DIELECTRIC CONSTANT STUDY OF POLYANILINE / NiCoFe$_2$O$_3$ COMPOSITES

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ABSTRACT

The conducting polyaniline/mixed ferrite (PANI / NiCoFe$_2$O$_3$) composites were synthesized by single step in situ polymerization technique by placing fine grinded powder of mixed ferrite (NiCoFe$_2$O$_3$) during the polymerization of aniline. Dielectric constant of these composites was investigated in the frequency range $10^2$Hz to $10^7$Hz. It is found that the Dielectric constant obeyed the power law index and the variation of Dielectric constant with wt% of NiCoFe$_2$O$_3$ could be related to conductivity relaxation phenomenon.

Key words: Polyaniline, Mixed Ferrite, Dielectric Constant.

1. INTRODUCTION

Polymers have traditionally been considered as a good electrical insulators and a variety of their applications have relied on their insulating property [1]. However more than a decade now, researchers have shown that certain class of polymers which are conjugated, exhibit semiconducting behavior [2]. The discovery of doping has led to a further dramatic increase in the conductivity of such conjugated polymers to values as high as $10^5$ S/cm. The presence of an extended $\pi$ conjugation in polymers, however, confers the required mobility to charges that are created on the polymer backbone (by the process of doping) and make them electrically conducting [3]. Conducting polymers have become the foci of much research in materials science and among all; polyaniline and polypyrrole have received greater attraction due to their favorable economics, easy synthesis, environmental stability and unique chemistry [4]. The electrical conductivities of the intrinsically and conducting polymer systems range from those insulators ($<10^{-5}$ and $10^{-10}$ S/cm) to those of typical semiconductors such as silicon ($\approx 10^{-5}$ S/cm) and to those greater than $10^4$ S/cm (nearly to that of a good metal such as copper $\approx 5\times 10^5$ S/cm) [5]. Applications of these polymers have begun to emerge a new era. These include coating and blends for electrostatic dissipation and electromagnetic
interface (EMI) shielding [6,7]. Electromagnetic radiation absorbs for welding (joining) of plastics, conductive layers for light emitting polymer devices and anti corrosion for iron and steel [8].

2. EXPERIMENTAL

All Chemicals used are analytical grade (AR) and were procured, used as received. The monomer aniline was doubly distilled prior to use. Synthesis of Polyaniline / NiCoFe$_2$O$_3$ composites has been carried out by single step in situ polymerization technique. 0.1 mol of aniline was dissolved in 1 M of Hydrochloric acid to form aniline hydrochloride. Fine grinded powder of NiCoFe$_2$O$_3$ is added in the weight percent of 10, 30 and 50 to the above solution with vigorous stirring to keep NiCoFe$_2$O$_3$ suspended in the solution. To this reaction mixture, 0.1 M of oxidizing agent ammonium persulphate [(NH$_4$)$_2$S$_2$O$_8$] in 1 M of Hydrochloric acid was added slowly with continuous stirring for 4-8 hr at 0-5$^\circ$C to polymerize. The precipitated powder was recovered, vacuum filtered and washed with deionised water. Finally, the resultant precipitate was dried in an oven for 24 hr to achieve constant weight. In this way, three different PANI /NiCoFe$_2$O$_3$ composites with different weight of NiCoFe$_2$O$_3$ (10, 30 & 50) in PANI have been synthesized [9-13]

2.1 Preparation of pallets
The pellets of 10 mm diameter are formed with thickness varying upto 2 mm by applying pressure of 10 Tons in a UTM – 40 (40 Ton Universal testing machine). For conductivity measurement, in this experiment, three different samples of each composite varying in their weight percentage are investigated for their frequency dependent Dielectric constant.

3. RESULTS AND DISCUSSIONS

Figure 1 shows the variation of $\varepsilon'$ as a function of frequency for polyaniline – NiCoFe$_2$O$_3$ composites (different wt %). In all the cases studied here, it is observed that, the dielectric constant is quite high at low frequency and decreases with increase in applied frequency but 30wt% of composite shows maximum value. The observed behavior may be due to Debye like relaxation mechanism taking place in all these materials.
4. CONCLUSION

Polyaniline composites with different weight percentages of NiCoFe$_2$O$_3$ in PANI were synthesized by chemical oxidative polymerization of monomer aniline. The results of Dielectric constant show a strong dependence on the weight percent of NiCoFe$_2$O$_3$ in polyaniline.

REFERENCES

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