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Study of Hardness and Wear Properties of Graphene Based Polyester Resin Composites

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ABSTRACT

Graphene is a material comprising a single layer of carbon atoms and having remarkable set of properties that offer potential benefits when added to polymer materials. The overall aim of the investigation to study the behavior of graphene reinforcement which can be used in various composite applications, to improve the properties of neat polyester based matrix materials. The key challenges with the good dispersion of graphene material, and the development of new fabrication processes to synthesis polymer nanocomposites. Graphene based polymer nanocomposites are promising advanced material used for very high performance materials that offer improved mechanical properties, electrical properties and other properties. Herein, an approach is presented to improve the mechanical properties of neat polyester resin by using graphene filler material. Polymer nanocomposites are constructed by uniformly dispersing a nanomaterial into the polymer matrix. Mechanical properties such as hardness and wear properties of graphene reinforced polyester composite were studied. The results showed that the nanofiller reinforced polyester composite tend to exhibit enhancement in mechanical properties as compared to the neat polyester.

Keywords : Nanofiller, Graphene, Polyester, Composites.

I. INTRODUCTION

Nanocomposites material has significantly to encompass a large variety one-dimensional, two-dimensional, three-dimensional and amorphous materials, made of distinctly dissimilar components and mixed at the nanometer scale. The general class of nanocomposites are organic/inorganic materials is a fast growing area of research. The properties of nano-composite materials depend not only on the properties of their individual parents but also on their morphology and interfacial characteristics. In the present age, the main focus area is in identifying a nanocomposites material which is lighter in weight, eco-friendly, bio-degradable, cost-effective, performance-oriented as well as suited for diverse applications. Unsaturated polyester resin is used for a wide variety of industrial and consumer applications [1]. This consumption can be split into two major categories of applications: reinforced and without reinforced. In reinforced applications, resin and reinforcement, such as fiberglass, are used together to produce a composite with improved physical properties.

The discovery of graphene used as a nanofiller for the production of lightweight, low cost, and high-performance composite materials for various

applications. Advanced composites are composite materials that are traditionally used in the aerospace components, parts of racing cars, transport vehicles applications. Choice of fabrication method depends on matrix properties and the effect of matrix on properties of reinforcements [2]. The incorporation of nanoparticles into polymers exhibit behavior different from conventional composite materials with microscale structure, due to the small size of the structural unit and the high surface to volume ratio [3]. From the literature studies gaps has been identified to manufacture graphene based polyester composites. The aim of the present investigation was to study the graphene reinforced and unreinforced composites fabricated using solution casting method. The dispersion of graphene in polyester matrix will be analyzed to study the mechanical properties.

II. Experimental Method

Materials

Graphene (GR)

The Graphene (GR) used as reinforcement in this study was supplied by United Nanotech Pvt Ltd Hoskote, Bangalore. Normally, Chemical vapour deposition was used to produce the GR with high aspect ratio, high purity of 96- 99% and surface area of 323- 600 m2/g.

Matrix

Unsaturated Polyester with 2% cobalt naphthanate as accelerator, 2% Methyl Ethyl Ketone Peroxide (MEKP) as catalyst in 10% Di-Methyl Aniline (DMA) solution as promoter, in the ratio of the resin/accelerator/catalyst/promoter.

Preparation of graphene based polymer composites

In fabrication of nanocomposites the graphene of 0.25wt%, 0.5wt%, 0.75wt% and 1.0wt% was added to epoxy material using solution casting method. The Fig1 shows the steps involved in preparation of polymer nanocomposites

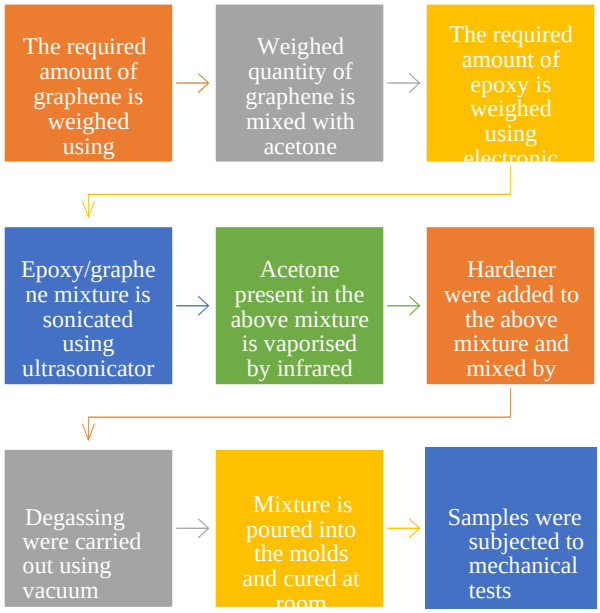

Fig 1 Steps in polymer nanocomposites synthesis

Hardness test

Hardness testing samples were prepared as per ASTM D 785 standards. In each case, five samples were tested and the average value was tabulated. Hardness test were carried out using Rockwell hardness testing machine.

Wear test

Wear testing samples were prepared as per ASTM G99 standards. In addition of graphene wt%, five samples were tested and the average value was tabulated. The wear testing were carried out using pin-on-disc wear testing machine.

III. RESULTS AND DISCUSSION

Hardness properties

Fig 2 shows the effect nanocomposites with addition of 0.25 wt%, 0.5wt%, 0.75wt% and 1.0wt% of graphene with polyester resin. Hardness measurements were carried out at 3 different locations and average value of the hardness was considered. The results of hardness test showed in Fig 2, the addition of graphene with polyester indicates improved hardness strength and decreased strength without addition of graphene filler. The hardness of the pure polyester specimen is low when compared addition of nanofiller, this is due to the

high surface area of graphene causes to enhance the hardness properties of nanocomposites.

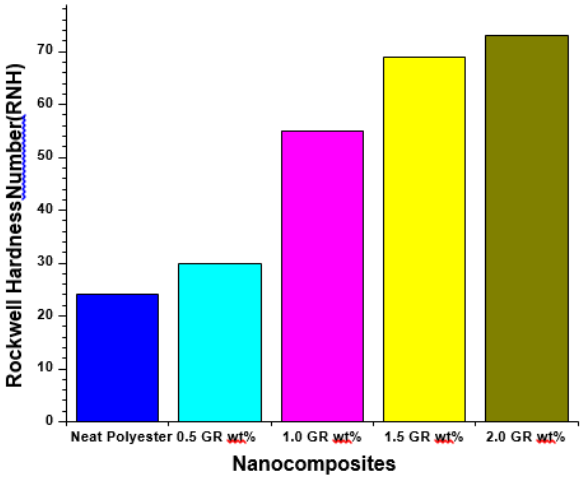

Fig 2 Hardness of polymer nanocomposites at different wt % of graphene content

Wear properties

Fig 3 shows the wear rate of nanocomposites with addition of 0.25 wt%, 0.5wt%, 0.75wt% and 1.0wt% of graphene with polyester resin. The wear test was conducted using pin on disc wear testing machine, neat polyester along with the graphene reinforced polyester samples were tested at constant speed and varying load.

The results indicated that for pure polyester the wear rate is high as compared to the graphene reinforced specimens. The wear rate decreased with increased in wt% of graphene, this is because of good interaction between matrix and reinforcement material and less agglomeration effect in the nanocomposites.

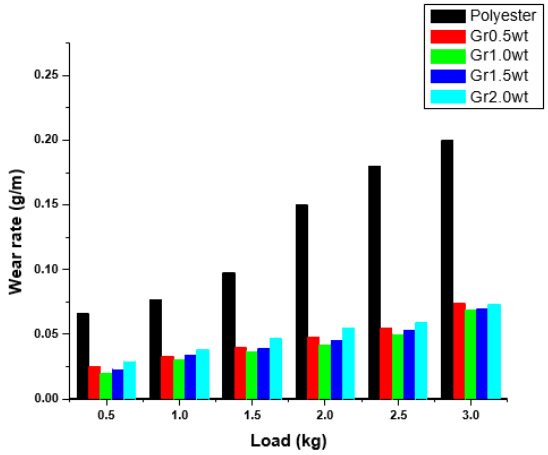

Fig 3 Wear rate of polymer nanocomposites at different wt% of graphene content

IV. CONCLUSION

Nanocomposites has excellent mechanical properties such as hardness and wear rate. The addition wt% of graphene as reinforcement in the polyester matrix doubled the hardness strength compared to neat polyester matrix. The wear rate decreased with increased in wt % of the graphene reinforcement in the polyester. The higher mechanical properties observed at 1wt% addition of graphene nanofiller due to high surface area.

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