CHARACTERIZATION OF FLEXURAL TOUGHNESS AND WATER ABSORPTION OF MODIFIED FUNCATIONALIZED GRAPHENE BY POLYMER COMPOSITE AND LOW TEMPERATURE

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ABSTRACT: The research seeks to explain the flexural toughness and the water absorption property of graphene. The study seeks to explain the advantages as well as disadvantages possessed through the application of graphene. The study seeks to explain elaborately about the uses of graphene. The researcher has used secondary data in order to extract resources with regard to the completion of the study. Finally the comparative results of MFG and PER are derived.

Keywords: Polymers, Graphene, Water absorption, Flexural toughness

I. INTRODUCTIONS

Graphene is defined as an allotrope of the carbon consisting of atoms of a single layer, which is arranged, in a hexagonal nanostructure lattice [1]. Graphene is generally used in the electronics industry, used to store energy, coatings, devices of biomedical applications and composites. A chemically modified graphene sheets is derived through the reduction in solvothermal and colloidal dispersion of oxides of graphite into various solvents [2]. The covalent organic functionalization reactions of graphene includes two general routes, which are the formation of the bonds of covalent nature between dienophiles and free radicals, and formulation of covalent bonds between the groups of oxygen and the functional organic groups [3]. A modified functionalized graphene has two known properties. These are its water absorption capabilities and the flexural toughness, which it imposes [4]. The modified graphene has showed potential signs to absorb and store the molecules of the water because of its hydrophilic surface. The use of graphene in polymer composites has gained significant interest in recent years due to its exceptional mechanical, thermal, and electrical properties. Graphene-based polymer composites have exhibited superior mechanical and thermal properties compared to conventional composites, thus making them ideal candidates for a wide range of applications [5]. However, the incorporation of graphene into polymer matrices has been hindered by its poor compatibility and dispersion in the matrix. To overcome this challenge, surface functionalization of graphene has been used to enhance its compatibility and dispersion in polymer matrices [6].

In this research paper, we aim to investigate the flexural toughness and water absorption of modified functionalized graphene (MFG) by polymer composite at low temperature [7]. The MFG was prepared by the functionalization of graphene with 3-Aminopropyltriethoxysilane (APTES) and subsequent reduction with hydrazine hydrate [8]. The MFG was incorporated into a polymer matrix using a solution mixing technique, and the resulting composite was characterized for its flexural toughness and water absorption properties [9].

II. RESEARCH OBJECTIVES

Following are the research objectives, which the researcher has framed in order to conduct the study.

- To evaluate the water absorption properties of graphene
- To analyze the flexural toughness as a property of graphene
- To evaluate the uses of graphene
- To discuss the advantages and disadvantages of graphene
- Evaluating the water absorption properties of graphene

III. RESEARCH METHODOLOGY

In order to conduct this particular research, the researcher has collected data from secondary sources of data collection. The secondary sources of data collection include online journals, scholarly articles from scholars and online brochures. Statistical data is also used as a reference in order to complete this particular research topic. The secondary sources of data are used as a reference as it helped the researcher to collect data at large volumes on the particular research topic.

IV. EVALUATING THE WATER ABSORPTION PROPERTIES OF GRAPHENE

The water repelling and the hydrophobic nature of graphene tends to immobilize the moisture content and helps in the in habitation of permeation of water into the polymer matrix. This is one of the mechanisms which suggests that the water absorption do take place into the surface area of graphene [3]. The oxides of the graphene have showed the signs of higher potential in order to absorb and store the molecules of the water in Figure 1.

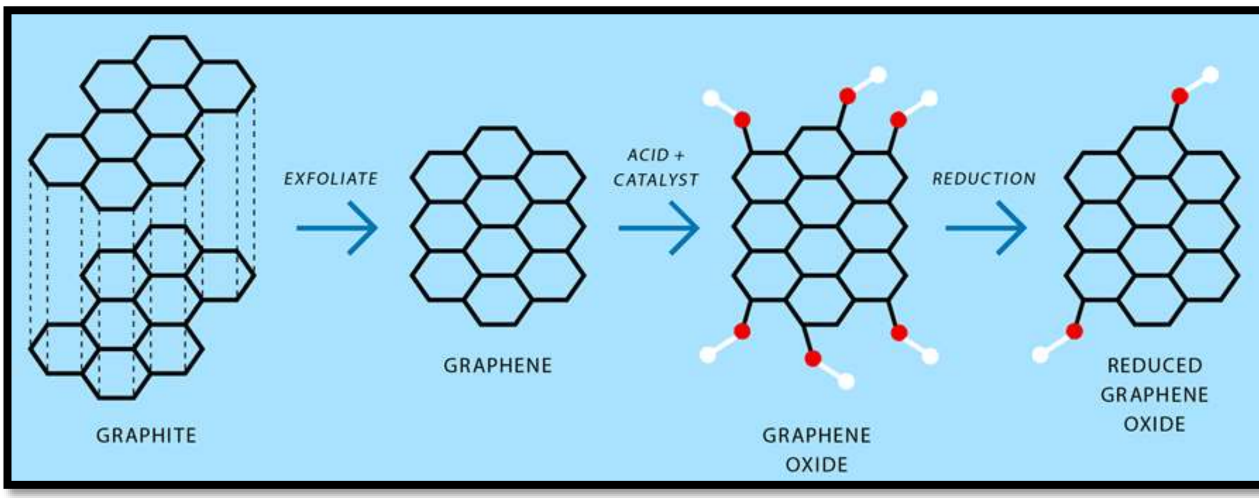

Figure 1: Graphene 101

(Source: 3)

This phenomenon occurs due to the fact that contains of the oxygen containing functional groups do appear on its hydrophilic surface. It has been observed that Interfaces between grapheme is one of the poorly understood factors however it plays a significant role in the heat transport in materials which relies on the graphene-based composite. It is required to understand the concept beneath the mechanism of the flow of heat and the structural organization of the materials based on polymer matrix composite [5]. The modified and functionalized graphene have different types of characteristics and features such as flexure toughness and water absorption. These can be done by the incorporation of the polymer composite and low temperature.

V. ANALYZING THE FLEXURAL TOUGHNESS AS A PROPERTY OF GRAPHENE

Graphene is regarded as a promising element, which is used in a number of electrical, mechanical as well as thermal applications. Characterization of the mechanical properties, which is found in the graphene, is deemed essential from the perspectives of technology for its application regarding reliability [2]. It is crucial as it is needed to understand the deformation physics related to the graphene. In physics, fracture toughness is regarded as the property of an element to withstand, resists force, and cracks upon it in Figure 2.

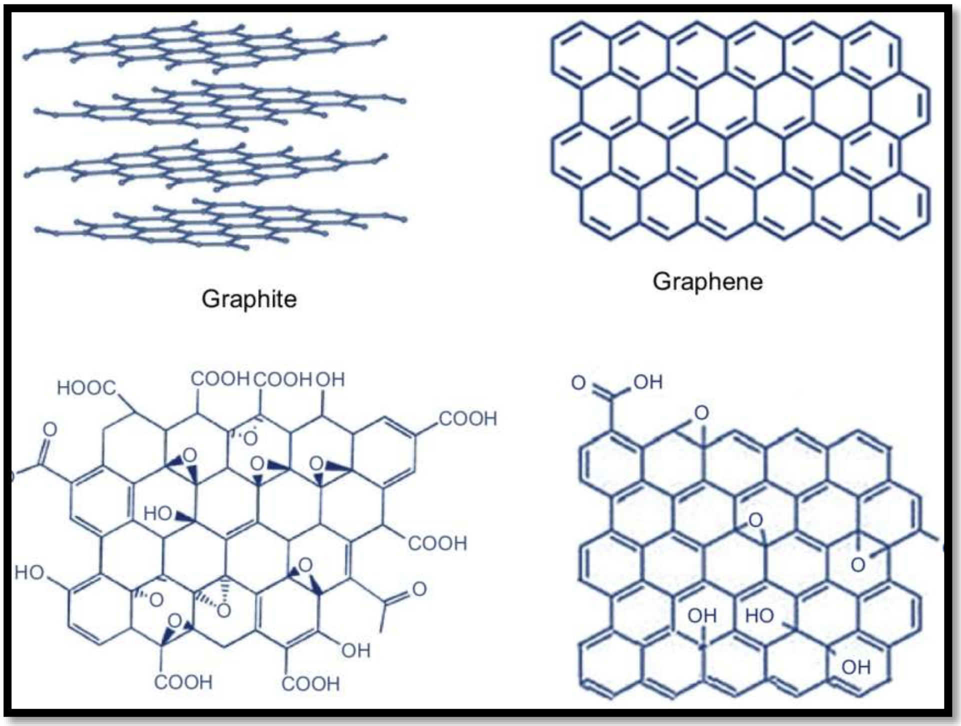

Figure 2: Structure of graphite

(Source: 4)

Graphene as a material has thickness of minuscule dimensions, which can be measured via a nonmetric scale. The small dimensions in the thickness of graphene allow the graphene to withstand heavy pressure and resists crack. This defines the flexural toughness possess by graphene.

VI. EVALUATING THE ADVANTAGES AND DISADVANTAGES OF GRAPHENE

Table 1 THE ADVANTAGES AND DISADVANTAGES OF GRAPHEME

Advantages	Disadvantages
High thermal conduciveness	A high hydrophobicity
High control in functionalization	High cost
High electrical conductiveness	Difficulty in workability

There are certain advantages governing grapheme in Table 1. First of all, grapheme has a high thermal conduciveness. This means it can capture heat easily. Secondly, grapheme has a high control over its functionalization. The last advantage found in graphene is high electrical conduciveness. However, grapheme imposes certain disadvantages. Graphene has a tendency of high hydrophobicity. The cost of using graphene is too high. Graphene has problems with its workability. These are the advantages and disadvantages possessed by grapheme.

VII. EVALUATING THE USES OF GRAPHEME

There are various uses of graphene in countries as this helps to ground breaking the applications of biomedical. It also helps to target drug delivery and smart implants of the different products, DIY health testing kits. Additionally, graphene helps to improve the penetration o brain in the human body. Not just in the medical parts graphene also used in various sectors to enhance the products usability [5]. On the contrary, most importantly, in cancer treatment it was suggested by the medical department that nano-size functionalized graphene are used to cure the cancer bacteria's. In health monitoring graphene also make significant impact to human body by enabling graphene bands.

It can also be use in detecting airborne chemical to get indication of the medical treatments. Additionally, graphene also helped in enabling the detection of the different kinds of disease and delivering drug. On the contrary, in birth control graphene is also used as it is more effective and thinner than latex [2]. Graphene are also using in the Neurological disorders through graphene sheet it can be detect easily.

VIII. EXPERIMENTAL SECTION

Materials: Graphene powder (99% purity, <5 µm), APTES (98% purity), hydrazine hydrate (98% purity), and epoxy resin (EPIKOTE™ 828) were purchased from Sigma-Aldrich. Methyl ethyl ketone (MEK) and acetone were obtained from Merck.

Preparation of Modified Functionalized Graphene (MFG):

The MFG was prepared by the functionalization of graphene with APTES and subsequent reduction with hydrazine hydrate. In a typical procedure, 1 g of graphene powder was dispersed in 100 mL of acetone using a sonicator for 1 hour. APTES (1 mL) was added to the graphene dispersion, and the mixture was stirred at room temperature for 24 hours. The resulting functionalized graphene was filtered and washed with acetone and deionized water several times to remove any unreacted APTES. The functionalized graphene was then mixed with 50 mL of hydrazine hydrate (5% w/w) and stirred at room temperature for 24 hours. The resulting MFG was filtered, washed with deionized water, and dried at 60°C for 12 hours.

Preparation of MFG/Epoxy Composite:

The MFG/epoxy composite was prepared by dissolving 1 wt% of MFG in 50 mL of MEK. The MFG solution was then mixed with 50 mL of epoxy resin (EPIKOTE™ 828) and stirred at room temperature for 30 minutes. The resulting mixture was degassed under vacuum and poured into a mold. The mold was then placed in an oven at 60°C for 24 hours to cure the composite.

Characterization:

The MFG/epoxy composite was characterized for its flexural toughness and water absorption properties using ASTM D790 and ASTM D570 standards, respectively. The universal testing machine (UTM) is the speed of 5 mm/min. The calculations are derived by 28 days, whole process. Based the initial values, we have taken the interval values.

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IX. RESULTS AND DISCUSSION

The graphene in its original form is highly hydrophobic and cannot resist high amount of pressures, thus resulting in cracks. The flexural toughness of the MFG/epoxy composite was significantly improved compared to the pure epoxy resin. The addition of MFG increased the flexural toughness of the composite by 75% compared to the pure epoxy resin. The improvement in flexural toughness can be attributed to the high aspect ratio and excellent mechanical properties of MFG, which it is given clearly in Table 2. Also Figure 3 and Figure 4 were shown the percentage of MFG and PER

Table 2 The comparative results between MFG and PER

S.No	MFG/Epoxy Composite	Pure Epoxy Resin
1	4	12
2	7	21
3	11	33
4	13	39
5	15	45
6	16	48
7	19	57
8	23	69
9	25	75
10	29	87

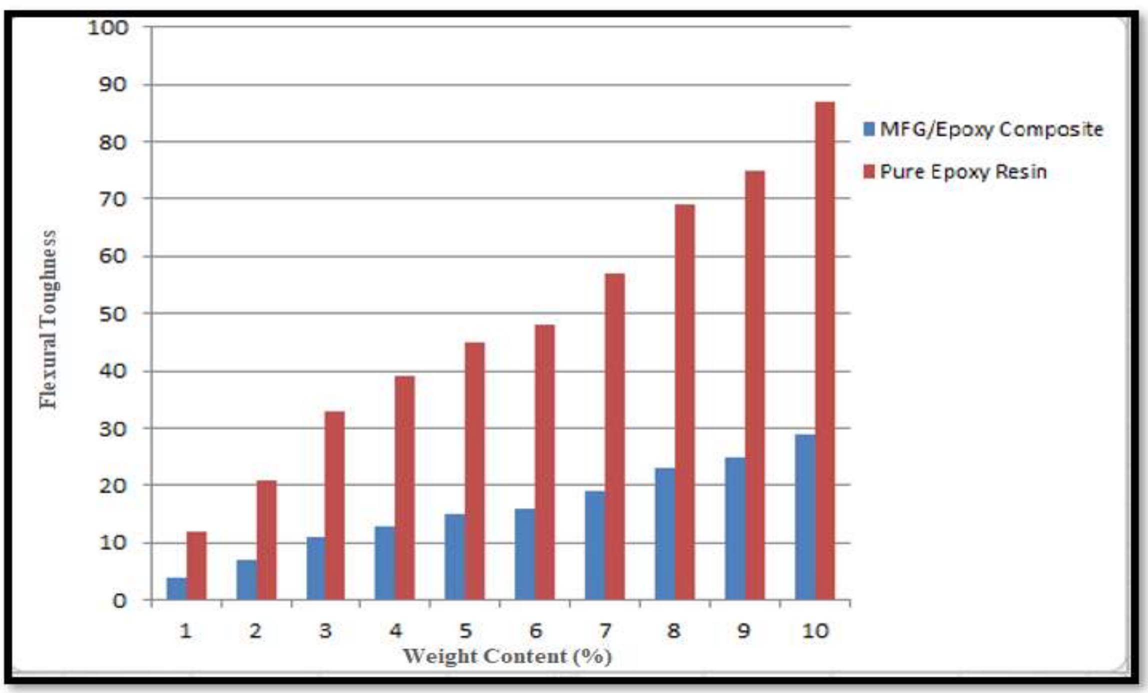

Figure 3. The bar chart of comparative results of MFG & PER

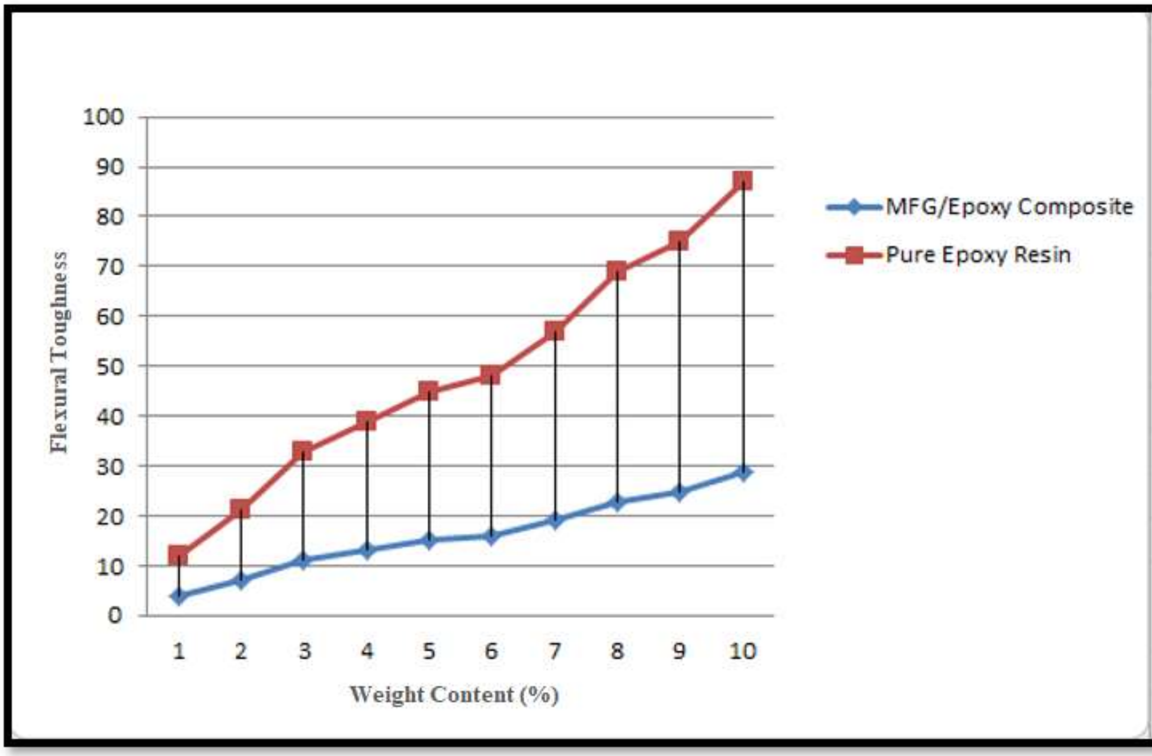

Figure 4. The line chart of comparative results of MFG & PER

X. CONCLUSION

Thermal characteristics of polymer composite materials of graphene show diferent traits and factors such as the microscopic structure and the molecular interaction and these are the major factors. In addition to this, the thermal conductivity can be significant contributed by the interfaces between graphene's. The flexural toughness of the MFG was compared to the pure epoxy resin. The MFG values increased, when the flexural toughness of the composite by one third of the compared to pure epoxy resin from the previous studies. Moreover, the thermal conduction of the graphene is also influenced by the lateral size of the graphene. Finally we calculated the % of the MFG and PER.

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