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SYNTHESIS OF NANO (PANI-SnO_2) COMPOSITES AND STUDY OF D. C. CONDUCTIVITY

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ABSTRACT

In the present paper, we report D.C. conductivity on the composite of conducting polymer polyaniline (PANI) with nano crystalline SnO_2 powder. The D.C. conductivity of (PANI-SnO_2) composite has been investigated. The PANI samples with SnO_2 are prepared with different (10, 12, 15, 20, 25) wt%. The experimental results showed that the D.C. electrical conductivity increased with increasing the tin oxide (SnO_2) concentration and temperature. The nanosize Tin oxide is prepared in the laboratory from $SnCl_4$ & ammonia solution. The polyaniline conducting polymer is synthesized by chemical oxidation method using ammonium persulfate as oxidizing agent. The 20 wt % of nanosize tin oxide (SnO_2) powder was added in solution during the synthesis of polyaniline. TEM (Transmission electron microscopy) results shows the particle size of SnO_2 in the range of 10-20 nm.

Key words: Nano composites, D. C. conductivity.

INTRODUCTION

Conducting polymers have emerged as a very important class of materials because of their unique electrical, optical, and chemical properties leading to the wide range of technological applications. This class of materials provide tremendous scope for tuning of their electrical conductivity from semiconducting to metallic regime by way of doping[1,2]. The unique properties of conducting polymers not only provide great scope for their applications but also have led to the development of new models to explain their observed properties, particularly various mechanisms of charge transport[3,4]. The importance of polymers is mainly because polymers are still regarded as a cheap alternative material that is manufactured easily. The intensive use of polymer in broad has led to the development of materials for specific applications namely composites[5]. Recently polymer matrix-ceramic filler composites receive increased attention due to their interesting electrical and electronic properties, integrated decoupling capacitors, angular aceleration accelerometers, acoustic emission sensors and electronic packaging are some potential applications. Ceramic materials are typically brittle, possess low dielectric strength and in many cases are different to be processed requiring high temperature. On the other hand, polymers are flexible, can be easily processed at low temperatures and exhibit high dielectric break down fields.Practical application of conducting polymers such as polypyrrole, polythiophene and polyaniline is limited particularly because of their poor mechanical

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properties. However, the composites prepared by mixing of conducting polymers with conventional polymers can be used in order to improve mechanical properties for all potential usages significantly[6].

EXPERIMENTAL

Synthesis of polyaniline (PANI)

0.2 M aniline hydrochloride is oxidised with 0.25 M ammonium peroxydisulfate in aqueous medium. Aniline hydrochloride (purum, 2.59 g, 20 mmol) was dissolved in distilled water in a volumetric flask to 50 mL of solution. Ammonium peroxydisulfate (purum, 5.71 g, 25 mmol) was dissolved in water also to make 50 mL solution. Both solution were kept for 1 h at room temperature (18-24^{0}C), then mixed in a beaker, briefly stirred, and left at rest to polymerize. Next day the PANI precipitate was collected on a filter, washed with 100 mL portions of 0.2 M HCl and similarly with acetone and then dried in air.

Preparation of nano SnO_2 powder

0.1 M of stantanous chloride dihydrate (2.2563 g) is dissolved in 100 mL water. After complete dissolution, about 4 mL ammonia solution is added. White gel precipitate is immediately formed. It is allowed to settle for 12 h. Then it is filtered and washed with water 2-3 times. The obtained mixture is dried for 24 h at 70^{0}C. Dried powder is crushed and heated at 600^{0}C for 3-4 h.

RESULTS AND DISCUSSION

TEM analysis

Fig. 1(a) and (b) shows theTransmission electron microscopy images of PANI and SnO_2 powder respectively. From the TEM pictures it is seen that the PANI has mostly amorphous nature but partly crystalline behaviour is seen. Small crystallites are formed like ball, which are attached to each other in chain like form. In case of SnO_2 nanosize crystallites (10-20 nm) are formed having regular shape. Some voids and spaces are seen in the picture. This may generate the porosity at the surface of the composite film of PANI and SnO_2.

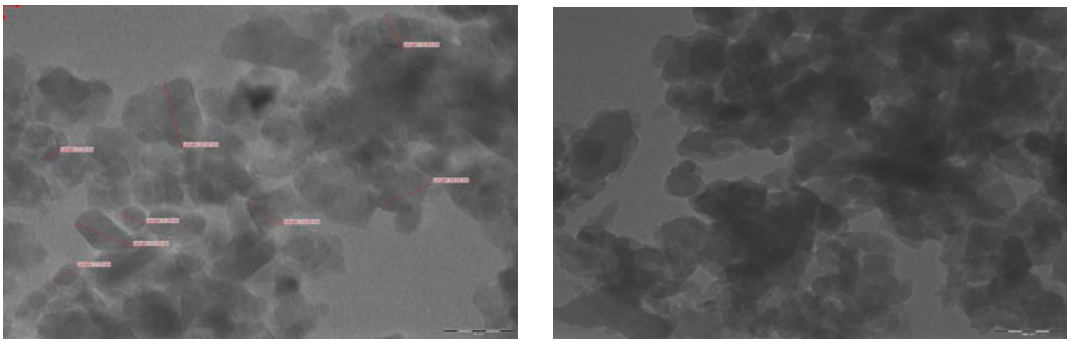

Fig. 1 (a): TEM images of PANI (b) TEM images of SnO_2

DC Electrical conductivity

D C electrical conductivity of PANI-SnO_2 composite polymer is calculated in the temperature range 303 to 373 K by measuring the resistance of the sample. The value of dc- electrical conductivity is found to be of the order of 10^{-3} (ohm-cm)$^{-1}$ for 303 K. The dc conductivity of polyaniline increases due to addition of SnO_2 wt%.The variation of dc- conductivity with temperature for the different composition of PANI and SnO_2 is shown in Fig. (2).

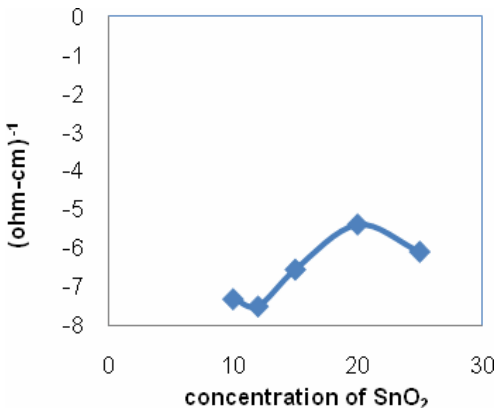

Fig. 2: Variation of dc conductivity with concentration of SnO_2

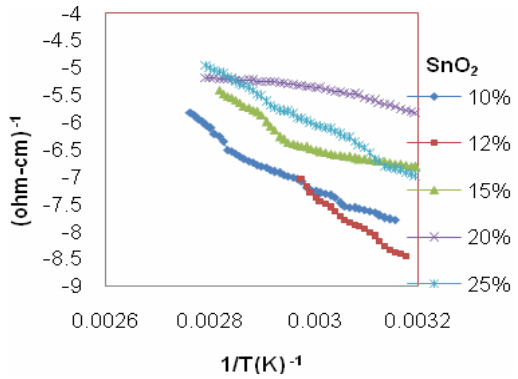

Fig. 3: Variation of log σ with inverse temperature PANI-SnO_2 composite polymer

For all the samples dc-conductivity follows Arrhenius relation.

$\sigma = \sigma_0 \exp(-W/KT)$

where σ_0 (ohm-cm) $^{-1}$ is the pre-exponential factor, W(ev) is the activation energy, T(K) is the temperature and K is the Boltzmann constant.

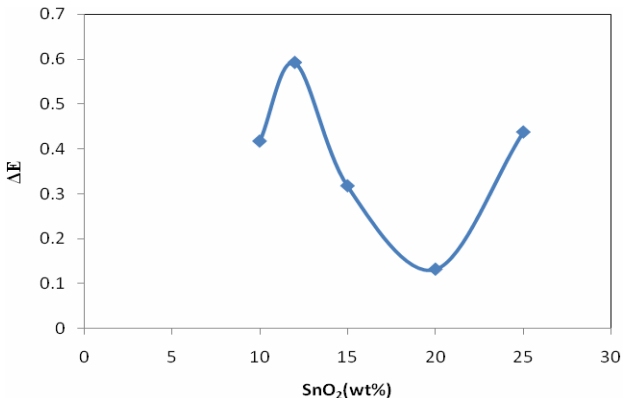

Fig. 4: Variation of activation energy with concentration

In the composite conductivity increases slowly with temperature and the variation of conductivity with temperature is linear. From the slope of the straight line, the activation energy is calculated. It is

observed that activation energy is temperature independent but depends on composition. It is observed that the activation energy (Fig. 4) increases with composition of SnO_2 and reaches manimum for 20% SnO_2. It is found to be miximum for 12% SnO_2.

CONCLUSION

From the study of the dc-conductivity,the dc conductivity of polyaniline increases due to addition of SnO_2 mol %. The variation of dc- conductivity with temperature is linear and found to be maximum for 20% SnO_2. The nano size SnO_2 ina polyaniline composites plays the important role in the contribution of conducivity. The rough surface morphologgy is observed.

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