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Spectroscopic Studies and Thermal Behaviour of Chemically synthesized Silver Doped Polyaniline / Strontium Titanatepolymer Composite

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ABSTRACT

The present work is the study of thermal properties of IPANI/Ag/$SrTiO_3$ (PAS) composites synthesized via in-situ chemical oxidative interfacial polymerization using ammonium per sulfate as an oxidant at 0-3^{0}C. The synthesized polymer composites were characterized by FT-IR analysis and their thermal stability was studied by TGA-DTA techniques. FT-IR patterns confirm the formation of the composite. The endotherms in the DTA profile are consistent with the change regions in the TG curve.

Keywords: Composite, Conducting, TGA, Polyaniline, strontium titanate.

I. INTRODUCTION

Conducting polymer composites blended with inorganic metal-oxides have attracted remarkable interest because of possible interactions between inorganic fillers and the host polymer matrices which may produce novel composite materials with superior properties [1-3]. These materials render the promise of achieving a new polymer composite matrix which exhibitremarkable features viz., reversibility, distinct electrical properties, simple method of polymerization, cost effective monomers and environmentally stable which increase their potential applications in LED's, battery electrodes, sensors, super capacitors, EMI shielding and corrosion coatings [12-14]. Structural conformation, distribution, stability and thermal properties of the composites were analysed using FT-IR and TGA-DTA techniques, and the results are presented here.

II. METHODS AND MATERIAL

Double distilled aniline (0.1M) monomer was dissolved in aqueous nitric acid (1M) solution in a beaker, an organic solvent; chloroform (10ml) was added to the beaker. Then, add 0.1M $(NH_4)_2S_2O_8$ solution and $AgNO_3$ (0.1M) solution separately dropwise, along the sides of the beaker to start oxidation at room temperature for about 2-4 hrs, a dark- greenish coloured precipitate was formed slowly at the junction and then gradually diffused into the aqueous phase. After 36 h; a dark greenish colour polyaniline matrix doped with shiny silver particles is obtained and the same is collected and washed with ethanol. $SrTiO_3$ powderwas added to polymer solution with constant stirring in order to make the $SrTiO_3$particlescompletelysuspended in to the entire polymer solution. The reaction mixture was allowed to proceed at 3^{0}C for about 4hrs. The precipitate so obtained was vacuum filtered, followed by washing with milli-Q water and acetone.Following this

procedure, different IPANI/Ag/$SrTiO_3$ (PAS) composites were prepared by varying 10%, 20%, 30%, 40% and 50% by weight of $SrTiO_3$in IPANI/Ag matrix. The resulting composites were crushed in to fine grained powder and dried in oven at 80^0 C to gain constant weight.

III. RESULTS AND DISCUSSION

A. FT-IR ANALYSIS

The important absorption bands of IPANI observed in the FT-IR spectra recorded for PAS-50% composite are in accordance with the published values found in the literature [4-8] and the corresponding band assignments are represented in the table 1. The Pure $SrTiO_3$ exhibits a characteristic broad band at 548 cm^{-1} which is due to the Ti-O stretching vibration and the band at 1449cm^{-1} may be ascribed to carboxylate group stretching mode [6,7].

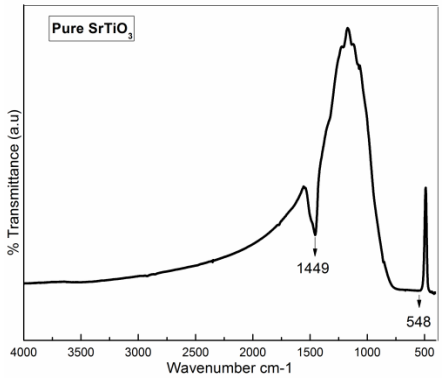

Figure 1a

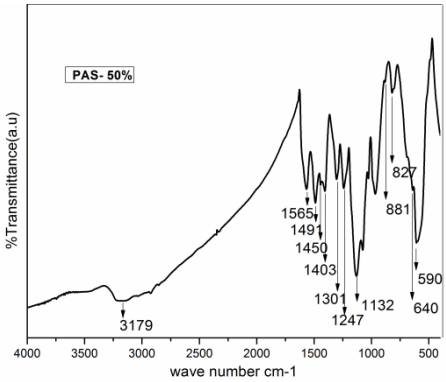

Figure 1b

Figure 1(a-b) represents FT-IR spectra of (a) Pure $SrTiO_3$ and (b) PAS-50% composite

Table 1. IR frequencies of PAS-50% composite and its band assignments

IR Frequencies (cm^{-1})	Band Assignments
3179	N–H stretching of aromatic amine
1565	N=Q=N ring stretching modes
1491	N-B-N ring stretching modes
1301	Asymmetric C–N stretching modes of the benzenoid moiety
1247	Conducting protonated form of IPANI
827	C-H out plane bending of p-disubstituted benzene ring

By vigilant observation of FT-IR spectra of the composite a well retained characteristics peaks of $SrTiO_3$ was observed, however the typical stretching frequencies are significantly shifted towards higher frequency region, suggesting weak vanderwaals interaction between the $SrTiO_3$ particles and polyaniline backbone [7,15].

B. THERMAL STUDIES

The TG curve of IPANI shows two stage weight loss behaviour, intial weight loss of about 3.90% below 150°C ascribed to the removal of absorbed water molecules and acid dopants on the surface of the IPANI chain [9] and the major weight loss of 9.50% is occurred from 300^0-400^0C due to degradation of IPANI backbone [10]. Similar behaviour in the degradation process was also observed for silver doped IPANI, it shows higher onset degradation temperatures compared to IPANI due to the presence of more thermally stable silver particles [12].

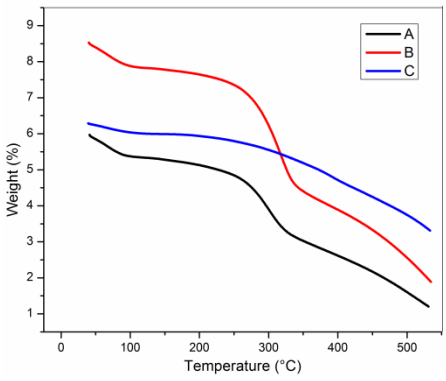

Figure 2a

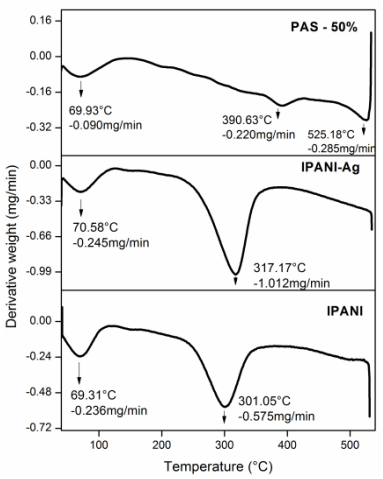

Figure 2b

Figure 2 Shows (a) TGA curves of A. IPANI, B. IPANI-Ag, C. PAS-50% composite. (b) Derivative weight loss pattern of IPANI, IPANI-Ag, and PAS-50% composite, which suggests most apparent weight loss steps corresponding to endothermic peaks in the region 40⁰- 550⁰C .

The TG thermogram of PAS-50% composite exhibit three distinctive decomposition patterns, from ambient temperature to 550⁰C, the first step weight loss of 1.5% below 100⁰C which is due to removal of moisture and volatile impurities, second step weight loss of 4.7% occurs in the range 300-350⁰C, the third step weight loss of 3.5% in the range 350⁰- 400⁰C is mostly attributed to degradation of IPANI backbone [11] and the third step weight loss of 4.5% takesplace beyond 500⁰C, which is due to decomposition of strontium titanate particles. The onset temperatures for three degradation stages of the composite are 69.93⁰, 390.63⁰, 382.65⁰ and 525.18⁰C respectively.The decomposition rate of the polyaniline when combined with $SrTiO_3$ and silver particle is found to be different from that of the bulk IPANI. IPANI undergoes rapid thermal degradation at 301.05⁰C; however the composite is stable up to 525.18⁰C. This suggests that, the composite is thermally more stable compared to that of bulk IPANI. From the table 2, it is clear that, upon addition of strontium titanate particles in to the IPANI/Ag matrix, the thermal stability of the composite is notably enhanced.

Table 2.% weight losses and onset temperatures of synthesized samples

Sample	Steps	% Weight loss	Onset temperature (⁰C)
IPANI	1	3.9	69.31
	2	9.5	301.05
IPANI-Ag	1	2.9	70.58
	2	11.8	317.17
PAS-50%	1	1.5	69.93
	2	3.5	390.63
	3	4.5	525.18

IV. CONCLUSION

In the present work, IPANI/Ag/$SrTiO_3$ composites were successfully prepared by in-situ oxidative interfacial polymerization using ammonium per sulfate as an oxidizing agent. The weak vanderwaals interaction of IPANI chain with $SrTiO_3$ particles and the structural changes in the composite were confirmed by the FT-IR spectra. It was found that, the additive has considerable effect on the stability of the composite, suggesting that the synthesized composite is thermally stable up to 525⁰C.

V. ACKNOWLEDGEMENT

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