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AC Conductivity Studies on Polyaniline/Cobalt Oxide Nanocomposites Thin Films

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Abstract

Cobalt oxide doped in polyaniline nanocomposite were prepared with various weight percentages by in situ polymerization method and thin films by solvent casting method,for preparation of composite using aniline, ammonium per sulfate, and Cobalt oxide as starting materials. The temperature dependent conductivity behavior of PANI/ Cobalt oxide composites have been studied. The formation of PANI and PANI/ Cobalt oxide composites with regards to the structural and microstructural properties of the materials were investigated by SEM techniques. The conductivity of Pure PANI and its composites have been measured.

Keywords: (SEM,PANI,Composite ,Cobalt oxide,AC)

1 INTRODUCTION

Among conducting polymers, polyaniline family has attracted much attention of scientists world-wide because of their ease of synthesis, unique conduction mechanism, high environmental stability in the presence of oxygen and water, low cost, light weight and good sensing capability[1-3]. They also exhibit highly reversible redox behavior, which is very important for many applications. Extensive literature review suggests that the considerable efforts have been made by researchers all over the world in improving the conductivity of polyaniline by various doping techniques, but little is known about the dielectric properties of conducting polymers associated with conduction mechanism[4] .On doping these conjugated polymers show very high conductivity similar to metals. Therefore sometimes they are also called synthetic metals. They combine the electrical properties of metals with the advantage of polymers such as smaller weight, greater workability, resistance to corrosion and lower cost[5-7] .

2 EXPERIMENTAL PROCEDURES:

2.1. Chemical Synthesis of Polyaniline

The synthesis was based on mixing aqueous solution of aniline hydrochloride and ammonium persulphate at room temperature,followed by the separation of PANI hydrochloride precipitate by filtration and drying. Aniline hydrochloride (equi molar volume of aniline and hydrochloride acid) was dissolved in distilled water in a volumetric flask to 100 ml of solution. Ammoniumpersulphate (0.25M) was dissolved in

water and also to 100ml of solution. Both solutions were kept for 1 hour at room temperature, then mixed in a beaker, stirred with a mechanical stirrer, and left at rest to polymerize. Next day, the PANI precipitate was collected on a filter, washed with 0.2 M HCL, and similarly with acetone. Polyaniline hydrochloride powder was dried in air and then in vacuum at 60^{o}C for 24 hours. Polyaniline prepared under these reaction and processing conditions are further referred to as "standard" samples.

2.2 PREPARATION OF POLYANILINE/ COBALT OXIDE COMPOSITES

Synthesis of the PANI- Cobalt oxide composites was carried out by in-situ polymerization method. Aniline (0.1 M) was mixed in 1 M HCl and stirred for 15 min to form aniline hydrochloride. Cobalt oxide particles were added in the mass fraction to the above solution with vigorous stirring in order to keep the Cobalt oxide homogeneously suspended in the solution. To this solution , 0.1 M of ammonium persulphate, which acts as an oxidizer was slowly added drop-wise with continuous stirring at 5°C for 4 h to completely polymerize. The precipitate was filtered, washed with deionized water, Acetone, and finally dried in an oven for 24 h to achieve a constant mass. In these way, PANI– Cobalt oxide composites containing various weight percentage of Cobalt oxide (10 %, 20 %, 30 %, 40 %, and 50 %) in PANI were synthesized.

3 RESULTS AND DISCUSSIONS

3.1 SCANNING ELECTRON MICROSCOPE

Fig.1 shows that Scanning Electronic Micrograph (SEM) image of pure PANI, which has highly agglomerated granular in shape. The grains are well interconnected with each other which indicate that they have enough binding energy to combine with neighbor grains or molecules.The sem image of pani- Cobalt oxide composite (50%) is shown in fig.2. It can be seen from the image that the particle having spherical and porous structure.
Fig.1&2 shows that Scanning Electronic Micrograph (SEM) image of pure PANI and Cobalt oxide Composite

3.2 AC CONDUCTIVITY

Fig.3 shows the ac conductivity of the Pani and Pani/ Cobalt oxide nanocomposites as a function of the frequency at room temperature .It is found that there is increase in the conductivity of the nanocomposites for the increase in frequency and this pattern is same for all nanocomposites which obeys the universal power law but, at high frequency region, there is an sudden increase in the conductivity with increase in frequency which is the characteristic property of disordered materials. Among all nanocomposites, 50wt% shows highest conductivity and this may due to dipole polarization.

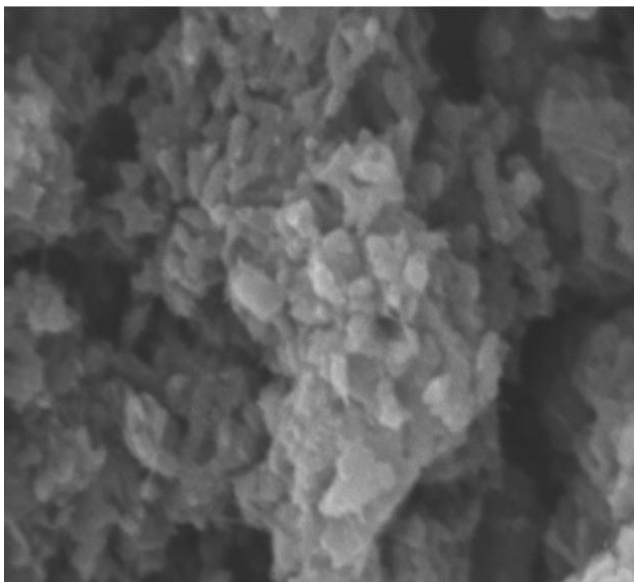

Fig. 1 PANI

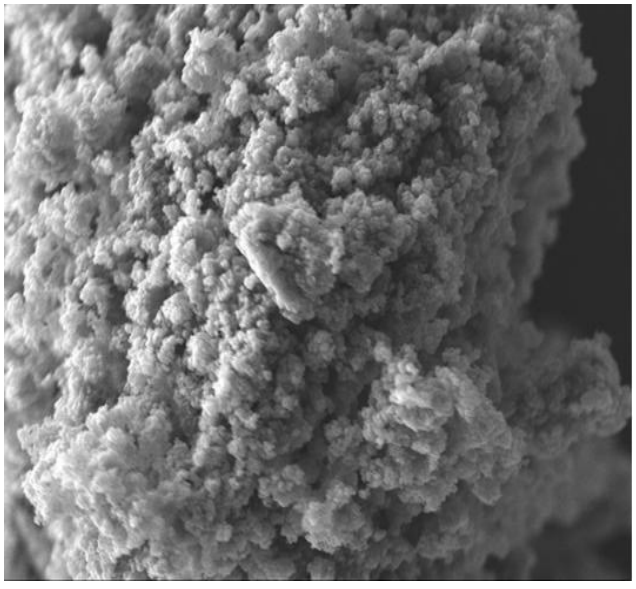

Fig. 2 PANI/ Cobalt oxide Composite

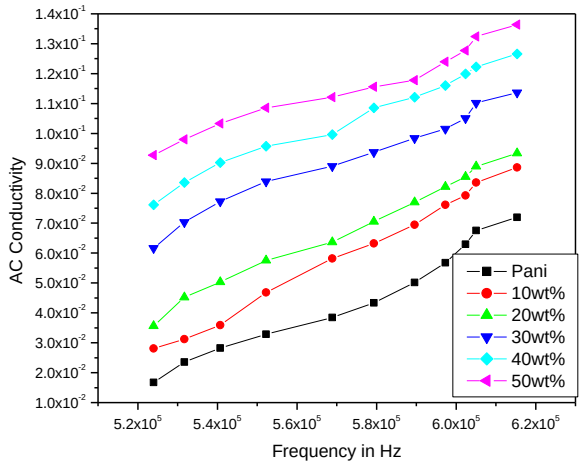

Fig.3 shows the ac conductivity of the Pani and Pani/cobalt nanocomposites

Conclusion

In this study pani/ Cobalt oxide nanocomposites were successfully synthesized by in-situ polymerization method in the presence of Cobalt oxide nanoparticles.the results of sem show the formation of the composite and indicate an interaction between pani and Cobalt oxide nanoparticles.. The electrical properties of pani/ Cobalt oxide nanocomposite are increases with increasing in frequency its because of interaction between metal oxide and pani. Hence this composite is a promising material for potential applications.

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