INVESTIGATION ON THE ELECTRICAL, OPTICAL AND PHYSICAL PROPERTIES OF POLYANILINE (PANI) PRODUCED BY CHEMICAL OXIDATION TECHNIQUE

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Abstract: Polyaniline powder sample was chemically synthesized using aniline doped with HCl and Ammonium-peroxi-disulphate as an oxidant. The PANI Film was further deposited by chemical bath deposition technique using *N*-dimethyl formamide (DMF) as a solvent. The film was further characterized with FTIR and UVspectroscopy.Conductivity measurement is done with the help of two probe method. The study reveals that the PANI film possesses a very good environmental stability, uniformity in surface, and very high conductivity. These properties which are desired for the active layers in a gas sensing applications and P- type material in P N-junction diodes etc.

I. INTRODUCTION

In recent year conducting polymer play an important role in the branch of material science for electronics applications. Among all conducting polymers, Polyaniline (PANI) and its derivatives have attracted much interest worldwide, because of its chemical stability, simple polymerization, high conductivity ease in synthesis, PANI has been used in various application, like, optoelectronics, bio-sensors, gas sensors, microelectronics etc.[1-4].A unique property of this conducting polymer PANI is its switching ability between different oxidation states. It varies from the fully reduced leucoemeraldine (X=0) to the fully oxidized pernigraniline (X=1). The half oxidized structure is called Emeraldine base (EB), treatment of this form of Pani with a protonic acid leads to the conductive form of PANI called Emeraldine salt (ES) [5, 6]. The efficient polymerization of aniline is achieved only in an acidic medium, where aniline exists as an anilinium cation. A variety of inorganic and organic acids of different concentration have been used in the syntheses of PANI; the resulting PANI, protonated with various acids, differs in solubility, conductivity, and stability [7-9]. For the present paper, we have selected hydrochloric acid in equimolar proportion to aniline, i.e., aniline hydrochloride was used as a monomer. The handling of solid aniline salt is preferred to liquid aniline from the point of view of toxic hazards Peroxidisulphate is the most commonly used oxidant, and its ammonium salt was preferred to the potassium counterpart because of its better solubility in water. [10-12]. The properties of the films depend on a number of parameters, such as the type of solvent and their molar concentrations, temperature and on other synthesis conditions. Research is still continuing on the preparation and characterization of conducting polymers. Hence, in the present paper effort has been made to investigate the electrical, optical and structural properties of conducting polymer PANI at a particular temperature 5^{0}C, by chemical polymerization process [13–15].

II. SYNTHESIS OF CONDUCTING POLYMER

In the present paper the conducting polymer is synthesized by chemical method by oxidizing the corresponding monomer. The PANI film has been prepared successfully by chemical bath deposition technique CBD. The physical properties of the film were characterized by the FTIR spectroscopy; the FTIR spectroscopy gives details of stretching bond in the prepared polymer film. The UV-vis spectrum is useful for gauging the extent of conjugation providing information about the extent of conjugation, the electronic spectrum is indicative of polymer morphology, the presence of a free carrier tail. The change in conductivity was observed with two probe method at room temperature.

To oxidize 0.2M Aniline hydrochloride with 0.25M Ammonium peroxidisulphate aqueous medium Aniline Hydrochloride was dissolved in deionized water in volumetric flask to 50 ml. of solution. Ammonium peroxidisulphate was dissolved in deionized water in volumetric flask to 50 ml. of solution. Both solutions are kept below room temperature for 1 hour, then mixed in beaker, and left to polymerize. The polymerization was carried out in a temperature controlled water bath for 24hour at 5^{0}C. After 24 hrs. PANI precipitate was formed and collected on Whatman's filter paper, washed

with thrice 100 ml portion of 0.2M HCL and thereafter with Acetone. Polyaniline (Emeraldine) powder was formed. This powder was immersed in 0.1 M NH_4OH and washed and dried in air [16]. Oxidation of aniline hydrochloride with ammonium peroxi -disulphate yields Polyaniline [17, 18] as shown in Figure-1.

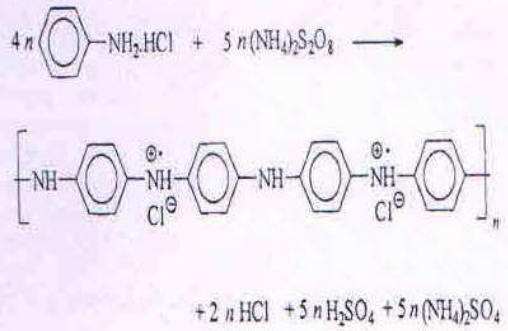

Fig.1. Oxidation of aniline hydrochloride with ammonium Peroxidisulphate yields PANI (Emeraldine) hydrochloride

III. PREPARATION FILM

For the measurement of conductivity, the film of Polyaniline is deposited by chemical bath deposition technique. In this process, the purified polymer was dissolved in DMF to form the solution. The PANI Emerdine salt will dissolve in DMF with 0.5g: 10 ml with 3 hrs stirring. The substrate is then allowed to immerse in this solution. Repeating
his process for two / three times the uniform film will be obtained. After evaporation of solvent a thin film is formed. During the deposition of the film the temperature of the assembly and surrounding is maintained below the room temperature thought the deposition process.

IV. RESULT AND DISCUSSION

The synthesized PANI films with optimized concentration of monomer, dopant, and oxidant prepared at a specific temperature 5^0C are subjected to study the electrical, optical and structural properties of PANI. The conductivity of resulting film is studied by the two probe method. The optical property of PANI films were characterized by analyzing UV-Visible spectroscopy. The physical properties of synthesized film are studied by FTIR spectroscopy.

1. Electrical characterization

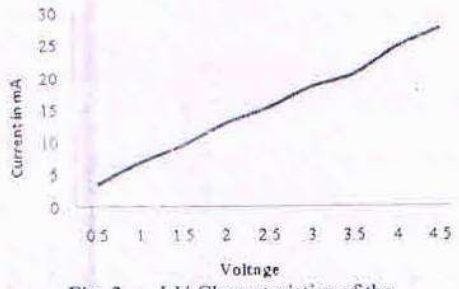

Fig. 2 I-V Characteristics of the

Figure 2 shows I-V Characteristics of the synthesized PANI film. The electrical charac- terization of film is carried out by the two-probe method at room temperature. The current voltage (I–V) characteristics of the synthesized PANI film was studied to ensure the ohmic behavior of the film. The I-V characteristic shows a linear relationship of PANI film. As we increase the applied voltage the current is increases in proportion with voltage, which reveals that the film of PANI has an ohmic behavior.

2. FTIR Analysis of synthesized PANI

The figure.3 shows the FTIR of synthesized PANI film. The Formation of the polymers, presence of a functional group on the polymer backbone and change in the protonation - deprotonation equilibrium of Emeraldine can be deduced from the presence of corresponding bands in the FTIR spectrum. It is seen that Quinoid and Benzenoid ring stretching bands are present at 1463.58 cm^{-1} and1377cm^{-1}.

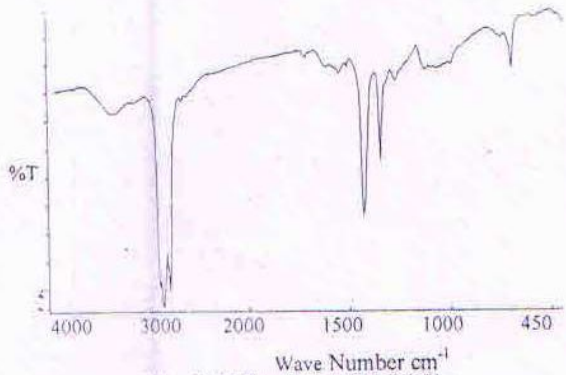

Fig. 3 FTIR spectra of PANI film

The C-H in plane and C-H out of plane bending vibrations appears at 1153.8 cm^{-1} and 722 cm^{-1} In addition, a relative weak peak at 1700 cm^{-1} appears in the spectrum is due to the stretching vibration of carbonyl group which shows the presence of AA in the film. Band at 2853 cm^{-1} is assigned to the N-H

stretching band. All these characteristic bands confirm the presence of conducting ES phase of the polymer. This shows very good agreement with earlier reported work [19].

3. UV-Visible analysis of PANI films

The Figure 4 shows the UV –Visible absorption spectrum of the synthesized PANI film. The peak at 320nm corresponds to the π-π^* transition of the Benzenoid ring, while the sharp trough at 420nm can be assigned to the localized polaron which are characteristics of the protonated Polyaniline, together with extended tail at 750 nm representing the conducting ES state of Polyaniline [19].

V. CONCLUSIONS

In the present work the electrical, optical and physical property of PANI films was investigated successfully. According to electrical measurements the conductivity of the polymer is in good agreement with standard reported data at room temperature.

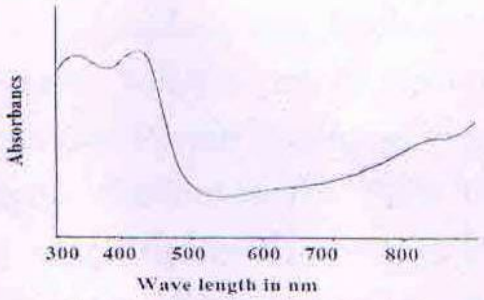

Fig.4 UV –Visible spectra of PANI film

Further, it can be conclude that the deposited film can be used to prepare efficient active layer for sensors because of its ease in synthesis and environmental stability. Its redox behavior (doped/dedoped) makes it a potential candidate for the electronics application.

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