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Synthesis, Characterization and I-V Studies Of Polyaniline Fe_2o_3 Nanocomposites

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ABSTRACT

Polyaniline is a good conducting polymer with anti-electrostatic and anti-corrosion properties. Polyaniline is conducting polymer of semi-flexible rod polymer family, it is doped with Fe_2O_3. Fe_2O_3 is red brown solid (odourless). Our study provides a clear insight that the formation of Polyaniline - Fe_2O_3 nanocomposite which gives a changes in conductivity after doping. Polyaniline-iron oxide nanocomposites were prepared by polymerization method. These nanocomposites were characterized by employing Fourier transform Infra-red (FTIR), I-V characteristic, UV spectroscopy and XRD.

Keywords: Polyaniline, Fe_2O_3

I INTRODUCTION

The conducting polymers were emerged as materials of current research worldwide. The conducting polymers have mechanical parameters of polymers as well as electrical properties of semiconductors. Among the various conducting polymers polyaniline and its derivatives are intensively studied, because of their good environmental, chemical, thermal stability. Polymers have always been considered as insulators of electricity. They have very poor electrical conductivity. The degree of conductivity of organic polymers arises from their state of relative oxidation or reduction. In such states the polymer itself losses (for oxidation) or gains (for reduction) electrons in its structure. In conductive polymers, the charge carriers are generated within the polymer chain. polymers could conduct as good as metals. By simple modification of organic polymer they become electrically conducting polymers. These metals combine the electrical Properties of metals with the advantages of polymers such as lighter weight, greater Workability, resistance to corrosion and lower cost[1,2].

II EXPERIMENTAL

2.1 Synthesis of Polyaniline

Various chemical routes are available to prepare powder of conducting PANI. Here we adopted oxidative polymerization of aniline. The solution of 0.5M aniline and 0.5M ammonium per sulphate was prepared in 0.5M HCl in two separate flasks. These two are mixed slowly under magnetic stirring, the colourless solution slowly turned to green. It is left for few hours without stirring to settle the powder, and then it was filtered using Bysner funnel. The dark green coloured residue in the form of thick paste was obtained. The paste was washed continuously with distilled water until the filtered solution become neutral. In this washing process, initially the

filtered solvent was dark brown and the residue was washed till the filtered solution became colourless. Finally the paste was washed with acetone to remove short chain molecules of aniline that are soluble in acetone and the paste was allowed to dry completely. The dried material is grinded to fine powder using passel motor and the powder is known as the conducting PANI and it was kept sealed for further processing.

2.2 Preparation of Polyaniline with Fe_2O_3 composite

Synthesis of the PANI- iron oxide nanocomposites was carried out by oxidative polymerization method. The solution of 0.5M ammonium persulphate was prepared in 0.5M HCl in two separate flasks. Iron oxide of various measures of weight is considered. Aniline is kept on the magnetic stirring for about 5-10 minutes, and then known amount of Fe_2O_3 is taken and slowly added in the aniline solution kept on stirring. It is again stirred for 20 minutes. Ammonium persulphate is added to the solution drop wise. The solution slowly turns to green. It was left for few hours without stirring to settle the powder, and then it was filtered. The dark green coloured residue in the form thick paste was obtained. The paste was washed continuously with distilled water until the filtered solution became neutral. Finally the paste was washed with acetone to remove short chain molecules of aniline and the paste was allowed to dry completely. The dried material was grinded to fine powder using passel motor. In this way PANI-iron oxide nanocomposites were synthesized.

III. CHARACTERIZATION TECHNIQUES

3.1. UV spectroscopy

Here instrument used is UV-vis spectrometer specord 200.

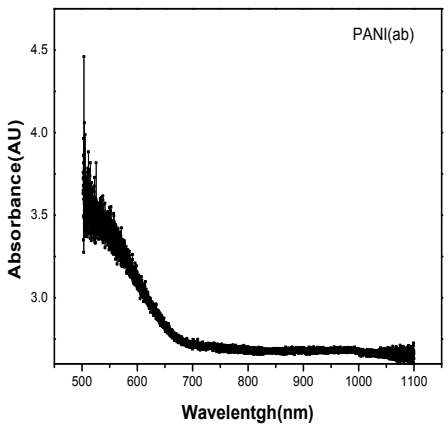

Figure 1

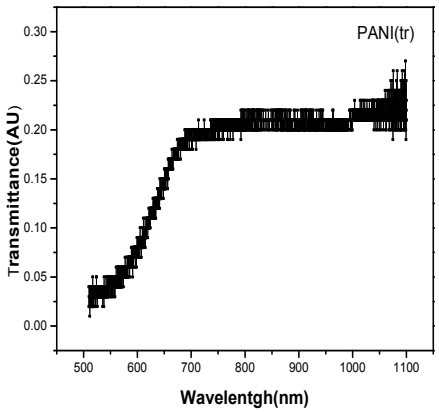

Figure 2

Figure 1 absorbance(AU) v/s Wavelength shows the optical absorbance curve of PANI

Figure 2 absorbance(AU) v/s Wavelength shows the optical transmittance curve of PANI

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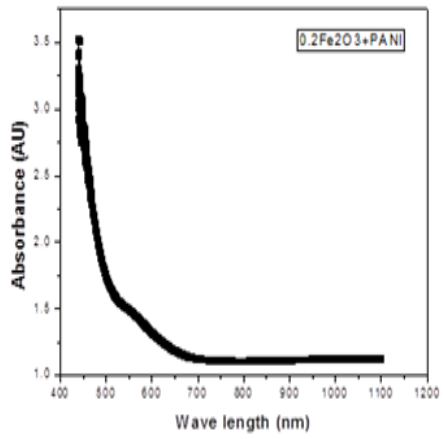

Figure 3

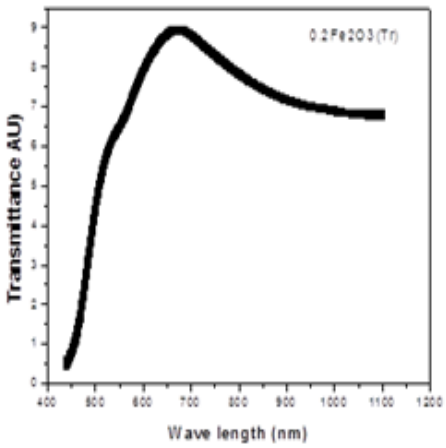

Figure 4

Fig 3 absorbance(AU) v/s Wavelength optical absorbance curve for Fe_2O_3/PANI

Fig 4 absorbance(AU) v/s Wavelength optical transmittance curve for Fe_2O_3/PANI

UV studies on samples shown that there is an influence of iron oxide in the composites.

3.2. FTIR

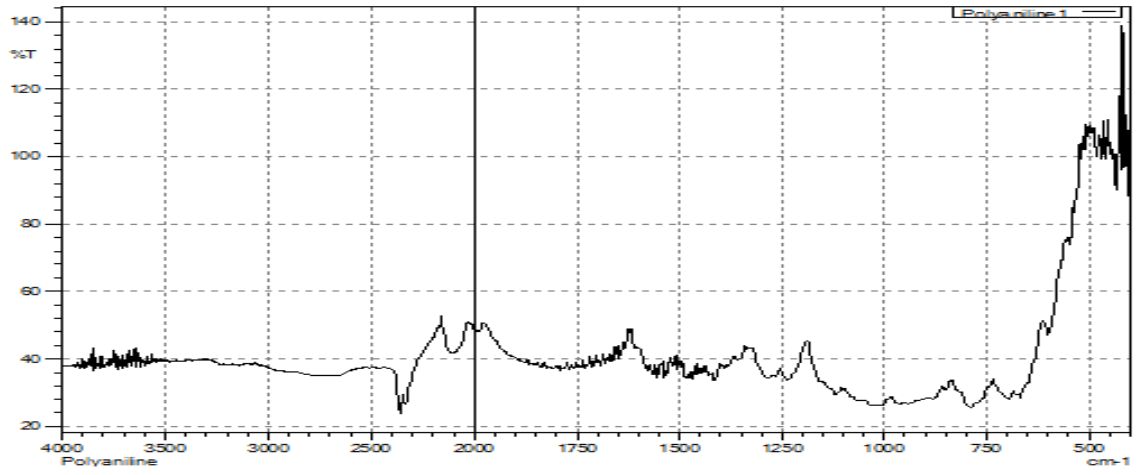

Figure 5

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Figure 6

Figure 5 & 6 shows the IR characterisation of PANI and PANI/0.2Fe_2O_3

Figure 5 shows FTIR spectra for pure PANI nano composite. The peaks at 3700 to 3400/cm is because of absorption of water molecule, the characteristic stretching frequencies at 1700 to 1550/cm is due to N-H stretching, the peaks at 1100 to 1000/cm is due to C-H bending. The peak from 800 to 750/cm is due to metallic stretching.

Figure 6 shows the IR spectra of PANI and PANI/0.2Fe_2O_3 nanocomposite stretching was observed at 3800 to 3400/cm it is due to O-H stretching, the peaks at 3000 to 2400/cm is due to C-H stretching, the peak at 1750 to 1600 is due to C-O stretching, the peaks at 1560 to 1300/cm is due to C-H bending, the peak at 1100 to 920/cm is due to alkene C-H bending, the peaks at 750 to 550/cm it is due to metallic stretching

The characteristic stretching frequencies are shifted which shows the interaction between PANI backbone and the selected dispersant during the composite formation.

3.3. I-V Characteristics

Here the range of voltage is set about -3 to +5volts. Current range is set about 1mA, by the kethely source meter.

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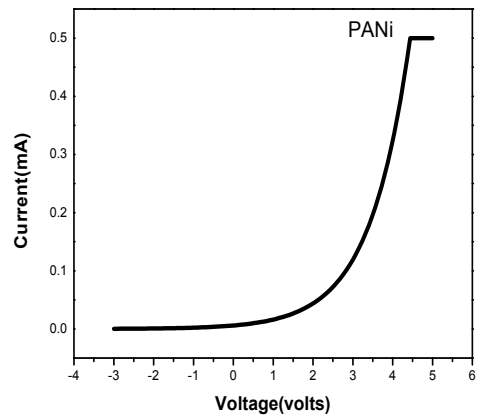

Figure 7

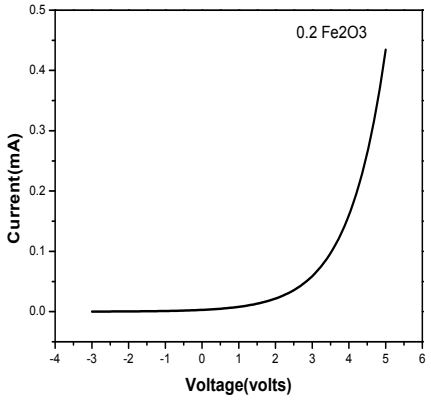

Figure 8

Figure 7&8 are the current v/s voltage characterization of PANI AND PANI/ Fe_2O_3. it is clear from the graphs that there is a linear relation between current and voltage. This indicates the ohmic nature, there is ohmic contact between sample and electrodes. The slope indicates that current increases as we increase the voltage. It is observed that slope of IV curve increases with increasing the concentration of Fe_2O_3 in PANI.

3.4. X-RAY DIFFRACTION

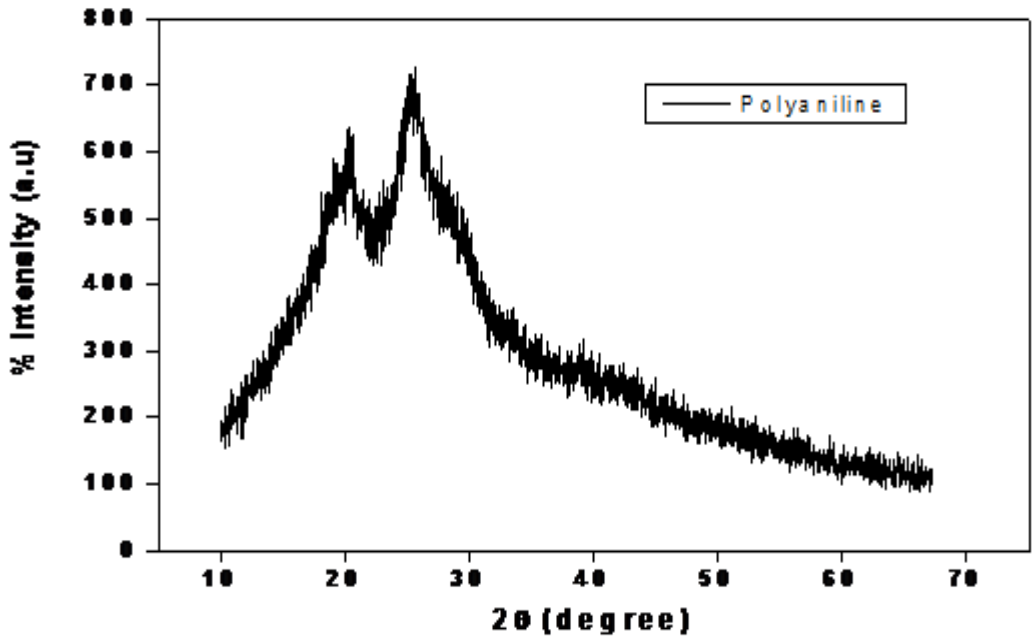

Figure 9

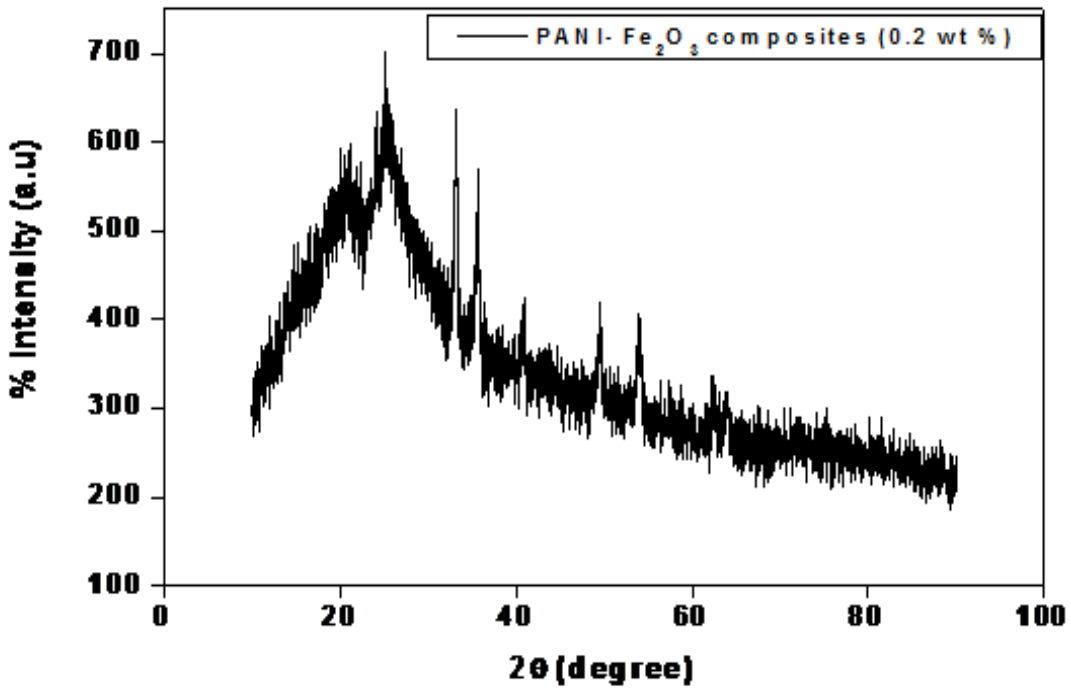

Figure 10

Figure 9 and 10 are the X-Ray Differaction pattern of PANI AND PANI/0.2Fe_2O_3

X-Ray Differaction pattern of polyaniline tells that, it has semi crystalline nature with broad peak centered around $2\theta=26^{o}$. The strong interaction between polyaniline backbone chain & the inorganic oxide particles due to the polymerization reactions is clearly observed in XRD patterns. By comparing the XRD patterns of composite with polyaniline, it is confirmed that iron oxide have retained their structures even though they are dispersed in PANI during polymerization.

IV CONCLUSION

PANI based polymers have been successfully synthesized by using oxidative polymerization method. FTIR spectra obtained in the work are in agreement with FTIR characterization reported in the literature and comparison with standards[7] . So FTIR spectra confirm the formation of Polyaniline. The favorable interaction between PANI and Fe2O3 was confirmed by XRD characterization. UV studies on samples shown that there is an influence of iron oxide in the composites, which is increase in concentration of iron oxide leading increase in the energy gap of sample. It is concluded that presence of iron oxide nanoparticles in PANI composite influences the electrical and sensing parameters. The DC conductivities carried over polyaniline and its composites shows the presence of polarons as charge carriers and confirms the extended chain length of

polyaniline. Prepared samples exhibited the typical semiconducting behavior, which are one of the most promising materials for potential applications .

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