International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 8.141
Peer Reviewed Bi-Monthly
Vol. 6 No. 18 March - April - 2025

Nanoparticles Synthesis And Morphological Characterization Of PANI Doped With ZnO

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DOI - 10.5281/zenodo.15266449

Abstract:

Nanoparticles of polyaniline and polyaniline-ZnO nanocomposites are prepared by chemical oxidative polymerization method. SEM micrographs of the film doped with ZnO shows certain types of crystallinity may be due to the ZnO. and morphology of PANI doped with ZnO shows further improvement of surface morphology. The surface morphology changes severely from rough to smooth. Also the addition of ZnO shows further drastic improvement of surface morphology of polymer composite.

Introduction:

There is an increasing demand of renewable energy sources in the coming days. For that an emerging alternate source is solar energy. This can be achieved by preparing such resource with conducting polymers. As Conducting polymers show different promising applications in various fields, for example in transistors, sensors, actuators/ muscles, [1]. The composites of the metal oxides in a polymer shows interesting mechanical and thermal properties that are necessary to be accomplished with any material. It has advanced applications in industries aerospace, shipbuilding, automotive, military, building and construction industries.

Polyaniline has incredible solidness in its doped, de-doped form. It has an extraordinary applications like anticorrosion coatings, [2-3], synthetic detecting, batteries [4], electromagnetic impedance protecting, microelectronics, etc. [5-6], Polymer composites have improved optoelectronic properties due to the expansion of fillers. Polymerization of polyaniline-graphene oxide nanocomposites showed enhanced electrical conductivity of 9.2 S/cm [7]. The conductivity of SnO_2/PANI nanocomposites is found to be 1.75×10^{-1}S/cm by some researchers [8]. Maximum conductivity of PANI/SnO_2 nanocomposite was found to be 6.4×10^{-3} s/cm at 9 wt%. Liu *et al* [9] prepared TiO_2/PANI solar cells. The composite of (ZnO/PANI) was found electrically responsive to humidity in a closed chamber.

In the present work, naoparticles of polyaniline and polyaniline-ZnO nanocomposites are prepared by chemical oxidative polymerization method. Their structural characterization is done by scanning electron microscopy technique and x-ray diffraction technique. We are getting crystalline nature of the nanocomposite with agglomeration of crystals over polymer and nanosized particles in nanocomposite.

Preparation of Materials:

Preparation of Polyaniline (PANI) nanoparticles:

In this process polyaniline nanocomposite was synthesized by chemical oxidative polymerization method [10]. 2.59 gm of aniline hydrochloride was dissolved in 50 ml distilled water in a volumetric flask. Similarly 5.71 g of ammonium persulfate (APS) was dissolved in 50 ml distilled water kept for 1 h. at room temperature (303 K), During additions, mixture is stirred for 2 hr. Then resulting dark green precipitate of PANI was filtered and washed with HCl and acetone. Obtained precipitate was kept in oven to dry for about 8 hrs. at 50-60 ^{0}C.

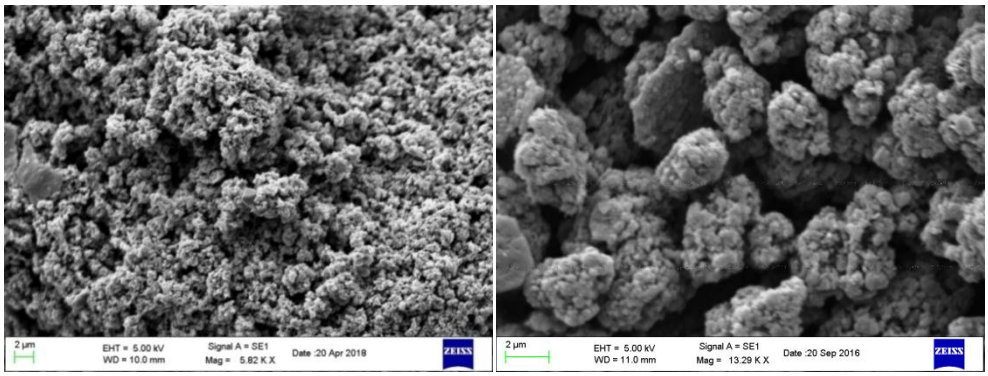
Preparation of Polyaniline-Zinc Oxide Nanocomposite:

In the present work polymer composite with ZnO was prepared by *in-situ* polymerization method [11] with Zinc Oxide (ZnO) 20 wt.%. ZnO nanoparticles were dispersed into the APS solution of 50 ml DD water and stirred for 1 hr. Aqueous solution of 2.59 g of aniline hydrochloride in 50 ml DD water added slowly in APS under vigorous stirring for 2 h. The resulting dark green PANI-ZnO precipitate was filtered and washed with HCl and acetone. Then kept in oven for about 8 h. at 50-60 ^{0}C. In this way PANI-ZnO nanoparticles were formed.

Characterization:

Scanning Electron Microscopy (SEM):

The SEM micrographs of PANI and ZnO doped with PANI are shown in figure below. From the SEM micrographs of the film doped with ZnO, it is found that image show certain types of crystallinity may be due to the ZnO. Morphology of PANI doped with ZnO shows further improvement of surface morphology. Nanoparticles formed are not of homogeneous size.



(a) **(b)**

Fig.: Scanning Electron Microscopy images of (a) PANI (b) PANI+ZnO (5%):

There is agglomeration of crystallites which is clearly seen from Figure. A fine microsphroidal surface was observed with poor matrix. The fine islands in micro meter size are observed with matrix having nano size particles. PANI is completely amorphous in nature whereas PANI-ZnO nanocomposite shows partly crystalline as well as amorphous phase. Nanoparticles were not of homogenous size but of different sizes ranging from 150-250 nm for PANI. These materials are polycrystalline in nature. Particle sizes of PANI- ZnO nanocomposite are found in the range 50 to 300 nm. Amorphous structure with very fine particles is seen. ZnO nanoparticles are seen which are deposited on surface of PANI.

X-Ray Diffraction Technique (XRD):

The X-Ray diffraction has been used to determine the possible crystallinity in the composite films. The X-ray diffraction was carried out in the 2θ range from 0 to 100^o. The XRD spectra of Pure PANI and PANI-

ZnO nanocomposites with 5 wt % of ZnO are shown in figure

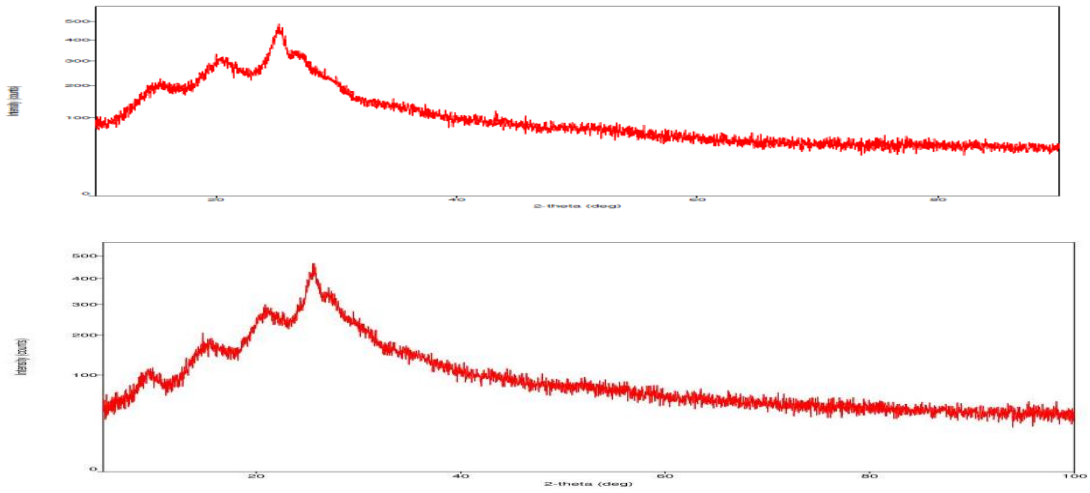


Fig.: X-Ray Diffraction images of PANI and PANI+ZnO (20%)

PANI showed two peaks at $2\theta=20.34^{o}$ with planes of (010) which represents the characteristic distance between the ring planes of benzene rings in adjacent chains or the close contact inter-chain distance and at 25.20^{o} with planes of (200) which represents the scattering from PANI chains at interplanar spacing (12, 13) and very low intensity of the observed peak indicates that the Polyaniline has amorphous nature with low crystallinity.

For to study the effect of doping of ZnO nanoparticles analysis of the position of the XRD peak indicates that there is a shifting in peak's position towards lower 2θ value. These results are in good agreement with the results reported before. The shifting of the peak's position shows that ZnO nanoparticles are incorporating into the PANI matrix [14]. The crystallite size of PANI-ZnO nanocomposite was estimated from X-ray line broadening using Scherer's equation and found around 30 to 60 nm. The X ray diffraction pattern shows that degree of crystallinity of PANI-ZnO composite is higher than that of PANI. This shows that the amorphous nature of PANI may affect the crystallisation of ZnO [15]

Conclusion:

SEM micrograph shows the partly crystalline behaviour as well as amorphous morphology of Polyaniline doped with Zinc Oxide (ZnO). Nanoparticles formed are not of homogeneous size. Agglomeration of the crystals were seen. These materials are polycrystalline in nature. The surface morphology changes severely from rough to smooth. Also the addition of ZnO shows further drastic improvement of surface morphology of polymer composite. The average size of the particles PANI and PANI-ZnO nanocomposite are found to be range between 200-550 nm, and 100-250 nm respectively.

From the X-Ray diffraction technique it was observed that Polyaniline doped with ZnO indicating the partly crystalline and partly amorphous in nature. The sharp peak observed in PANI-ZnO nanocompositeis due to the presence of ZnO in the nanocomposite. A nanocomposite show greater crystallinity due to the addition of ZnO in PANI matrix as compared to pure PANI.

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