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Synthesis of POA and study of its conducting and gas sensing properties

R. S. Khadayate[1] S.L. Vispute[2], Varsha Manvatkar[3]
G.D.M. Arts, K.R.N. Commerce and M. D. Science College, Jamner, Dist. Jalgaon, Maharashtra, INDIA
North Maharashtra University,Jalgaon, Maharashtra, INDIA

Abstract: In this work, the poly (o-anisidine) (POA) powder was synthesized by chemical synthesis route. The resulting POA powder was characterized by UV-Visible absorption spectroscopy. A pellet of synthesized powder was prepared. The I-V characteristics and gas sensing properties of prepared pellets of POA at room temperature was investigated.
Keywords: POA, chemical synthesis, UV, pellet, conducting polymer

I. INTRODUCTION

Polymers are generally known as insulators. In 1981, the U.S. produced more than 24 million metric tons of polymers, more than the volume of steel. 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]. 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 [15-17], and some others discussed sensing performance of certain conducting polymers [12-13,15], 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 [16-19]. A detailed review of polymer and polyaniline sensors can be found in [20] and [21], respectively. In this work, the POA (poly (o-anisidine)) powder was synthesized by chemical polymerization method. The synthesized powder was characterized by UV-Visible spectrophotometer. Pellets of synthesized powder were prepared. The I-V characteristics and gas sensing properties of prepared pellets of POA at room temperature was investigated.

II. EXPERIMENTAL

In this work, the POA powder was synthesized by chemical polymerization method. The aqueous solution of Hydrochloric acid (HCl) was used as a protonic acid medium and monomer o-anisidine was used with potassium dichromate was used as a oxidizing agent. The monomer o-anisidine was double distilled prior to use. Fig.1. shows schematic of chemical polymerization method.

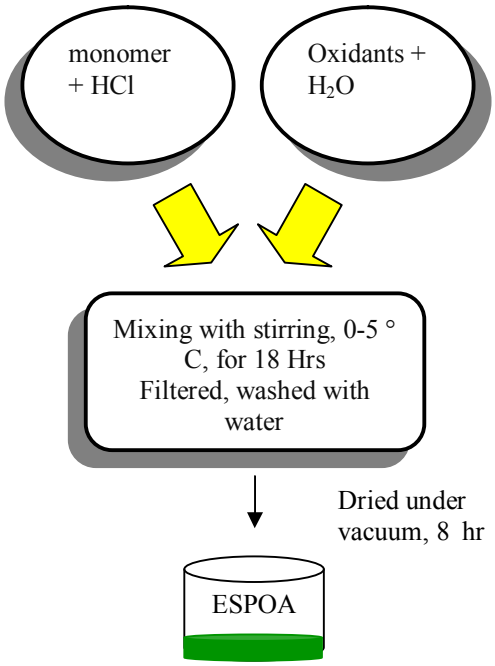

Fig.1. Schematic diagram of chemical polymerization method

Freshly distilled o-anisidine monomer is used for synthesis of polymer. For the chemical synthesis of poly(o-anisidine), 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. 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 (o-anisidine) powder having mixed phase. The optical absorption studies of POA powder using the microprocessor controlled double beam UV-Visible spectrophotometer (Hitachi-Japan, Model U2000). All the spectra were recorded in the wavelength range 300-1100 nm. Base line corrections were done before recording the spectra. Pellets of the synthesized powder were prepared by using a die under pressure of 2 tons for 10 sec with the help of a hydraulic press. The I-V characteristics of prepared pellet was investigated. Also the prepared pellet of POA was exposed to fumes of ammonia, acetone, LPG, H_2S etc at room temperature.

III. RESULTS AND DISCUSSION

The synthesized powder was characterized by UV-visible absorption spectroscopy. Fig.2. shows UV absorption spectra of synthesized POA powder. The spectrums were recorded in DMSO solution. It was recorded using UV-visible spectrophotometer 1601. All spectra were recorded in the wavelength range of 300- 1100nm. The shoulder is appearing at 412 nm and peak appearing at about 895nm corresponds to the formation of ES phase. It shows very good resemblance with earlier reported work [8-11]. The pellets obtained from hydraulic press are of diameter 8 mm and thickness 2 mm. The pellets of POA are found to be conducting. The I-V characteristics of the prepared POA pellet is shown in fig.3. It confirms the conductivity of synthesized POA powder.

The slope from the graph shows that the pellet has resistance ~ 714K-ohm.

The prepared pellet of POA shows slight change in its resistance value when exposed to fumes of ammonia, acetone, LPG, H_2S etc

at room temperature. The doping of some oxide materials may enhance the gas response.

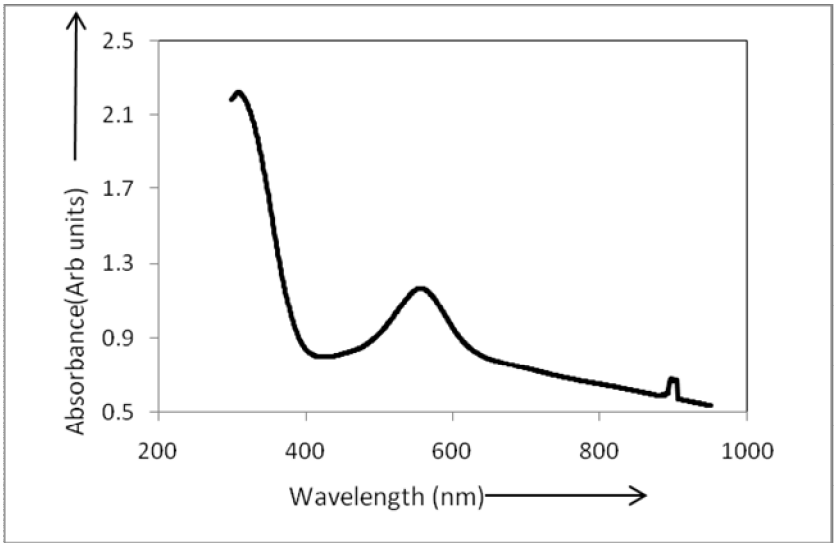

Fig. 2: UV Absorption Spectra of POA powder

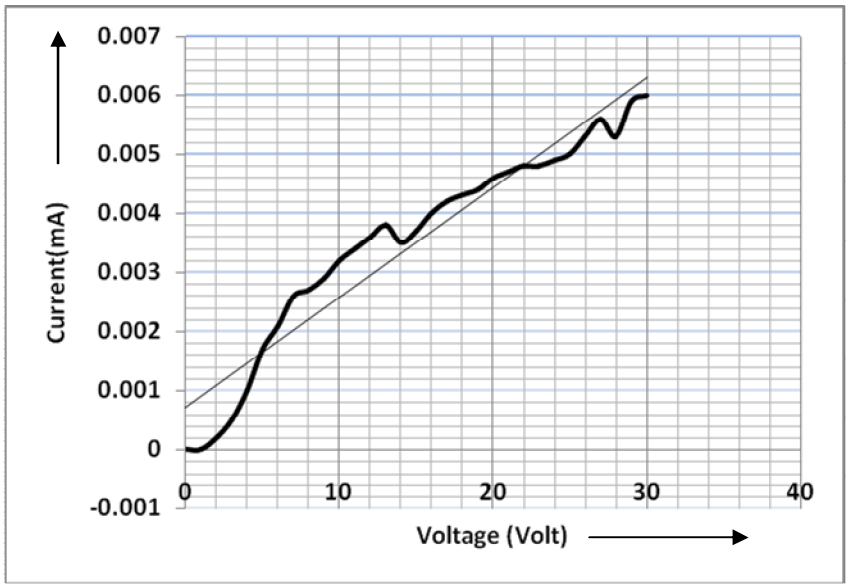

Fig.3: I-V Characteristics of POA pellets

IV. CONCLUSIONS

A. The conducting powder POA can be synthesized by simple chemical synthesis route.
B. The pellets of synthesized POA can be prepared by using hydraulic press.
C. The I-V characteristics of synthesized POA can be obtained.
D. The synthesized POA powder is found to be conducting.
E. The prepared POA pellets can be used for gas sensing purpose.

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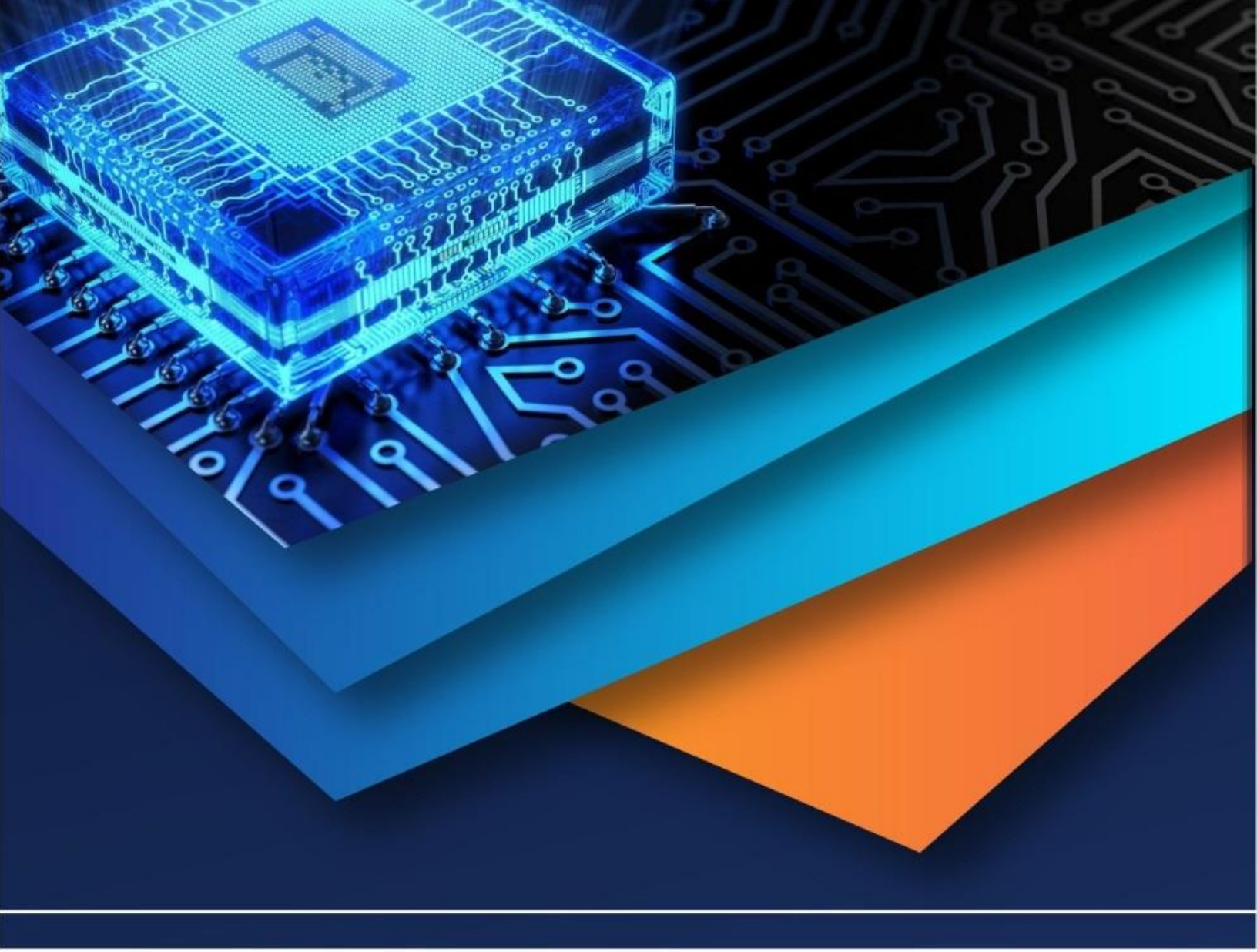

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