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Preparation and Characterization of Polyaniline/Ag Nanocomposites

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Abstract: Nanocomposites of conducting polyaniline with Silver nanoparticles (PAni/Ag nano) have been synthesized by *in- situ* polymerization of aniline monomer containing silver nitrate using ammonium persulphate as oxidizing agent. The weight percentage of Ag varied from 3% to 25%. The structure and properties of PAni/Ag composites was assessed by X-Ray Diffraction (XRD), Field Emission Scanning Electron Microscope (FESEM) and UV-Vis spectroscopy. The XRD image shows a nanoparticular structure of silver which is well dispersed in the polyaniline matrix. Uv-Vis spectrum of pure PAni and composites shows three peaks. The DC conductivity of Pure PAni and its composites have been measured in the temperature range from 25°C to 205°C. The DC electrical study of PAni/Ag nanocomposite clearly indicated that the Ag nanoparticles increased the electrical conductivity of polyaniline nanocomposites as compared to pure aniline. **Key words :** Polyaniline; DC electrical conductivity; FESEM.

Introduction and Experimental

Conducting polymers and composites are one of the major areas of experimental research ever due to the possibility to control electrical conductivity of these films from insulating to metallic by doping. A number of metal and metal oxide particles have been encapsulated into the conductive polymer to form nanocomposites. The incorporation of metal nanoparticles acts as a conductive junction between PAni resulting in an increase electrical properties of the polyaniline composites [1]. These properties are extremely sensitive to small changes in content, size and shape of the metal nanoparticles incorporated.

In the present study, PAni/Ag nanocomposites with different Ag concentration were synthesized by *in situ* polymerization techniques using ammonium persulphate as an oxidising agent. The structural, morphological, optical and electrical characterizations of nanocomposites are reported in the present work.

Analytical grade Aniline monomer, Hydrochloric acid and Ammonium persulphate was purchased from Qualigens, and silver nitrate is purchased from Merck chemicals.

Aniline and Ammonium per sulphate are prepared in 1:1.2 molar ratios in 3M HCl. Ammonium per sulphate solution was added drop by drop to the prepared aniline solution over a period of 30 min with continuous

stirring. A dark green colour was seen indicating the formation of polyaniline. Polymerized sample was purified by dialyzing against distilled water and is dried to form films at room temperature.

In order to make the composites, various percentages of Silver nitrate prepared in distilled water are added drop by drop to polyaniline solution dialyzed and dried.

Crystal structure of the prepared PAni and PAni/Ag composites were carried out in Bruker X-ray diffractrometer using Cu-K α radiation. Uv – Visible spectroscopy analysis was done in a Schimadzu 1800 instrument in the wavelengths 190 to 1200 nm.

Results and Discussion

XRD Studies

Fig (1) shows XRD pattern of pure PAni and PAni silver nanocomposites. Pure PAni shows two peaks of 20 at ~ 20° and 25° which correspond to (100) and (110) crystal planes [2, 3]. In addition to PAni peaks, peaks corresponding to the cubic structure of silver were also found at ~45° (200), ~65° (220) and ~78° (311) plane [4].

Degree of crystallinity of PAni/Ag composites were also calculated by X-ray diffraction analysis. The values were found to vary from 20% to 73%. Degree of crystallinity increases with increase in concentration of silver nanoparticles clearly indicating the homogeneous distribution of nanoparticles in the polymer matrix. The particle size Ag in the nanocomposites by using Debye-Scherrer formula is ~ 17.5 nm.



Fig. 1. X-ray diffraction pattern of PANI and PANI/Ag nanocomposite of 25%

Uv – Vis study

Fig. 2. shows the Uv-Vis graph of Pure PAni and one of its composites. Pure PAni shows three peaks at ~200nm, 329 nm and a broader peak in the range 580 to 750 nm. The 329 nm peak can be assigned to $\pi \rightarrow \pi^*$ electronic transition, and is sensitive to the number of aniline units [5]. The broad peak in the range 580 to 750 nm might be due to the exiciton like transition in quinoid units[6]. PAni nanocomposites (25%) also shows three peaks at ~193nm, 322 nm and a broader peak in the range 522 to 693 nm respectively. The peak around ~193 nm could be assigned to the characteristic absorption of small metallic Ag cluster.



Fig.2. UV–Vis spectra of PAni and PAni/Ag nanocomposites

DC conductivity

Fig (3) shows the temperature dependence of DC conductivity in the temperature range of 298 to 478 K for pure PAni and PAni/Ag nanocomposites. The DC electrical study of PAni/Ag nanocomposite of 25% clearly indicated that the Ag nanoparticles increased the electrical conductivity of polyaniline nanocomposites as compared to pure aniline.



Fig 3. DC conductivity graph of Pure PAni and PAni/Ag nanocomposites

PAni/Ag nanocomposites were synthesized by in-situ polymerization at different Ag concentrations. The formations of Ag nanoparticles in the nanocomposites were confirmed by XRD and Uv-Vis spectroscopy. The fibrillar structure of PAni and the linkage of these PAni chains with silver nanoparticles incorporated in it could be the reason for the better conductivity in the PAni nanocomposites.

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