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Abstract: Composite materials are one type of materials, which reinforced by particles, fabrics or plates of another type. They consist of fibers and materials that keep these fibers known as a matrix that improves the stiffness of the composites, these fibers are widely used to strengthen polymeric. In this paper, the mechanical properties of Kevlar/glass fiber hybrid composite laminate with nanoparticles will be studied. Composite laminates with an epoxy matrix reinforced with twill Kevlar weaved fiber and plain glass was woven fiber. Three different types of composite laminates were manufactured, polymer composite with nanoparticles (AL_2O_3), polymer composite with glass fiber, and polymer composite with glass fiber and Kevlar. The effect of Kevlar/glass fiber content on the mechanical properties are studied such as hardness, tensile, and impact. The results indicated that hybridization of Kevlar fiber to glass fiber with nanoparticles improved the hardness values, impact energy absorbed, and tensile strength of fibers that were spun with Kevlar fibers and of composite laminates with nanoparticles.

Keywords: epoxy resin, Composite materials, mechanical properties, woven fiber, nanoparticles.

1. Introduction

Study of the mechanical properties of polymeric materials is important since they determine the behavior of these substances under the influence of different external effects such as the temperature, pressure, the nature of chemical solvents and several other factors [1]. Fiber-reinforced epoxy compounds have many features including improved mechanical properties and they are important in many industries because of the increasing use of many applications such as gears, roller, seals, bearings, clutch, wheel, and camshafts] 2]. To improve the material properties, glass fiber has a vast range of availability out of which bi-directional woven glass fiber reinforced polymer has been attracted by many industrial applications due to its low price, low weight, and ease of processing [3]. Improving the properties and the performance can be achieved by strengthening the nanoparticles, such as the aluminum compounds and the epoxy glass fibers used in high-performance applications. Throughout the decades, several previous studies were conducted to determine the change in the mechanical properties of polymeric composites with the change in the type and quantity of the reinforced material [4].

Environmental considerations promote scientific researches into the design and proposition of new engineering products for the building, furniture, packaging, and car industries involving modified thermoset polymer [5]. The epoxy resins are one of the most important common polymeric or semi-polymeric materials. Several studies have been conducted to improve the mechanical properties of reinforced fiber compounds due to the increasing demand for these materials in the sectors of machinery, marine, aviation, military machinery, petroleum and sports equipment [6]. Most studies have focused on promoting single natural or synthetic fibers such as carbon fibers, fiberglass, Kevlar fibers, Kenav, jute, hemp, abaca, sisal and many others for polymer matrix this is due to good mechanical properties, good corrosion resistance and design flexibility compared to metals [7].

The use of vehicles has increased widely due to the development of new fibers such as carbon, glass, Kevlar and new composite systems with ceramic and metal matrices [8]. The wide use of epoxy as matrix materials to manufacture of glass fiber composites because improving mechanical properties, good chemical resistance and their ability to distort the influence of forces [9].

In this research study mechanical properties of glass-fiber and Kevler fiber-reinforced epoxy resin with reinforced by Nano Alumina (AL_2O_3) particles or both, and reinforced with glass fibers, and their effect on mechanical properties such as hardness, tensile strength, and impact strength used in various applications.

2. Experimental Work

2.1. Materials used

In this study, Al_2O_3 particles manufactured from Hefei Ev NANO Technology Co., Ltd. China are used. According to the specifications mentioned in Table 1, the particles are used to modify the matrix of the polymer compound using Sikadur-52 type epoxy resin with the specifications mentioned in Table 2, and according to the mixing ratio (A: B = 2: 1 part by weight and volume) where a viscous liquid is formed transparent at room temperature. The woven carpet is made of fiberglass, Kevlar and epoxy as shown in Table 3.

Table 1. Designation and Composition of Composites

Sample No.	**Reinforcement, %**			
	Epoxy resin %	**Glass fibers (CF) %**	**Kevlar fibers Kf %**	**Nano AL_2O_3(A)%**
1	**98**	**-**	**-**	**2**
2	**100**	**2 layers**	**1 layer**	**----**
3	**98**	**2 layers**	**1 layer**	**2**

2.2 Mixing Process

A synthetic resin that can be used for several different applications is epoxy resin. By combining two components that are suited to each other, epoxy is formed. When the liquid resin is mixed with a suitable hardener, with the ratio (2:1) % and adding the nanoparticles Al2O3 by the ratio (2%) into the mixture and stirring it for a period of (30) minutes to obtain homogeneity

[10]. The rise in the temperature of the blend will result as an indication of the beginning of the association process [11]. It is very important that the blend must have a decent consistency to protect the particles from precipitation which may bring the heterogeneity of the mixture that leads to the agglomeration after hardening. The first group samples contained epoxy resin with nanoparticles The epoxy resin is then poured until it is completely co verse placed in the mold, the second group has three layers, with one layer of glass fibers on top and bottom and one layer of kevlar fibers in the middle. The epoxy resin is then poured until it completely covers the knotted fibers, The samples of the third group have three layers, with one layer of glass fibers on top and bottom and one layer of kevlar fibers in the middle and The epoxy resin with nanoparticles is then poured until it completely covers the knotted fibers, shown in figure (1). All samples were prepared at room temperature 24 ° C, and the samples were left in the mold for (24) hours, as shown in Figure (2), after which they were dried in a drying oven at a temperature of 65 ° C for four hours [12].

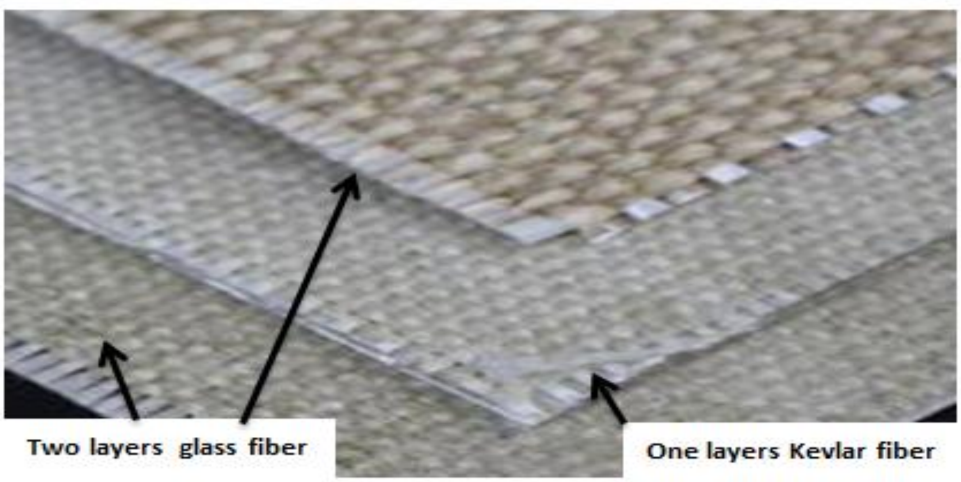


Figure 1. The shape of the glass and Kevlar fibers**.**

2.3 Mechanical Tests

Mechanical tests were performed on samples of polymeric compounds involved (tensile, hardness and impact. All these tests were conducted according to American standard (ASTM D2240) respectively at room temperature. Three samples of each polymeric compound are cut by laser machines to the dimensions required for the mechanical characterization. The hardness of the sample was tested as per ASTM D2240 type durometer hardness test, which is called shore D hardness test. It is used for low hardness materials such as polymeric compounds, as shown in Figure 3. The sample tensile tests were performed using the universal testing machine to ASTM D638-type 1, testing speed was set at 5 mm/min and carried out at room temperature as appeared in Figure 4. Charpy impact test was accomplished according to ASTM-E23, as shown in Figure 5, all specimens are shown in Figure 6.

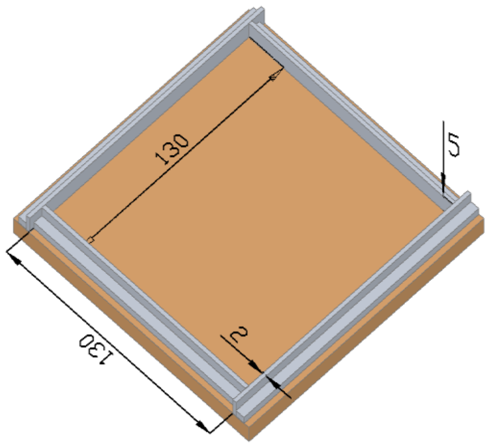


Figure 2. The shape of the prepared moulid

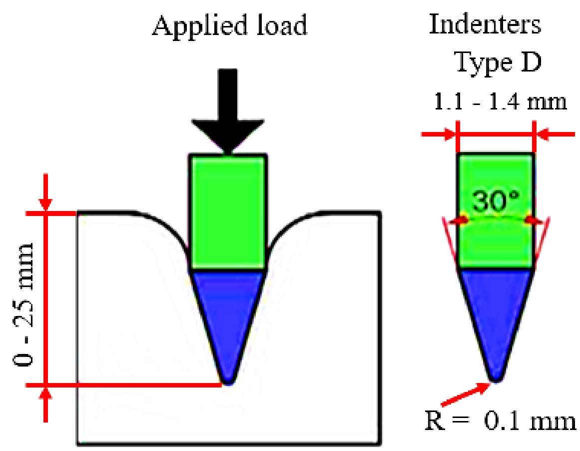


Figure 3. Shore D Test

Figure 4. Tensile Test Machine

Figure 5. Impact Test Machine

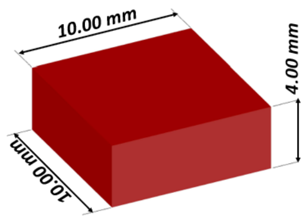
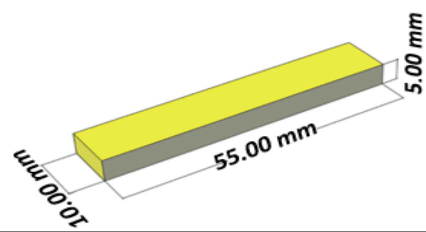
Hardness	
Tensile	
Impact	

Figure 6. Test samples of hardness, tensile, and impact

3. RESULTS AND DISCUSSION
3.1. HARDNESS (SHORE D)

These compounds have a brittle behavior of failure under bending force. They have a great modulus of elasticity in comparison to epoxy resin reinforced with equivalent Nano alumina content as shown in Figure 7. The increase is expected since this particle is inherently strict and thus influences the rigidity of the composite materials. Their contents may happen due to insufficient bonding between fiber and matrix because the distribution of filler is uniform in each layer [13]. It can also be seen that the degree of plastic deformation is reduced with increasing Nano alumina content. This shows that the density of the filler is not affecting the hardness values of the composite polymer.

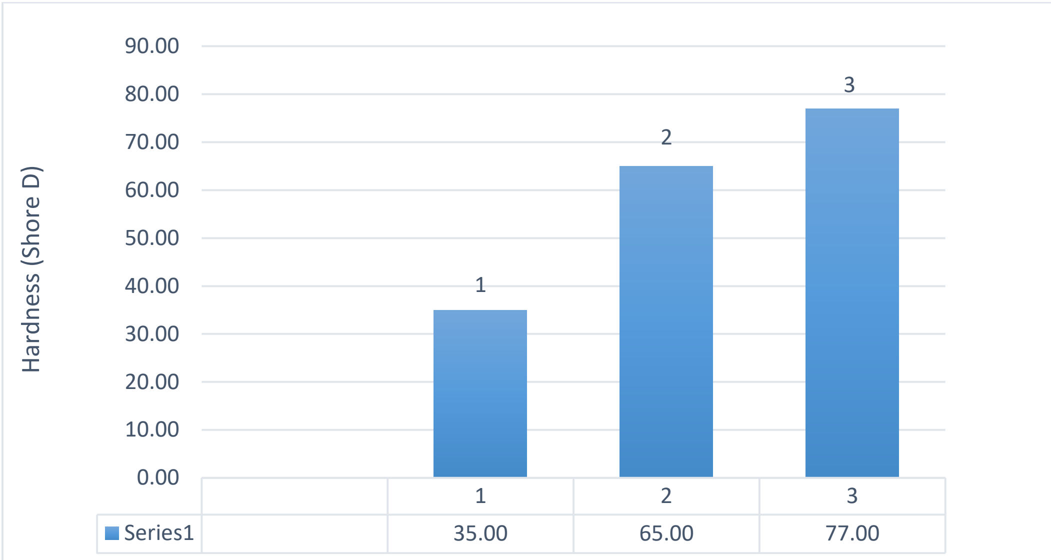


Figure 7 The Influence of Hardness

3.2 TENSILE STRENGTH

Resins are fragile materials with very low resistance to tensile strength. Tensile strength is increased when the resin is reinforced by nanoparticles (AL_2O_3) to (200MPa). This can be seen in Figure 8 when adding nanoparticles to polymer, since the nanoparticles act as impediments to the movement of interferences within the base material, which reduces the possibility of plastic deformation and the density of the resin impact on the mechanical properties, as the greater density of polymer increases the hardness and material abuse to increase the crystal property. The fibers are reinforced with reinforced glass fiber, which increased the matting strength to (600MPa) while the fibers of hybridized fiberglass with Kevlar fiber gives tensile strength of (720 MPa). Since the use of fiber leads to the prevention of cracks and a deeper increase in the material where the fibers act as breakers, thus reducing the possibility of plastic deformation resistance to submission.

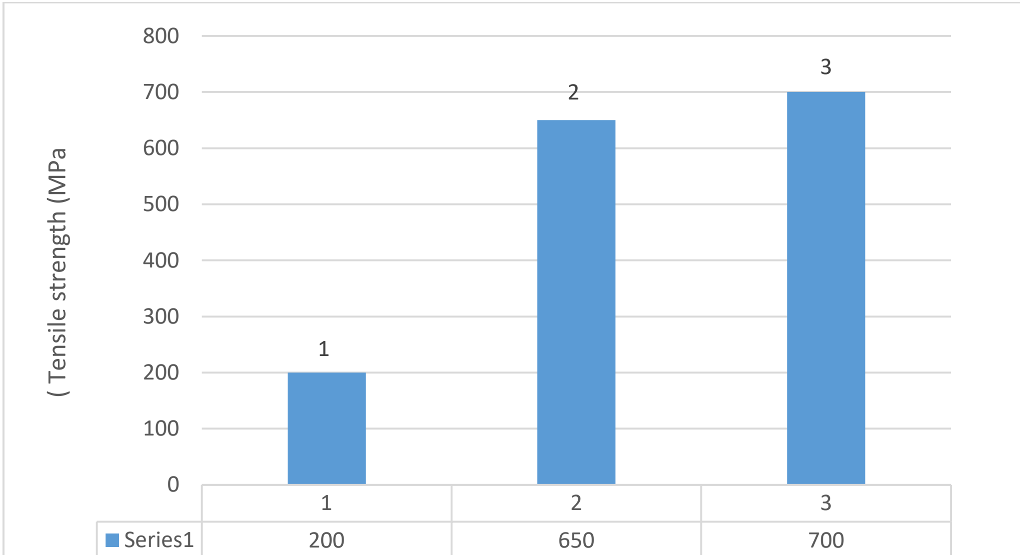


Figure 8 The influence of Tensile strength

3.3 IMPACT RESISTANCE

This test is important to determine the behavior of the materials under the influence of rapid forces, a measure of the ability of the material to absorb energy to break. Figure 9 shows the impact strength increases with the increase of the ratio of the reinforcement materials for both types of samples supported by the minutes is increased slightly and the fact that the minutes work to resist of the impact effort on the composite material and work to prevent the growth of cracks to increase the link between the material [14]. The fragile fracture nature of the reinforcing material plays a prominent role in determining the energy impact, leading to improved impact strength to increase the impact resistance since the overlapping material passes through two stages before the failure. The first is breaking the material and the second is the failure occurred in fibers undergone from rupture or dissociation of the base materials in which the energy spent for breakage is large.

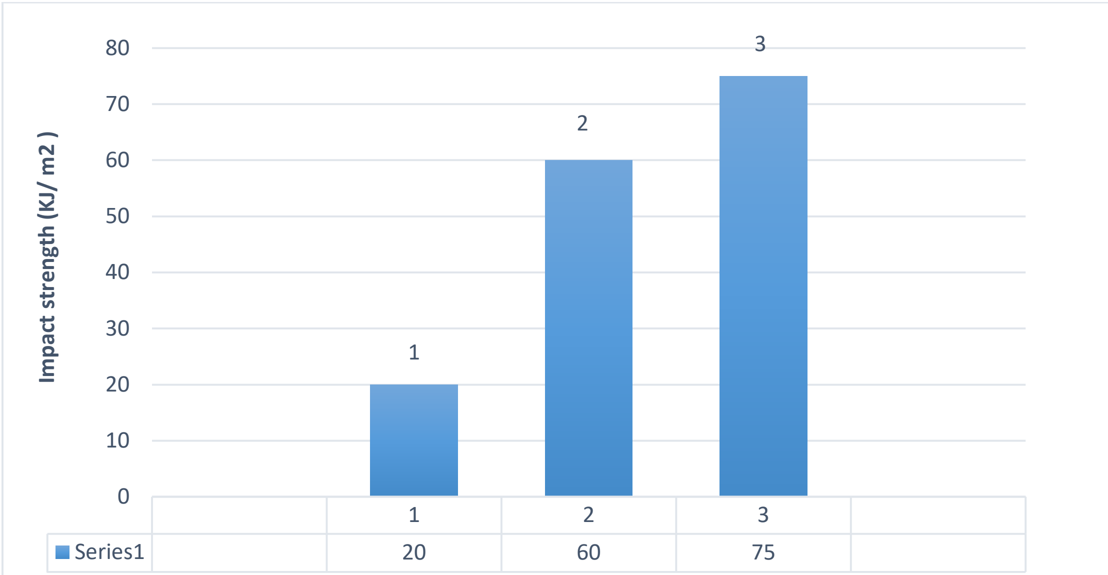


Figure 9 The influence of impact energy

CONCLUSION

In this study, the addition of nanoparticles to epoxy resins resulted in an increase in mechanical properties. The effect of the reinforced nanoparticles on the impact resistance values of the samples increases with the addition of nanoparticles compared to the non-reinforced composite material, for the ease of penetration of nanoparticles and interfaces into the network. Improved mechanical properties of epoxy resins after the addition of nanoparticles to glass fibers and Kevlar fibers hybrid reinforced epoxy composites evaluated. Hardness, tensile strength, and impact values increase after adding the nanoparticle. The increase in tensile strength is also explained by the increase in cross-linking density with the addition of nanoparticles will amplify the effect of stress transfer under loaded conditions due to increased filler-matrix bonding and degree of crosslinking action

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