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GRAPHENE: A FUTURE POTENTIAL CARBON FIBER MATERIAL

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ABSTRACT

A small amount of Graphene by direct mixing were employed to disperse these nanoparticles into a mono-component epoxy system and used as matrix for advanced composites with woven Glass and Carbon fiber reinforcements. These nanoparticles were added directly into the hosting system and dispersion was carried out by using mechanical stirring. In this study the hybrid polymer composite with Glass fiber, Carbon fiber and epoxy polymer is used. The mechanical characterization results confirm that the composite developed by using graphene nanoparticles represents a fundamental feature in enhancing the tensile elastic modulus and hardness behavior of the composite system, whereas graphene has significant effect on the bending modulus and impact behavior. The optical microscopic study for the fractured samples reveals a significant increase in the fiber-matrix interface adhesion whereas decrease in fiber breakage, fiber pullout and deboning.

Keywords: Epoxy resin, Graphene fillers, Graphene oxide, Hybrid polymer composites, Nano composites, thermosetting resin, Thermal properties.

I.INTRODUCTION

In recent years, composite materials have found increasing applications in construction, aerospace and automotive industries due to their good characteristics of light weight, improved strength, corrosion resistance, controlled anisotropic properties, reduced manufacturing and maintenance costs. However, there is a growing demand to improve on composite materials with reduction in the cost of construction.Everyone agrees that graphene holds massive promise [1]. Possessing a unique portfolio of desirable properties, including excellent conductivity, mechanical strength, gas barrier, thermal and biocompatibility, graphene is an intriguing material.The physical nature of the graphene platelets is important: Factors such as the uniformity, platelet size and the number of graphene platelets in a stack have a fundamental effect on the physical and chemical properties of the grapheme[2], which in turn affects the efficacy of the graphene in its intended use.

II. HISTORY

TABLE 1 HISTORY

SR.NO.	YEAR	TECHNOLOGY
1	1950	Carbon fiber study would start in scientifically.

2	1963	Carbon fiber study will start in industries.
3	1985	Carbon fiber Nano technology with graphene
4	1993	Carbon graphene study will start.

III.CARBON FIBER

Carbon fiber is a material consisting of extremely thin fibers about 0.005–0.010 mm in diameter. The carbon atoms inside the fibers are bonded together in microscopic crystals [3]. There are also other fibers such as glass fiber and aramid fibers. Carbon fiber is mostly occurs in black color.

3.1 Comparison of Carbon Fillers

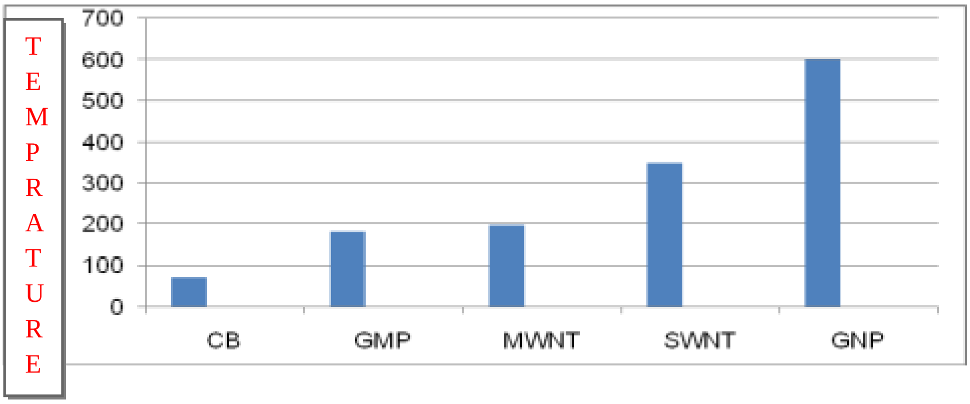

Fig. 1: Graph of Material vs. Temperature

CB- Carbon black

GMP- Graphite microplatelet

MWNT-Multi-WalledCarbon Nanotubes

SWNT- Single-Wall Carbon Nanotubes

GNP- Graphite Nano platelet

3.2 Carbon Fiber Manufacturing Technology

Fig. 2: Manufacturing Technology For Graphene

IV. GRAPHENE

The use of functional graphene is therefore a fundamental part of new product design and should be factored into the plan for the product in the earliest stages of development.

A definitive identification of graphene can be made by analysis of XRD pattern.The XRD pattern of graphite,graphite oxide and graphene are shown in figure 6. XRD pattern of graphite shows an intense peak 2θ = 26·4°.This peak corresponds to 002 plane of graphite withinterlayer spacing of 0·34 nm. In the XRD pattern ofgraphite oxide a new peak appears at 2θ = 13·2°, correspondingto the 002 plane of graphite oxide (Schniepp etal 2003). The interlayer spacing of GO is ~ 0·75 nm,which is significantly larger than that of graphite, due tointercalating oxide functional groups. The mechanism ofexfoliation is mainly the expansion of CO2 evolved intothe interstices between the graphene sheets during rapidheating. The disappearance of native graphite XRD peaksin the XRD pattern of as-prepared graphene sample supportsthe formation of graphene sheets. The SEM imageof graphene sample is shown in figure 7a, where thesheets are highly agglomerated and particles have a fluffymorphology. The TEM image of graphene sample showsa wrinkled paper like structure in low magnification.The selected area diffraction (SAED) pattern ofgraphene sheets is shown in inset of figure 7b. The diffractionpattern indicates the formation of few layers ofgraphene[4].We have measured the d.c. electrical conductivity ofas-prepared graphene sample by four probe setup whichwas ~ 10·6 S/cm at room temperature. The characterizationof graphene sample and investigation of graphene–polymer composites are being carried out and results willbe forthcoming.

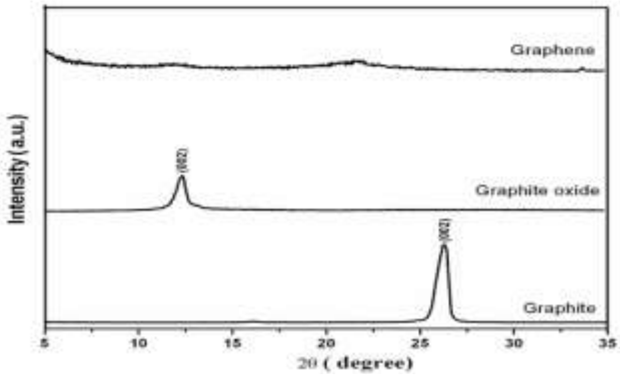

Fig. 3: XRD Patterns of Graphite, Graphite Oxide and Graphene Samples

V. SYNTHESIS OF GRAPHENE

Graphite oxide (GO) was prepared by reacting graphitepowder (5 g) with a mixture of conc. nitric acid (45 ml) and sulphuric acid (90 ml) with potassium chlorate(~ 55 g) at room temperature for 5 days. For thermal exfoliationof graphite oxide, the dried graphite oxide powder (~ 200 m) was placed in a quartz tube (diameter~ 25 mm and length ~ 1·3 m). The sample was flushedwithAir for 15 min and the quartz tube was quickly insertedinto a furnace preheated to 1050°C and held in thefurnace for 30 s. The as-prepared GO was a brownishpowder while the exfoliated version was of light consist enchant shiny black [5].The structural characterization of all the carbon Nano materials were carried out using X-ray diffraction techniqueemploying Expert PRO PANanalytical diffract meter equipped with graphite monochromatic with a Cusource (λ = 1·54 Å, CuKα operating at 45 kV and 40 mA).The as-grown carbons material was characterized byusing scanning (SEM, Philips XL 20), and transmission(TEM, Tacna 20 G2) electron microscopes.

VI. ADVANTAGES

- Carbon fiber has less factor of safety.
- CF has maximum high strength compared withall other fiber material.

- Carbon fiber secure its strength at elevatedambient temperature
- Moisture, acid and solvent at ambienttemperature don't affect carbon fiber.
- Carbon fiber is cheap.
- Light weight at low cost.

VII. LIMITATION

- Manufacturing techniques required to producecarbon fiber are relatively complicated.
- Design of component made of fiber reinforcedplastics is complex. It is necessary to know thedirection of principal stresses in suchcomponents. The fibers are aligned along thedirection of principal stresses.

VIII. APPLICATIONS

- Aerospace engineering.
- Automotive engineering.
- Sports.
- Civil engineering.
- Low-weight high pressure gas storage tank.

IX. FUTURE SCOPE

The future scope of the carbon fiber is soon after university of Manchester physicist's kostyanovosilov & andrejeim discover the wonder material Graphehne-1-atom-thick sheets of carbon that are a one hundred times stronger & much lighter than steel-researchers started incorporating it into polymer composites in the hope of creating materials with greatly improved physical properties. Nearly decade later, efforts to fabricate practical Graphene composites continue apace, but the technology is still in its infancy. Recently, however, a pioneering project began to develop novel Graphene-based Nano composites that one day could truly revolutionize the automotive industry [6]. The 18-month, $1.1-million iGCAuto research collaborative, which is funded by the European Union's 10-years, billion-Euro Graphene Flagship program aims to make high-performance Graphene composites that could reduce the weight of car structures by One-third or more. Advanced composite material are widely viewed as the promising way to make vehicles more fuel-efficient & light weight, but low-mass vehicles tend to perform less vehicle in collisions. So new approaches must be found to enhance the crashworthiness of composites. Graphene composites may be able fill that role. The new iGCAuto consortium comprises a half-dozen research group at the University of Sunderland in Britain, Centro Ricerche FIAT inItaly, Fraunhofer ICT in Germany, Interquimica in Spain, & two Italian Specialist R&D entities, Nanesa, Srl& Delta-Tech SpA.

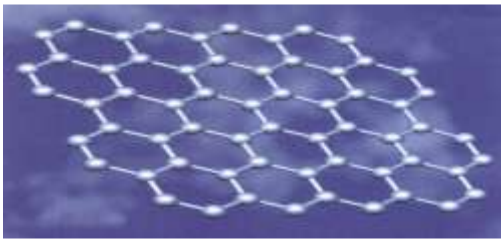

Fig. 4: Structure of Graphene

"Graphene has tremendous application for the automotive industry, and using it to enhance the composite materials in car has considerable potential," said Ahmed Elmarakbi, Prof. of Automotive Engineering at Sunderland, who wrote the original iGCAuto proposal.

"We planned to develop a new way to use Graphene to enhance polymer composites that we hope can save as much as 30% to 50% in automotive structural weight-the chassis and body-in-white-compared to today's steel cars," Elmarakbi said. "In five or six years that improvement could even reach 70%."

The resulting components could not only lesson weight, but also could feature substantially thinner cross section as well.

Fig. 5: Future Potential Application of Graphene in Automobiles

The Graphene-based material will be investigated, modeled, & designed to provide improve strength, dimensional stability, thermal behavior, & flame retardance [6]. Fewer smoke emissions is another goal, as is as superior durability-properties that would boost vehicles & occupant safety.

Thus research plans to exploit a novel nanocatalyst and unique Graphene-based nanocomposites materials that were develop by Egyptian scientist Sherif EI-Safety, Chief Researcher at Japan's National Institute for Materials Science, Elkmarakbi said. "Although we're at a very early stage & still have to fully prove the concept, I am growing more confident that our collaboration will be fruitful."

X. CONCLUSION

It has bright future scope because of their low cost, light weight, good mechanical and physical properties like stiffness, high tensile strength etc. from this paper, factor of safety is essential for every component. It depends upon factor i.e. predictable or unpredictable. If predictable, than factor of safety is less and if unpredictable, than factor of safety is high. Carbon fiber is better than all other fibers.The addition of graphene to carbon laminated composites seems to have no influence into stiffness, as the slopes of the stress-strain curves were near constant for all specimen tested. The bending strength, however, wash easily influenced by the formation of graphene pileups into the epoxy matrix and its dispersion around the carbon fibers. The increase on bending strength reached a peak of 140%for the 0.5 % wt. specimens. This enormous increase on bending strength can be attributed to changes on failure mechanism, moving from intra-laminar failure to a mix failure mode where inter- and intra-laminarfailure are combined in a zigzag pattern. A possible explanation for such behavior is the formation ofstrong bonds at fiber/matrix surroundings due to nanostructures formation.

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