effect of AgNP content displays improved tensile and modulus properties, as well as thermal and antimicrobial properties

2. Improving hydrophobicity and compatibility between kenaf fiber and polymer composite by surface treatment with inorganic nanoparticles Mohammed Mohammed a,b, *, Rozyanty Rahman a,b, *, Aeshah M. Mohammed

Compatibility of natural fiber with hydrophobic matrix is a herculean task in literature works. Surface treatment is a well-known approach for increasing the strength of interfacial adhesion between fibres and polymer matrices. Therefore, this study aims to examine the impact of surface treatment with zinc oxide nanoparticles (ZnONPs) in improving hydrophobicity of kenaf fiber (KF) to enhance the compatibility between KF and polymer matrix. In this study, KF reinforced unsaturated polyester composites (KF/UPE) were fabricated by the hand lay-up method with varying fiber loadings (wt %) of 10 20, 30, and 40. KF were treated with five different contents of ZnONPs (1% to 5 wt%) to make UPE/KF-ZnONPs composites

3. Zinc Oxide Nano Particles Integrated Kenaf/Unsaturated Polyester BioComposite Mohammed Mohammed1 , Bashir O. Betar2 , Rozyanty Rahman1 , Aeshah M. Mohammed3 , Azlin F. Osman1 , Muhammed Jaafar4 , Tijjani Adam5,

Increasing need for materials with special features have brought various new inventions, one of the most promising hope for new material with special features and functionalities is composites materials. Thus, this study report an integration of zinc nanoparticles into kenaf/polyester polymer composite to introduce newbehaviour to the composite. The composite behaviours were compared for mechanical, thermal, moisture absorption and biodegradability properties. Prepared Zinc Oxide nanoparticles entrenched in the kenaf/polyestaer composites net structure through chemical bonds between kenaf/ZnO/polyester resin, existence of ZnO significantly influence the mechanical and thermals properties of composites. Thermal analysis based on (TGA) response revealed the integration of ZnO nanoparticles improved the thermal stability when thermal decomposition temperature beyond 3650 .

4. Georgios Koronis et al. (2013), As per European guidelines 2000/53/EC provided by the European commission, 85% of the weight of products especially automobiles had to be recyclable by 2015. This percentage of recyclable will be increased to 95% by 2025. In order to face balancing sustainability and cost, the automakers are invited to use bio fibers in composites.

5.M.K. Gupta (2016), Incorporation of two or more fibers into a single polymer matrix leads the development of hybrid composite. Hybridization can improve the mechanical properties of single fiber reinforced polymer composite.

6.T.P. Mohan (2012), the purpose of fiber treatment is to improve the fiber matrix compatibility, interface strength, mechanical, thermal and water barrier properties.The result shows increased mechanical and thermal properties. The results indicates that interface strength, adhesion, glass transition temperature and tensile properties of composites were improved in treated fiber composites.

MATERIALS AND THEIR EXPERINMENTAL

METHODS:

1.EXTRACTION OF NATURAL FIBERS

The most common methods to separate the plant fibers are dew retting and water retting process. Depending on the fiber category, these methods require approximately 14 to 28 days for the degradation of waxes, pectin, hemicellulose and lignin. To reduce long processing time, alternative method like mechanical decortication has been introduced.

2.MECHANICAL DECORTICATION:

The mechanical decorticator consists of a series of components (i.e., rollers, beater and etc.). The space between these rollers is 3mm has been maintained for the extraction of the fibers. The outer layers of the fibers such as the gums and the stems skin are eliminated by the continuous feeding of the fibers between the rotating rollers. The decorticated fibers were repeatedly washed with water and dried for 48 hours in sunlight eliminating the water content from the fibers.

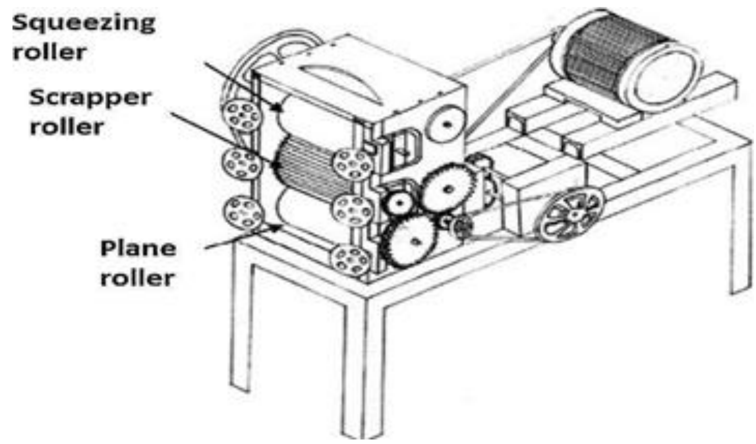

Fig 1. Mechanical Decortication

MATERIALS:

The National Kenaf and Tobacco Board (NKTB), Kota Bahru, Kelantan, Malaysia, provided the KF in the form of a mat. The unsaturated polyester Reversol P-9565 (UP) resin was utilized as the polymer matrix for the composites during the entire study. Synthomer PLC manufactured the resin, and Dr. Rahmatullah Sdn. Bhd., Bukit Mertajam, Malaysia supplied it. Methyl ethyl ketone peroxide (MEKP) was marketed under the trade name Butanox M-50 by Kaumjung Akzo Nobel and distributed by Hasrat Sdn. Bhd. Butterworth, Malaysia. Sigma-Aldrich (M) Sdn. Bhd. (Kuala Lumpur, Malaysia) provided rod-shaped zinc oxide nanoparticles (ZnONPs).

Fig.2 Zinc-oxide Nano particle Fig3 Epoxy resin Fig4 Kenaf fibre

Treatment with Nano-ZnO

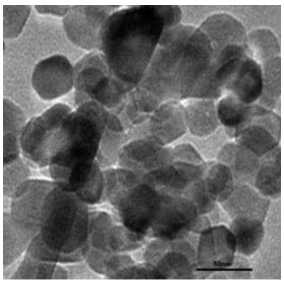

Fig.5 Nano particle structure (SEM)

In this study, the kenaf mat was cut into 20 x 20 x 0.3 cm to length and width, respectively, to be used for further treatment. Surface treatment of KF by using ZnONPs, different percentages of the ZnONPs suspension in distilled water were used, namely 1, 2, 3 wt%. A moderate mixing speed (up to 2,900 rpm) was employed at room temperature to avoid the destabilization of suspension. A satisfactory dispersion was accomplished using a Ragogna mixer specifically manufactured for FP Innovations by Custom Machinery Ltd. (Ontario, Canada) with speed up to 5,000 rpm. The prepared KF was then submerged into a water ZnONPs emulsion that had been made beforehand. To prevent the nanoparticles from sediment Ing, the KF was promptly immersed in the solution having ZnONPs for 60 min at 60 °C (moderate heat was applied to open up KF voids and allow ZnONPs to penetrate the KF cells). The treated KF layers were dried overnight at 80 °C in a conventional oven. ZnONPs powder was mixed with distilled water in serial percentages.

Composite preparation:

The hand lay-up method was utilized to make a composite material formed into a stainless-steel mold with dimensions of 200 mm 200 m m 3 mm. Untreated and treated KF layers were compressed using Introns Universal Testing Machine (Model 5569) at 90 °C. Initially, the KF mat was positioned in the mold. Next, 2% of MEKP was added to UPE resin based on the UPE weight. This chemical item is utilizing in small quantities as a trigger for initiating the cross-linking of UP resin during the composites manufacturing process. Table has been tabulated the percentages of KF, UPE, and MEKP. The UPE resin and MEKP mixture were then poured over the KF mat. The resin was distributed and impregnated using a hand roller. KF loadings were arranged in three different loadings (weight %) of 10, 20, 30, and 40 for both treated and untreated KF. The mold was covered on top and bottom of the mold with two stainless steel sheets, the molding was pressed using a Kalpak Testing Machine and left at room temperature for 24 hr to cure. Finally, the composites were cut into a 25 x 20 x 0.3 cm specimen using an electric saw.

PROFILE PROJECTOR TEST:

1. DEFINITION AND ITS PROCEDURE:

A profile projector is an optical measuring instrument used in metrology quality control. This device allows the shadow of the part to be measured to be projected on a screen which is then used by the operator to perform the measurements. It's the principle of Chinese shadows, but it still works very well today.It is a measurement tools used in the manufacturing industry. It inspects, measures and compares the dimensions of manufactured parts. Profile Projectors are used to identify imperfections on parts such as burrs, scratches, indentations can be detected on profile projector. It is easy to use and highly efficient. Procedures has to be written

Delamination factor fd= D max/D nom

FIG 7PROFILE PROJECTOR

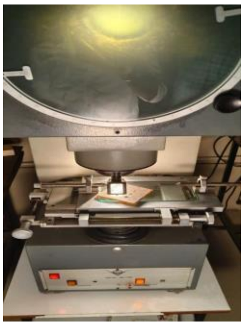

FIG 8 DELAMINATION FOR CALCULATION

FIG 9 MAX DELAMINATION AT HOLE ENTRY

SURFACE ROUGHNESS:

Definition and procedure:

Surface roughness is the measure of the finely spaced micro-irregularities on the surface texture which is composed of three components namely, roughness, waviness, and form. Surface roughness is the measure of the finely spaced micro- irregularities on the surface texture. Surface Roughness tests measures the smoothness (degree of roughness) of the surface of a target. With a contact-type roughness meter, surface roughness is measured by tracing the probe across the surface of the target.

FIG 10 SURFACE ROUGHNESS TESTER

FIG 11 SURFACE ROUGHNESS TESTING

CONCLUSION

The impacts of surface treatment with zinc oxide nanoparticles on water absorption and tensile strength, compression and impact characteristics of KF-reinforced UPE composites were evaluated.

1.The addition of ZnONPs in the composites exhibited a hydrophobicity trend. As the ZnONPs were added from 1% to 5%, a linear increment in contact angle was noted, 80° for the 1% ZnONPs and up to 104.4° for the 5% ZnONPs.

2.Water absorption is more remarkable in untreated KF- reinforced UPE composites than in treated KF- reinforced UPE composites due to the existence of more hydroxyl groups.

3.Treated KF-reinforced UPE composites exhibit increased tensile strength due to the enhanced interfacial bonding between the treated KF and UPE matrix compared to untreated KF-reinforced UPE composites.

4.Compared to untreated KF, treated KF had a rough surface, no fiber pull out, and fewer gaps between the fibers and matrix. Additionally, ZnONPs exhibit agglomeration at higher concentrations of 3%, 4%, and 5% of ZnONPs because nanoparticles have a higher surface area to volume fraction and high surface energy (SEM micrographs).

5.Surface treatment was successful by ZnONPs nanoparticles, and the roughness of KF was further improved by adding ZnONPs nanoparticles (SEM and AFM images).

6.The results show that adding 2 wt% ZnONPs nanoparticles and 30 (wt%) of KF loading led to a good hydrophobicity and better compatibility between fiber and polymer matrix. As a result, we recommend these composites for outdoor applications such as paving slabs, park carpets, floor decking, and for use in wet working environments.

REFERENCE

1.AbdElhady, M.M., 2012. Preparation and characterization of chi- tosan/zinc oxide nanoparticles for imparting antimicrobial and UV protection to cotton fabric. Int. J. Carbohydrate Chem. 2012.

2.Akil, H., Omar, M.F., Mazuki, A.M., Safiee, S.Z.A.M., Ishak, Z.M., Bakar, A.A., 2011. Kenaf fiber reinforced composites: A review. Mater. Des. 32 (8– 9), 4107–4121.

3.Arfaoui, M.A., Dolez, P.I., Dube´, M., David, E´ ., 2017. Developmentand characterization of a hydrophobic treatment for jute fibres based on zinc oxide nanoparticles and a fatty acid. Appl. Surf. Sci. 397, 19–29.

4.Obi Reddy, K., Yorseng, K., Rajini, N., Hariram, N., Siengchin, S., et al, 2018. Modification of natural fibers from Thespesia lampas plant by in situ generation of silver nanoparticles in single-step hydrothermal method. Int. J. Polym. Anal. Charact. 23 (6), 509–516.

5.Ashok, B., Feng, T.H., Natarajan, H., Anumakonda, V.R., 2019. Preparation and characterization of tamarind nut powder with in situ generated copper nanoparticles using one-step hydrothermal method. Int. J. Polym. Anal. Charact. 24 (6), 548–555.

6.Ashok, B., Hariram, N., Siengchin, S., Rajulu, A.V., 2020. Modifica- tion of tamarind fruit shell powder with in situ generated copper nanoparticles by single step hydrothermal method. J. Bioresourc. Bioproduct 5 (3), 180– 185.

7.Ashok, B., Umamahesh, M., Hariram, N., Siengchin, S., Rajulu, A.V., 2021. Modification of waste leather trimming with in situ generated silver nanoparticles by one step method. Appl. Sci. Eng. Progress 14 (2), 236– 246.

8.ASTM D3039. Standard Test Method for Tensile Properties of Plastics. West Conshohocken, PA: ASTM International; 2014.

9.9Azwa, Z.N., Yousif, B.F., Manalo, A.C., Karunasena, W., 2013. A review on the degradability of polymeric composites based on natural fibers. Mater. Des. 47, 424–442.

10.P. Jagadeesh, M. Puttegowda, S. Mavinkere Rangappa, S. Siengchin, A review on extraction, chemical treatment, characterization of natural fibers and its composites for potential applications, Polym. Compos. 42 (2021) 6239–6264, https://doi.org/10.1002/pc.26312.

11.S. Nayak, R.K. Nayak, I. Panigrahi, Effect of nano-fillers on low-velocity impact properties of synthetic and natural fibre reinforced polymer composites- a review, Adv. Mater. Process. Technol. (2021) 1–24, https://doi.org/10.1080/2374068x.2021.1945293.

12.H. Hocheng, C.C. Tsao, The path towards delamination-free drilling of composite materials, J. Mater. Process. Technol. 167 (2005) 251–264, https://doi.org/ 10.1016/j.jmatprotec.2005.06.039.

13F. Impero, M. Dix, A. Squillace, U. Prisco, B. Palumbo, F. Tagliaferri, A comparison between wet and cryogenic drilling of CFRP/Ti stacks, Mater. Manuf. Process.33 (2018) 1354–1360, https://doi.org/10.1080/10426914.2018.1453162.

14.Y.T. Oh, G.D. Kim, C.N. Chu, Design of a drilling torque controller for a machining center, Int. J. Adv. Manuf. Technol. 22 (2003) 329–335, https://doi.org/10.1007/s00170-002-1503-z.