EXPERMINTAL STUDY ON FERRITE DOPED IN POLYANILININE NANO COMPOSITES

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Abstract : Polyaniline/ nickel ferrite nanocomposites were synthesized by in-situ polymerization methods. The prepared nanocomposites were characterized by X-Ray diffraction . The AC conductivity of the samples was measured as a function of frequency ,it was found that the increasing the concentration of nickel ferrite particles increases the conductivity due to the polarization and extended chain length of composites. among all the nanocomposite 50% showing highest conductivity and Sensitivity so from the study it is suggested that these nanocomposites are useful in potential applications.

Key words: PANI,Composite,XRD,Conductivity,Sensitivity .

I. INTRODUCTION

Nickel ferrite is an important magnetic material with a variety of applications, such as fabrication of ferrofluids, catalysis, and magnetic refrigeration [1, 2], and is one of the most important soft ferrites with high electromagnetic performance, low coactivity, good mechanical hardness, and chemical stability [3].
The nickel ferrite is obtained by sol-gel process followed by thermal treatment above 1000°C, which is the temperature of crystallization reported in previous works [4, 5]. The crystal structure of the obtained ferrites is neither a simple NaCl-type nor a simple spinel type. The average structure can be described in the space group Fd3m, but additional octahedral sites, with respect to the spinel structure, are partially occupied whenever an excess of divalent action is used [6].

Conducting polymers are attractive materials because they have a wide range of functions from insulators to metals and retain their mechanical properties of polymers and also have many promising technological applications [7-8]. Among the conducting polymers, polyaniline (PANI) gets a great deal of attention due to its good properties . In the present work, $NiFe_2O_4$ particles were chosen as a magnetic source due to their scientific and technological applications, which was prepared by combustion route. The polyaniline/nickel ferrite (PANI/$NiFe_2O_4$) composites have been synthesized via interfacial polymerization. The effect of $NiFe_2O_4$ particles with respect to the electrical properties of PANI/$NiFe_2O_4$ composites

II. EXPERIMENTAL PROCEDURE

2.1 CHEMICAL SYNTHESIS OF POLYANILINE.

The synthesis 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. Aniline hydrochloride (equi molar volume of aniline and hydrochloride acid) was dissolved in distilled water in a volumetric flask to 100 ml of solution. Ammoniumpersulphate (0.25M) was dissolved in water also to 100ml of solution.Both solutions were kept for 1 hour at room temperature, then mixed in a beaker, stirred with a mechanical stirrer, and left at rest to polymerize. Next day, the PANI precipitate was collected on a filter, washed with 0.2 M HCL, and similarly with acetone. Polyaniline hydrochloride powder was dried in air and then in vacuum at 60°C for 24 hours. Polyaniline prepare under these reaction and processing conditions are further referred to as "standard" samples.

2.2 Preparation of Polyaniline/ $NiFe_2O_4$composites

Synthesis of the PANI- $NiFe_2O_4$ composites was carried out by in-situ polymerization method. Aniline (0.1 M) was mixed in 1 M HCL and stirred for 15 min to form aniline hydrochloride. $NiFe_2O_4$ particles were added in the mass fraction to the above solution with vigorous stirring in order to keep the $NiFe_2O_4$ homogeneously suspended in the solution. To this solution , 0.1 M of ammonium persulphate, which acts as an oxidizer was slowly added drop-wise with continuous stirring at 5°C for 4hr to completely polymerize. The precipitate was filtered, washed with deionized water, Acetone, and finally dried in an oven for 24hr to achieve a constant mass. In these way, PANI– $NiFe_2O_4$ composites containing various weight percentage of Wo_3 (10 %, 20 %, 30 %, 40 %, and 50 %) in PANI were synthesized.

III. PREPARATION OF PELLETS

The powders of Polyaniline, Polyaniline/ $NiFe_2O_4$ composites, so obtained from synthesis techniques discussed in early sections were crushed and finely ground in 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 2 mm by applying pressure of 90 MPa in a hydraulic pressure. For temperature dependent conductivity studies, a silver paste was coated on both sides of surface of the pellet for providing electrical contacts.

IV RESULT AND DISCUSSION

4.1 X-Ray diffraction

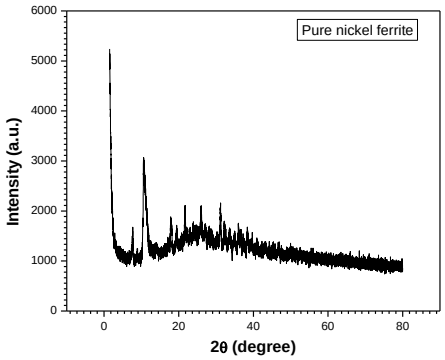

Figure 4.1(a) shows the XRD pattern Nickel ferrite

Figure 4.1(a) shows the XRD pattern for the as-synthesized powder of Nickel ferrite nanoparticle . The characteristic peak (311) of ferrite can be observed at $2\theta = \sim 34^0$. It can be seen from the figure that all the main peaks are related to a single-phase spinel structure. No impurity phases were detected in the XRD patterns. The crystallite size (Dm) of the ferrite was calculated from the X-ray peak broadening of the (3 1 1) diffraction peak using Scherer's formula:

Dm ¼ Kk=bCosθ where K is a constant, b is the full width half maxima and k is the wavelength of X-rays used and h is the diffraction angle. The average crystallite size estimated for the ferrite is 50 nm.

4.2 AC conductivity

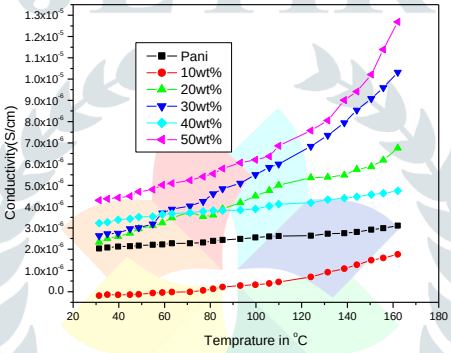

Figure 4.2 shows the ac conductivity of Polyaniline – Nickel Ferrite composites

Figure 4.2 shows the variation of ac conductivity as a function of frequency for Polyaniline – Nickel Ferrite composites for (different wt %). It is observed that in all the cases, σ_{ac} remains constant up to 10^4Hz. Among all the composites, 50wt% of polyaniline / nickel Ferrite nanocomposites shows high conductivity due to interfacial polarization.However, in case of polyaniline and other composites 10, 20, 30 and 40wt%, the conductivity value is low because of dipole polarization. This behavior of these composites may be due to the variation in the distribution of nickel ferrite particles in polyaniline. there is an sudden increase in the conductivity with increase in frequency which is the characteristic property of disordered materil

4.3 Sensor studies

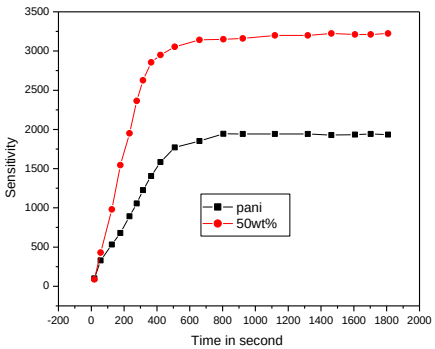

Fig 4.3 shows sensitivity vs time for PANI / Nickel Ferrite nanocomposites

Fig 4.3 shows sensitivity vs time for PANI / Nickel Ferrite nanocomposites, it is observed that the sensitivity increases with increase in the weight percentage of Nickel Ferrite nanoparticles and in the case of PANI Sensitivity is low because of lower surface area.

Among all the nanocomposites, 50wt% shows maximum sensitivity when compared to pure Pani and other nanocomposites and this is due to the reaction between metal nanoparticle and LPG.In the case of semiconducting metal oxide –based gas sensor sensitivity depends on the chemisorbed oxygen ions, oxygen vacancies and the interstitial ions. The gases to be sensed cause a change in the oxygen balance of the oxide sensors and variation in its conductance and in almost all semiconducting oxide based sensors the chemisorbed oxygen is involved in their sensing action.

V.CONCLUSION:

In the present research, polyaniline composites with different wt % of $NiFe_2O_4$ in PANI have been synthesized by interfacial polymerization using ammonium persulphate as an oxidizing agent. The results of AC conductivity obey the power law. The effect of ferrite concentration on conductivity properties were investigated. The LPG sensing characteristics of the composites were measured at room temperature and the improved response of the PANI- $NiFe_2O_4$ nanocomposite is explained in terms of the synergetic interaction of both PANI and the $NiFe_2O_4$ particles.AC conductivity increases at higher in frequencies because of hopping of polarons from one localized states to another localized state.

REFERENCE

1) . R. Adnan, N. A. Razana, I. A. Rahman, M. A Farrukh. Journal of the Chinese Chemical Society, (2010) 57, 222-2292.
2). J. Zhu, B. Tay, Y. Ma, J. Mater. Lett.(2006) 60, 1003.
3). A.R Peaker, B. Horsley, Rev. Sci. Instrum. (1971) 42, 1825-1827
4). D. S. Kumar, P. R. Carbarrocas, J. M. Siefert, Appl. Phys Lett. (1989) 54, 2088
5). J. Pan, H. Shen, S. Mathur, Hindawi Publishing Corporation, Journal of Nanotechnology, Article ID 917320 (2012) 12 pages,doi:10.1155/2012/917320.
6). Y. Shimizu, M. Egashira, MRS Bulletin, (1999). vol. 24, no. 6, pp.18–24
7) Synthesis, characterization, electrical and sensor behavior of PANI/Nickel ferrite nano composites ferroelectrics(2016), vol. 502, 159–169.i.f(0.8)
8) Effects of zno on electrical properties of polyaniline composites issn : .(2016)2248-9622, vol. 6, issue september, pp.07-11