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Electrochemical behavior and Optical properties of Pani/ Mn

[1]Divyanshi Srivastava, [1]R.K. Shukla, [2] K.C.Dubey*

[1]Deparment of Physics, University of Lucknow, Lucknow, 226007, U.P, India.

[2]Department of Physics, Shia P.G. College, Lucknow-226020.

*Corresponding Author

Email: krishnacdubey@gmail.com

Abstract

This study shows Polyaniline (Pani) coatings were electrodeposited on the surfaces of ITO to form new electrodes. Characterizations of Polyaniline (Pani) by electrochemical and spectroscopic techniques are presented. The electrochemical parameters of the deposited Polyaniline were determined using cyclic voltammetry and chronoamperograms. The electrochemical investigation reveals the influence of the dopants on the exchange current density of polyaniline films. UV-Vis spectra of thin films indicate the decrease of the absorbance due to doping. Photoluminescence properties are also discussed.

Keywords: Polyaniline, electrochemical properties, cyclic voltammetry, UV-Vis, Photoluminescence.

1. Introduction

Polyaniline has been extensively studied because of its low cost, good environmental stability, good conuctivity, redox reversibility and easy synthesis procedure. A wide number of conducting polymers such as polyacetelyne, poly (p-phenylene), polypyrrole and polyaniline and many more, has been studied. Polyaniline is a very attracting polymer for its diversifying structures also it has attracted much attention due to its possible application (Gurunathan, K. et al. 1999), (Jiaxing, H., 2006), (Jhon, D. Stenger-smith., 1998) in electrochromic display, schottky diodes, supercapacitors, rechargeable batteries etc. Electrochemical method (Milica M. et al. 2011) is an easier method of mass production and its properties are mainly depends on the dopant ions employed such as Cl_6^- , PF_6^-, SO_4^- etc. and organic like camphor sulphonic acid (CSA) etc. Some data are also available regarding Pani/ Mn. In this present study investigated the electrochemical and optical properties of Pani/ Mn.

2. Experimental Analysis

2.1 Chemicals

Pure Aniline, H_2SO_4 and MnO_2 powder were purchased from Sigma-Aldrich. All the chemicals were used as received, without further purifications. The aqueous solutions were prepared in double distilled deionized water.

2.2 Synthesis

The electrochemical experiments were carried out in a one-compartment, three electrode connected cell. The working anode ITO and the counter cathode Pt wire electrodes with Ag/ AgCl as Reference Electrode. Film deposited on anode. Electrodes are carefully washed with acetone and ethanol. The space between anode and cathode was~1.5 cm. In order to deposit Pani/ Mn film on anode, an electrolyte solution of 0.15M of aniline and 0.15M H_2SO_4 with different molarities of Mn of 1, 2 and 5 at. wt. % to make 50 ml of solution. Electrochemical deposition processes for Set-up 1 were carried out at a constant applied voltage at 1V and current 1mA .The anode was rinsed off gently with distilled water and let it dry for six-hours and stored it a proper place.

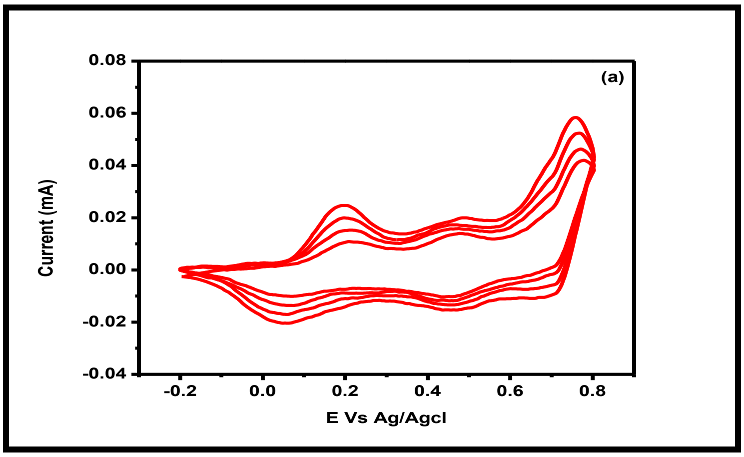
3. Results and discussion

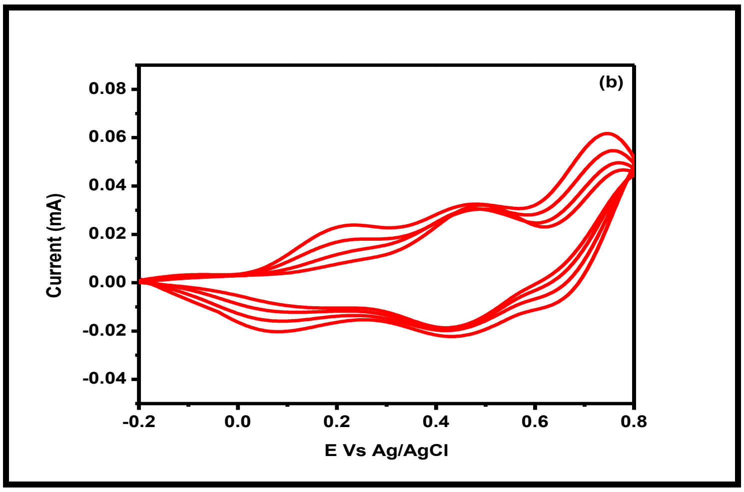
The electrochemical performance was done with K_lyte 1.0. The UV-vis spectrum of the polyaniline is recorded at room temperature by spectrophotometer between the wavelength ranges b/w 240nm – 850 nm. Photoluminescence spectrum is recorded by Perkin-Elmer LS-55 photoluminescence spectrometer with the excitation wavelength 300nm.

3.1 Cyclic Voltammetry

Voltammetric cycles of Pani/ Mn in aqueous acid solution are shown in Fig. 1.Cycles were obtained till 4 successive scans. CV of all samples was recorded in the potential range from -0.2 to 0.8 V Vs. Ag/ AgCl at the rate of 0.05 V/s at 1mA current.

In case of Pani, a couple of oxidation and reduction peaks were observed at around 0.2V which is due to the transition of leucoemeraldine to emeraldine base form. Second is around at 0.8V which corresponds to transition emeraldine base to pernigraniline. Anodic and Cathodic peak position also depends upon the pH values of the electrolytes. Usually there are two peaks appeared in the case of Pani but if the middle pair of peaks also appeared at around 0.4V, it has been concluded as either due to the presence of ortho-coupled polymer or due to the soluble species which causes degradation of Pani (Hand R. L. and Nelson R. F., 1974), (Shim Y. B. et al., 1990). Here in case of pure Pani, two pairs of oxidation peaks are obtained at 0.19 and 0.75V and two reduction peaks obtained at 0.05 and 0.69V. It has been also found that due to the presence of Mn current conduction also increases and reaches up to 0.1 mA with doping which is also observed in chronoamperometry. That confirms improvement in electrical conductivity due to the presence of Mn particles.





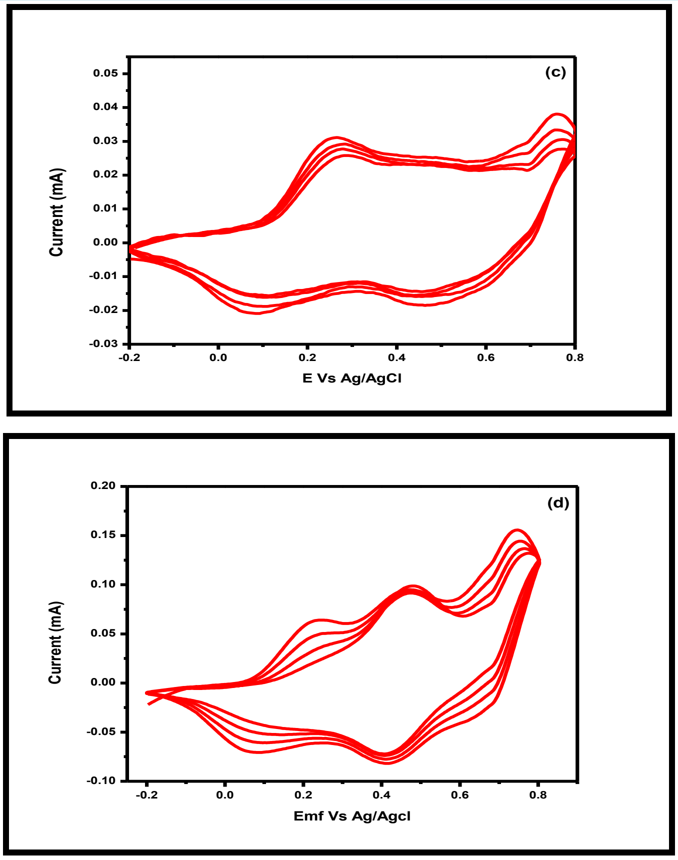


Fig.1. Cyclic Voltammetry of Pani/Mn (a) 0 % (b) 1 % (c) 2 % and (d) 5 %

3.2 Chronoamperometry

Chronoamperometry measurement has been calculated at fixed voltage 1.0V and at fixed current at 1 mA for 20 minutes. Here Fig. 2 shows the chronoamperometry plots of Pani/Mn which shows that the doping process increases the electrical current conductivity. And it is more prominent for 5%.The current increment suggests the dominance of polymerization and current decreament suggest the dominance of degradation and the steady current indicates the competition b/w polymerization and egradation. The polymerization and degradation is mainly depends upon concentration of aniline and potentials.

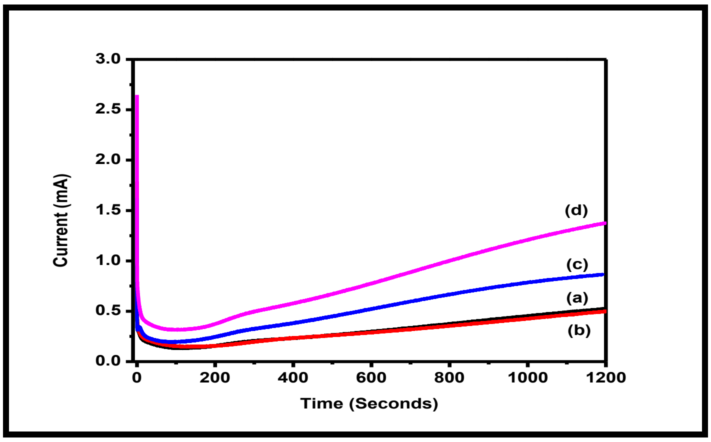


Fig.2 Chronoamperometry of Pani/Mn at (a) 0% (b) 1% (c) 2% and (d) 5%

3.3 Absorption Spectra

Fig 3.shows U.V. spectrum of Pani with DMSO as a solvent .Three absorption bands are observed at 290 nm, 440 nm and a long tail at 800 nm .Usually, Pani peak attributed at 330 nm which was assigned to π-π* band transition of benzenoid units in the polymer chain(Rajiv Borah, et al. 2014), (Somik Banerjee, et al. 2009). It also associated with Humo to Lumo transition and this indicates energy band gap of the polymer. Here the band observed at 290nm which is slightly shifted compared to the normal band transition at 330nm. Another band observed at 440nm is associated with π-polaron transition (Pouget, J. P., 1991) which is generally observed in ES salt form of Polyaniline and the band observed at 800nm is due to polaron-π* transition (Shim Y. B. et al. 1990).

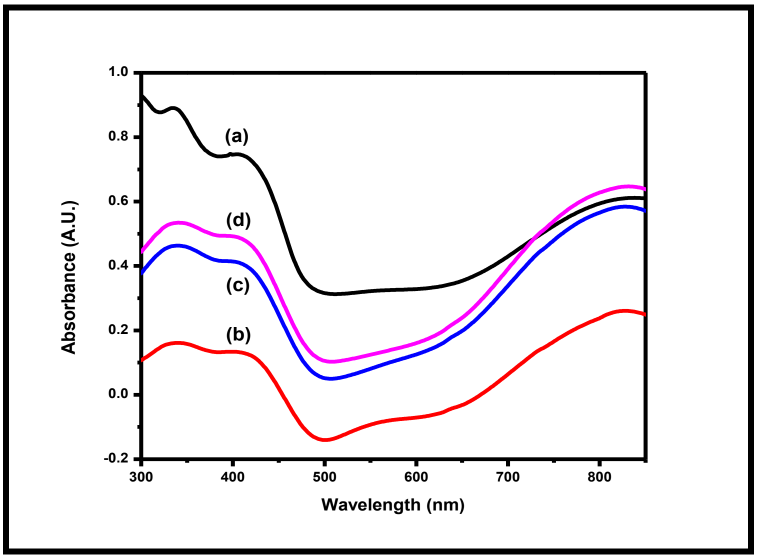


Fig.3. Absorbance Spectra of Pani/Mn at (a) 0 % (b) 1% (c) 2% and (d) 5 %

3.4 Photoluminescence Studies

The Photoluminescence spectrum of PANI/Mn was taken with the excitation wavelength at 325 nm shown in fig. 4. All the curves show common peaks at around 360nm, 420nm, 450nm and 485nm which lie in blue and violet regions. Also it reduces with the dopant concentration increase. The decrease in intensity can also be attributed to enhancement of particle size (Jiahua Z. et al., 2011).

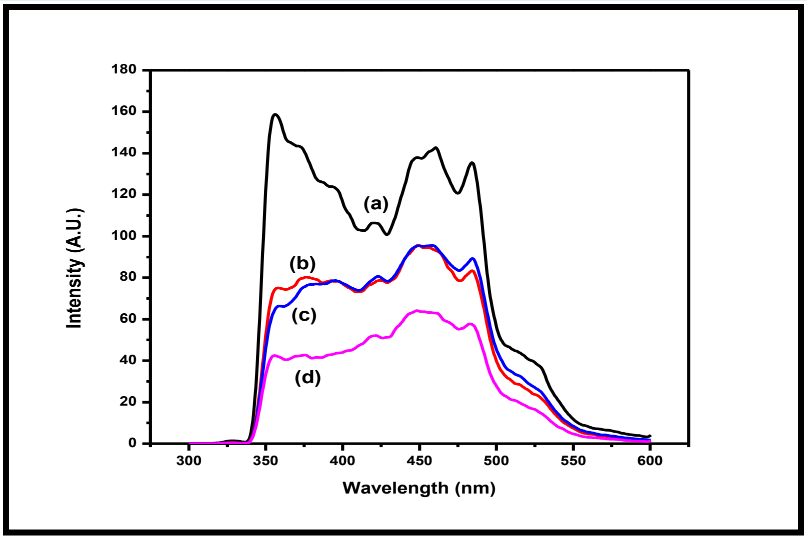


Fig.4 Photoluminescence of Pani/Mn at (a) 0 % (b) 1 % (c) 2 % and (d) 5%

4. Conclusion

Through this study it is clear that Mn particles are helpful to improve electrical current conduction but with reduced absorption and Luminescence properties. Electrical properties of the samples were also enhanced due to the presence of Mn which finds its applications in areas such as sensors, solar cells, capacitors etc.

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