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Oxidation Derived PANI/MgO Nanocomposites : Electrical and Sensors Study

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Abstract: Nanosized metal oxide dispersed polymer nanocomposites constitute a new class of polymeric materials finds enhanced properties and applications. The present work aims to prepare MgO dispersed polyaniline nanocomposite (MgO/PANI) and also its properties. Insitu chemical oxidative polymerisation method with ammonium per sulphate as an oxidising agent is used for the preparation of PANI/MgO nanocomposites. The reaction was catalysed by hydrochloric acid and also different weight percentage of MgO is maintained with same PANI for different nanocomposites. Structural characterisation of the said composites was carried out by X-ray diffraction tool and the morphology by Scanning Electron microscope (SEM) respectively. AC electrical conductivity of PANI/MgO nanocomposites were well studied and deliberate with the help of equivalent hotness. Further, it demonstrates an corroboration for the transport property of PANI / MgO

nanocomposite. Sensor study for the composite is also undertaken with different gases to know its sensing behaviour.

Keywords: Polyaniline, MgO, XRD, SEM, AC conductivity, Sensors.

1. Introduction

Recent researchers are attracted to the polymeric material due to the reality of materials' properties and applications in various fields and have large potential device of the sold states. Conducting polymer shows an organic conductivity confirm the performance mutually obtain through the chemical and electrochemical route[1-3]. The Structure of conducting polymeric materials was a conjugate organically chain compound that shows the electrical conducting nature due to carrier concentration of extensive π-electron, known as polaron. This permits the charging mobilities along with the strength of character of the polymeric chains. Polymeric conductive materials have many applications such as cellular telephones, television sets, displays, solar cells light emitting diodes, actuators, sensors, batteries, electromagnetic shields, and microelectronic devices Among the conductive polymer, PANI has been of exacting curiosity due to its handy electrically conducting, more absorptions coefficient in the noticeable light, attractive redox properties, good chemical stabilities, relative highly conducting and easy polymerizations[4-8] PANI survive in a different number of form can be different in the chemical and physical properties[9-12]. Chemical oxidation methods using chemical oxidising agent finds simple and easy synthetic method. Ammonium peroxydisulphate is usually used as oxidizing agent for chemical oxidation of aniline. There are quinonoid and benzenoid resonances according to amines and imines structure[13-15]. Metal oxides may disperse during chemical oxidation in the polymer matrix constitute PANI composites with new properties and applications The PANI/MgO nanocomposite that have large property like being unscented and the nontoxic's as well as possessing highly hardenings, superior purities and highly melting points[16-18]. The magnesium oxide may be an add-on advantage in these fields of polymer; in exacting, it may give superior applications in various fields. The property of the MgO having high hardening and highly melt points can be used as refractory's agent. The enhancement of sensitivities and selectivities in the nanostructured PANI with different metals oxides[19-21]. Dispersed nanostructure metals oxide are promise original material for blends with polymer, due to brilliant mechanically, electrically, thermally and multifunctional properties. In case the mercury in a thermometer move 1 centimetre when the temp change by 1°C, the sensitivity is 1 cm/°C. Sensors that evaluate very little change must

have extremely high sensitivity. Sensors also have a force on what they measures[22].

2. Experimental Materials and Methods

All Chemicals used in the present experimentation were analytical reagent (AR) grade and were procured from Sigma Aldrich. Chemical oxidation method is used to prepare PANI and PANI/MgO composites.

Synthesis of Polyaniline –MgO Composites (PANI/MgO)

0.1 moles of aniline and 1 M HCl to form hydrochlorides of aniline Adding with different percentages of composite MgO is with HCL solutions constantly stirring the MgO suspended in the solutions. To this response combination, point one mole of $[(NH_4)_2S_2O_8]$ which act seeing that the oxidants was additional gradually with incessant moving for four to six hour at 0 - 4^0 C then finally obtained the powder form with vacuum technique instruments.

3. Result and Discussions

XRD

The structural analysis of the prepared sample was studied by XRD technique. Figure1 shows the XRD pattern of pure polyaniline. This diffract gram exhibit the typically reflections in the 2θ ranging from 25-28°. The broad peak in the pattern shows the amorphous nature of the sample.

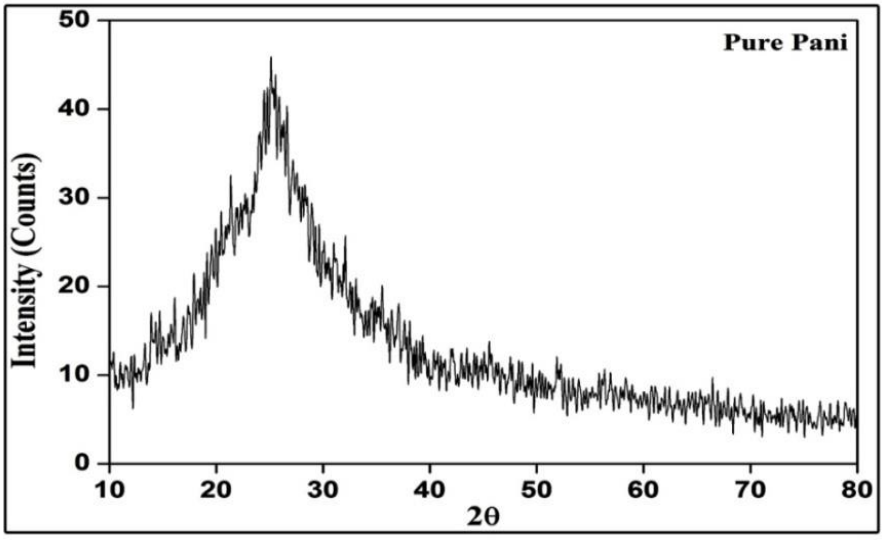

Figure 1: XRD pattern of pure PANI

Figure 2 shows the XRD pattern of PANI/MgO nanocomposite. Number of Bragg's reflections in the pattern explains the crystalline nature of the sample. The pattern reflecting indexed to be cubic structure with 20 wt % of MgO in polyaniline. The composite pattern shows both PANI and MgO peaks indicating the dispersion of MgO in the PANI matrix confirms the formation of nanocomposite[23-25].

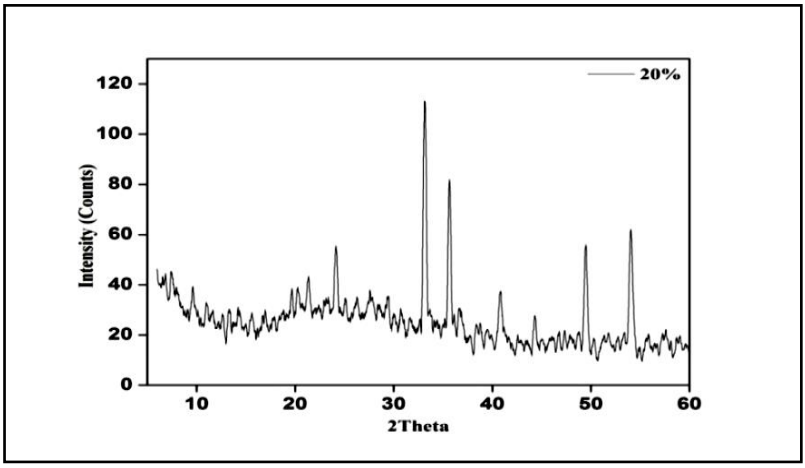

Figure 2: XRD pattern of PANI/MgO nanocomposite

SEM

The surface morphology of the prepared PANI and its nanocomposte was studied by scanning electron micrograph study. SEM images shows the orientation of polyaniline chains, Spherical shaped particles with varied sizes are observed in the image. Grouping of the particles shows close and compact with partially crystalline nature[26-28].

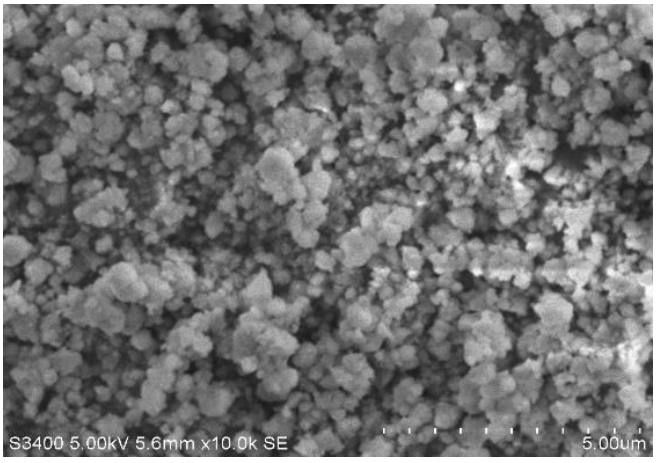

Figure 3: SEM image of Pure PANI

The Figure 4 shows SEM image of PANI/MgO composite for 20 weight % of MgO. This image shows clusters of spherical shaped particles are observed. In addition significantly changes the aggregate state of polymeric molecular chain. The incorporation of MgO into the PANI network induces uniform porosity[29].

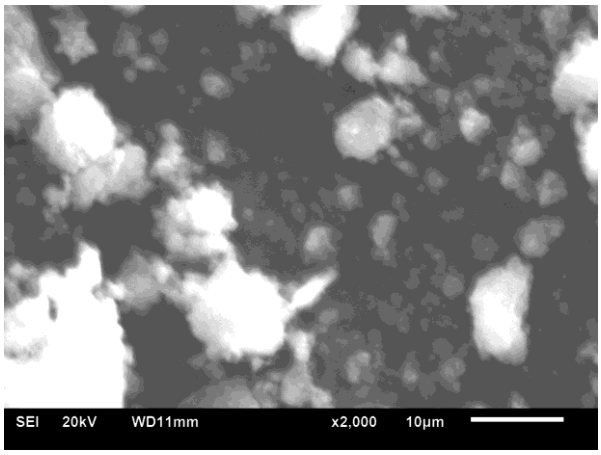

Figure 4: SEM photograph of PANI/MgO nanocomposite

AC-conductivity:

Figure 5 shows AC conductivity of PURE PANI. It is observed from the figure that, the conductivity increases with increase in frequency. The AC conductivity exhibits two phases in the frequency range 10^2 Hz to 10^6 Hz. Initially the conductivities in same line further increase and the pattern division approximately a charge in limited to a small area condition may be in charge for manifold phase of conductivity in polyaniline[30-35].

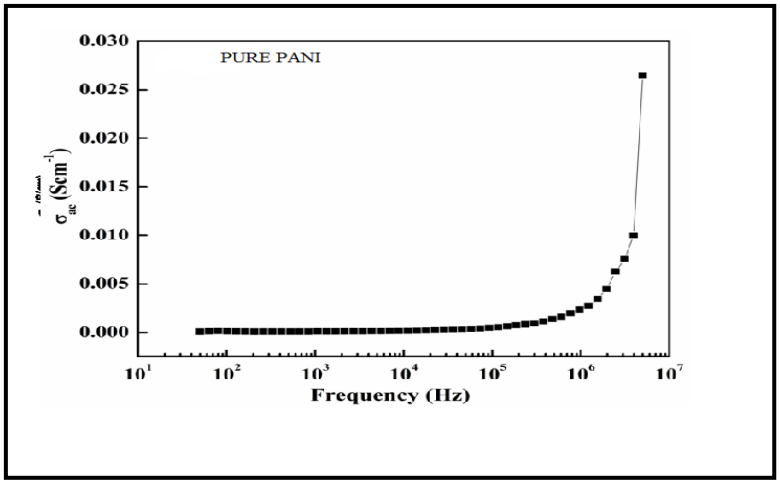

Figure 5: Variation of σ_{ac} as a purpose of occurrence of pure PANI

Figure 6 shows that it is observe the AC conductivities of PANI/MgO composite leftovers the stable and prove alike performance up to 10^5 Hz, past this regularity it raise abruptly. Further, activities are the characteristics of disordering material, and attributes in variations of distributions of MgO particle in polymer matrix.

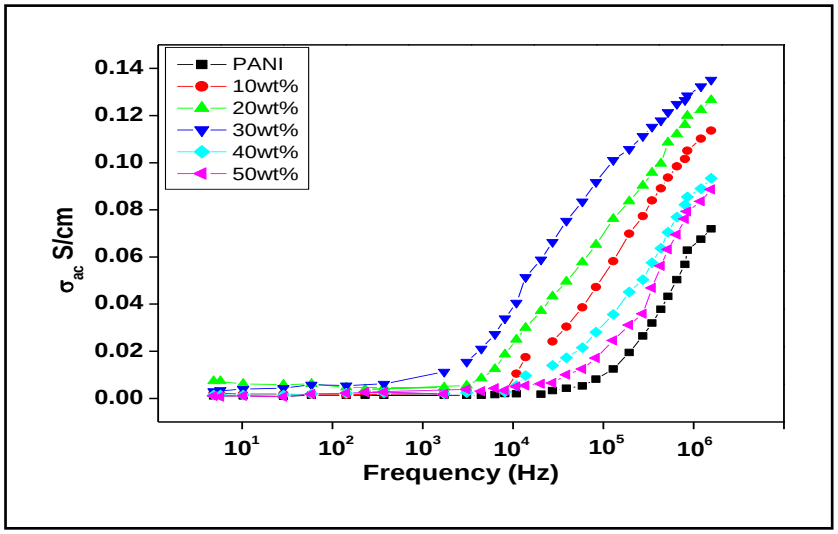

Figure 6: Variation of σ_{ac} as a function of frequency of PANI/MgO

Sensor Studies:

Figure 7 shows the difference of sensitivities with time for pure PANI. It is recorded that, the sensitivity values the pure PANI sensing range is 27%.

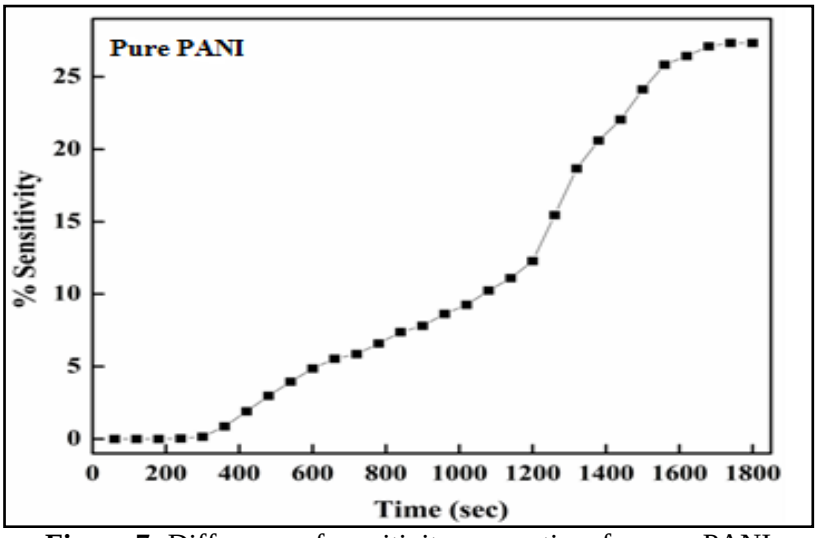

Figure 7: Difference of sensitivity versus time for pure PANI

Figure 8 shows the sensitivity against time for PANI/MgOcomposite. In addition, It is also recorded the sensitivity values in the ranges from 120 to 160% obtained from composites 40 and 30 the all different wt percentages compared to 50 wt composite because 50 wt percent composite the sensitivity is high[36-43].

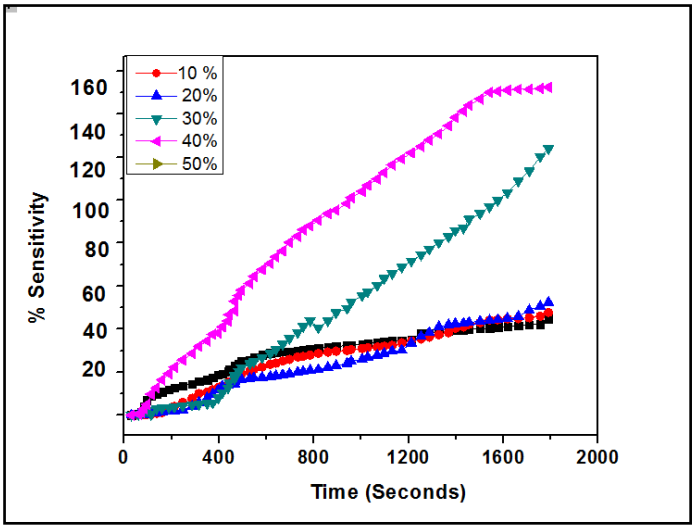

Figure 8: Difference of sensitivity verses time for PANI/MgO

4. Conclusion

The PANI and PANI/MgO composites were prepared by chemical oxidative polymerisation method using aniline monomer with FAS as oxidising agent. The XRD studies indicates that PANI/ MgO composite have an orderly arrangement of the polymer chain, slightly higher crystalline nature. SEM images helped to draw the conclusion that the doping of MgO had an effect on PANI morphology, and also with increased MgO content. The composites showed a transformation in morphology from typical granular and nonporous PANI particles. Further these nano composites had also proved beneficial for using Gas sensors have found wide applications in industrial production, environmental monitoring and protection

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