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Review Article

Properties of Nano Glass Fibre Composites

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Abstract

Owing to their very high weight in proportion to their strength in comparison with monolithic metals, fiber reinforced polymer (FRP) composites find many end uses. A major setback with FRP composites arises from their poor mechanical properties, owing to the polymers related with it. To address this attempt made in this study to investigate the use of different nano particles mixed in different polymers to improve mechanical properties of the polymer. In this study nano-aluminium oxide powder was dispersed in polystyrene resin using ultrasonic bath sonicator and used as matrix phase for manufacturing glass fiber reinforced plastics by hand layup method. As per the ASTM standards tensile, compression test and impact test were carried out. A linear regression model was also developed to compute the improved mechanical properties of nano-aluminium oxide filled GFRP composites. The findings reveal that the predicted values through the developed linear regression model are well aligned with the experimental results and proved that with the increase in weight percentage of nano-aluminium oxide powder the mechanical properties of FRP composites improved.

Keywords: Composites; Aluminium oxide; Nano, Polymer; Glass fibres; Regression model

Introduction

Composites filled up with nano particles are known as nano composites (NC). Usages of NC are increasing in recent years. It has been verified that nano composites could give predominant physical properties, as a result of the high surface-to-volume proportion at level of reinforce fillers in the grid, compared with the traditional fiber or PR composites. Polymer nano composites have found greater application, as they exhibit remarkable material properties compared with virgin polymer or traditional micro and macro composites [1]. Conventional composites usually require a high content (> 10%) of the inorganic fillers to impart the desired mechanical properties [2]. Such high filler levels increase their density of the product and can cause weakening of properties due to interfacial compatibility between the filler and the organic material. Higher filler content also affects the properties. In contrast, nano composites show improved thermo mechanical properties even with a small amount of layered silicate (5%) [2]. Polymer nano composites are generally defined as the mixture of polymer matrix and fillers that have at least one dimension in nanometer range [2]. "The nano fillers can be one-dimensional, two-dimensional, and three-dimensional [2]. Polymer nano composites are well known for having superior mechanical properties like high elastic modulus, flame retardancy, increased strength, etc. with very small addition (5 wt.%) of nano particles [3]. Kanagaraj [4] reported that there is a quick increase in Young's modulus with an raise of CNT attention. , Toughness and Ultimate strength also increasing linearly with addition of CNT". Toughness is the most important property to find out the volumetric wear rate. Yang [5] experimental observed that multi-walled carbon nano tubes (CNTs) enhance the thermal stability and also the mechanical properties of polymer composites. Anaya and Schaller [6] saw that reinforcement will nano tube increases the toughness of the polymer composites by observing energy due to their flexible elastic behavior during loading.

Also the bonding between nano tubes and the surface of the polymer matrix could be greatly enhanced by van deer Waals force attraction. Lim et al. [7] reported that the friction and wear rates are reduced through addition of CNTs in carbon/carbon composites. Mahrclz et al. [8] studied various nano filler which are most suitable for various polymers. They reported that the effect of Silicon Dioxide (SiOz) and Barium Sulphate (BaS04) on angle ply GFRP laminates carry. "Mahrholz et al. [9] explained the reinforcement effect of silica nano particle. They concluded that the amount of silica content improves the strength, stiffness and toughness of composites. Magee and Davies [10] studied the effect of strain rate on the polyester composites/ glass epoxy. Smith and Okoli [11] examined the effect of strain rate on the shear, tensile and flexural propertied of glass epoxy laminateand report that transition metal oxide such as iron oxide (FeO, Fe203 or Fe304), copper oxide (Coo and CU20), and zinc oxide (ZnO) nano materials have special physicochemical properties arising from the high specific surface area, and quantum size effect which may be different from their bulk or atomic counterparts [12,13]. Very limited research is made on transition metal oxide filled glass fiber reinforced polymer matrix composites. Work This research work resorted aims at investigation on synthesis and characterization of nano Al2O3 filled SGlass filled fiber prepared by hand layup technique and the mechanical behavior of samples has been investigated as per ASME standards and validate using the linear regression model developed".

Technical Details

The specifications of the S-glass, polymer resin, and aluminium oxide filler are as follows.

a) Fiber: S. Glass

b) Resin: Epoxy and hardener

c) Filler: Nano aluminium hydroxide

Manufacture of the Nano Composite

Initially, the wooden mold was cleaned, and the wooden plates were covered with releasing agent. Hardener and Polyester resin were mixed systematically in a beaker with a stirrer in 1:10 ratio. Using a paint brush, the hardener- Polyester blend is gently applied on the surface area of the mould. A little bit concerned was taken to ensure that the coat is even and uniform. A square piece of the S-glass fiber with the same dimensions of the mould was taken and placed on the mould. An ultrasonic bath sonicator, (Make: OSCAR® model PR-1000, ultrasonic power: 750W & operating frequency: 36 kHz) was used to ensure uniform dispersion of aluminium oxide nano particles into resin not including agglomeration. The resin and aluminium oxide nano particles (0%, 1% & 2% by weight.) were initially taken in separate beakers. The beakers are kept in an ultrasonic bath sonicator and allowed to vibrate for a period of two hours and then the same blends were kept in a rotary shaker for additional four hours to ensure uniform mixing of Aluminium oxide nano particles into epoxy resin without agglomeration. Next, the remaining resin mixture is applied using a brush on the surface of the fiber [14,15]. It is important that the resin is forced against the surface of the fiber to ensure that the mixture sticks and penetrates through the pores of the fiber for best results. Woven type S- glass fiber of the same dimension was placed on the mould and the same systematic procedure is repeated on this layer too. This process is repetitive until a thickness of about 3mm is achieved. Now the upper wooden plate is placed on the layers and a weight is applied on this. The entire setup is allowed to cure for about three hours. The wooden plates are then carefully removed and the prepared specimen of GFRP formed is taken out. The samples were cut according to ASTM standards. The composition of the GRFP composites is as given below.

a) Specimen A: S-glass fiber - 40%
Epoxy resin – 60%
Nano aluminium oxide – 0%

b) Specimen B: Epoxy resin – 60%
Nano aluminium oxide – 1%
S-glass fiber - 38%

c) Specimen C: Epoxy resin - 60%
Nano aluminium oxide – 2%

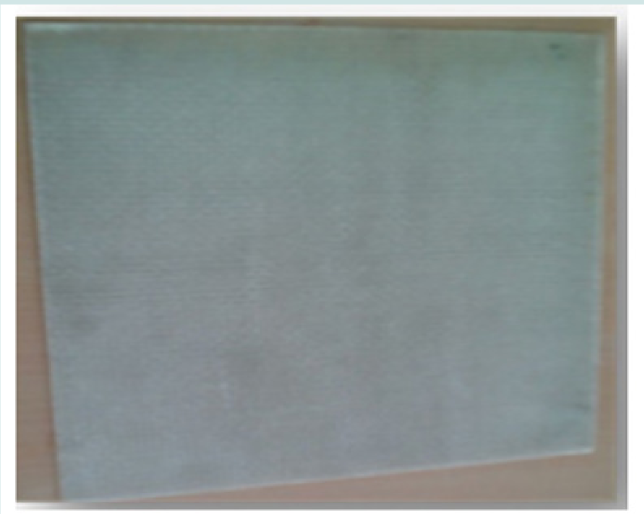

Figure 1

The composite preparations are shown Figure 1 below. The performance of an engineering material is judged by its properties and behavior under different mechanical properties and dynamic and static loading condition in both cases. This information is essential for selecting the proper material for a given application and as well as designing a structure with selected fiber materials. Figure 1 shows prepared composite for testing. The properties are found out by different mechanical and physical tests under controlled conditions.

Mechanical Properties

The mechanical properties of the composite, namely tensile, compression and flexural properties were characterized to evaluate the improvement derived by adding nano fillers. Tensile test and compression test were performed according to ASTM standards. The ASTM standards for testing had been recommended. The results of mechanical properties are presented; it can be seen that increase in Wt % of nano aluminum oxide improves the mechanical properties. This is due to the very large surface are of infraction between nanofiller and polymer matrix. Tensile strength vs different samples have been determined. It is found that specimen A has less tensile strength because sample was prepared without mixing aluminium oxide. In specimen C tensile strength was more because it mixed with % aluminium oxide. Compression strength vs different samples have been determined. It is found that specimen A has less compression strength because sample was prepared without mixing of aluminium oxide. In specimen C compression strength was more because it mixed with % aluminium oxide. Flexural strength vs different samples have been determined. It is found that specimen A has less flexural strength because the sample was prepared without mixing aluminium oxide. In specimen C, compression strength was more because it mixed with % aluminium oxide. The above mechanical properties are validated by doing regression analyses and this analyses plays main vital role in material science. It can give a relation between processes. Data has been utilized to get linear regression analyses for various parameters and linear regression equation has been generated.

Conclusion

Nano Aluminium oxide filled S glass fiber composites are successfully prepared by using hand layup technique. Nano aluminium oxide polymer resin was prepared by using ultrasonic bath sonicator and ensures that homogeneous dispersion of Aluminium oxide nano particles into resin without agglomeration. The Characterization of Aluminium oxide nano particles filled S –Glass fiber composites were done using Universal testing machine test equipment properties of Aluminium oxide S –Glass fiber reinforced composites. The results are indicated with increase in weight % of nano Aluminium oxide improves the mechanical properties.

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