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SYNTHESIS OF POLYANILINE AND POLYANILINE-ZN POWDER AND TO STUDY ITS CONDUCTING PROPERTIES

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Abstract: In the present work, the poly aniline (PANI) and Polyaniline-Zn powders were synthesized by chemical synthesis route. The resulting PANI and PANI-Zn powders were characterized by UV-Visible absorption spectroscopy. The pellets of synthesized powder of PANI and PANI-Zn were prepared. The I-V characteristic of prepared pellets of PANI and PANI-Zn was investigated.

Keywords: PANI, PANI –Zn, chemical synthesis, conducting polymer, I-V characteristics

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INTRODUCTION

Polymers are generally known as insulators. Polymers are simply very large molecules (macromolecules) that are made up of smaller molecules (monomers) that can be linked together in various ways, resulting in a range of what we call microstructures (e.g. linear chains, branched chains, densely interconnected networks etc.). Plastics that conduct electricity have been around since 1970's, but their electronic properties, and widespread use, have been limited by structural disorder. Polymers are a shiny material derived from acetylene, whose electrical conductivity surpassed those of conductors. The oxidation of Polyacetelene with Iodine, using Ziegler-Natta-catalyst yielded this material. Large efortts have been taken during the past two decades in the understanding of the chemical, electrochemical, structural, electrical and optical phenomena of inherently conducting polymers, such as polypyrrole (PPy), polythiophene (PT), polyaniline (PANI), polyphenylene (PPh) and their derivatives [1-3]. The great interest in these polymers arises from their relative ease of synthesis by chemical or electrochemical oxidative polymerisation of the monomers and from their considerable importance as candidates for new materials that would lead to the next generation of electronic and optical devices and as promising transducers for chemo or bio- sensors [1-11]. The fact that the 2000 Nobel Prize in Chemistry went to Alan J. Heeger, Alan G. MacDiarmid and Hideki Shirakawa *"for the discovery and development of conductive polymers" (Nobel Citation)* also reflects both research and practical importance of conducting polymers and their applications in modern science and daily life. This new conducting polymer is being used in anti-static and anti-corrosive materials, electronic integrated circuits, photonics, displays, lasers, sensors, photovoltaics, actuators, and electromagnetic shielding. Compared to silicon technology, polymers are not only flexible, but cost less to manufacture [1-14]. Now polymers are amongst the most widely used materials in the modern world due to their diversified technological applications. The main advantage of these conduting polymers is that they exhibit conductivity ranging from insulator to conductor [15-16].

In comparison with most of the commercially available sensors, based usually on metal oxides and operated at high temperatures, the sensors made of conducting polymers have many improved characteristics. They have high sensitivities and short response time; especially, these feathers are ensured at room temperature. Conducting polymers are easy to be synthesized through chemical or electrochemical processes, and their molecular chain structure can be modified conveniently by copolymerization or structural derivations. Furthermore, conducting polymers have good mechanical properties, which allow a facile fabrication of sensors. As a result, more and more attentions have been paid to the sensors fabricated from conducting

polymers, and a lot of related articles were published. There are several reviews emphasizing different aspects of gas sensors [17-19], and some others discussed sensing performance of certain conducting polymers [12-13,19], but few of them paid special attention to summarizing gas sensors based on different conducting polymers.

Conducting polymer gas sensors based on measuring resistance changes in thin-film structures have been studied by a number of researchers [18-21]. A detailed review of polymer and polyaniline sensors can be found in [22] and [23], respectively.

Polyaniline has attracted a great interest due to its large field of applications like batteries [24], protection of metals against corrosion, [25-26], electrocatalysis, [27-28] biosensors (analysis of ADN, proteins, and antipollution), [29-30], electrochromism (flat-faced screens and diodes) [31-35].

In this work, Polyaniline (PANI) and Polyaniline-Zn (PANI-Zn)composite powders were prepared by chemical synthesis route. The resulting PANI and PANI-Zn powders were characterized by UV-Visible absorption spectroscopy. A pellet of synthesized powder was prepared. The I-V characteristics of prepared pellets of PANI and PANI-Zn was investigated.

II. Experimental and Characterizations

Synthesis of PANI:

In this work, the Polyaniline (PANI) powder was synthesized by chemical polymerization method. The aqueous solution of Hydrochloric acid (HCl) was used as a protonic acid medium and monomer aniline was used with potassium dichromate was used as a oxidizing agent. The monomer aniline was double distilled prior to use.

Fig.1.showsschematic of chemical polymerization method. Freshly distilled aniline monomer is used for synthesis of polymer. For the chemical synthesis of polyaniline, two solutions were prepared with appropriate volume concentration. In first solution, 1M HCl and 0.1 M OA are dissolved in distilled water and second one is, the aqueous solution of 0.02 M KDC. The monomer solution is cooled down in an ice bath upto 0 to 5 ^{0}C under constant stirring and this was maintained for 2 hours. As the temperature reaches 5 ^{0}C slowly add the oxidant solution to the monomer solution drop by drop after each 1min time interval. Then this polymerization process was carried out up to 20 hrs. After this process, the solution was filtered and washed with distilled water repeatedly to remove the impurities. This powder was dried under dynamic vacuum for constant weight. After that we get poly aniline powder having mixed phase.

- **Synthesis of PANI- Zn:**

For the chemical synthesis of polyaniline-Zn, three solutions were prepared with appropriate volume concentration. In first solution, 1M HCl and 0.1 M OA are dissolved in distilled water second one 0.01M solution of zinc acetate and third one is, the aqueous solution of 0.02 M KDC.

First two solutions were added in a beaker. This monomer-Zn solution is cooled down in an ice bath up to 0 to 5 ^{0}C under constant stirring and this was maintained for 2 hours. As the temperature reaches 5 ^{0}C slowly add the oxidant solution to the monomer solution drop by drop after each 1min time interval. Then this polymerization process was carried out up to 20 hrs. After this process, the solution was filtered and washed with distilled water repeatedly to

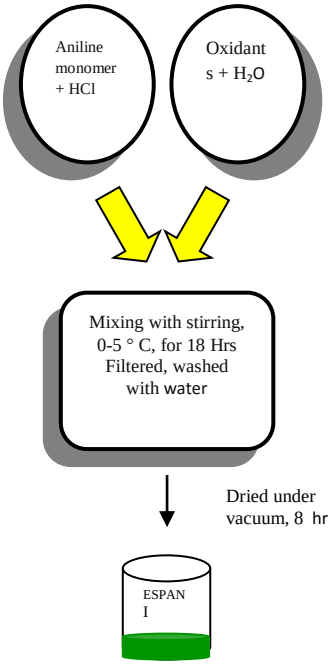

Fig.1. Schematic diagram of chemical polymerization method

remove the impurities. This powder was dried under dynamic vacuum for constant weight. After that we get poly aniline-Zn powder having mixed phase.

- **Preparation of Pellet**:

For the purpose of studying the conducting properties of Polyaniline and Polyaniline-Zn we prepared an element in the form of a Pellet. Pellets of the synthesized powders were prepared by using a die under pressure of 4 tons for 10 sec with the help of a hydraulic press.

➔ **Characterization**

- **UV characterization of prepared pellets:**

The synthesized powders of PANI and PANI-Zn are characterized by UV-visible spectrophotometer .

- **I-V Characteristics of Prepared Pellets:**

The I-V characteristics of prepared pellet was investigated.

III. Results and Discussions

The synthesized powder was characterized by UV-visible absorption spectroscopy. The spectrums were recorded in DMSO solution. It was recorded using UV-visible spectrophotometer 2600. All spectra were recorded in the wavelength range of 185- 800 nm. Fig.2(a). shows UV absorption spectra of synthesized PANI powder. The shoulder is appearing at 415 nm and peak appearing at about ~ 500 nm corresponds to the formation of ES phase. It shows very good resemblance with earlier reported work. Fig.2(b) shows UV absorption spectra of synthesized composite PANI-Zn powder. The shoulder is appearing at 431 nm and peak appearing at about ~ 630 nm corresponds to the formation of ES phase.

The bands at 415 and 500 nm are attributed to the p–p* and polaron-p* transition in the conducting PANI. Specially; it is observed that for PANI-Zn composite thin films, the absorption intensity increases with Zn. It may be due to the good absorption property of Zn particles. In addition, it can be noted that there are some shifts in the peaks for PANI-Zn composites thin films as compared to the pure PANI thin film. It may be due to that the encapsulation of Zn particles has the effect on the doping of conducting PANI or coordinate complex formation between Zn particles and POA chains.

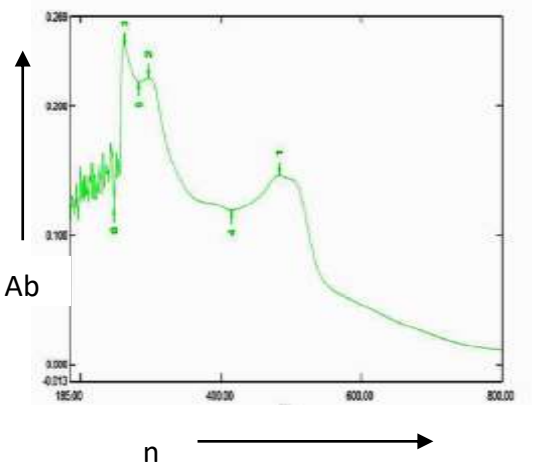

Fig. 2(a) : UV Absorbance spectra of

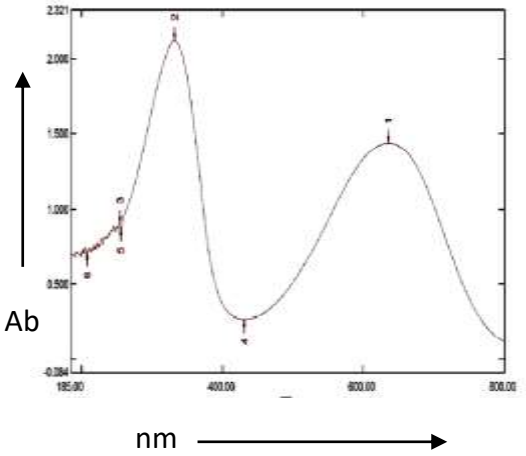

Fig 2(b): UV Absorbance spectra of PANI-Zn

I-V Charactization:

The pellets obtained from hydraulic press are of diameter 5 mm and thickness 2 mm. The pellets of PANI and PANI-Zn are found to be conducting.

The I-V characteristics of the prepared PANI and PANI-Zn is shown in fig.3. It confirms the conductivity of synthesized PANI and PANI-Zn powder.

The slope from the graph shows that the pellet of PANI has resistance ~ 2.451 x10^3 Ω and the pellet of PANI-Zn has resistance ~ 79.936 Ω .

It clearly confirms that doping of Zn in PANI enhances its conductivity.

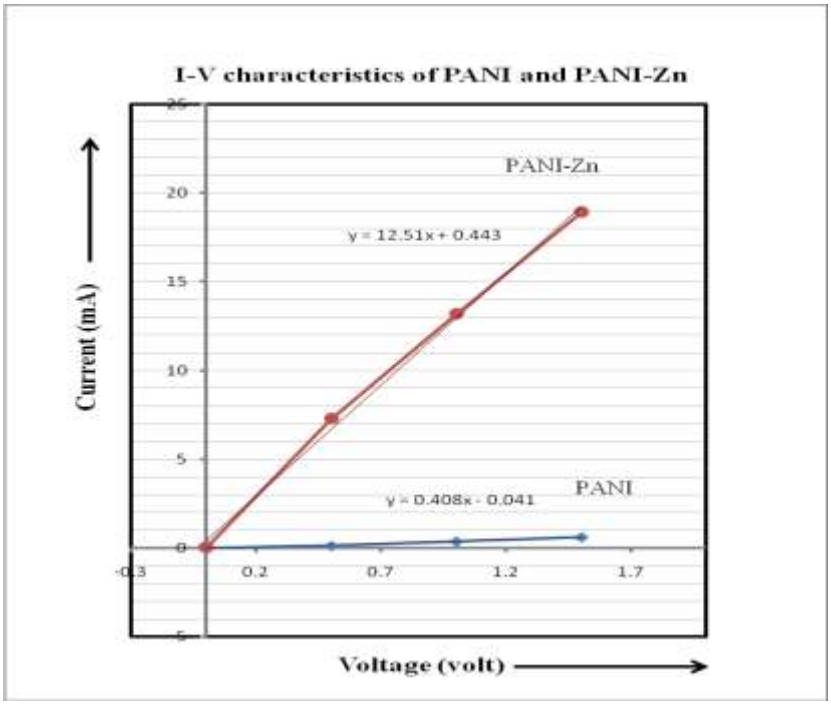

Fig. 3 : I-V characteristics of PANI and PANI-Zn

Following table shows the comparison between PANI and PANI-Zn pellet in terms of their dimension, conductance and resistance.

Sr. No.	Synthesized powder	Sample form	Dimensions of Pellet	Conductance mho	Resistance Ohm
1	Polyaniline	Pellet	Thickness: 2mm Diameter: 5mm	0.408×10^{-3}	$2.451 \times 10^{3}\ \Omega$
2	Polyaniline-Zn	Pellet	Thickness: 2mm Diameter: 5mm	12.51×10^{-3}	79.936 Ω

IV Conclusions

1. The conducting powder of PANI and PANI-Zn can be synthesized by simple chemical synthesis route.
2. The pellets of synthesized PANI and PANI-Zn can be prepared by using hydraulic press.
3. The I-V characteristics of synthesized PANI and PANI-Zn can be obtained.
4. The synthesized PANI and PANI-Zn powders are found to be conducting.
5. The conductivity of PANI found enhanced because of doping of Zn.

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