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Investigate the Effect of Different Kinds of Discontinuous Fibers on the Mechanical Properties of Epoxy Matrix Composite Materials

Abstract-*The composite manufacturing has been a wide variety of applications. The low density, stiffness, and weight to strength ratio giving these materials significant mechanical properties in aerospace, and automotive industries. In this work, the specimens of fiber reinforced composites have been prepared by adding different percentage of two types of fibers in epoxy resins matrix. So, the aim of this study is to evaluate the effect of additives on the mechanical properties according to Standard Test Method for Tensile Properties ASTM D3039. The tensile and hardness testing show that the carbon fibers improve the hardness and tensile strength due to their higher mechanical properties. In addition, they have high strength to weight ratio as compare with polypropylene fibers.*

Keywords- *Composite, Carbon fiber, Epoxy resin, Fiber effect, Mechanical properties, Tensile test.*

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1. Introduction

Fiber reinforced polymeric materials show a higher strength even more than metallic due to high strength to weight ratio [1]. Hence, carbon fiber is an ideal reinforcement for epoxy because of its tensile strength properties. Therefore, the attempts are carried out to compare the carbon composite with another fiber in order to demonstrate higher strength to weight ratio. Polypropylene (PP) is a thermoplastic polymer using due to their damping and structure properties [2]. In contrast, carbon fiber has high stiffness and high strength [3]. Hence, PP was compared with carbon fiber the superior fiber strength in composite materials. Carbon fabric/epoxy composites are used in aeronautical industry due to high stiffness and strength [1,3]. Fiber reinforced polymeric materials show a higher strength even more than metallic due to high strength to weight ratio [1].Epoxies as a thermosets polymer have a considerable attention in structural, electrical, and marine applications due to their temperatures and chemical resistance. Therefore, it's using in metal coating, insulators and electronics parts. The improving properties in different sides can be obtained. Therefore, thermal, mechanical, chemical and physical properties can be found in one material.Epoxies materials are widely used for decades in airframe structures with limit 120 °C [3]. These materials are brittle materials. They are toughened to improve the impact resistance and fracture properties [4] .To enhance the epoxies usage and overcome their brittleness, many polymers have blended with it. The adding of Polysulfide rubber will increase the impact resistance of Epoxy, however, its reduces the strength, modulus of elasticity, hardness and creep resistance [5]. Therefore, another material is investigated as a blending material to compensate the reduction in these properties. Epoxy resin based materials have been a significant importance to the engineering community and have provided recognized properties [6]. Using an additive like fillers will improve the properties of epoxy resins has become a common practice [6]. However, carbon fiber-reinforced composites play a prominent role in automotive applications, epoxy resins are used as matrix materials [7]. The polymer-based composites reinforced with carbon fiber improve significantly the mechanical, thermal, and barrier properties of the polymer

matrix [8]. The epoxy/carbon fiber composites are widely used in various applications such as packaging, coating, electronics, automotive, and aerospace. Because they have high stiffness, high fatigue life, and low density. Therefore, the high strength to weight ratio have been considered [6] . To improve the surface area of the fiber surface, carbon fiber surfaces were treated [9]. The surface treatment of fibers is one of the suggested methods to improve adhesion between matrix and fibers, i.e. enhance the bonding. The fracture properties can be analyzed using scanning electron microscopy to identify the matrix cracking .Few experimental works have been studied the effect of the Nano reinforcements on the mechanical properties of the laminated composites. They have discussed the effect of the Nano reinforcements on the mechanical properties, structural simulation and design [10].The tensile strength has been improved by using low ratio of polyethylene additive. The mechanical properties of epoxy resin composites reinforced with carbon fiber. For this purpose, the effects of fiber orientations, resin types, and number of laminates on mechanical properties of laminated composites have been investigated [6]. In this work, the comparison between carbon and polypropylene fibers in epoxy matrix was investigated. The tensile test properties and hardness have been investigated.

2. Experimental Work

I. Materials and Equipments Used:

1-Unsaturated Epoxy resin of a trade mark TOPAZ-1110TP produced by (ICR) Saudi Arabia Company.
2-Hardener: (Methyl Ethyl Kenton peroxide (MEKP) produced by (ICR) Saudi Arabia Company. polypropylene fibers.
3-Sensitive digital balance of (0.01 g and 0.0001 g) digit.
4-Tensile test machine.
5-Hardness test instrument (D)

II. Mould Preparation

The fiber reinforced composites were prepared with fiber length 5-6 mm. Polyester and epoxy are used as the resins. The prepared composites were tested mechanically. Acrylic moulds in dimensions of (250×25×2.5) mm have been used for preparing the test specimens, see Fig. 1. To avoid sticking, the walls of the mould have been coated using wax.

III. Preparation method

The steps of test specimens preparation are explained as follows:

1-Mixing the resin with hardener. The carbon fiber with percentage 2%, 4%, 6%, and 8% weight was added to the mixture of resin and hardener for two minutes in glass rod.
2-Avoiding the gases porosity and bubble formation by adding the matrix liquid from one corner into the mould until filling.
3-Shaking the mould to prevent gas capture.
4-Solidified time about 24 hr at room temperature.
5-Heating the samples in furnace for 3-4 hrs in 60 ºC.

IV. Tensile and Hardness Test

To evaluate the materials and understand their durability and quality, tensile test is carried out. This test performed at room temperature by using universal tensile test according to ASTM-D 3039 [11].The standard sample with dimension of (250×25×2.5) mm, The hardness test is performed by using shore hardness (D) at room temperature.

3. Results and Discussion

The mechanical tests results of carbon fiber and Polypropylene fiber /epoxy composite materials are shown in Figures, 1 and 2. Figure 1 shows the tensile strength of carbon and polypropylene fibers reinforced epoxy composites, while Figure 2 shows the hardness of carbon and polypropylene fibers reinforced epoxy composites. The tensile strength and hardness of composite materials increases with increasing fiber weight percentage. However, the strength of the carbon fiber reinforced epoxy increases in direct relation for this reason, carbon fiber is regarded a perfect reinforcement for epoxy because of its high tensile strength properties. Polypropylene going to little increasing up to a certain amount (8% wt).

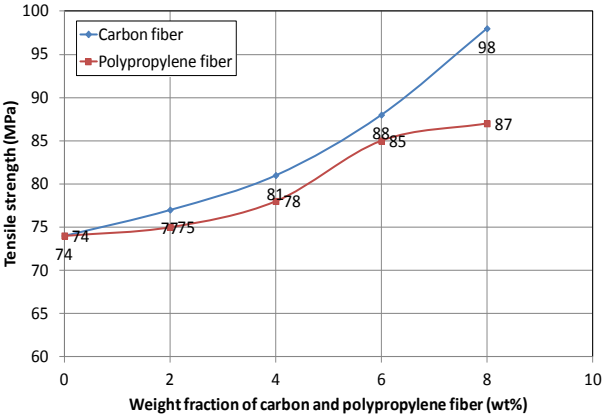

Figure 1: The effect of weight ratio of carbon and polypropylene fiber on tensile strength of epoxy matrix composite materials

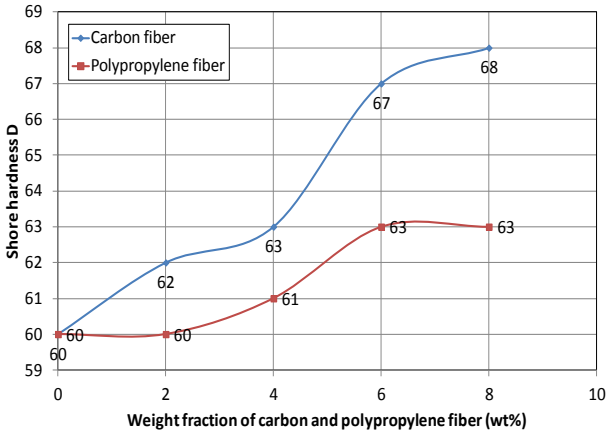

Figure 2: The effect of weight ratio of carbon and polypropylene fiber on hardness of epoxy matrix composite materials

4. Conclusions

Epoxy based matrix composites has been reinforced with different weight fractions of short carbon and polypropylene fibers. The tensile and hardness properties have been investigated. The results show that the short carbon fibers have better mechanical properties. The highest tensile strength was obtained for epoxy composites reinforced with 8 wt % carbon fiber. The experiments have been carried out to show the durability of fiber addition. Hence, the adding of carbon fiber has a big draw on the mechanical properties. Carbon fibers enhance the hardness and tensile strength due to their higher mechanical properties and strength to weight ratio as compare with polypropylene. The fiber plays an importance role in composite strength. There is a lack in investigation of another additives and weight ratio effect.

References

[1] J.M.F. de Paiva, S. Mayer, and M.C. Rezende, "Comparison of tensile strength of different carbon fabric reinforced epoxy composites," Mater. Res., vol. 9, pp. 83–90, 2006.

[2] Q.T.H. Shubhra, A. Alam, and M.A. Quaiyyum, "Mechanical properties of polypropylene composites: A review," J. Thermoplast. Compos. Mater. p. 892705711428659, 2011.

[3] A.M. Al-Mukhtar, "The Effected Parameters For Designing The Single Layer Composite Materials," Int. J. Mech. Eng. Robot. Res., vol. 1, no. 3, 2012.

[4] W. Gu, H.F. Wu, S. L. Kampe, and G.-Q. Lu, "Volume fraction effects on interfacial adhesion strength of glass-fiber-reinforced polymer composites," Mater. Sci. Eng. A, vol. 277, no. 1, pp. 237–243, 2000.

[5] Arundhati, R. Singhal, and A.K. Nagpal, "Effect of polysulfide modifier on mechanical and morphological properties of epoxy/phthalic anhydride system," Int. J. Plast. Technol., vol. 13, no. 2, pp. 193–204, 2009.

[6] H. Rahmani, S.H. Mahmoudi, and A. Ashori, "Mechanical performance of epoxy/carbon fiber laminated composites," Journal. Reinf. Plast. Compos. 2014.

[7] S. Sprenger, M.H. Kothmann, and V. Altstaedt, "Carbon fiber-reinforced composites using an epoxy resin matrix modified with reactive liquid rubber and silica nanoparticles," Compos. Sci. Technol., vol. 105, pp. 86–95, 2014.

[8] B.Z. Jang, "Control of interfacial adhesion in continuous carbon and Kevlar fiber reinforced polymer composites," Compos. Sci. Technol., vol. 44, no. 4, pp. 333–349, 1992.

[9] S. Tiwari and J. Bijwe, "Surface Treatment of Carbon Fibers - A Review," Procedia Technol., vol. 14, pp. 505–512, 2014.

[10] G. Lubineau and A. Rahaman, "A review of strategies for improving the degradation properties of laminated continuous-fiber/epoxy composites with carbon-based nanoreinforcements,"

[11] A.C.D.-30 on C. Materials, Standard test method for tensile properties of polymer matrix composite materials. ASTM International, 2008.