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# Analysis of Thermal Behavior of Graphite Flakes Filled Epoxy Composites

KEYWORDS: Graphite particles, Epoxy resin, Thermal properties

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**ABSTRACT** *In this paper, the composites were prepared by mixing epoxy resin and graphite in varying proportions by weight of resin. Aliphatic amine was used as an accelerator to improve the interfacial adhesion between the graphite filler and matrix. The experimental study relating to the thermal properties of graphite filled epoxy composites was carried out. The study revealed that the properties of the composites mainly depended on dispersion condition of filler particles, particle size and aggregate structure.*

## 1. INTRODUCTION

Composite are engineering materials made from two or more constituents with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure. One material (the matrix or binder) surrounds and binds together a cluster of fibres or fragments of a much stronger material (the reinforcement). For the matrix, many modern composites use thermosetting or thermoplastic polymers.

The plastics hold the reinforcement together and help to determine the physical properties of the end product. Graphite is pure carbon in a crystal form much like that of mica–sheets of strongly linked atoms, with very weak bonds between the sheets. This structure makes graphite an excellent dry lubricant wherever temperatures do not get too high. Pencils make use of graphite for the same reason, as graphite rubs off on paper so easily.

## 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 Sheets

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% was to initiate the reaction. After achieving the homogenous mixture, the mixture was cast into the steel mould. Prior to the casting, the steel mould was thoroughly cleaned by using a cleaning agent such as, toluene, xylene etc. and then, a thin layer of a release agent, usually, silicon wax was applied onto the mould to facilitate easy removal of the cured sheet.

### 2.3 Characterization of Composite Sheets

The composite samples were tested for their thermal behaviour in thermo gravimetric analyzer. The thermal stability of the composites was investigated using a TGA-SDT 2960 Thermo gravimetric Analyzer (TA Instrument, USA). The TGA scans were recorded at20 ˚C/min under constant nitrogen flow of 100 ml/min from room temperature to 800 ˚C.

## 3. RESULTS

Thermal stabilities of the composites were determined by thermal gravimetric analysis. The TGA curves of pure epoxy and the composites with different graphite contents are shown in figure 1. It was observed that pure graphite exhibits very high thermal stability with only total weight loss 1.8% up to 750˚C while pure epoxy and the composites of variable filler concentrations showed thermal degradation at much lower temperature and significant weight loss with temperature. The onset and the end set of thermal degradation temperature were determined from the intersection of two tangents. The TGA values of pure epoxy and composites (onset; end set; degradation temperature at 5%, 25%, 50% loss) were given in table 1, indicated that the thermal stability of the pure epoxy was enhanced by the incorporation of graphite particles. For pure epoxy, the onset temperature is 290$^0$C while for the composites it increases from 313 to 323 to 330 for 2% 4% and 6% graphite/epoxy composites respectively. Further, the incorporation of 2%, 4%, 6% graphite particles in pure epoxy matrix increases the 5% decomposition temperature of pure epoxy by 19, 21 and 24$^0$C, respectively. Therefore, the incorporation of the graphite particles results in pronounced improvement in thermal stability. This can be attributed to the homogeneous distribution of graphite particles as well as the tortuous path in the composite that hinders diffusion of the volatile decomposition products in the composites compared to that in pure epoxy.

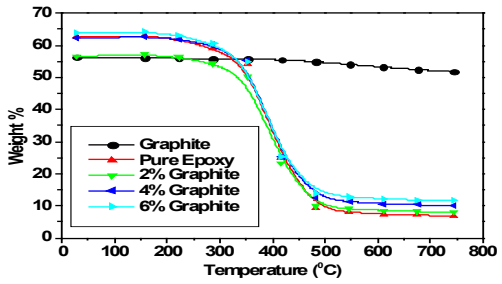


**Figure 1: TGA of pure graphite, pure epoxy, and its composites**

**Table 1: TGA values for pure epoxy and its composites**

| Sample | Onset (°C) | End set (°C) | T(°C) for 5% loss | T(°C) for 25% loss | T(°C) for 50% loss |
|---|---|---|---|---|---|
| Pure epoxy | 290 | 486 | 300 | 363 | 400 |
| 2 % graphite | 313 | 490 | 319 | 368 | 413 |
| 4 % graphite | 323 | 500 | 321 | 371 | 415 |
| 6 % graphite | 330 | 506 | 324 | 380 | 419 |

## 4. CONCLUSION

From the experimental study it is concluded that pure graphite exhibits very high thermal stability with only total weight loss 1.8% up to 750˚C while pure epoxy and the composites of variable filler concentrations showed thermal degradation at much lower temperature and significant weight loss with temperature. It is investigated from TGA that the thermal stability of the pure epoxy was enhanced by the incorporation of

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