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Synthesis, Characterization and ac conductivity Study of Polyaniline/ $MgSnO_3$ Composites

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Abstract

Metallic oxides dispersed polymers constitutes a new class of polymer composites materials. Synthesis of such polymer composites integrates the science and technology of materials. Magnesium stanate ($MgSnO_3$) dispersed polyaniline composite materials were prepared by *in-situ* polymerization of aniline using ammonium peroxidisulphate as an oxidizing agent. Different weight percentage of $MgSnO_3$ (10, 30 and 50wt %) is dispersed in polyaniline (PANI) to form its composites. Structural study of the plain PANI and its composites was undertaken by X-ray diffraction (XRD) tool, Morphological changes of the polymer and its composites are well studied using scanning electron microscope (SEM) and the variation of bonding due to composites formation is studied by Fourier transfer infrared (FTIR) tool. Electrical study like ac conductivity is also carried out to know its electrical behavior.

Keywords: Polyaniline, composite, $MgSnO_3$, ac conductivity

INTRODUCTION

Polymer composites represent a new class of conventionally filled polymer materials which increases strength, heat resistance and decreased flammability[1] These Polymer composites materials are formed by dispersion of inorganic particles in an organic polymer matrix to dramatically improve the performance properties of the polymer [2-3]. Metal oxides dispersed polymer composites have attracted a great deal

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of interest from researchers, because they frequently exhibit unexpected hybrid properties synergistically derived from both components [4-5]. Similarly, conducting polymer composites have attracted considerable interest in recent years because of their numerous applications in variety of electrical and electronic devices. Composites of conducting polymer with suitable compositions with inorganic materials led to desirable properties [6-8]. For application of conducting polymers knowing how these conducting polymers composite will affect the behavior in an electric field is a long-standing problem and great importance. The discovery of doping in conducting polymer has led to further dramatic increase in the conductivity of such conjugated polymers.

Polyaniline composites have been widely studied in view of their unique electrical, dielectic, optical and optoelectrical properties in addition to their ease of preparation and excellent environmental stability. Conducting polyaniline and its composites with metal oxides has recently been the subject for the researchers with great interest [9]. The insulating emeraldine base form of PANI consists of equal number of reduced and oxidized repeat units. The conducting emeraldine salt form is achieved by doping with aqueous protonic acids. This leads to an increase in conductivity by more than 10 orders of magnitude depending on the strength of the acids [10-11].

EXPERIMENTAL

Materials and Methods

Ammonium persulphate $(NH4)_2S_2O_8$, Hydrochloric acid (HCl) and Magnesium stanate ($MgSnO_3$) used were of AR grade. Doubly distilled water and aniline is used as a solvent and monomer. Polyaniline is prepared by oxidation of aniline and Polyaniline composites were prepared by Insitu polymerization method with dispersion of $MgSnO_3$

Synthesis of Polyaniline/ $MgSnO_3$ Composites

Aniline was dissolved in 1m HCl to form polyaniline (PANI). Magnesium stanate was added to PANI solution with vigorous stirring to keep the Magnesium stanate suspended in the solution. To this reaction mixture, 0.1M of ammonium persulphate $[(NH_4)_2S_2O_8]$ which acts as the oxidant, was added slowly with continuous stirring for 4-6 hours at 0-5^{O}c. The precipitated powder recover was vacuum-filtered and washed with deionizer water. Finally, the resultant precipitate was dried in an oven for 24 hours to achieve a constant weight. In the similar manner plain PANI is prepared without adding Magnesium stanate. PANI/ $MgSnO_3$ composites were prepared in weight percent ratio in which the concentration of Magnesium stanate (10, 30 and 50%) was varied. The test samples to be used were prepared in pellet form AC conductivity measurements were carried out at room temperature over the frequency range 10^2-10^7Hz using the Hewlett-Packard impedance analyzer 4192-A model.

RESULTS AND DISCUSSIONS

Figure 1and 2; shows the X-ray diffraction pattern of pure PANI and PANI / $MgSnO_3$ composites (50 wt %). XRD pattern of pure PANI shows absence of Bragg's reflection indicates the amorphous nature, However PANI/ $MgSnO_3$ composites pattern shows partial crystalline state, on comparison of PANI and composites patterns conforms change of amorphous nature of the PANI to that of the observed oxide peaks in the composite pattern was identified in accordance with JCPDS file.

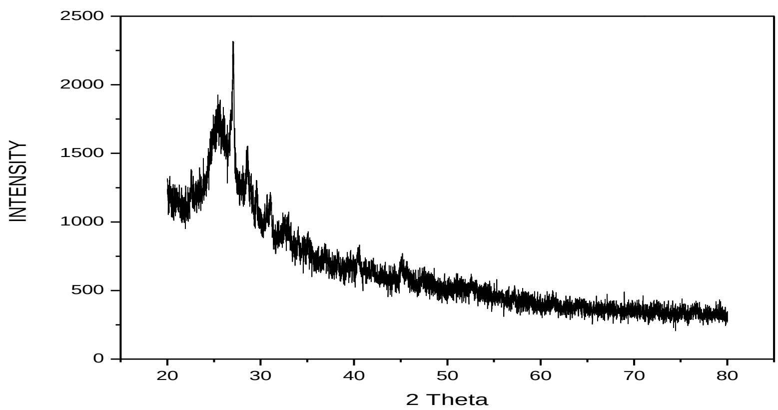

Figure 1: Shows X-ray diffraction pattern of Polyaniline

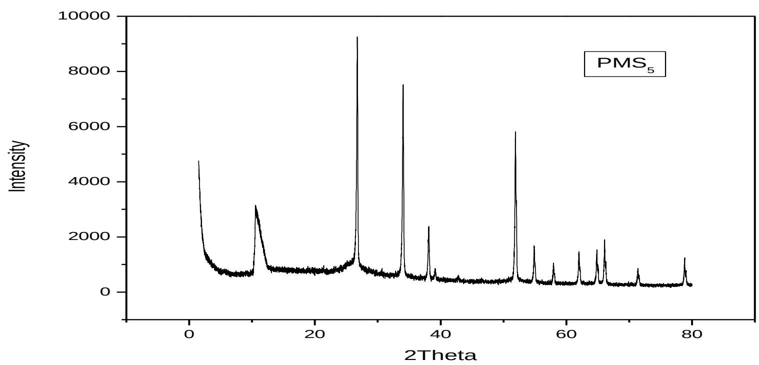

Figure 2: shows X-ray diffraction pattern of Polyaniline/$MgSnO_3$ (50 wt %)

Figure 3 shows FTIR spectra of pure PANI and figure 4 shows PANI/$MgSnO_3$ composite respectively. FTIR studies were carried out to confirm the possible chemical interaction between $MgSnO_3$ and PANI. PANI composite with $MgSnO_3$ spectra shows the metal oxide peaks at around 550 to 600 $cm^{-1}$are observed due the dispersion of $MgSnO_3$ materialism in to the polymer matrix. The characteristics peaks observed for plain PANI is identical to those composites, confirming no chemical interaction between $MgSnO_3$ and PANI.

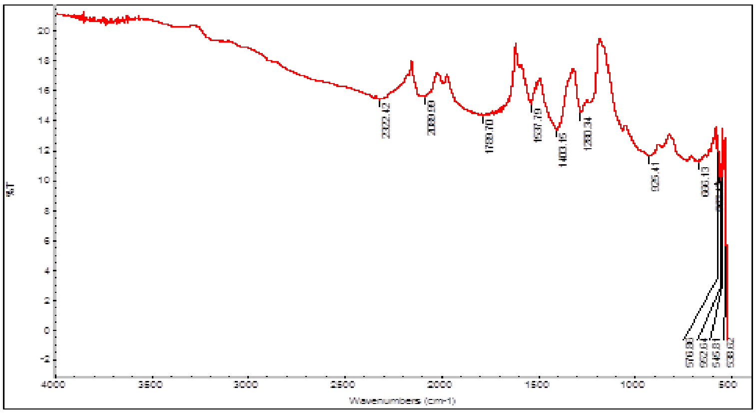

Figure 3: shows the FTIR spectra pure PANI

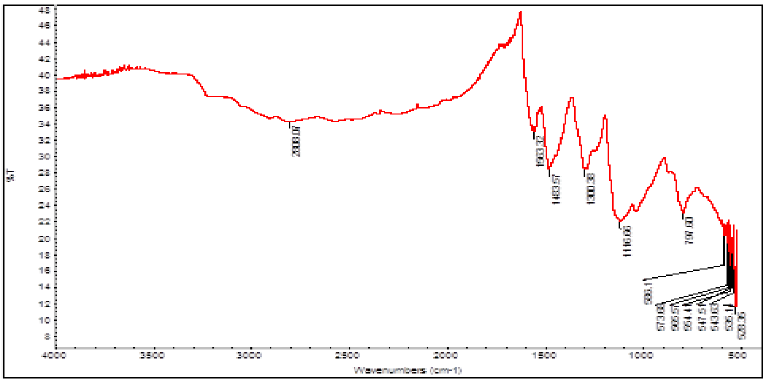

Figure 4: shows PANI/ $MgSnO_3$ composite (50 wt %)

Figure 5 shows SEM image of pure PANI. The clear observation of SEM image of plain PANI shows some pores, which are usually observed due to some deformation of polymer film during casting. However in some streaks with disjoints are also observed in the image. Composite images show that, the fine dispersion of oxide particles in the PANI matrix is observed, irregular shaped particles with compacting nature of the particles are also observed. These films look more homogeneous however, particle agglomeration can’t be ruled out.

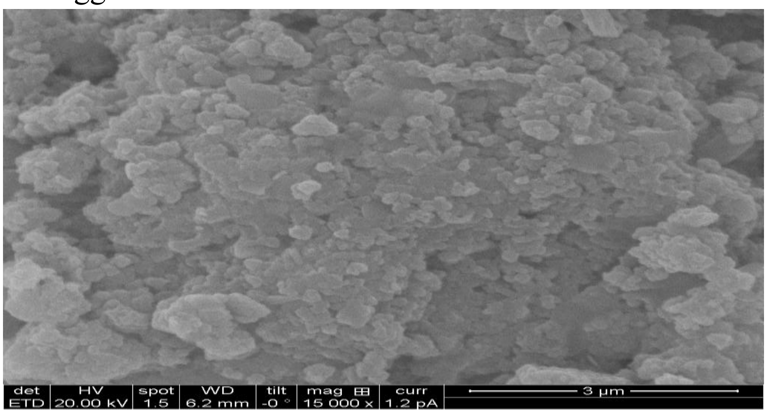

Figure 5: shows SEM Image of pure PANI

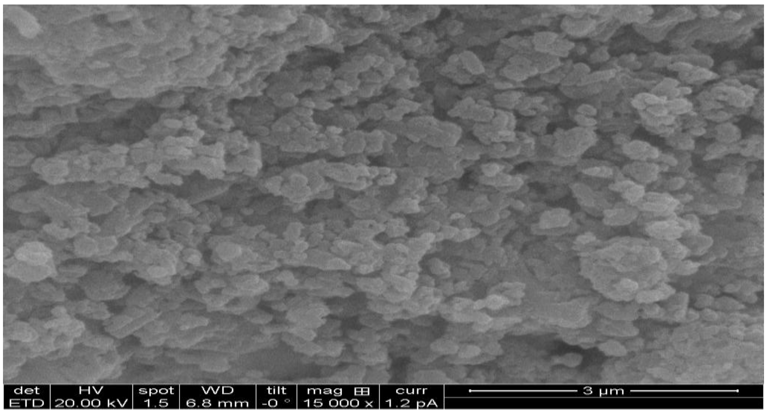

Figure 6: shows SEM Image of PANI/$MgSnO_3$composites

Conductivity Study

Figure 7 shows the variation of ac conductivity as a function of frequency for polyaniline. The conductivity increases with increase in frequency. The ac conductivity of polyaniline exhibit two phases in the frequency range 10^2 Hz to 10^5 Hz. In frequency between 10^2 Hz to 10^4 Hz, the conductivity values are almost constant and increases suddenly in the frequency range 10^4 – 10^5 Hz. Lattice polarization around a charge in localized state may be responsible for multiple phases of conductivity in polyaniline

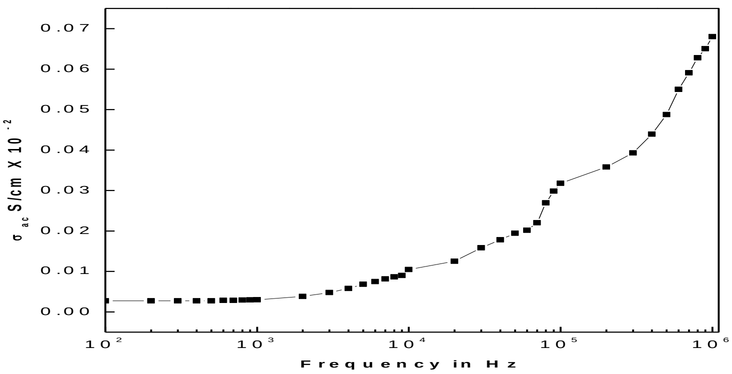

Figure 7: Variation of ac conductivity as a function of frequency for polyaniline

Figure 8 shows the variation of ac conductivity as a function of frequency for polyaniline – $MgSnO_3$ composites (different wt %). It is observed that in 10 and 50wt% the σ_{ac} remains constant. In case of composites with 30 wt%, the conductivity increases. The anomaly in the conductivity behavior of these composites may be due to the variation in the distribution of MgSnO3 in polyaniline. Still in depth study is needed to understand the mechanism.

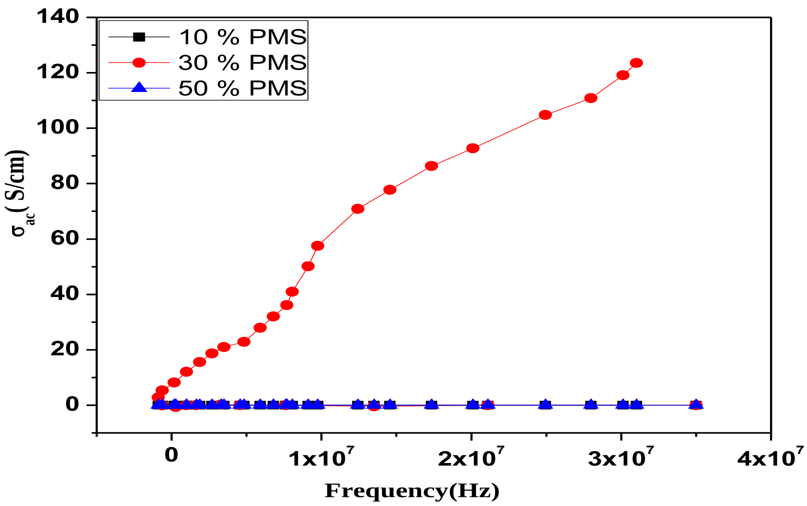

Figure 8: Variation of ac conductivity as a function of frequency for Polyaniline $MgSnO_3$ Composites

CONCLUSION

Efforts have been made to synthesize PANI/ $MgSnO_3$ composites to tailor their properties. The results of ac conductivity show a strong dependence of $MgSnO_3$ in PANI.

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