



## Dielectric study on Polyaniline-SbO<sub>2</sub> Composites

### KEYWORDS

Polymeric materials, Oxidation, Dielectric, SEM, XRD, IR, SbO<sub>2</sub>

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**ABSTRACT** Chemical route for the synthesis of polymer composites with oxide materials enhances the composite technology. Polyaniline (PANI) and Polyaniline- SbO<sub>2</sub> (PANI- SbO<sub>2</sub>) composite material was prepared by insitu polymerization of aniline with SbO<sub>2</sub> as composite material. Variation in the oxide composition with polymer matrix is maintained to know its detailed changes. The structural characterization of prepared composite materials and metal oxide material are carried out by X-ray diffraction (XRD), morphological study by Scanning Electron Micrograph (SEM) and bonding by Infrared (IR) study. Variation in Structural, morphology and bonding is observed in composite materials compared to SbO<sub>2</sub> sample and PANI. The dielectric behavior is also investigated in the frequency range 102–107 Hz at room temperature. The dimensions of SbO<sub>2</sub> particles in the matrix have a greater influence on the observed dielectric values

### 1. INTRODUCTION

Synthesis of polymer composites of core shell inorganic particle-polymer has attracted much research attention in recent years because its properties [1-2]. In particular, the composites of core shell metal oxide particles-conducting polymer combine the electrical properties of the polymer shell and the magnetic, optical, electrical or catalytic characteristics of the metal oxide core, which could greatly widen their applicability in the fields of catalysis, electronics and optics [3]. Many efforts have been made to successfully prepare composites such as Fe<sub>2</sub>O<sub>3</sub>-polypyrrole by chemical preparation and electrochemical method [4-5]. Besides the preparation of MO-Polymer, the synthesis of hollow conducting polymer capsules is expected to become much feasible by the chemical removal of the metal oxide core of the MO-Polymer. The resulting conducting polymer capsules with controllable hollow structure have shown promising prospective applications [6]. The challenge for the preparation of the MO-Polymer is how to generate the polymer coating uniformly and completely on the surface of the metal oxide core by a polymerization reaction in a solution phase. The key issue aims at slowing down the rate of polymerization and controlling the polymerization on the surface of the core rather than in the solution. The fabrication of MO-Polyaniline is particularly of interest because polyaniline (PANI) is one of the most important conducting polymers with high conductivity, ease of synthesis, and good environmental stability [7].

In this paper, we describe the synthesis of PANI and SbO<sub>2</sub> dispersed PANI composite materials through oxidative polymerization of aniline. As prepared PANI and its SbO<sub>2</sub> composite is well characterized by various characterization techniques. Dielectric study of the prepared PANI composite material is also well studied for its Dielectric behavior.

### 2. EXPERIMENTAL

#### 2.1. Materials and Methods

PANI and PANI composites were prepared by chemicals i.e Ammonium persulphate (NH<sub>4</sub>)<sub>2</sub>S<sub>2</sub>O<sub>8</sub>, Hydrochloric acid (HCl), Aniline and SbO<sub>2</sub> are of AR grade. Double distilled water was used in the synthetic process. In situ polymerization of aniline was carried out for PANI and SbO<sub>2</sub> composite materials.

#### 2.2. Synthesis of PANI-SbO<sub>2</sub> Composites

0.1 M aniline was dissolved in 1M HCl to form aniline hydrochloride. SbO<sub>2</sub> was added in the weight percent of 10, 20, 30, 40 and 50 to the above solution with vigorous stirring in order to keep the SbO<sub>2</sub> material suspended in the solution.

0.1M of ammonium persulphate [(NH<sub>4</sub>)<sub>2</sub>S<sub>2</sub>O<sub>8</sub>] as an oxidant was added slowly to the reaction mixture with continuous stirring for 4-6 hours at 0-5°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. Similarly five different PANI- SbO<sub>2</sub> composites with different weight of SbO<sub>2</sub> (10, 20, 30, 40 and 50) in PANI have been synthesized. Pure polyaniline was prepared by chemical oxidation of aniline without adding Indium oxide [8-9].

#### 2.3. Preparation of Pellets

Varied concentrations of prepared composites were pressed under pressure for its pellet form. The test samples to be used were prepared in pellet form of diameter 10mm and thickness 3mm by applying pressure of 7t using Pye-Unicam dye. The contacts for these composites were made using silver paste as electrodes on both sides.

### 2. RESULTS AND DISCUSSION

#### 2.1. X-ray diffraction

Figure-1 shows XRD pattern of PANI- SbO<sub>2</sub> at 50% weight composition. The pattern shows large number of peaks confirms shows the presence of SbO<sub>2</sub> reflections in the composite pattern and is comparison with literature. [9]. Some of the SbO<sub>2</sub> peaks are disappeared in the composite pattern compared to XRD pattern of pure SbO<sub>2</sub> is due to demasking of the oxide in the polymer matrix. This oxide peaks in the composite pattern confirms the formation of SbO<sub>2</sub> dispersed polyaniline composite.

#### 2.2. Scanning Electron Microscopy (SEM)

Figure-2 shows SEM image of SbO<sub>2</sub> sample. This image shows, the most of the particles are in spherical shape and also a compact arrangement. The particle nature clearly indicates the crystalline structure of the sample. Figure-3 shows SEM image of pure PANI obtained by chemical oxidation of aniline. The close packing with amorphous nature is observed in the image. This image also shows the high particle size with self assembly.

Figure-4 shows the SEM image of PANI- SbO<sub>2</sub> at 50% weight percentage. The close mapping of spherical Sb particles in the polyaniline matrix is observed in the image. Clear enhanced crystalline morphology PANI composite is observed. Morphological change in the composite compared to pure PANI and pure SbO<sub>2</sub> show the formation of PANI composites.

Figure 5 shows a representative energy-dispersive X ray (EDX) spectrum of as prepared  $SbO_2$  sample. The pattern shows the presence of Sb metal peaks, which again confirms the presence of  $SbO_2$  in polyaniline matrix.

**2.3. Infrared Study**

Figure-6 shows FTIR spectrum of pure  $SbO_2$ . The sample shows the absorption peak at 1659, 1261, 724, 555, 535, 531, 528 $cm^{-1}$ . The peaks below 1000 $cm^{-1}$  is due the presence of Sb-O bonding.

Figure-7 shows the FTIR spectrum of as prepared PANI-  $SbO_2$  composite. The spectrum shows the peaks at 2287, 2113, 1915, 1552, 1408, 1290, 1081, 1000, 886, 806, 577, 561, 527  $cm^{-1}$ . Peaks below 1000 $cm^{-1}$  clearly shows presence of  $SbO_2$  sample. The peak at 1081 $cm^{-1}$  is due to the B-NH+ = Q vibration, indicating that the PANI is conductive and is in the form of emeraldine salt. The absorption peak at 1000  $cm^{-1}$  is due the C-H bonding of the aromatic ring. The peak 577 is attributed to the out of plane deformation of C-H aromatic ring. The additional peaks at 2287, 2113, 1915, 1552, 1408, 1290 may be due to some overtones.. Some additional peaks and shift in vibrational frequency were also observed on comparison with pure  $SbO_2$  spectrum. This confirms the formation PANI-  $SbO_2$  composite.

**2.4. Dielectric constant**

Figure 8 shows the variation of  $\epsilon'$  as a function of frequency for polyaniline –  $SbO_2$  composites (different wt %). In all the cases it is observed that, the dielectric constant is quite high at low frequency and decreases with increase in applied frequency. The observed behavior may be due to the Debye relaxation mechanism taking place in these materials [10].

**Conclusion**

In this paper Dielectric properties of PANI-  $SbO_2$  composites in the frequency range  $10^2$ - $10^7$  have been presented. Results clearly demonstrate that conducting PANI composite with  $SbO_2$  show better Dielectric constant and observed that 50 wt%  $SbO_2$  in PANI shows maximum Dielectric constant. These composites may be used for the technological development

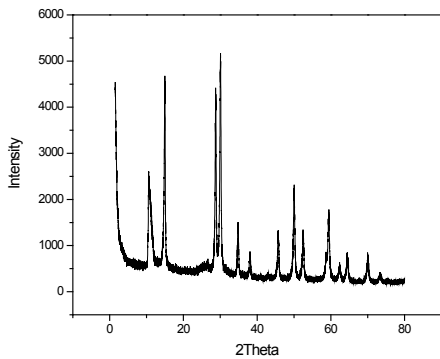


Figure 1: XRD pattern of pure PANI-  $SbO_2$  at 50% weight composition

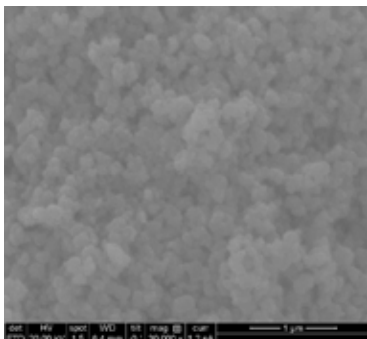


Figure 2: SEM image of  $SbO_2$

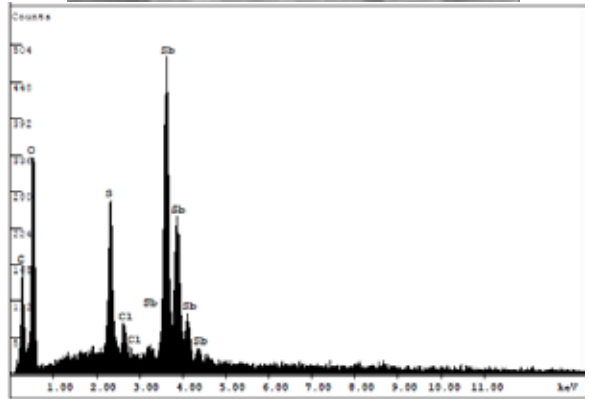
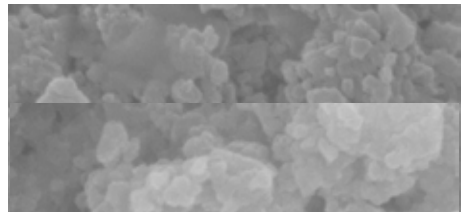


Figure 5: EDAX of PANI-  $SbO_2$  at 50% weight composition

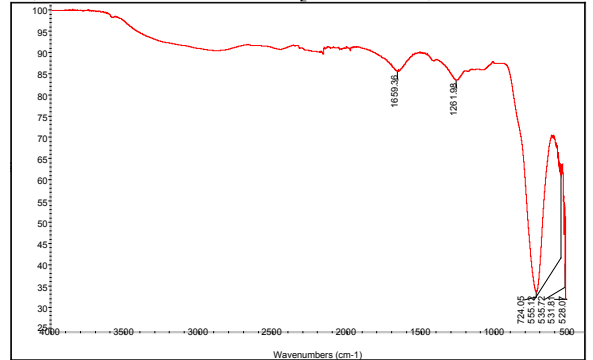


Figure 6: FTIR of pure  $SbO_2$

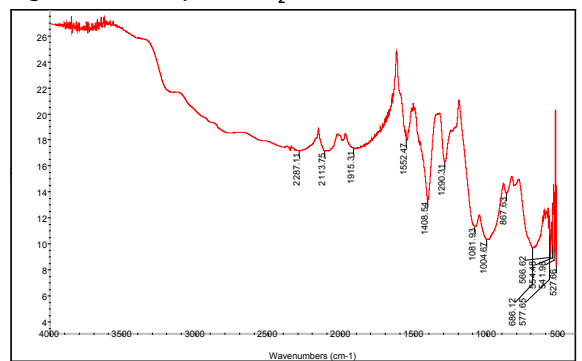


Figure 7: FTIR spectrum of PANI-  $SbO_2$  composite

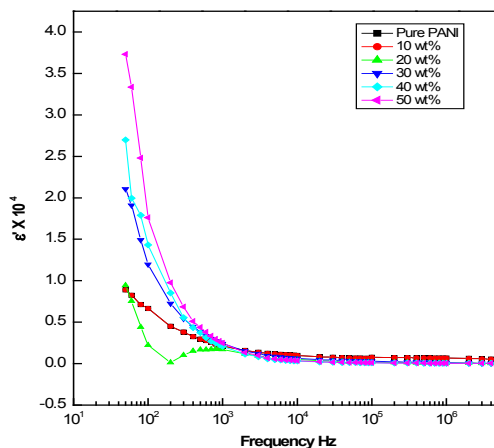


Figure 8: Shows Dielectric constant of PANI-  $\text{Sb}_2\text{O}_3$  composites

## REFERENCE

- Govindraj, N. V. Sastry and A. Venkataraman, Studies on  $\text{Fe}_2\text{O}_3$ -High-Density Polyethylene Composites and their additives, J. Appl. Poly. Sci., 92,2004, 1527-1533. | 2. Syed Khasim, S.C.Raghvendra, M.Revansiddappa and MVN Ambika Prasad, Synthesis, Characterization and Electrical Properties of Polyaniline/ $\text{BaTiO}_3$  Composites. Ferroelectrics, 325,2005, 111-116. | 3. R. Sinha, Outline s of polymer technology, New Delhi:Prentice Hall of India private Limited, (2002). | 4. M.V.Murugendrappa and M V N Ambika Prasad. Chemical Synthesis Characterization and dc Conductivity of polypyrrole –  $\text{Fe}_2\text{O}_3$  composites. J. Appl. Poly. Sci.103, 2007, 2797-2805. | 5. M.V.Murugendrappa and M V N Ambika Prasad, Dielectric Spectroscopy of polypyrrole –  $\text{Fe}_2\text{O}_3$  Composites. Materials Research Bull 41, 2006,1364-1371. | 6. Shankarananda, Arunkumar Lagashetty and Sangshetty Kalyani, Chemical oxidation method for synthesis of Polyaniline- $\text{In}_2\text{O}_3$  Composites, Int. J. Engg. Sci (In Press). | 7. B. Mahesh, S. Basavaraj, S.D. Balaji, V. Shivakumar, A. Lagashetty A. Venkataraman, Preparation and characterization of Polyaniline and Polyaniline-Silver Nanocomposites via interfacial Polymerisation. | Polymer Composites., 30, 2009, 1668-1677. | 8. M.V.Murugendrappa and M V N Ambika, Chemical Synthesis Characterization and dc Conductivity of polypyrrole –  $\text{Fe}_2\text{O}_3$  composites. Prasad. J. Appl. Poly. Sci.. 103, 2007, 2797-2804. | 9. H. S. Chin, K. Y. Cheong, K. A. Razak ,Review on oxides of antimony nanoparticles: synthesis, properties, and applications, J Mater Sci. 45, 2010, 5993–6008 | 10. C.N.R. Rao . Chemical applications of infrared spectroscopy, Newyark and London Academic Press, (1963). | 11. Narsimha Parvatikar and M V N Ambika Prasad, Frequency dependent conductivity and dielectric permittivity of Polyaniline –  $\text{CeO}_2$  composites, Journal of Applied Polymer Science 100(2006)1403.