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Mechanical and Electrical Properties of Polyaniline/ Lead Oxide Nano Composites

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ABSTRACT: *Lead oxide nanoparticles were synthesized by ecofriendly low temperature solution combustion method.Polyaniline (PANI) and PANI- Lead oxide nanocomposites through in-situ chemical oxidative polymerization. The XRD spectrum analysis of the nanocomposites indicates high crystallinity. SEM images showed fine dispersion of Lead oxide nanoparticles in polymer matrix. The study through DCconductivity showed enhancement in electrical conductivity of PANI- Lead oxide nanocomposites over pure PANI. The enhancement of electrical conductivity has been attributed to accumulation of charge carriers at the interfaces of the polymer-semiconductor metal oxide nanocomposite and the formation of large dipoles by the semiconductor nanoparticles.*

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I. INTRODUCTION

Conducting polymer nanostructures combine the interaction of two dissimilar chemical components. Most studies in the field were devoted to the systems and therefore should yield many interesting preparation of Polyaniline (PANI) /noble metal composites physicochemical properties and useful applications and ease of preparation. Conducting polymers have been foundduring the last decade,and considerable attention has been given to applications in fields like: sensors, electro catalysts, synthesis and evaluation of clay/polymer microelectronics, electromagnetic shielding, rechargeable nanocomposites via the intercalation polymerization of batteries and controlling systems[1-4]. Special monomers such as aniline, pyrrole, thiophene or with a high surface area and porosities are known to show N-vinylcarbazole[5-6]. Among the organic conducting polymers Polyaniline (PANI) is the only conducting polymer whose properties not only depend on the oxidation state but also on it protonation state / doping level and also on the nature of dopants. It possesses excellent electric, magnetic and optical properties. It is generally regarded as one of the conducting polymer with high potential in commercial application.With the appearance of nanotechnology, nanofillers play significant roles in the improvement of mechanical, thermal, electrical and anticorrosive properties of polymers[7-9].

II. EXPERIMENTAL

2.1Synthesis ofconducting Polymer

The synthesis of Polyaniline (PANI) 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. An equi-molar volume of aniline and hydrochloride acid was dissolved in distilled water in a volumetric flask to obtain 100 ml of solution. Similarly, ammoniumpersulphate (0.6M) was dissolved in 100 ml water. Both solutions were kept for 1 hour at room temperature and then mixed in a beaker, stirred with a mechanical stirrer and allowed to polymerizing. After a day, the PANI precipitate was collected on a filter washed with 0.3 M HCL and acetone repeatedly. The Polyaniline hydrochloride powder was then dried in vacuum at 6^{o}C for 24 hours.

2.2Synthesis of Polyaniline/Lead oxide nanocomposites

Synthesis of Polyaniline–Lead oxide nanocomposites were carried out by in-situ polymerization method. Aniline (0.3 M) was mixed in 0.3 M HCl and stirred for 15 min to form aniline hydrochloride. Lead oxide powder were added in the mass fraction to the above solution with vigorous stirring in order to keep the lead oxide homogeneously suspended in the solution. To this solution, 0.6 M of ammonium per-sulphate, which acts as an oxidizer was slowly added drop-wise with continuous stirring at ice temperature for 4 hours to completely polymerize. The precipitate was filtered, washed with deionized water and acetone, and finally dried in an oven for 24 h to achieve a constant mass. The Polyaniline - lead oxide nanocomposites were thus obtained containing various weight percentage of nickel oxide (i.e.10, 20, 30, 40, & 50%).

2.3Preparation of Pellets

The powders of Polyaniline, Polyaniline/PbO nanocomposites, so obtained from synthesis Method discussed in early sections were made as a fine powder with the help of agate mortar in the presence of acetone medium. The powder is then pressed to form pellets of 10 mm diameter and thickness varying up to 1.8mm by applying pressure of 80 MPa in a hydraulic pressure. Temperature dependent conductivity studies, the n the pellets were coated with the silver paste on both faces of the pellet for providing electrical contacts.

III. CHARACTERIZATIONS

3.1XRD Analysis

X-Ray Diffraction were done studies using Shimadzu-7000 diffractometer with Cu as the target (1.54 Å) and nickel as the filter. A broad peak centered at $2\theta = 25.53^0$ may be assigned to the scattering from the Polyaniline chains at interplanar spacing which clearly implies the amorphous nature of Polyaniline and it corresponds to diffraction planes (200) of pure Polyaniline. In the case of pure PBO which has a sharp and well defined peak and it indicates good crystallinity of PbO nanoparticles in the XRD POattern and shows the intensity of diffraction peaks for PANI/PbO nanocomposites and it is found to be lower than that for pure leadoxide. The peaks of pure lead oxide nanoparticles are also present in PANI/PbO nanocomposites. The XRD peaks are broad indicating that the particles are in nanometer size range.The amorphous background hump comes from the Polyaniline. The average particle size of lead oxide calculated by using Scherer equation is found to be 40nm .

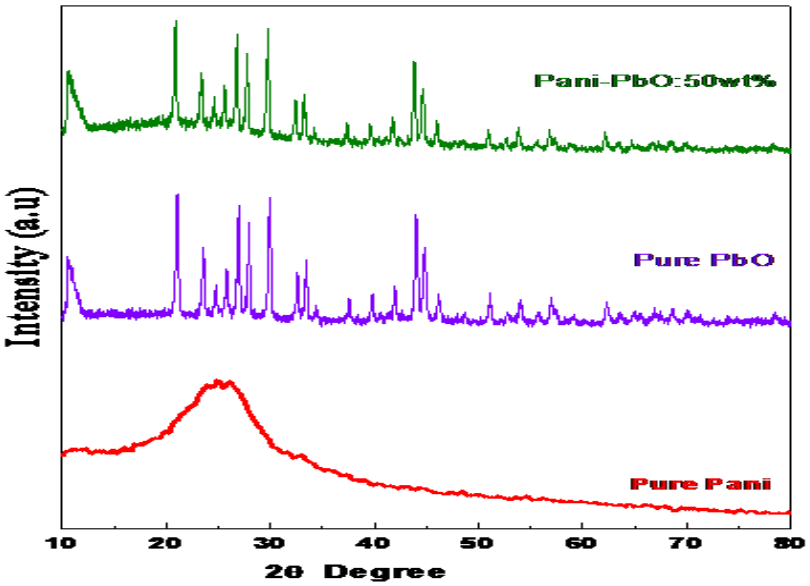

Fig3.1 (a) Observed diffraction pattern of Polyaniline.

3.2 STRUCTURAL ANALYSIS

The morphology of the nanoLead oxide and nanocomposites in the form of powder were investigated using SEM micrographs. Fig 3.2(a) reveal that the pure PbO nano particles are irregular agglomerated in nature. Fig 3.2 (b) shows SEM micrographs for PANI: PbO (50 wt %) nanocomposites .AFM in a two dimensional and three dimensional views are shown in Fig C and .D Two dimensional view shows that the Pani/PbO (50%) nanocompositesurface is covered uniformly by fine grains.The three dimensional view shows that the consists of

distributecuboidal shaped grains with some visible voids.From AFM images it is revealed that the nanocomposite is accompanied by much micrometric and nanometric roughness.

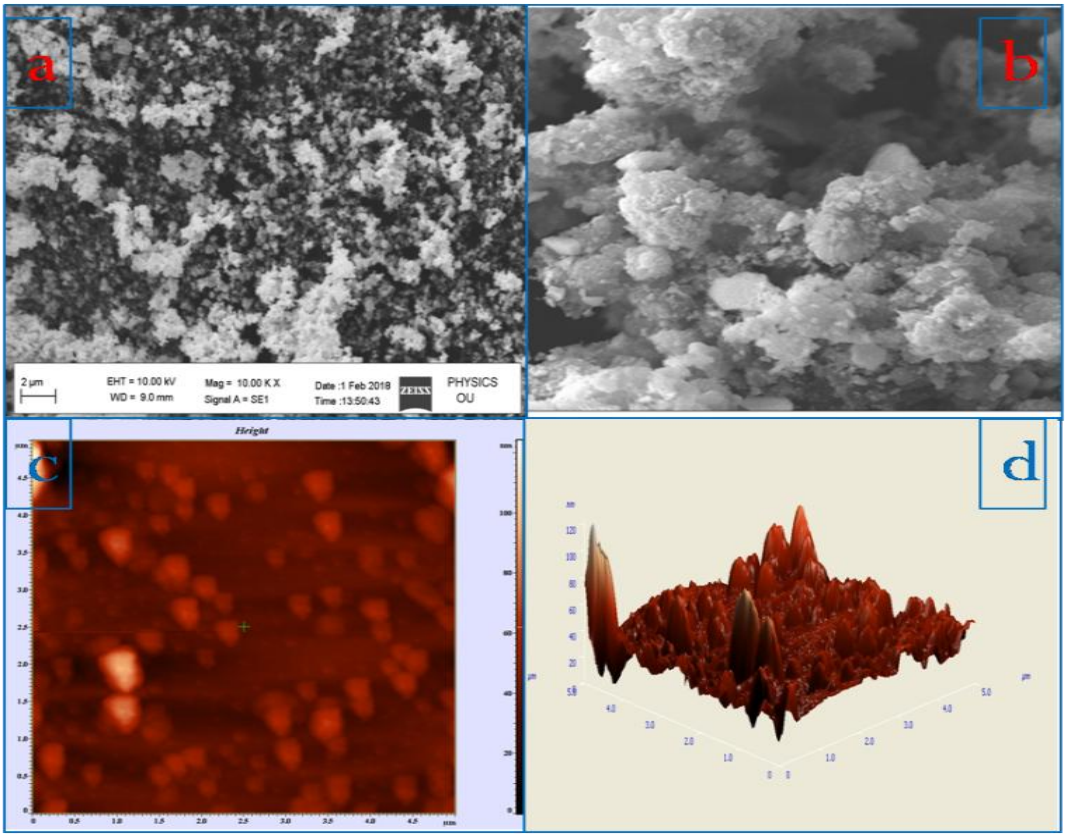

Figure3.2(a&b) SEM and (c&d) AFM Images of Pani-PbO 50wt% NCs

IV. RESULTS AND DISCUSSION

4.1MECHANICAL PROPERTIES

Name of sample	Stress (GPa)	Strain	Y (GPa)	Poission ratio	Shear modulus (GPa)	Bulk modulus(GPa)
Pure Pani	0.8	0.4112	1.94	0.14	0.889	0.898
Pani-PbO 30wt%	0.848	0.421	2.01	0.148	0.838	0.95
Pani-PbO 50wt%	0.85	0.42	2.02	0.142	0.884	0.94

4.2AC Conductivity:

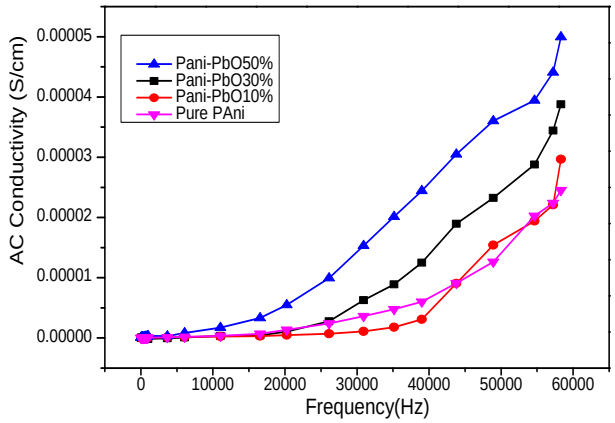

Fig.5.The variation of AC conductivity

Electrical studies The electrical property of AC conductivity as a function of frequency are obtained for lead oxide nanoparticles and for its nanocomposites with conducting polymer of PANI at different concentrations .The variation of AC conductivity as a function of frequency at room temperature is given in Fig.5. It is observed AC conductivity remains constant up to 1.6 MHz after that the conductivity increased exponentially. It is also observed that as doping of PANI with lead oxide nanoparticles increased the AC conductivity also increased. The increase in conductivity may be due to available number of charge carriers for conduction and all the dipoles are aligned in one particular direction and also the extension of chain length of PANI where the polarons get sufficient energy to hop between favorable localized sites.

V. CONCLUSION

In the present article, we report on the preparation of composites of conducting Pani/LeadOxide nanocomposites by using in-situ chemical polymerization route. The conductivity, and mechanical properties of these nanocomposites were studied. The effect of lead Oxide concentration on conductivity properties **was**investigated.

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