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Preparation and Characterization of New Polymer Electrolyte for Fuel Cell and Its Application

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ABSTRACT: *Polyaniline/Zinc oxides (ZnO) Nano composites were synthesized by chemical method .Intrinsically conducting PANI/ZnO composites were synthesized with varying amounts of zinc oxide (0.1g, 0.5g wt. %) via a facile chemical oxidation polymerization approach. The structure and properties of PANI/ZnO composites were assessed by X-Ray Diffraction (XRD), Scanning Electron Microscope (SEM) and FT-IR spectroscopy. The XRD analysis demonstrated the nanocrytalline nature of PANI and its composites. FT-IR results show broadening and shifts of peaks towards lower wave numbers in all composites suggesting better conjugation and some chemical interactions between PANI and ZnO particles.*
Keywords: *FT-IR,Nanocomposites, Polyaniline, SEM.XRD, Zinc oxide.*

I. INTRODUCTION

A polymer is a molecule composed of a large number of covalently-bonded repeating structural units. Applications of polymers range from daily uses (e.g., plastics, rubbers, fibers, paints, adhesives, etc.) to cutting-edge uses (aircraft, bullet-proof vests, artificial joints, etc.). All polymers were thought to be excellent insulating materials until the 1970's, when Hideshi Shirakawa, Alan G. MacDiarmid, Alan J. Heeger and their coworkers reported the high conductivity of polyacetylene doped with AsF_5.[1,2] Since then, extensive research has been carried out on conducting polymers because of their excellent electrical and optical properties. These materials have broad application in areas ranging from anticorrosion coatings, to chemical sensors and biosensors, light-emitting devices, and solar cells, as well as many others.[3] Among various types of organic compounds, conducting polymers found different applications due to their unique properties. PANI is one of the most promising conducting polymers and received full interests due to its special properties such as high conductivity, simple methods of preparation, stability and good mechanical properties [4].

The mentioned advantages of PANI lead to wide potential applications in various fields, such as rechargeable and lightweight batteries, drug delivery, membrane separation, supercapacitors, sensors, corrosion protection and electronic and electrochromic devices. The unique properties of metal nanoparticles and conducting polymers result in an increasing motivation in the synthesis of nanocomposite materials containing from finely and homogenously dispersed nanoparticles in conducting polymer matrices [5,6]. On the other hand, the metal oxides nanoparticles,, have attracted much attention currently due to their high conductivity, therefore potential applications in technological fields. Therefore, the preparation of composite of PANI and Zinc Oxide can be a fresh contest for investigators. Oxidative polymerization exemplifies a new route to access conducting polymers and nanocomposites with conducting polymers matrices [7]. It is one of the important green chemistry processes to prepare multifunctional polymers. This method has been widely used to prepare different types of conducting polymers and their different derivatives [8,9]. In particular ZnO is widely used for sensor applications because of its excellent sensitivity towards gas pollutant.In this paper PANI/ZnO nanocomposites were synthesised and prepared by direct chemical oxidative polymerization method. The prepared PANI/ZnO nanocomposite material used to prepare various wt% PANI/ZnO composite. Considering the excellent electrical properties of PANI and ZnO nanocomposite, it is expected to obtain excellent final electrical properties for their nanocomposites [10-12]. The nanocomposite were characterized by the impact of the structures and properties of the PANI–Zno nanocomposites were deeply discussed by means of their characterization with Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD),scanning electron microscope (SEM).

II. EXPERIMENTAL STUDIES

In this chapter, a description of polymerization synthesis of Zinc Oxide and Aluminium nano composite polyaniline polymer.

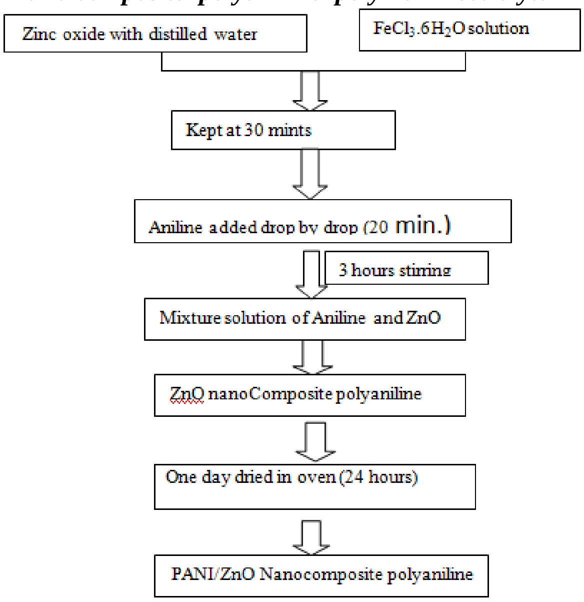
2.1 Chemicals Required

1. Aniline
2 .Feric Chloride
3. Zinc Oxide - (1.0g, 0.1 g)
4. Aluminum nitrate - (0.1 g, 0.5 g)

Aniline (99%) , ZnO were obtained from E.Merck. Aniline was distilled prior to use. All supplementary chemicals were analytical grade and solutions were prepared with double distilled water. The solution was magnetically stirred well. The mixture was continuously stirred in upto 30 minutes. By using a burette, The Aniline was added drop by drop wise for about 20 minutes .

PANI–ZnO nano composites were prepared by mixing different weight % of ZnO (1.0g , 0.1g) with PANI powder. Similarly the aluminium (0.1 g, 0.5g) composite PANI was prepared. At end point of the polymerization reaction , final product was dried at 60°C in one day . The synthesized polyaniline was grinded and the product was obtained in the form of fine block power.

2.2. Flow chart for ZnO nano composite polyaniline polymer Electrolyte



III. RESULT AND DISCUSSION

3.1 X-Ray Diffraction Analysis

The X-ray diffraction (XRD) studies of the sample was done in Rigaka X-ray Diffractiometer with Cu-Kα radiation operating at 80 KV . XRD was carried out in the 2Θ range from 10 to 80 ° at the scan speed of 10° per minute. The XRD patterns of the PANI/ZnO nanocomposite are shown in figure 4.1., 4.2. The average crystalline size of the polyaniline – ZnO composite was calculated using the Scherrer equation.

D=0.9 □/cos □

Where D is the crystalline size of particles , λ is the wavelength of X-ray , Θ is the half diffraction angle peak (in degree) and β is the true half peak width. The average crystalline size of determined through the plane is 30 nm using Scherrer equation.

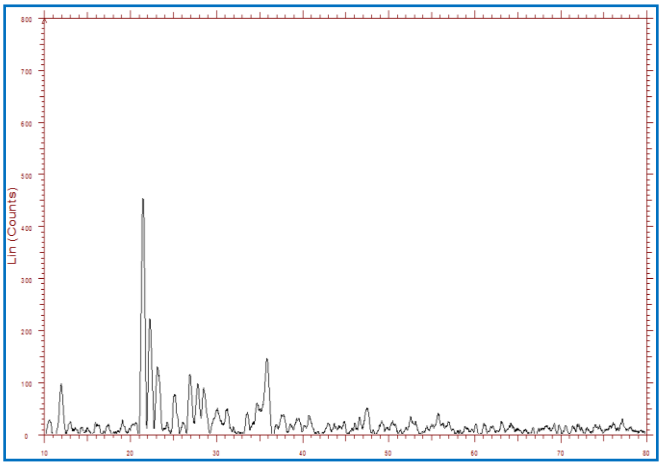


Fig 3.1 X-ray diffraction pattern of PANI/ZnO (0.1g)

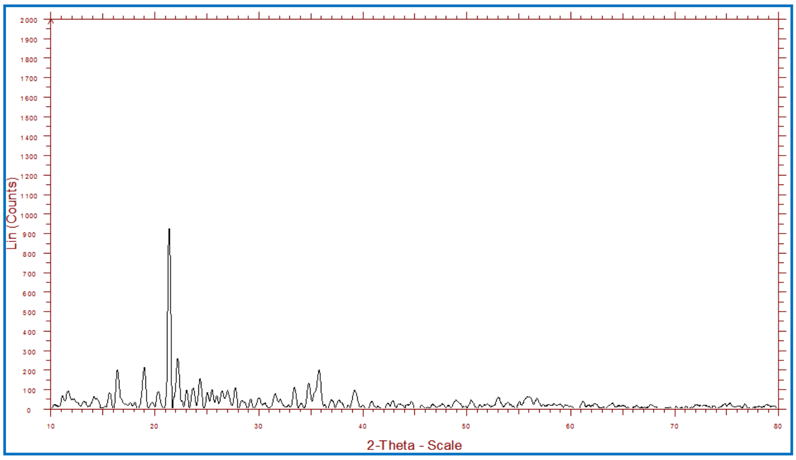
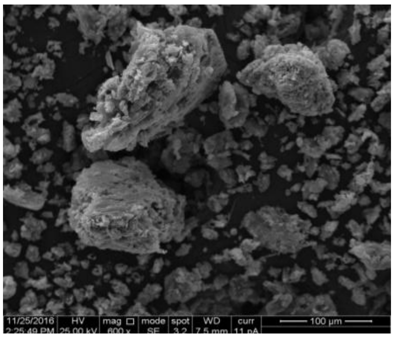


Fig 3.2 X-ray diffraction pattern of PANI/ ZnO (1.0g)

3.2 Scanning Electron Microscope

The surface morphology of Synthesized PANI/ZnO in the form of granular structure with round morphology and little agglomeration were investigated by scanning electron microscope.



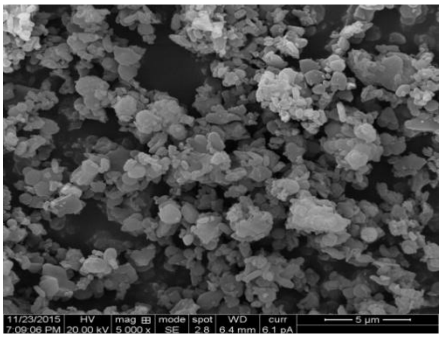


Fig 3.3 SEM pattern of PANI/ZnO (0.1g) Fig 3.4 SEM pattern of PANI/ZnO (1.0 g)

The SEM study of polyaniline-ZnO nanocomposite are shown in fig.3.3,3.4 demonstrated that the surface was covered with grains.The scanning electron microscope shows the morphology of the polyaniline – ZnO nano composite. It indicates that the nano-sized PANI posses nano fibers morphology and influence strongly the composite morphology. Since, the ZnO nano particles were synthesized in the polyaniline solution, the nano particles embedded into the polyaniline matrix.

3.3 FT-IR Analysis

Fourier transform infrared spectroscopy is a technique used to determine the Absorption of light in the infrared spectrum at each wavelength , it can also be used as a quantitative technique to identify unknown materials , and the amount of compounds in a mixture. The spectrum results in certain absorption peaks which are frequencies from vibrations of the bonds of the atoms . The size of the peaks provide with the amount of each material present in the substrate. Agilent FTIR spectrometer was used in both transmission and reflection mode to understand the composite polyaniline films.

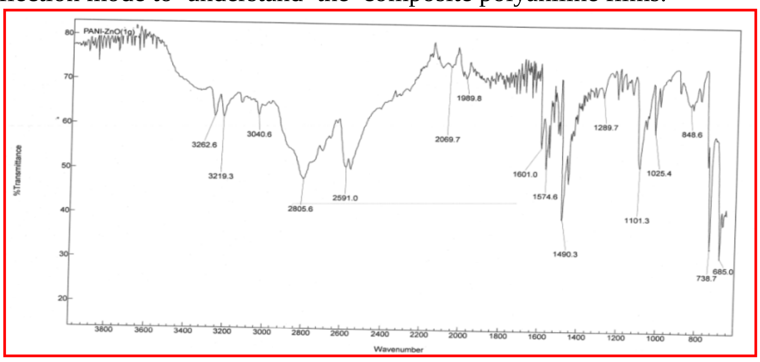


Fig 3.5 FT-IR Spectrum Obtained On PANI/ ZnO (0.1g)

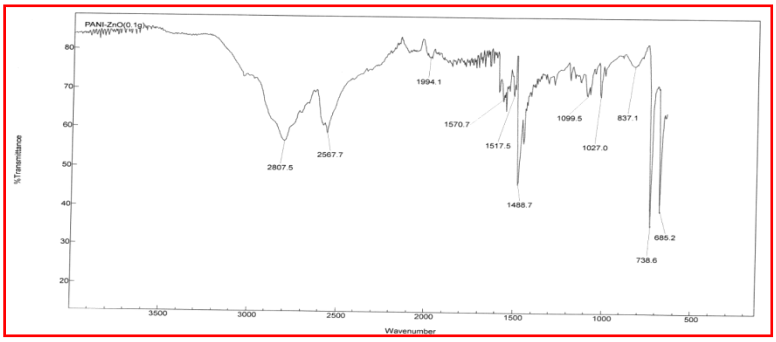


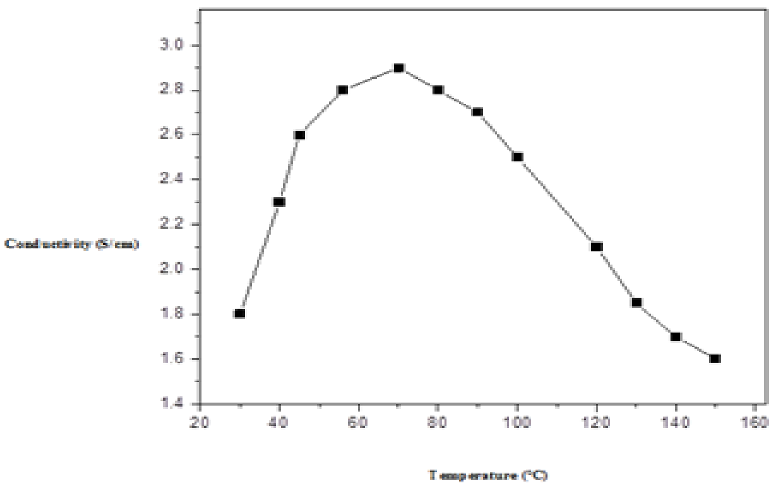
Fig 3.6 FT-IR Spectrum Obtained On PANI/ ZnO (1.0g)

Fig 3.5, 3.6 shows that the FT-IR spectrum obtained on PANI/ ZnO. The bond corresponding for bending vibration of C-H bond of p-substituted benzene ring appears at 825-830 cm^{-1}. The bonds corresponding for to stretching vibration of N-B-N and N=Q=N structures appears at 1490-1492cm^{-1}, respectively. (Where –B- and N =Q=N stand for benzonoid and Quinoid moieties in the polyaniline back bone). The peak appears at 1107-1112cm^{-1} corresponding to –N=Q-N+-B- which characteristic of the protonated state.The bonds corresponding to vibration mode of N=Q=N ring and stretching mode of C-N bond appear at 1298-1314cm^{-1} respectively. The peak appeared at 2100-2300 cm^{-1} corresponding to the H-O-H bond mode confirming the presence of moisture in the sample.

3.4 Electrical Conductivity Studies

Electrical conductivity of PANI/ZnO nanocomposite is shown in fig.4.7 It is noted that the conductivity of the composite increases slowly with the increasing temperature until temperature reached at 65°C, after that the conductivity decrease gradually. The increase in conductivity with temperature is a property of semiconductors. Such phenomenon has been reported for polyaniline and composites.

The decreasing conductivity above 70°C could be due to the presence of absorbed water and it is removed,it may have caused structural changes in the hygroscopic PANI Polymer chains which revealed a small weight loss below 125°C. The decreasing conductivity with increasing temperature is owing to chemical changes is degradation of evaporation of dopant. Furthermore , it has been reported that a dry sample has lower conductivity than a hydrated sample and loss of moisture, results in a decrease of conductivity of polyaniline and PANI-ZnO nanocomposite. Interfacial electronic interaction between polymer, semiconductor and ZnO , formation of electrical barriers can be caused of these results.The change of chain structure by thermal treatment and interchange interaction between two components has an effect on morphological change. For increasing temperature, the intermolecular spacing between adjacent chains of the composites is decreased. The electric conductivity of composite is represented by ZnO nanoparticles embedded in the matrix of a conducting polymer is expected to be high. The combination of PANI as a semi conducting with the ZnO as a noble metal produce hybrid material that behaves as semiconductor at low temperature and as metal at high temperature.



3.7 Electrical Conductivity PANI/ZnO

IV. CONCLUSION

PANI/ZnO nano composite was successfully synthesized by chemical oxidation method.This method is more suitable compared to electrochemical method.The combination of PANI as a semi conducting with the ZnO as a noble metal produce hybrid material that behaves as semiconductor at low temperature and as metal at high temperature.

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