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Sensing and Electrical properties of Polyaniline /Nanocomposites For Gas Sensor Application

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ABSTRACT
Polyaniline nanocomposite using metal oxides have wide variety of applicability because of its enhanced properties to that of pure polyaniline. Here we employed titanium dioxide as the metal oxide to synthesize polyaniline composite (PANi-TiO_2) through chemical oxidative polymerization in-situ. The obtained PANi-TiO_2 is tested for powder X-Ray diffractometry (XRD), & Scanning electron microscopy(SEM).
Keywords:-XRD,SEM,Conductivity,Sensitivity,AC

I. Introduction:-

The discovery of conducting polymer has opened up a new promising field in materials Science and engineering. Among them, conducting polyaniline(PANI) is one of the most promising conducting polymer because of its unique electrical, optical and optoelectrical properties, as well as its ease of preparation and excellent environmental stability. Polyaniline Can be used in electrochromic device, light-emitting diodes, electrostatic discharge protection, secondary batteries etc(1-4).
Among those inorganic nanoparticles, Titanium dioxide nanoparticles are appealing because of their excellent physical and chemical properties, as well as extensive applications in diverse areas such as coatings, solar cells and photocatalysts(5-8).

II. Experimental:-

Aniline monomer, ammonium per sulphate, hydrochloric acid and titanium dioxide were purchased from s.d. fine chemicals ltd i.e., SDFCL MUMBAI). Aniline monomer was distilled under reduced pressure and kept below 0-5 ^{0}C prior to use.All the reagents were analytical grade only and were used as received.

2.1.Synthesis of Polyaniline (PANI):-

Synthesis 0f PANI was carried out by in-situ chemical oxidation polymerization Technique. Aniline(0.1M) was mixed in 1M hydrochloric acid and stirred for 15 min to form aniline hydrochloride. To this solution, add 0.1M of ammonium persulphate, which acts as an oxidizer was slowly added drop-wise with continuous stirring at 5^{0}C for 4 hrs to completely polymerize. The precipitate was filtered, washed with deionized water, acetone and finally dried in an oven for 24hrs to achieve a constant mass. In this way, polyaniline(PANI) is synthesized.

2.2.Synthesis of PANI/TiO_2 composites:-

Synthesis of Pani/TiO_2 composites was carried out by In-situ chemical oxidation polymerization method. Aniline (0.1M) was mixed in 1M hydrochloric acid and stirred for 15 min to form Aniline hydrochloride. TiO_2 powder is added in the mass fraction to the above Solution with vigorous stirring in order to keep the TiO_2 homogeneously suspended in the Solution. To this solution, add 0.1M of ammonium persulphate, which acts as an oxidizer was slowly added drop-wise with continuous stirring at 5^{0}C for 4 hrs to completely polymerize. The precipitate was filtered, washed with deionized water, acetone and finally dried in an oven for 24hrs to achieve a constant mass. In this way,

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polyaniline/titanium-di-oxide composites with various weight percentages of TiO_2 (10%, 20%, 30%, 40% and 50%) were synthesized.

III. Results and Discussions :-

3.1.XRD analysis :-

XRD patterns of the samples are as shown in fig-(1a), (1b), which are recorded in 2θ ranging from 0-80. Pure Titanium dioxide(TiO_2) composite shows a broad peak at $2\theta=27^0$ which has a sharp and well defined peak, which indicates good crystallinity of the synthesized materials. The observed 2theta values are consistent with the standard JCPDS no-1I/TiO2-250. When we compare Fig-1a&1b, it clearly shows that the intensity of diffraction peaks for PANI/Titanium dioxide composite and is found to be lower than that of pure titanium dioxide.

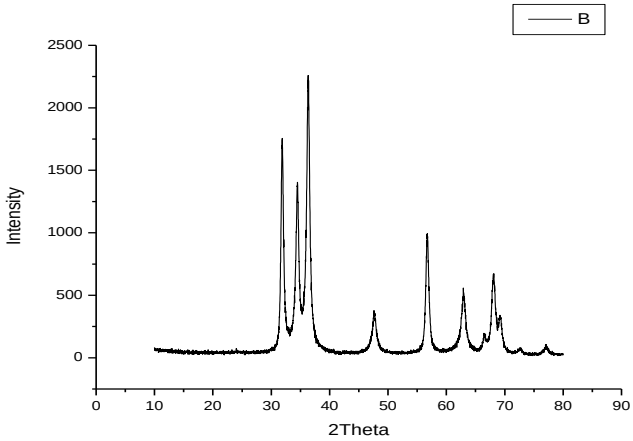

Fig-(1a)- XRD of Pure TiO2.

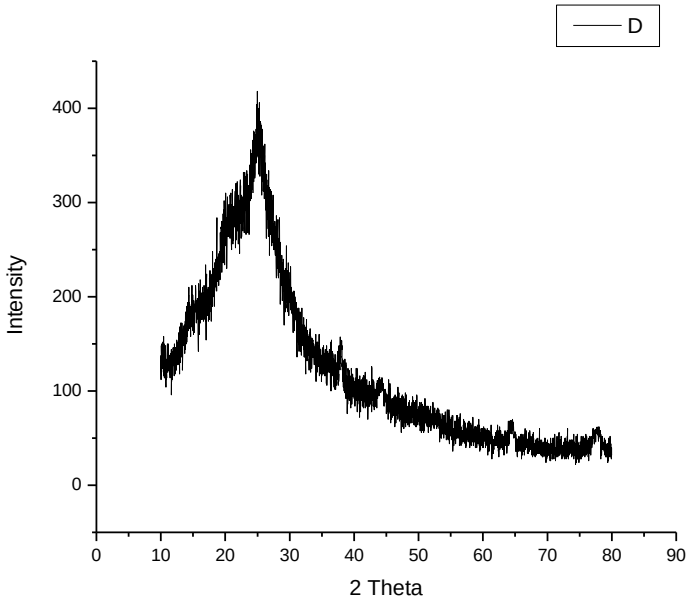

Fig-(1b)-XRD of PANI/TiO_2 composite

3.2.SEM analysis :-

Scanning election microscopy of conducting PANI synthesized by insitu chemical oxidative method is shown in fig-(3.2)The sem image (3a)of pure Tio2 is highly mesoporous, agglomerated granular

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in shape and the particles are well interconnected to each other .Fig (3.2b) shows that most of the particles are agglomerated irregular in shape & they are well interconnected to each other.

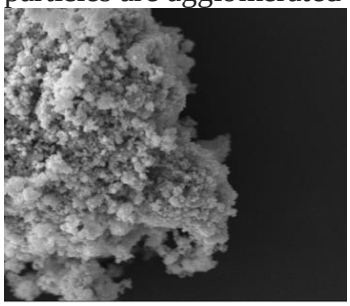

Fig3a- SEM image of Pure TiO_2

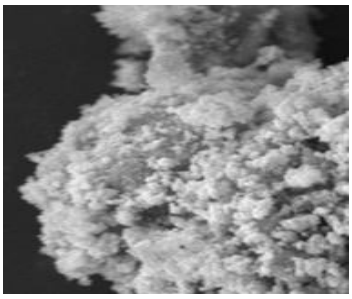

Fig3b- SEM image of PANI/TiO2 composite

4 DC Conductivity

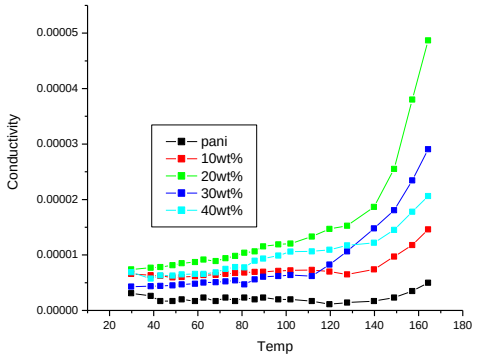

Fig.4 shows the dc conductivity of pani/iron oxide nanocomposites..

Fig 4 shows the DC conductivity as a function of temperature it is observed that the DC conductivity behavior of Polyaniline and Pani/iron oxide of different weight percentage are as shown in fig 4.the plot shows dcconductivity as a function of temperature for Polyanilne/iron oxide nanocomposites in the temperature range from 30 to 180 ^{0}c. The DC conductivity remains almost constant up to 80^{0}c and thereafter it increases up to180^{0}c, which is the charectestic behavior of semiconducting materials

5 Sensor Studies

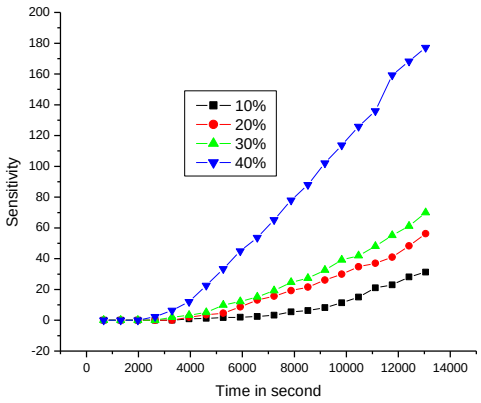

Fig.5. Variation of sensitivity against LPG

fig (5) shows sensitivity vs time for Polyaniline /Iron oxide nanocomposites it is seen that the Pani/iron oxide nanocomposites shows better sensitivity to gas vapor compared to pure polyaniline the 20wt% nanocomposites shows height sensitivity compared to other nanocomposites this is due to

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the strong interaction between the Polyanline and iron oxide nanoparticles. In the case of pure Polyaniline and 10wt% of nanocomposites sensitivity is very low because of lower surface area.

Conclusion

Polyaniline —TiO_2 composites were synthesized by in-situ polymerization method. The prepared composites were characterized by XRD & SEM and their results were confirmed by the formation of composite and indicate an interaction between Pani and titanium dioxide particles and also discussed the onductivity and sensing properties of Nanocomposites

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