Potentiodynamically Synthesis And Characterization Of Polyaniline Thin Films.

Prashant P. Gedam
Shri R.L.T.College of Science, Akola
RUSA – Centre For Advanced Sensor Technology, Aurangabad

Mahendra D. Shirsat
RUSA – Centre For Advanced Sensor Technology, Aurangabad
Dept. of Physics Dr. BAMU, Aurangabad

Abstract :

In the present investigation, we study the electrochemical behavior of polyaniline thin films (PANITFs) which is synthesized by cyclic voltametry on platinum working electrode in three electrode system. During deposition of PANITFs various process parameter viz. concentration of monomer, dopant and scan rate of the cycle were optimized. The surface morphology was characterized by scanning probe technique viz. Atomic Force Microscopy (AFM) shows the thin films of PANI were grown on platinum working electrode.

Keywords : polyaniline thin film, cyclic voltametry, Atomic Force Microscopy.

Introduction:

World is going to developed tremendously due to liberalization, privatization and globalization but at the same time we have to face the some adverse effect of environment on living being. Therefore the researchers from various fields are tryig to developed new materials which is helpful to nurture our nature for our future. Therefore scientist fascinated towards the conducting polymers i.e. polypyrrole [1 - 2], polyaniline [3 - 4] and polythiophene [5] due to its tunable conductivity, low power consumption and ease of synthesis [6 - 9]. Conducting polymer films is synthesize by chemical oxidative polymerization technique [10] with the necessity of good oxidizing agent which can produced a thick films and required very large reaction time to carry out the process. Thin films of conducting polymer is synthesized by electrochemical route [11] which provide short duration of time to carry out the process without oxidizing agents.

Therefore in present investigation keeping the idea of electrochemical polymerization technique PANI thin films were synthesized potentiostatically and deposited on platinum working electrode (vs Ag/AgCl reference electrode). The topographical image of PANI thin film is recorded by Atomic Force Microscopy (Park XE 7). The electrochemical characterization performed by utilizing CH 600C electrochemical work station. A three electrode cell containing platinum plates of dimensions 20 * 5 *0.5 mm^3 were used as working & counter electrodes and saturated Ag/AgCl used as reference electrode. In the preparation of electrolyte, aniline monomer distilled twice prior to used and stored in cold environment were purchase from Sigma Aldrich. The reagent used as hydrochloric acid (HCl) of laboratory grade. . In the electrolyte preparation 1 M of HCL is added drop wise with continuous stirring in 0.5 M of aniline for half an hour. This solution was used for electrochemical deposition of PANI thin films on platinum working electrode at room temperature.

Result And Discussion:

PANI thin films were synthesis by cyclic voltametry by sweeping the potential between -1.0 to + 1.0 V for a 10 successive cycles at a scan rate of 50 mV/s. electrochemical polymerization of PANI involves two stage. In first stage PANI grown on the bare electrode shows a compact granular layer. In second stage PANI further grown on the form of granular layer and finaly form loosely bound open structure. It is seen that the first oxidation peak is at a potential of 0.3 V can attributed to the formation of emeraldine from lucoemeraldine, wheras the oxidation peak 0.9 V is related to the formation of pernigraniline from emeraldine. Beside, the oxidation process of other impurities was also found at the potential of 0.6 V. reverse reduction process occurs with a peak potential beyond 0.8 V and with a formation of lucoemeraldine from emeraldine and at a potential of 0.2 V is the formation of emeraldine from pernigraniline [12]. The modification in the topographic surface of the substrate after deposition of PANI thin film on working electrode is confirmed by Atomic Force Microscopy (AFM). The AFM topographical image shows the deposition of PANI on the electrode due to the increase surface area of sample.

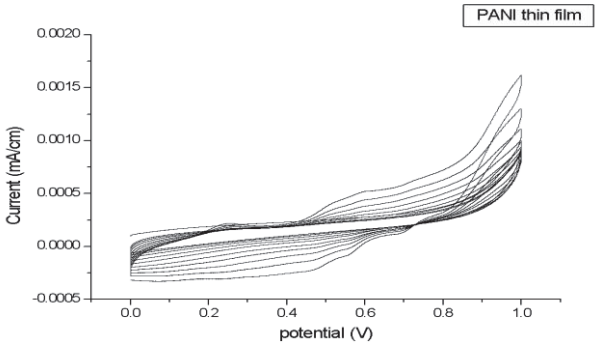

Fig. 1.: Cyclic voltamogram of PANI thin film recorded for sweeping rate 50 mV/s in 1M HCL aqueous solution

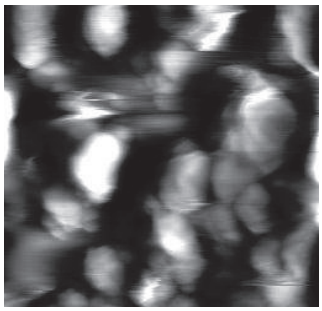

Fig 2.; Surface morphology of PANI thin film by AFM.

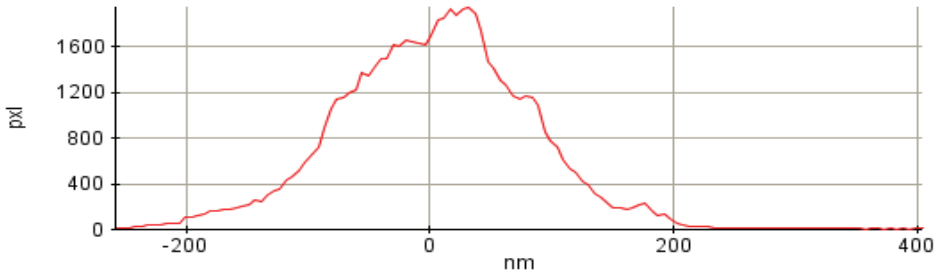

Fig. 3. Histogram of PANI thin films.

Conclusion :

electrochemical polymerization technique is utilized to synthesis and characterization of PANI thin film on platinum working electrode at room temperature. A voltamogram is recorded which required less reaction time with lower sweeping voltage with a scan rate of 50 mV/s as well as do not require any oxidant compare to the chemical oxidative polymerization technique. The oxidation peak nearly at 3 V confirmed the synthesis of PANI thin films. Surface morphology of deposited PANI thin film was studied by Atomic Force Microscopy, which confirms the deposition of PANI thin film on the working electrode due to roughness of topographic image

Acknowledgement

The authors are grateful to RUSA – Centre For Advanced Sensor Technology Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for providing a synthesis & characterization technology.

References:

1. P. Pawar, A.B. Gaikawad, P.P. Patil, Electrochemical synthesis of corrosion protective coating on mild steel from aqueous salicylate medium, Sci. Technol. Adv. Mat. 7 (2006) 732–744.
2. A.H. El- Shazly, H.A. Al-Turaif, Improving the corrosion resistance of buried steel by using polyaniline coating, Int. J. Electrochem. Sci. 7 (2012) 211–221.

3. P. Herrasti, P. Ocon, Polypyrrole layers for steel protection, Appl. Surf. Sci. 172 (2001) 276–284.
4. J.I. Martins, T.C. Reis, M. Bazzaoui, E.A. Bazzaoui, L.I. Martins, Polypyrrole coatings as a treatment for zinc-coated steel surfaces against corrosion, Corros. Sci. 46 (2004) 2361–2381
5. Stelian Lupu, In situ electrochemical preparation and characterization of PEDOT–Prussian blue composite materials Synthetic Metals 161 (2011) 384–390
6. Heeger Alan J. " Semiconducting and polymers: the fourth generation of polymeric materials " *Synth. Met.* **125** 23, 2002.
7. MacDiarmid G " Synthetic metals : a novel role for organic polymers"2002 *Synth. Met.* **125** 11
8. R.K. Paul, C.K.S. Pillai, B.R. Mattes.(2000) Melt/solution processable conducting polyaniline with novel sulpfonic acid dopants and its thermoplastics blends. Synth. Met. 114 , pp 27- 35.
9. M.T. Nguyen, P. Kasai, J.L. Miller, A.F. Diaz, (1994). Synthesis and properties of novel water soluble conducting polyaniline copolymers. ACS, Macromolecules. volume 27 pp 3625 – 3631.
10. S. Adhikari, P. Banerjee (2010). Enhanced conductivity in iodine doped polyaniline thin film form by thermal evaporation, Thin films volume 518, issue 19,pp 5421 – 5425.
11. O.Kazume , M Bobby Kannan (2013). Galvanostatic polymerization of aniline on steel : improving the coating performance in choride – containing environment. Synthetic metal Vol. 180, pp 54 – 58.
12. Chu Van Tuan , Mai Anh Tuan, Nguyen Van Hieu , Tran Trung. Electrochemical synthesis of polyaniline nanowires on Pt interdigitated microelectrode for room temperature NH3 gas sensor application