Effect of Filler Parameter on Morphology of Graphite Filled Epoxy Composites

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Abstract

General purpose epoxy resin (araldite{LY-554}) was used as matrix reinforced with graphite as filler in varying weight fractions to form composites to study their morphological response using X-Ray Diffractrometer. Graphite filler fraction was varied as 2%, 4%, 6%, and 8% by weight of total composite system. The amount of catalyst i.e., (Aliphatic amine {HY-951}) 1% as constant of the total weight of resin. The study revealed that the properties of the composites mainly depended on dispersion condition of filler particles, particle size and aggregate structure.

Keywords: Graphite particles, Epoxy resin, XRD, Aliphatic amine etc.

1. INTRODUCTION

Composite materials are combinations of two materials in which one of the materials, called the reinforcing phase, which is in the form of fiber sheets or particles and are embedded in the other material called the matrix phase. Composite materials have successfully substituted the conventional materials in several applications like light weight, high strength etc.

Composites are selected for such applications are mainly due to their high strength-to-weight ratio, high tensile strength at elevated temperatures, high creep resistance and high toughness etc. Typically, the reinforcing materials are strong with low densities while the matrix is usually a ductile or tough material. If the composite is designed and fabricated correctly it combines the strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single traditional material. The strength of the composites depends primarily on the amount, arrangement and type of fiber or particle reinforcement in the matrix.

Epoxy resins or plastics are typically formed by the reaction of epichlorohydrin and bisphenol A. Epoxy resin may be prepared by reacting epichlorohydrin and a dihydric phenol. The most common type of phenol used for the industrial production is bis-phenol A, which is obtained by condensation of acetone and phenol. The other reactant is epichlorohydrin, which is prepared from propylene.

Curing agent sometimes called hardener, are added in significant amount to the epoxide and react with it to become a part of the cross linked network. Curing agent speed up the gel time, rate of cure and cure time of the reaction. The curing agent can be aliphatic amine, aromatic amine, anhydrides. Aliphatic amine, rapidly reacts with epoxy resin, is a representative room-temperature curing agent. However, it generates a large quantity of heat and has a short pot life. Resins that have been cured using aliphatic amines are strong, and are excellent in bonding properties.

2. EXPERIMENTAL

2.1 Materials Used

For the present study, a commercial available epoxy resin procured from Ciba Geigy India Ltd was used as the polymer matrix. Aliphatic amine (HY-951) was used as the hardener for epoxy resin. The graphite powder with a particle size (<50 micron meter) minimum 99.5% was obtained from S.D. Fine-Chemical Ltd. Mumbai- 400025.

2.2 Preparation of Composite Samples

A weighed amount of epoxy resin and graphite powder were taken and mixed properly. When the mixture was thoroughly mixed, the hardener, aliphatic amine (HY-951) 1% (by wt. of resin) was added to initiate the reaction and act as a cross linking agent. Over mixing was avoided as it adversely affected the flow characteristics and final properties of the composite sheets. When efficient mixing was achieved the mixture was cast into the steel mould.

3. CHARACTERIZATION OF COMPOSITE SAMPLES

The composite samples were tested for their morphological behaviour using X-Ray Diffractrometer.

X-Ray Diffraction:

The samples were sectioned in machine shop and cut it into the rectangular shape with dimensions of 30 mm× 25 mm. After cutting the samples, the edges were cleaned properly with help of fine grit paper of 400 grades. The test was carried out in X-Ray Diffractrometer.

4. RESULTS

XRD technique was used for the study of polymer structure. XRD offers a direct means of determining the orientation characteristics of composites. The XRD pattern of graphite powder, epoxy resin and epoxy- graphite composites containing 4%, 6% filler contents by wt. of total resin were shown in figures1 to 4.

Figure 1 shows the X-ray diffraction pattern of epoxy indicated that the epoxy was amorphous in nature consist a broad amorphous peak appeared at an angle 16.853.

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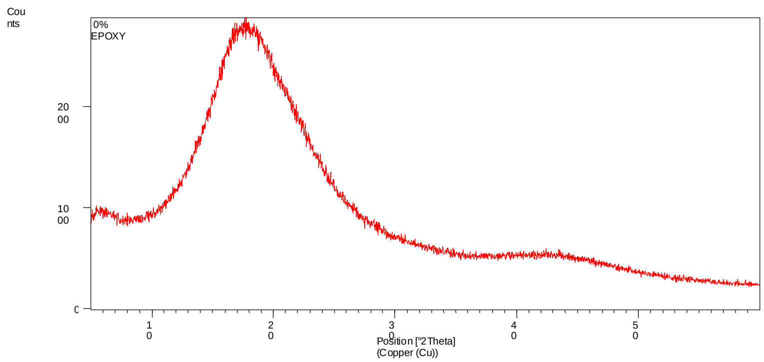

Fig.1. Diffraction pattern of pure epoxy resin

Figure 2 shows the X-ray diffraction pattern of graphite powder used as filler in the epoxy reinforced composites. XRD pattern obtainable from figure 2 showed a crystalline behavior of graphite having highest peak appeared at an angle 26.542 indicated the high degree of crystallinity. The degree of crystallinity is most important basic parameter characterizing the crystalline polymers.

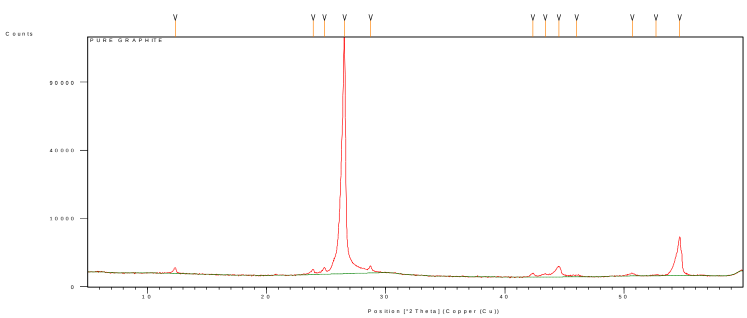

Fig.2. Diffraction pattern of pure graphite

Figure 3 shows the diffraction pattern of epoxy graphite composite contained 4% filler by wt of resin. X-ray diffraction revealed that the composite was crystalline as the highest peak was observed at an angle 26.481 and narrow peaks were observed at angles 44.493 & 54.620.

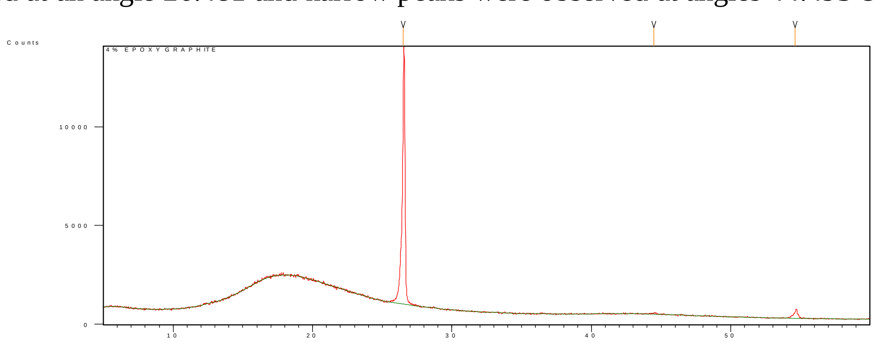

Fig.3. Diffraction pattern of epoxy graphite composites containing 4% filler

Figure 4.1.4 shows the diffraction pattern of epoxy graphite composites with 6 % filler by wt of resin. X-ray diffraction reveals that the composite is crystalline as highest peak is observed at an angle 26.484 and intensity increases than 4% epoxy graphite composites.

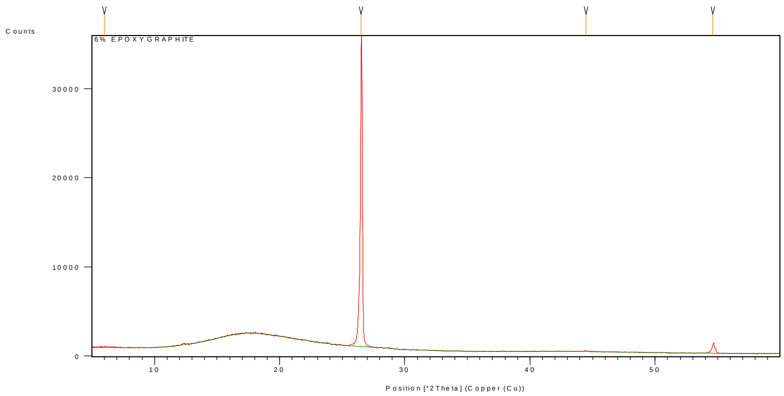

Fig.4. Diffraction pattern of epoxy graphite composites containing 6% filler

5. CONCLUSION

XRD micrographs were obtained for epoxy graphite composites with variation in filler concentration. An attempt was made to explain the affect of filler content in the morphology of composites. As seen in figure1, the XRD pattern showed that epoxy exhibits highly amorphous behavior and showed highest amorphous peak. The graphite powder exhibited highly crystalline behavior and highest peak was observed at an angle 26.542. It was examined from XRD study that the amorphosity decreases and crystallinity increases as the filler content increases and the highest peaks were observed at various angles. In other words intensity increases with increases the filler concentration which showed the higher crystallinity of polymer composites.

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