

Effect of UV irradiation and water absorption on mechanical properties of epoxy composites

Abstract

The epoxy reinforcement with glass fibers high flexible coefficient compares another fibers. The young modulus as a function of water when the immersion the samples in water at a room temperature found that the coefficient of elasticity of samples increases and decreases after four weeks. Increase in the fracture strength of all composites because of the existence of fibers that bear most of the shock stress and that the fibers act as a crack stopper the change in energy with the time of exposure to irradiation, which decreases by increasing the time of irradiation and all samples, as well as in the case of immersion in water. The hardness values with composites increasing compared with epoxy pure and the higher values of glass fibers. The values of hardness decreases by increasing the time of irradiation and all samples, as well as in the case of immersion in water.

Keywords: epoxy, natural fibers, bending test, impact test, hardness

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Introduction

Natural fibers are now dominate the automotive, construction and sporting industries by its superior mechanical properties. These natural fibers include flax, hemp, jute, sisal, kenaf, coir and many others.¹ The various advantages of natural fibers are low density, low cost, low energy inputs and comparable mechanical properties.² The composite engineers are focusing on the development of new stronger, tougher, lightweight structural materials supporting latest technologies and design concepts for the complex shaped structures like aircraft, automotive structures and large wind turbine blade structures.³ Glass Fibers Reinforced Polymers are a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiber glass is a lightweight, strong, and robust material used in different industries due to their excellent properties.⁴ Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Nowadays, natural fibers such as sisal and jute fiber composite materials are replacing the glass and carbon fibers owing to their easy availability and cost. The use of natural fibers is improved remarkably due to the fact that the field of application is improved day by day especially in automotive industries. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties.⁵

Ramesh et al.⁶ investigate the mechanical properties of sisal, jute and glass fiber reinforced polyester composites. They observed that the addition of glass fiber into jute fiber composite resulted in maximum tensile strength. In the same way they have observed that jute and sisal mixture composites sample is maximum flexural strength and maximum impact strength was obtained for the sisal fiber composite.

Berhanu et al.⁷ studies the effect of weight percentage ratio of jute fiber reinforced in polypropylene based composites and found out the mechanical properties enhanced as the jute weight percentage increased up to 40%.

Dash et al.⁸ studies the mechanical properties of composites such as tensile strength and compressive strength of natural fiber composite was reported and compare with the glass/epoxy composites. It has

been seen form tensile test that bamboo composite laminates having higher tensile strength and stiffness than jute composite laminates, but not at par the glass fibre reinforced composite. Compressive test shows that compressive strength and modulus of jute composite is higher than bamboo composite, Zamri et al.⁹ studied the mechanical properties of jute/glass reinforced polyester with water absorption. Composites are subjected to various water conditions and test were performed by immersing composite, specimen in to three different water conditions, distilled water, sea water and acidic water, and water was in room temperature for a period of three weeks and also effect of the various water environments on the flexural and compression It found out that the jute composite is not suitable for underwater applications.

Onal et al.¹⁰ studies the tensile and flexural strength of glass/carbon hybrid specimen with layer by layer sequence before impact and after impact. It is found out that carbon fibers on the end surfaces increases flexural strength and also the tensile property of hybrid is better.

Experimental part

Materials

Epoxy resin:

- Epoxy:** epoxy (105) Don Construction products (DCP), Amman –Jordan. The ratio of hardener to epoxy used in this study was approximately (3:1).
- Fibers:** Sisal fibers are extracted from the leaves of sisal plant. The fibers are extracted through hand extraction machine composed of serrated knives. Jute woven fibers are purchased from Chandra Prakash & Co., India. Glass fiber (E-Class) of Surfacing mats composed of continuous glass filaments made of Chennai, India. Chopped carbon fiber with 3 to 8 mm long and 1.82 g/cm³ density supplied by Jiangsu Company in China.

Preparation sample of epoxy pure

The epoxy and hardener was formed with ratio of 3:1. The hardener was added slowly to epoxy resin at room temperature, this

mixture was stirred for 5 min, and the composition was left at room temperature for 24 hours to dry.

Preparation samples of epoxy/fibers composites

To prepare Epoxy/fibers (sisal, jute, glass, and chopped carbon fibers) composites. To prepare the composites fibers with volume fraction 15%, were added chopped carbon fibers to epoxy and result solution was stirred manually for 20 minutes at room temperature. After that, hardener was added to the mixture and the solution was stirred for 5 minutes. Hand-lay-up technique was used to cast the samples in the mold glass. The mixture was left 24 hours to dry. The cutted of samples according the ASTM of mechanical test and Tribological test .shows in Figure 1.



Figure 1 Molds of epoxy pure and composites.

UV-Irradiation

The samples to be irradiated were exposed to UV radiation at room temperature by using mercury vapor lamp (type Osram 400Watt) at wavelengths of 365 nm.

Mechanical tests

Flexural Test (three point bending): Flexural strength was measured under a three-point bending approach using a universal testing T-machine according to ASTM D790. The dimensions of the samples were 120mm x 13mm x 3mm. The distance between the spans was 100mm, and the strain rate was 5 mm/min.

Impact test: Charpy method performs impact tests specimens as per ASTM –ISO 179 and the sample without notch charpy. The impact specimens in this apparatus had dimensions of 55mm x10mm x 3mm.

Hardness test: Hardness Shore D, the indenter was attached on the surface which has a digital scale that from 0 to 100unit.

Results and discussion of mechanical properties

Bending test

Note from the curves (stress-strain) of epoxy before and after reinforcement and then that the material without strengthening possess the least flexible coefficient, but after strengthening the fibers, the material shows resistance to bend and this is the basis of increasing the coefficients of flexibility. Figure 2 shows the epoxy reinforcement with glass fibers high flexible coefficient compare anther fibers. If we take the effect of ultraviolet radiation, which is one of the factors causing the break of the bonds by the effect of their wavelength and the type of source used? Figure 3 shows the young modulus as a function of water when the immersion the samples in water at a room temperature found that the coefficient of elasticity of samples increases and decreases after four weeks. Water affects the bonding of the bonds between the molecules of the material and the temperature of water.¹¹

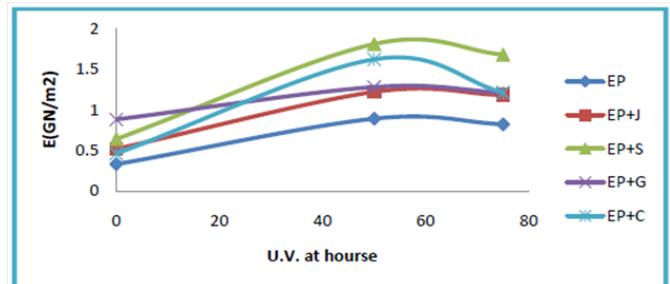


Figure 2 Modulus of elasticity as a function of U.V. time.

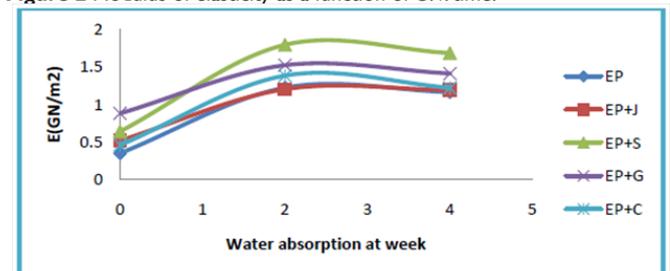


Figure 3 Modulus of elasticity as a function of water absorption.

Impact test

Impact test was carried out to identify the resistance of the material to shocks in the different conditions (ultraviolet light and water absorption) Figure 4 shows impact strength of epoxy and composites the epoxy with glass fibers is high value which agree with.¹² General increase in the fracture strength of all composites because of the existence of fibers that bear most of the shock stress and that the fibers act as a crack stopper. From the observation of the (Figure 4)(Figure 5)shows the change in energy with the time of exposure to irradiation, which decreases by increasing the time of irradiation and all samples, as well as in the case of immersion in water.

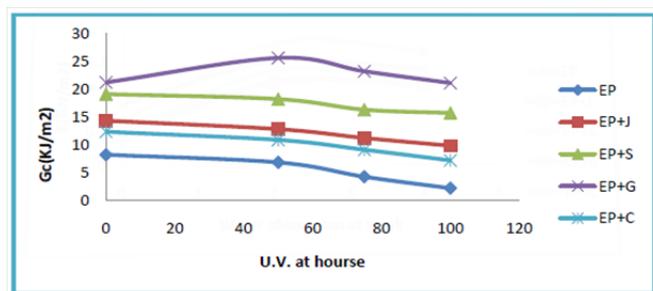


Figure 4 Fracture strength as a function of UV time.

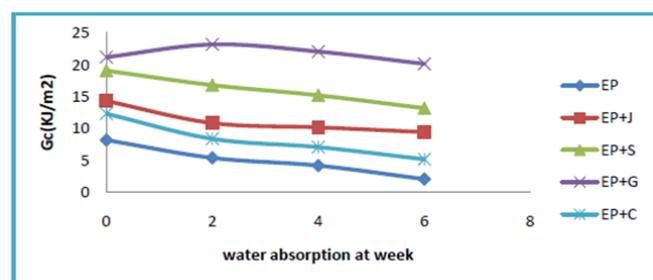


Figure 5 Fracture strength as a function of water absorption.

Hardness test

Hardness is described as resistance to surface indentation of the material. The variations of hardness of the composite materials are shown in the (Figure 6)(Figure 7). This graph explains the effect of fibers reinforcements on the hardness of the irradiation and immersion in water. The hardness values with composites increasing compared with epoxy pure and the higher values of glass fibers. (Figure 6) (Figure 7) which decreases by increasing the time of irradiation and all samples, as well as in the case of immersion in water.

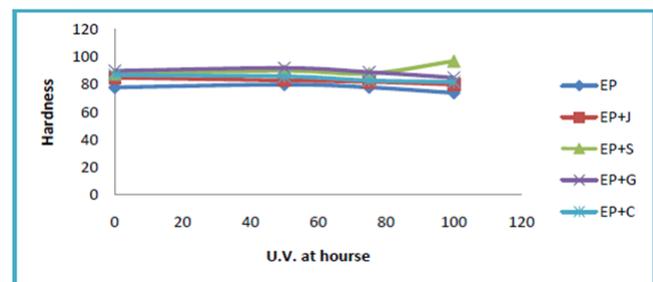


Figure 6 Hardness as a function of UV time.

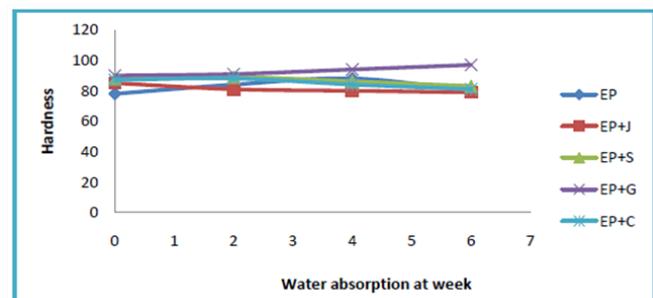


Figure 7 Hardness as a function of water absorption.

Acknowledgment

None.

Conflict of interest

Author declares there is no conflict of interest.

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