

# International Journal of Innovative Research in Science, Engineering and Technology

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## Material and Mechanical Characterization of Ilmenite Reinforced Hybrid Composite Materials

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**ABSTRACT:** In the present study, the micro, macro and structural analysis of composites with and without reinforcement of ilmenite are investigated. The carboxylic acid ilmenite were randomly dispersed in low viscosity epoxy resin through an organic solvent using the ultrasonic liquid processor. The micromechanical analysis of composite material was carried out using the Scanning Electron Microscopy, Transmission Electron Microscopy, structural integrity, aspect ratio, functional group and purity level of ilmenite. True density and Young's modulus of ilmenite were identified using the gas displacement technique and indentation technique, respectively. The structural analysis was performed on composites made up of glass fiber reinforced polymer composites without and with 1% wt reinforcement of ilmenite using hand layup method. The impact hammer test, tensile test and free and forced vibration analysis of the hybrid composite beams were carried out to identify the elastic properties, fundamental natural frequency, damping ratio and transverse deflection of the hybrid structure. The strong adhesion of bonding and proper dispersion of ilmenite in the wide surface area of composite strengthens the polymer composites substantially than Glass/Epoxy hybrid composite structures without reinforcement of ilmenite.

### I. INTRODUCTION

A Composite material is a material system composed of two or more macro constituents that differ in shape and chemical composition and which are insoluble in each other. The history of composite materials dates back to early 20th century. In 1940, fiber glass was first used to reinforce epoxy. Hybrid composite materials are the great potential for engineering material in many applications. Hybrid polymer composite material offers the designer to obtain the required properties in a controlled considerable extent by the choice of fibers and matrix. The properties are tailored in the material by selecting different kinds of fiber incorporated in the same resin matrix.

In the present investigation, the mechanical properties of carbon and glass fibers reinforced epoxy hybrid composite were studied. The vacuum bagging technique was adopted for the fabrication of hybrid composite materials. A composite material is a combination of two or more different materials, it gives superior quality than its constituents. Composite materials can be used not only for structural applications, but also in various other applications such as automobiles, aerospace, marine, etc. fiber reinforced plastic materials are widely used in various engineering industries because of their superior performance and tailor made properties. Though FRPs are widely used in various fields, they are flammable. This research work is sponsored by Naval Research Board (NRB) to develop flame retardant fiber reinforced polyester composite with nil or reduced smoke generation on ignition for roofing application.

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To meet the requirement of NRB, the Phase I work is aimed to develop FRP composite using the general purpose polyester resin and chopped glass fibre mat with different FRs to optimize the compositions by studying their curing, mechanical and flammability properties.

The continuous phase is the matrix, which is a polymer, metal, or ceramic. Polymers have low strength and stiffness, metals have intermediate strength and stiffness but high ductility, and ceramics have high strength and stiffness but are brittle. The matrix (continuous phase) performs several critical functions, including maintaining the fibers in the proper orientation and spacing and protecting them from abrasion and the environment. In polymer and metal matrix composites that form a strong bond between the fiber and the matrix, the matrix transmits loads from the matrix to the fibers through shear loading at the interface. In ceramic matrix composites, the objective is often to increase the toughness rather than the strength and stiffness; therefore, a low interfacial strength bond is desirable.

## II. LITERATURE REVIEW

Soma Dalbehera S. K. Acharya[1]: This Paper summarized the history of natural fibers and its applications. Also, this paper focused on different properties of natural fibers (such as hemp, jute, bamboo and sisal) and its applications which were used to substitute glass fiber. Natural fibres will take a major role in the emerging “green” economy based on energy efficiency, the use of renewable materials in polymer products, industrial processes that reduce carbon emissions and recyclable materials that minimize waste. Natural fibres are a kind of renewable resources, which have been renewed by nature and human ingenuity for thousands of years. They are also carbon neutral; they absorb the equal amount of carbon dioxide they produce. These fibers are completely renewable, environmental friendly, high specific strength, non-abrasive, low cost, and bio-degradability. Due to these characteristics, natural fibers have recently become attractive to researchers and scientists as an alternative method for fibers reinforced composites

AjithGopinatha, SenthilKumar.Mb, Elayaperumal.Ac[2]: “Experimental Investigations on Mechanical Properties of Jute Fiber Reinforced Composites with Polyester and Epoxy Resin Matrices” [2]: This paper described the superior properties like low density, stiffness, light weight and possesses better mechanical properties. This has found its wide applications in aerospace, automotive, marine and sporting industries. There has been continuous lookout for synthesizing composites without compromising on the mechanical and physical properties. In this research, fiber reinforced composites were prepared with jute fibers of fiber length 5-6 mm. The resins used in this study are polyester and epoxy. The composites were synthesized at 18:82 fiber-resin weight percentages. The results show that the jute reinforced epoxy composite exhibited better mechanical properties than Jute-polyestercomposite.

D.Verma1\*, P.C.Gope2 A.Shandilya1 A.Gupta1, M.K.Maheshwari3 “Coir Fibre Reinforcement and Application in polymer Composites: A Review”[3]:This paper described the materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. Materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components are known as composite materials. Its most advanced applications are useful applications for aircrafts & spacecraft in demanding environments. A hybrid composite material consisting of coir fibres, e-glass fibres and epoxy resin was fabricated. The percentages of each material used were: 5%, 25% and 70% respectively.

P.N.E.Naveen1 &T.Dharma Raju2,“Evaluation of Mechanical properties of coir fiber reinforced polyester matrix composites” [4]:This paper described the The utilization of natural fibres for the reinforcement of the composites has received increasing attention. Natural fibres have many remarkable advantages over synthetic fibres. Natural fibre composites possess the advantages such as easy availability, renewability of raw materials, low cost, light weight and high specific strength, and stiffness. These composite materials have received much commercial success in the semi-structural as well as structural applications. The specimens of resin-fibre-coir weight ratio of 2:1:1, were prepared using

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hand lay-up technique and then the specimens of standard size of 250mm × 25mm × 4mm. were fabricated according to the ASTM 3039 for tensile testing experiments.

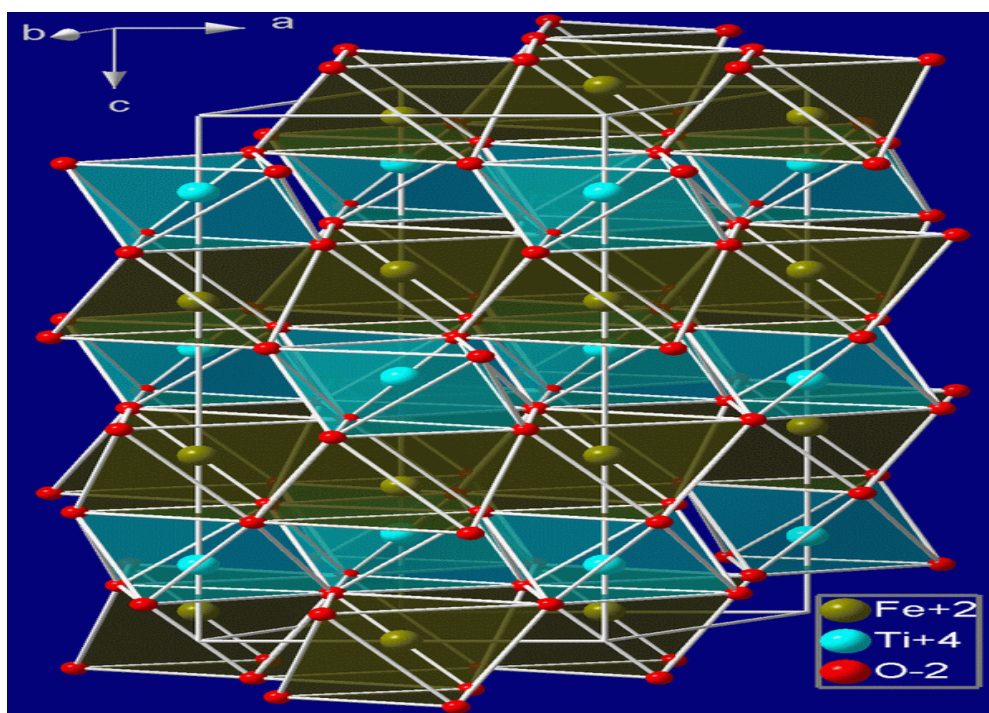
Inamdar, Prakash S., H. K. Shivanand, and Santosh Kumar, S."Study on Tensile Properties of Natural Fiber Polymer Matrix Composites." [5]:This paper described the natural fiber based polymer matrix composites are prepared by using natural fibers Coir, Saw Dust, Rice husk and their tensile properties are studied. Usual hand- lay-up technique has been adopted for manufacturing the composite. To have a good compatibility between the fiber and matrix, chemical modification of fibers has been carried out. The study confirms that the tensile strength of the composites are varies with the volume fraction of the fibers.

N. J. WelhamP. E. Willis Formation of TiN/TiC-Fe composites from ilmenite (FeTiO<sub>3</sub>) concentrate [6]: This paper describing about the production of a ceramic hard material-metal composite directly from a mineral concentrate has great potential application. An homogenizing pretreatment of a mixture of ilmenite (FeTiO<sub>3</sub>) and graphite, followed by annealing under an argon ambient, showed the formation of titanium carbide and elemental iron. Annealing of the same powder in nitrogen resulted in the formation of a composite of elemental iron and titanium nitride. The nitride was formed at a lower temperature than the carbide with almost complete conversion after 1 hour at 1000 °C.

### III. METHODS

Ilmenite crystallizes in the trigonal system. The ilmenite crystal structure consists of an ordered derivative of the corundum structure; in corundum all cations are identical but in ilmenite Fe<sup>2+</sup> and Ti<sup>4+</sup> ions occupy alternating layers perpendicular to the trigonal c axis. Containing high spin ferrous centers, ilmenite is paramagnetic.

Ilmenite is commonly recognized in altered igneous rocks by the presence of a white alteration product, the pseudo-mineral leucoxene. Often ilmenites are rimmed with leucoxene, which allows ilmenite to be distinguished from magnetite and other iron-titanium oxides.



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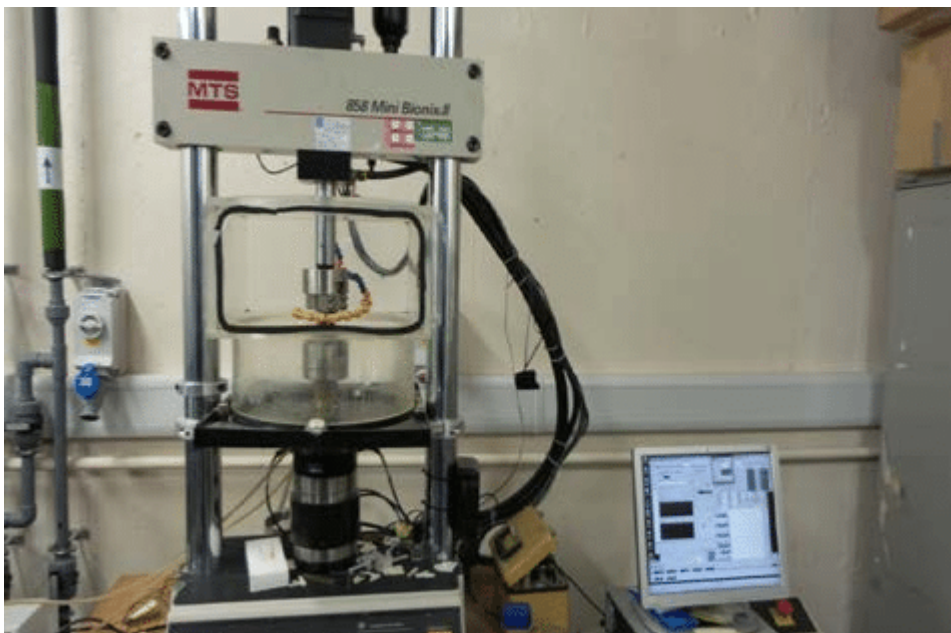
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**Fig:1 Crystal structure of Ilmenite** In reflected light it may be distinguished from magnetite by more pronounced reflection pleochroism and a brown-pink tinge. Samples of ilmenite exhibit a weak response to a hand magnet

### 1Test procedure:

Specimens are placed in the grips of a Universal Test Machine at a specified grip separation and pulled until failure. For ASTM D3039 the test speed can be determined by the material specification or time to failure (1 to 10 minutes). A typical test speed for standard test specimens is 2 mm/min (0.05 in/min). An extensometer or strain gauge is used to determine elongation and tensile modulus.

Depending upon the reinforcement and type, testing in more than one orientation may be necessary. State-of-the-art equipment including Align-pro for reduced bending.



**Fig: 2 Tension test in UTM**

### III. RESULTS AND DISCUSSION

Mechanical properties such as tensile strength, flexural strength and impact strength were analysed for Flax/Basalt hybrid fibre epoxy composites and their results discussed as follows. This chapter presents and discusses the experimental results of the tensile, flexural and impact strength of the hybrid composite with molybdenum laminates that are Suited for the wings of aero vehicles.

#### Tensile Test Results of Ilmenite Hybrid Composites

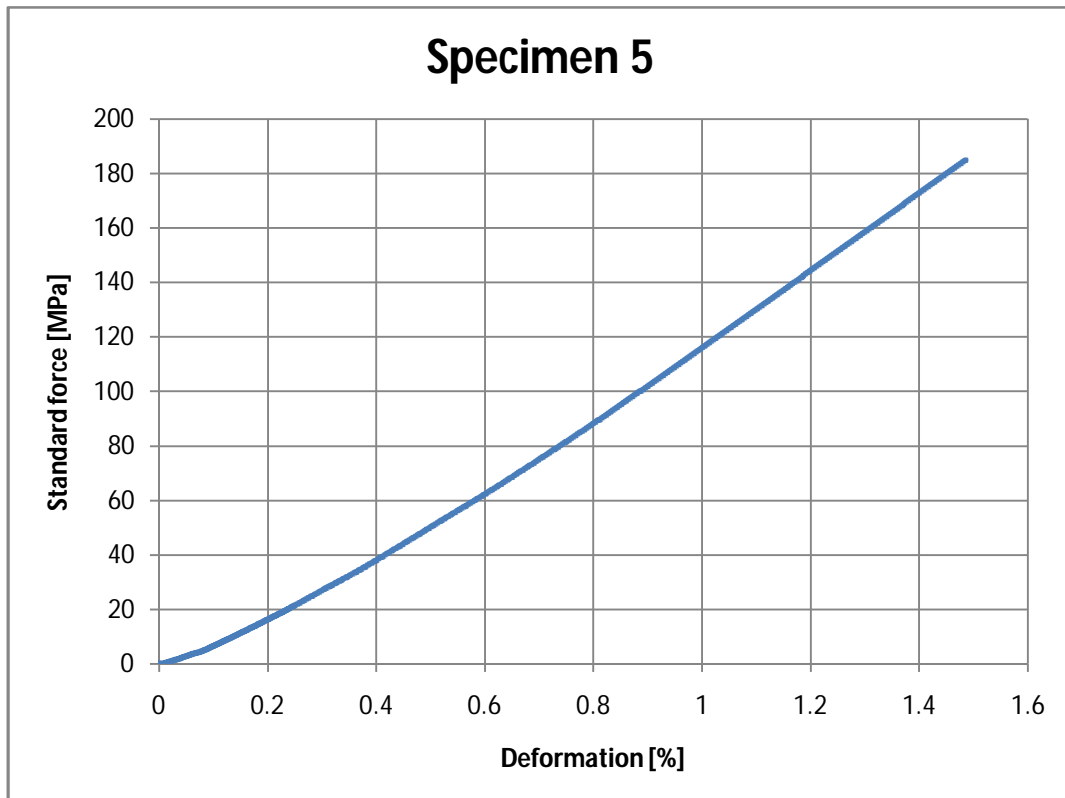
Tensile test results for ilmenite hybrid composites are as shown below. The tensile test of ilmenite composite has been done through ASTM D3039, 2008. The tensile strength of 5 specimens of ilmenite composite has been done. The following tables show the % of deformation and Tensile strength of the specimen 1 to 5 respectively. The following tables show the % of Extension and Tensile strength of the specimen 1 to 5

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respectively In the Graph X axis shows the % of extension and Y axis shows the tensile strength of the specimen. By analyzing results it is observed that ilmenite composite specimens are found satisfactory. tensile tests of hybrid ilmenite composite specimen.

#### IV. CONCLUSION

Based on the experimental results and analysis, the following conclusions were arrived at: Various types of hybrid composites are fabricated and experimented the different types of composites are like hybrid glass fiber reinforced composites and hybrid ilmenite composite are fabricated and tested. The glass fiber reinforced composites are not sustained in the tensile strength test and flexural properties are not satisfactory. In the case of Hybrid ilmenite composite specimens were fabricated and the tensile strength and flexural properties of 5 specimens are tested through ASTM D 3039, 2008 and ASTM D 790 1995 respectively. The deformation and extension of the specimens and the tensile and flexural properties of the hybrid ilmenite composite are found suitable and satisfied.

#### REFERENCES

- [1] Synthesis and Characterization of Polyimide/Silica Hybrid Composites Yan Chen, and Jude O. Iroh\* Department of Materials Science and Engineering, University of Cincinnati, Cincinnati, Ohio 45221-0012
- [2] A hollow fibre reinforced polymer composite encompassing self-healing and enhanced damage visibility Author links open overlay panel Jody W.C.Pang Ian P.Bond
- [3] Mechanical properties of poly(butylene succinate) (PBS) biocomposites reinforced with surface modified jute fibre Author links open overlay panel Lifang Liu ab Jianyong Yu ac Longdi Cheng ab Weiwei Q



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- [4] Modeling the mechanical behavior of fiber-reinforced polymeric composite materials using artificial neural networks—A review  
Author links open overlay panelHanyEl Kadi
- [5] Physico-mechanical characteristics of commercially available bulk-fill composites Author links open overlay panelJulian G.Leprinceabcd William PalineJulie Vanackerc JosephS abbaghfJacques Devauxb dGaetane Leloup.
- [6] Microstructural image analysis applied to fibre composite materials: a review Author links open overlay panelF.J.Guild†§J.Summerscales
- [7] Venkatesh s J.M “study of the NALCO guide to boiler failure analysis”. Germany, McGraw. Hill Inc,(1998) Optical properties of hybrid composites based on highly luminescent CdS nanocrystals in polymer
- [8] M Tamborra<sup>1</sup>, M Striccoli<sup>2,3</sup>, R Comparelli<sup>1</sup>, M L Curri<sup>2</sup>, A Petrella<sup>1</sup> and A Agostiano<sup>1,2</sup>Published 27 February 2004.