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Effect of mechanical defects on EM shielding properties of Aluminium particulate composites in S band

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Abstract : Portable Electronic Devices (PED) are widespread in a market that demands challenging performance combined with highly cosmetic housings, which are expected to be also lightweight and cost effective.. This reveals the importance of shielding of instruments from Electro magnetic (EM) waves. In our present study we have tested composite materials made in labs for EM shielding testing and compared the effect of various mechanical properties on shielding effectiveness of the materials.

Key Words : P*articulate composite, Electromagnetic shielding effectiveness and* S band.

The need for electromagnetic interference (EMI) shielding materials has increased recently due to the more prevalent use of personal communications devices[1]. So new renewable, cheap, conducting and eco friendly materials has to be developed to meet the needs of today's world [2]. Polymeric specimens having different thickness and considering different volume fractions as governing factors were tested for various responses namely attenuation (dB) and % shielding. It is observed that different responses depend on one or more above considered factors.

Hence it was undertaken in the present work to study the electromagnetic performance of polymers of particulate composites at S Band of microwave frequency range and evaluate the EM shielding effectiveness in order to analyze the possibility of its usage in shielding elements [3]. As discussed in the scope of present work, testing was done on aluminium epoxy particulate. Experiments are carried out according to Taguchi's efficient experimental design methods and response data is analyzed with ANOVA technique with the help of commercial software MINITAB 14 [4,5].The EM shielding effectiveness we obtained were less which is attributed to various mechanical defects we found in the composite materials.

Materials and Methods :

Epoxy Resin :

Matrix polymer used in present study is Lapox L12 resin and K-6 hardener supplied by ATUL India Ltd. with following properties as given in table 1.

Table (1) : Details Concerning the Constituents of Matrix System.

Constituent	Trade name	Chemical name	Density (gm/cm^3)
Resin	LAPOX L12	Diglycidyl Ether bisphenol(DGEBA)	1120
Hardener	K-6	Tryethylel tetramine(TETA)	954

We used epoxy resin with Lapox L12 resin. They bond practically to any material when inner support structures for additional tool stiffness are required. They are durable and won't rust and won't warp. They provide quick, easy and inexpensive modification for repair of valuable tools. These are low temperature curing resins, normally between 20 to 90 degree C, but some formulations are made for high temp curing. They are advantage of being used without solvent and curing without creating volatile by products and have low volume shrinkage. It's a thermosetting plastic and get hardened with the help of hardener K6. This hardener is room temperature curing, low viscosity and commonly used for hand lay application. It gives rapid cure at normal ambient temperature.

EM PERFORMANCE OF POLYMERS

As discussed in section above, polymer composite enclosures for portable electronic devices (PED's) and other devices provide excellent weight savings, aesthetics, utility etc. [1] as the polymers tend to be basically dielectric materials; they are transparent to EM radiation. [1]. Attempts to increase the conductivity of these composite with conductive particulate dispersion has been verified earlier with thermoplastics [6]. The section below illustrates the results of exposing carbon-epoxy particulate composites to EM radiation of frequencies 2.78, 2.85 and 2.94 which fall in S band range.

Attenuation of Aluminium Particulate Composites :

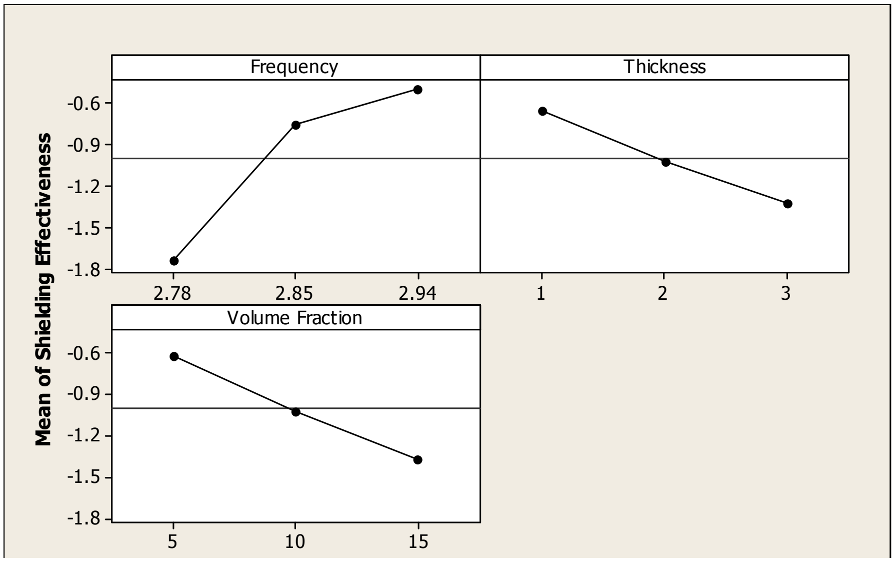

Fig 1, Main effects plots for aluminium particulate composites.

In the effect plots (Fig. 1) it can be observed that attenuation has increased from 2.78GHz to 2.94GHz. It is also inferred that Aluminium particulate composites of 1mm thickness at 5% volume fraction has contributed better attenuation. From the main effects plots we can notice that frequency and thickness has strong influence on the SE. For Aluminium composites at S Band maximum SE obtained is less than zero which is mainly due to various defects we found in the composites which is described below.

(a) Density of Aluminium epoxy particulate composites :

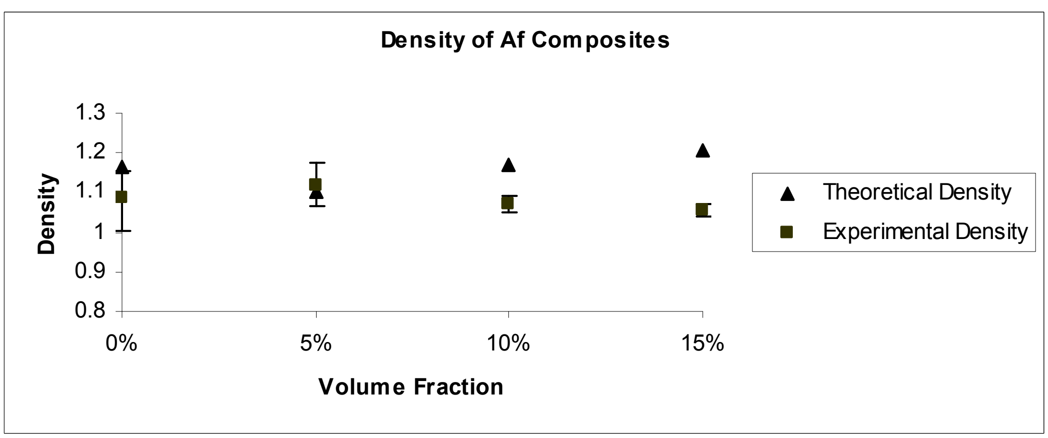

Fig 2 Density of aluminium composites

From the density graph Fig 2, it can be noticed that experimental and calculated values density show much closer in carbon epoxy particulate(Af- fine aluminium as reinforcement material) composite because of the better distribution of carbon particles for lower volume fractions. It may also be observed that at higher volume fractions density is decreasing which could be attributed to increase in voids at these filler loadings

(b) Void Content of Aluminium Epoxy Particulate Composites :

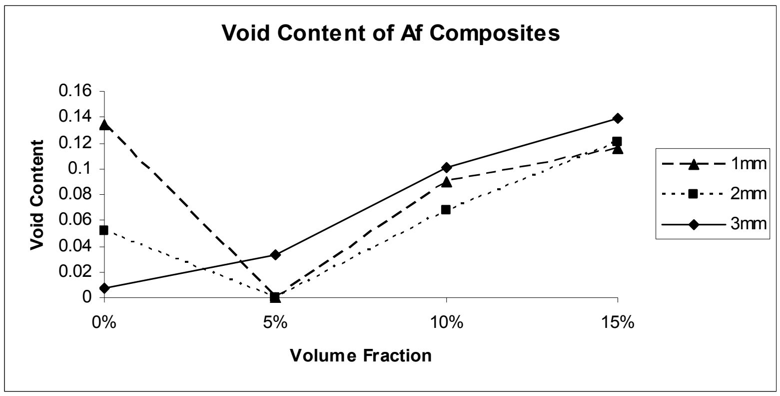

Fig (3) : Void Content of Aluminium Composites.

To explain the relation between density values, void contents for different particle sizes and their filler loadings were computed. Fig 3 shows the plots of void content verses volume fraction in the study. Here thickness of the plate sample was varied. It could be noticed in these plots that smaller particle size samples have exhibited more voids. It could be interestingly noted that for 2 and 3 mm thicknesses void content at low volume fraction is very insignificant. This fact lead may lead to infer that higher volume samples may seem to be having lesser voids. The void content trend for 3 mm thickness is different. As the volume fraction increases, void content also increases which could be due to increase in concentration of particle with less alignment, creating more voids in the specimen.

Shrinkage of Aluminium Epoxy Particulate Composites :

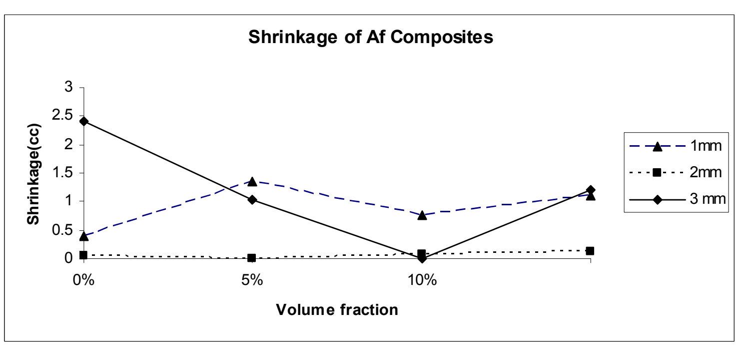

Fig (4) : Shrinkage of Carbon Composites.

Shrinkage or volume loss in polymer composites is a consideration that cannot be ignored. Fig 4 shows the volume losses in different aluminium epoxy particulate composites. These can be considered to be within limits over the volume of the sample considered. It is also interesting to notice that shrinkage exhibited is higher in all cases for larger samples viz 3 mm thick sample.

Conclusions :

Volume fractions for these composites when larger particles sizes are used is found to be affecting SE to a larger extend in carbon epoxy particulate composite in S band. As volume fraction increases, SE decreases which could be due to the presence of voids present in the composite, there by not able to form a conducting network. As SE value is very low in S band, which is mainly due to shrinkage loses and void contents present in the composite materials.

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