Electrochemical activity of chemically deposited polypyrrole films

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In this work we compare the electrochemical behavior of chemically and electrochemically polymerized polypyrrole. Electrochemical approaches provide a simple way to identify counter ions introduced in to chemically polymerized electroactive polymer films. Here we use cyclic voltammetry and charge potential plots..

Many references discuss the electro-polymerization of pyrrole (Py) and the properties of the resulting polypyrrole (PPY) films[1]. Less information exists concerning the chemical polymerization of pyrrole in homogeneous solution which occurs readily in the presence of different oxidants, such as $FeCl_3$[2,3] and $(NH_4)_2S_2O_8$[4].The formation of PPY films on solid surfaces by chemical polymerization of pyrrole is well-known, e.g., onto printed circuit boards[5] and various textile composites [6,7]. In these cases, the deposited layers were characterized by conductivity measurements, mass changes and other methods[2] such as mass spectrometry , vibrational spectoscopy[7], Rutherford back scattering spectrometry, scanning electron microscopy and scanning tunneling microscopy [8,9].

Electrochemistry of such films provides a simple diagnostic tool for identifying the doping anion which is determined by the composition of the solution containing in which polymerization occurs.

Conducting polypyrrole (PPY) films were deposited on platinum and gold by chemical oxidation of pyrrole from acid solutions of H_2O_2, $K_2S_2O_8$, $K_2Cr_2O_7$, $FeCl_3$ and $Fe_2(SO_4)_3$. Cyclic voltammograms (CV) and charge-potential data were obtained for the PPY film chemically deposited on a platinum wire. The electrochemistry was done in 0.1M $LiClO_4$ and in 0.1 M Na_2SO_4 solutions.

Chemically deposited PPY films are electrochemically active and yield oxidation-reduction peak potentials that are similar to those of electrochemically deposited PPY films in solutions with the same anion introduced into the PPY film. The shape of the cyclic current-potential curves and the charge - potential responses of the chemically deposited PPY depend on the composition of the solution in which deposition occurs because its composition determines the polypyrrole's counter anion

These conducting PPY films were electrochemically active and exhibited cyclic voltammetric oxidation and reduction currents in 0.1 M $LiClO_4$ solution.

Peak potentials and charge changes in the films are characteristic of the counter (doping) anion. We assume that electrochemical behavior of chemically polymerized polypyrrole will resemble that seen with electrochemically polymerized PPY films having the same counterion..The counter anions present in electrochemically active PPY films produced by chemical means were identified in this way,. Comparison of chemically and electrochemically prepared soluble polypyrrole has also been made for homogeneously polymerized pyrrole with a very large counteranion[10].

References

1. Electrochemical Science and Technology of Polymers—2. Ed. R.G. Linford, pp. 166-173, Elsevier Applied Science, London, 1990.
2. J. Ley, Z. Cai, C. R. Martin, *Synthetic materials*, **46** (1992) 53-69.
3. S. Gottesfeld, F. A. Uribe and S. P. Armes *J. Electrochem. Soc.* **139 (1)**, 14 (1992). book.
4. Handbook of Conducting Polymers, Second Edition, Eds. T.A. Skotheim, R.L. Elsenbaumer, and J. R. Reynolds, p. 423 (1998)
5. M. Saurin and S. P Armes *J. Appl. Polym. Sci.* , **56(1)**, 41-50 (1995).
6. R. V. Gregory, W. C. Kimbrell and H. H. Kuhn, *Synthetic metals*, **28** ,C823-C835(1989).
7. M. J. Hearn ,I. W. Fletcher, S. P. Church and S. P. Armes. *Polymer*, **34**, 262 (1993).
8. S. P. Armes , M. Aldissi,, M. Hawley, J. G. Beery and S. Gottesfeld, *Langmuir* **7**, 1447 (1991).
9. S. P. Armes , S. Gottesfeld , J. G. Beery, F. Garzon, C. Mombourquette, M. Hawley, H. H. Kuhl, *J Mater. Chem.* **1**, 525, (1991).
10. Y.Son, J.S. Choi, K.S. Jand, J.S. Suh, E.J. Oh, J. Joo, J.H. Cho. Synthetic Metals 84 175 (1997)