



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 1, January 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

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# Transport Properties of Conducting Polymer PANI with MgO Nanoparticles

Bharati Basavaraj<sup>1</sup>, Basavaraja Sannakki<sup>2</sup>

Research Scholar, Department of Post Graduate Studies and Research in Physics, Gulbarga University, Kalaburagi, Karnataka, India<sup>1</sup>

Professor, Department of Post Graduate Studies and Research in Physics, Gulbarga University, Kalaburagi, Karnataka, India<sup>2</sup>

**ABSTRACT:** The Conducting polymer pani and Pani/MgO nanocomposites were synthesized by chemical Oxidative method at 5°C temperature. The chemically synthesized pani and Pani/MgO nanocomposites at different weight percentages of MgO have been studied at room temperature and normal pressure. The structure and properties of PANI/ MgO nanocomposites was characterized by X-Ray Diffraction. The XRD analysis shows MgO NPs is well dispersed in the polyaniline matrix. The DC conductivity of Pure PANI and its nanocomposites have been measured in the temperature range from 30°C to 200°C. The DC electrical study of PANI/MgO nanocomposite clearly indicates that the MgO particles increase the electrical conductivity of polyaniline nanocomposites as compared to pure polyaniline. It is attributed due to extended chain length of Polyaniline which facilitate the hopping of charge carriers. And also the Arrhenius plots revealed the decrease in the activation energy the pure PANI while for the doped ones it has decreased and it is assigned to the creation of vacancies.

**KEYWORDS:** Conducting polymer, dc conductivity, activation energy and Pani/MgO nanocomposites.

## I. INTRODUCTION

All over the world Polymer nanocomposites have become one of the most extensively studied materials in recent years due to their unusual properties of the synthesis of conducting polymers like poly-pyrrole (PPy), polyaniline (PANI), and polythiophene (PTh) due to their high electrical conductivity, interesting electrochemical properties and easy processability [1-3]. These electrical and electro-chemical properties of such conducting polymers show much assurance for commercial applications in battery materials[4], electrochromic devices [5] sensor technology [6] and nonlinear optics [7]. In a number of applications the control of band gap is essential, be it for light emitting diodes (LED) transparency in the visible region combined with high electrical conductivity etc. The various aromatic-compound-based conducting polymers, polyaniline (PANI) is one of the most attractive conducting polymers due to its special transport properties, facile synthesis, tunable conductivity and good environmental stability [8]. Nanocrystalline materials are considerable interest due to their unique dielectric, magnetic and optical properties. We have selected magnesium oxide nanoparticles due to their importance in wide range of applications in lithium batteries, high-density information storage devices, magnetic fluids, radar absorbing materials etc [9]. In the present work we report optical band gap, of pure Polyaniline and polyaniline doped with Magnesium oxide (MgO) nanoparticles.

## II. MATERIALS USED

Aniline monomer of Analytical reagent grade (AR) for synthesis of polyaniline (PANI), Ammonium persulphate (APS) for oxidising agent, Magnesium nitrate Hexahydrate (AR), Acetone and hydrochloric acid (HCL), AloeVera (AV) plant for its solution, What's man filter papers with double distilled water were used for green synthesis of MgO Nanoparticles and for Pani/MgO Nanocomposites.

### III. METHODOLOGY

#### SYNTHESIS OF PANI AND PANI/MGO NANOCOMPOSITES

The chemicals, such as aniline monomer, oxidising agent of Ammonium persulphate (APS) used as catalyst were of analytical grade and procured from SD Fine Chemicals, India. The aniline monomer was used for synthesis of polyaniline. The polymer of polyaniline were prepared via chemical oxidative technique using APS as an oxidising agent. In the typical procedure, monomer and oxidant in stoichiometric ratio of 1:1 were dissolved in deionized distilled water, then, HCL (0.3 M) was added into the reaction mixture, which was not enhance the rate of reaction and yield. The reaction mixture was allowed for constant stirring for 6hr at 5°C to complete polymerization reaction and then kept for overnight for further polymerisation process to carryout at room temperature. next day the prepared solution is filtered by using whatman filter to obtained precipitation. The precipitate was washed with copious amounts of Acetone and Ethanol, double distilled water until the washings continues to get clear solution and. Subsequent to this step, sample was sintered at 60° C for 12 hrs By adopting same route, successful synthesis of three samples at different 10,30,50wt% was carried out and further these samples are used for the charectarizations such as XRD , DC conductivity .

### IV. EXPERIMENTAL RESULTS

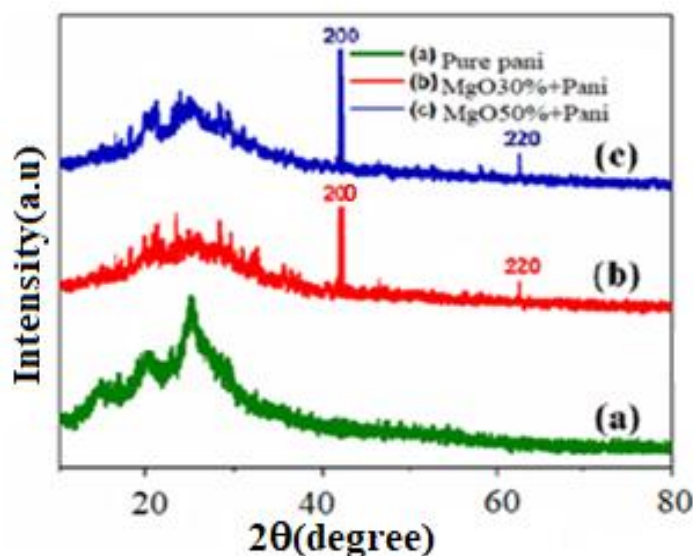


Figure.1. The X-ray diffraction pattern for (a)PANI and (b)PANI/MgO nanocomposites.

To study the nature of crystallinity of prepared sample, we used the powder method of XRD for Pure PANI and polymer nanocomposites. The XRD figures are given in Fig1.(a-c). The X-ray diffraction pattern of the samples in this present study is obtained using a Philips X-ray diffractometer with  $\text{CuK}\alpha$  radiation ( $\lambda = 1.54060 \text{ \AA}$ ). The diffractograms were recorded in terms of  $2\theta$  in the range 10 to 80 degrees with a scanning rate of 4 degrees per minute. The Figures of 1 (a), (b) & (c) shows the XRD pattern of synthesized (a)pure PANI and (b,c) polymer nanocomposites of 30, 50wt% respectively. In Fig.1(a) it shows the X-ray diffraction pattern of PANI and a broad peak occurred at  $2\theta = 25.49^\circ$  which is the characteristic peak says the amorphous nature of PANI.

Fig. 1(b,c) it shows the X-ray diffraction pattern of PANI/ MgO nanocomposites of and peaks occurred at  $2\theta = 43^\circ$  with plane (200) and  $62^\circ$  at plane (220) for PANI/MgO of 30% and PANI/MgO of 50% are the characteristic peaks of MgO NPs observed in polyaniline matrix which indicates the semi crystalline nature of PANI /MgO nanocomposites. All the diffraction peaks are well assigned to the Cubic Crystal structure (Halite) phase MgO (JCPDS card No.87-0652) [10]. Further it shows that PANI deposited on the surface of MgO has effected on the crystalline structure of MgO. Since the molecular chain of the absorbed PANI is confined and the degree of crystallinity is decreased as shown in Fig1.(c)[11]. The X-ray diffraction peaks of the material were analyzed by using Debye–Scherer equation.



$$D = \frac{k\lambda}{\beta \cos\theta} \tag{1}$$

Where, D is crystalline size,  $\lambda$  is wavelength of X-ray,  $\beta$  is full-width at half-maximum and  $\theta$  is diffraction angle. The crystallite size of synthesized PANI/MgO nanoparticles average were found to be in range 35-45nm.

### V. DC-CONDUCTIVITY

The temperature dependence of dc-conductivity for PANI/MgO nanocomposites in a temperature range between 30<sup>0</sup>C and 200<sup>0</sup>C is illustrated in Fig.2. The conductivity values of investigated nanocomposites are higher than that of pure PANI. The conductivity increases steadily with temperature showing semiconductor behavior upto a transition temperature  $T_i$ . And the temperature higher than  $T_i$ , the conductivity increases with increasing MgO particle content to attain an almost constant value at higher concentrations of MgO. Among all the nanocomposites, at 50 wt% shows higher conductivity and it clearly shows that the conductivity is not only the motion of ions but also hopping of charge carriers and also because when PANI mixed with 50 wt% MgO gives more feasibility of matrix's for fast mobility of ions through it easily.

The conductivity varies directly with the temperature, obeying an expression of the following equation [12].

$$\sigma(T) = \sigma_0 \exp[-(T_0/T)^{1/4}] \tag{2}$$

Where  $\sigma$  is the conductivity, T is the temperature and  $\sigma_0$  is the conductivity at characteristic temperature  $T_0$ . The nanocomposite having 50wt% of PANI/MgO shows the higher conductivity than pure PANI such enhancement of DC conductivity values can be attributed to the uncoiling of polymeric chains due to strong interfacial interaction between MgO with PANI caused by their composition indicating that they have enough binding energy to combine with neighbors grains or molecules. The electrical properties in MgO can be explained on the basis of exchange of electrons between ions of the same element that are present in more than one valence state distributed randomly over equivalent crystallographic lattice sites.

the Arrhenius plot of dc conductivity shows straight line behavior. The dc conductivity of pure PANI increased exponentially with doping, exhibiting semiconductor characteristics. The conductivity as a function of temperature can be represented by the relation (3).

$$\sigma_{dc} = \sigma_0 \exp[-(\Delta E/KT)] \tag{3}$$

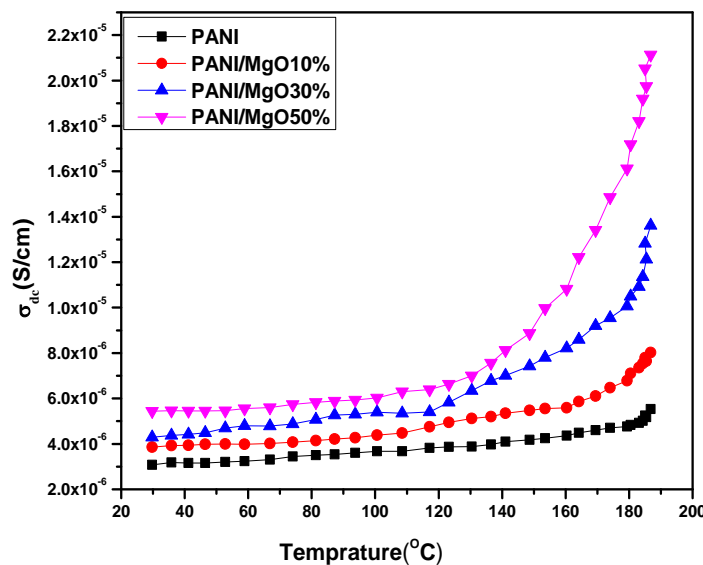


Figure.2. shows DC conductivity of PANI and PANI/MgO nanocomposites.

The activation energy is found to be decreased with increase in the weight percentage of MgO in Polyaniline and. The Arrhenius plots revealed the decrease in the activation Energy for the pure PANI while for the doped ones it has decreased and it is ascribed to the creation of vacancies [13].

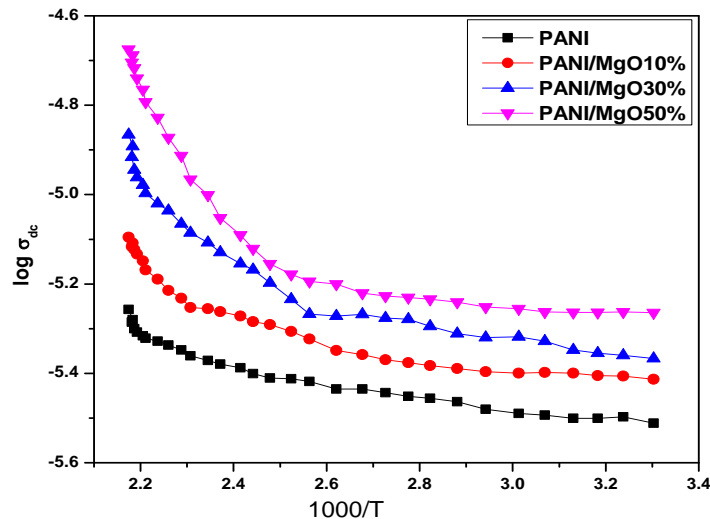


Figure.3.Graph of  $\log \sigma_{dc}$  v/s  $1000/T$  for PANI and PANI/MgO nanocomposites.

## V. CONCLUSIONS

The present work highlights the synthesized samples of PANI with MgO NPs were characterized by using X-Ray diffraction (XRD). The characteristic peak for PANI occurred at  $2\theta = 25.58^\circ$  and the for PANI/MgO nanocomposites the characteristic peaks occurred at  $2\theta = 43^\circ$  with plane (200) and  $62^\circ$  at plane (220) for PANI/MgO of 30% and PANI/MgO of 50% shows semicrystalline in nature. It is found that the Arrhenius plots revealed the decrease in the activation energy for the pure PANI while for the doped ones it has decreased and it is ascribed to the creation of vacancies. The conductivity values with increase in weight percentage of MgO in Polyaniline were found to be increased. It is attributed due to extended chain length of Polyaniline which facilitate the hopping of charge carriers.

## REFERENCES

- [1] J.Stejskal,P.Bober,M.Trchova,J.Horsky,J.Pilar,Z.Walterova.Theoxidationof aniline with p-benzoquinone and its impact on the preparation of the conducting polymer, polyaniline.Synth Met (2014)192:66e73.
- [2] J.K.Xu ,G.Q.Shi ,L.T.Qu,J.X.Zhang.Electrosyntheses of high quality polypyrrole films in isopropyl alcohol solution ofboron trifluoride diethyl etherate.Synth Met( 2003)135:221e2.
- [3] S.S. Jeon,S.J.Yang,K.J. Lee,S.S. Im . A facile and rapid synthesis of unsubstituted polythiophene with high electrical conductivity using binary organic solvents. Polym(2010)51:4069e76.
- [4] N.Mermilliod,J.Tanguy,F.Petiot. A study of chemicallysynthesized polypyrrole as electrode material for batteryapplications. J Electrochem So(1986)133:1073e9
- [5] A.G.MacDiarmid,A.J.Epstein. Application of thin films of polyaniline and polypyrrole in novel light-emitting devices ACS Symp Ser( 1997)672:395e415.
- [6] H.G. Xue,S.L Mu. Bioelectrochemical response of the polypyrrole xanthine-oxidase electrode. J Electroanal Chem(1995)397:241e7.
- [7] H.Lindenberger , D.Schafersiebert, S.Roth ,M.Hanack. Synthesis andproperties of polypyrrole prepared by electrochemica polymerization of a-bipyrrole. Synth Met (1987)18:37e41.
- [8] P.Ritu Mahare, K.Devendra Burghate,B.Subhash Kondawar,. Development of nanocomposites based on polypyrrole and carbon nanoyubes for supercapacitors,Adv.Mat.Lett., 5(7) (2014)400-405.
- [9] Anjaneyalu, P.Narayana Murthy, Sk. Md.Rafi, Sk.Bademiya,G. Samuel John,. Effect on magnetic properties of zinc doped nano ferrites synthesized by precursor or method, International letters of Chemistry, Physics and Astronomy, ISSN:2299-3843, Vol.(19)(2013)37-43.
- [10] S Krishna Moorthya , CH Ashokb , K Venkateswara Raob, C Viswanathana synthesis and characterization of mgo nanoparticles by neem leaves through green method, Materials Today: Proceedings 2 ( 2015 ) 4360 – 4368.



- [11] Neetu Singh, Prabhat Kumar Singh, Mridula Singh, Poonam Tandon, Saurabh Kumar Singh, Satyendra Singh, Journal of Materials Science, Materials in Electronics (2019) 30:4487–4498.
- [12] Shranabasamma Amabalagi, M Devendrappa, B Biradar, B Bharati, A Manjunath, Mohanraj Pattar, and Basavaraja Sannakki, AIP Conference Proceedings, 2100, 020102 (2019).
- [13] Mahantappa Limbitot, Sangshetty Kalyane, Nagbasavanna Sharanappa, Basavaraj Evale, Kamalakanth Lagali, Airo International Research Journal Volume XIV, ISSN: 2320-3714.



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**ISSN** INTERNATIONAL  
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