DC conductivity study of PANI /$MgFe_2O_4$ nanocomposite

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Abstract: ***Metallic oxides dispersed polymers constitutes a new class of polymer composites materials. Polyaniline is a good conducting polymer with anti-electrostatic and anti-corrosion properties. In the present work the synthesis of PANI & Magnesium ferrite (PANI/$MgFe_2O_4$) nanocomposite was prepared by in-situ chemical oxidative polymerization method and it is observed that the conductivity is strongly depends on the temperature.***

Keywords:- Conducting polymer, PANI/ $MgFe_2O_4$, DC conductivity.

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1. Introduction:-

Metallic oxides dispersed polymers constitutes a new class of polymer composites materials [1]. Nanocomposites of PANI with metal oxide nanoparticles have shown potential as advanced functional materials [2]. The properties of PANI such as electro-activity, charge transfer kinetics and stability can be improved by incorporating metal or metal oxide nanoparticles in its backbone [3]. Among them, oxides have been the focus of research due to their potential application in electronic devices, sensor, catalysis, batteries, and photocatalysis [4]. Particularly, **γ-**Fe_2O_3 nanostructures have attained prominence due to their biocompatibility, low cost, chemical stability, magnetic, and electrochemical properties [5-6]. When PANI combined with **γ-**Fe_2O_3 *nanoparticles*, its existing performance will be enhanced. For example, Sen [7] reported the PANi/γ-Fe_2O_3 nanocomposite film and its excellent sensing ability toward LPG at room temperature. Mallikarjuna [8] reported a novel nanocomposites of polyaniline dispersed with γ-Fe_2O_3 nanoparticles by an in-situ polymerization method. Sharma [9] also reported the synthesis of iron oxide-PANI nanoclusters with its magnetic property. Hsieh [10] successfully synthesized superparamagnetic PANI/γ-Fe_2O_3 nanocomposites by using a reverse micelle method.

Here, we report the preparation and conductivity study of PANI/ Magnesium ferrite (PANI/$MgFe_2O_4$**)** nanocomposite.

2. Experimental part:

2.1 Materials and method:

All the reagents were analytical grade only and were used as received. Aniline monomer was distilled under reduced pressure and kept below 0-5^{0}C prior to use, polyvilnyl alcohol fuel. Aniline monomer, hydrochloric acid (HCl) were purchased from s.d. fine chemicals ltd.

2.2 Preparation of magnesium ferrite nanomaterials

In our earlier study we reported the synthesis of magnesium ferrite using PVA as a fuel [ ]. In brief, one gram of magnesium chloride and ferrous ammonium sulphate was ignited with polyvinyl alcohol fuel in a separate container on electrical oven to get partially decomposed product. After complete evolution of the fumes, both samples were again grinded with polyvinyl alcohol in weight ration 1:1:5. The partially decomposed product formed may be may be attributed to the low temperature of the reaction giving rise to insufficient energy needed for complete conversion. Hence, the sample was under microwave irradiation in domestic microwave woven having frequency 2.45GHz for about ten minutes at highest power level. The solid burns by producing different coloured light and leaving behind magnesium ferrite nano product.

2.3 Preparation of Polyaniline-$MgFe_2O_4$ nanocomposite.

In a typical procedure, 10 g of aniline was dissolved in 100 ml of distilled water containing 15 ml of hydrochloric acid. The solution was pre-cooled to 0^{0}C. $(NH_4)_2S_2O_8$ was added in the form of a 1M solution (15-20 ml) to the reaction mixture, and 0.1g of $MgFe_2O_4$ was added to the same and then thoroughly stirred, which was stirred for 30 minutes and allowed to stand for a further period of 60 minutes. The resultant product obtained was filtered out, washed thoroughly with water, and dried until constant weight at 40^{0}C.

3.0. Results and discussion

3. DC conductivity study:

Figure-1 shows the variation of dc conductivity as a function of temperature of PANI /$MgFe_2O_4$. It is observed that the value of dc conductivity composites increases exponentially with temperature and shows the semiconductor behaviour. The observed behaviour is the typical characteristic property of the amorphous materials. The initial increase in the values of conductivity is due to the extended chain length of Polyaniline due to which the hopping charge carriers occurs between the favorable localized sites. But, at higher temperature region, the increase in the conductivity due to intra-chain transport of charge carriers which can be described by the band conduction mechanism and is usually it is observed at high temperatures [11]. The maximum conductivity was found to be approximately in the range of 10^{-7} S/Cm at measured temperature 155^{0}C.

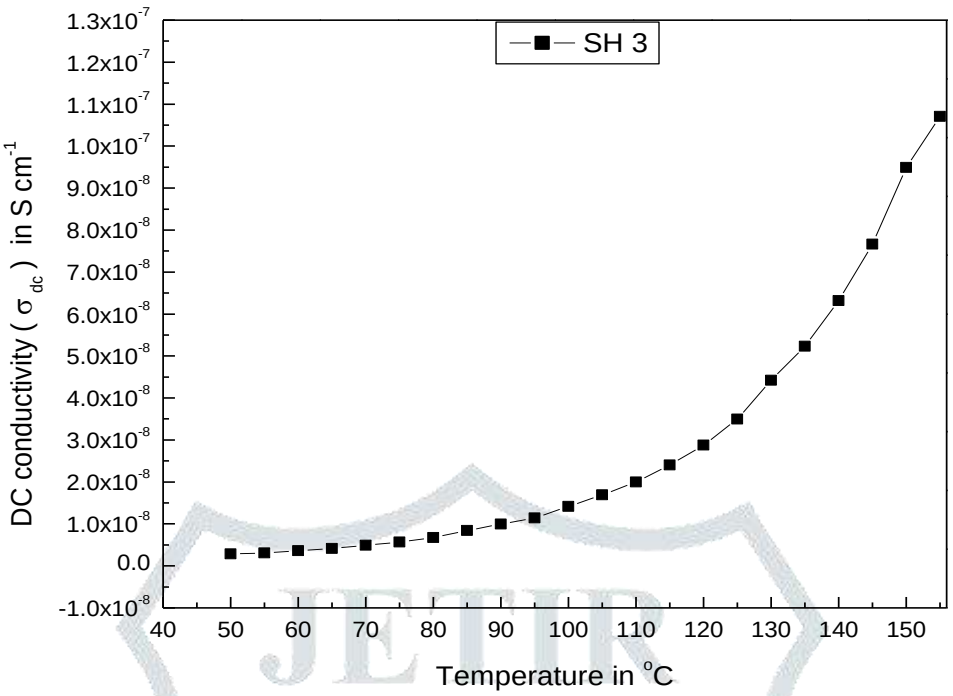

Figure-1: DC conductivity of PANI /$MgFe_2O_4$

4. Conclusion:

PANI /$MgFe_2O_4$ composites were synthesized by in-situ polymerization method. The temperature dependent DC conductivity was carried out in the temperature range 45^0C-155^0C. The conductivity measurements as a function of temperature showed increase in the conducting properties of PANI by the addition of $MgFe_2O_4$ and showing semi-conducting behavior. The maximum conductivity was found to be approximately in the range of 10^{-7} S/Cm at measured temperature 155^0C. Generally, the obtained results indicated the possibility of tailoring electromagnetic properties of PANI depending on the weight percent of $MgFe_2O_4$.

5. References:

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