Influence of Applied Potential on the Conductivity of Polypyrrole Thin Films growing on Indium Tin Oxide

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1. Abstract:

As one of the promising conducting polymers (CPs), polypyrrole (PPy) has been extensively used as active electrode material for many applications: anti-corrosive coatings, batteries, electronic devices, sensors and biomaterials [1-5]. In fact, PPy is a widely studied conductive polymer due to its high environmental, thermal and chemical stability, their good electronic conductivity and ease of synthesis [6, 7]. PPy is a conjugated polymer with alternating single and double bonds. Its conductivity originates from the π electrons delocalized over the conjugated system and from the doping ions. PPy thin films can be synthesized on electrodes from organic or aqueous media by chemical and electrochemical methods. Electrochemical deposition offers a versatile and facile method since the film formation and its properties (thickness and surface topography) can be easily controlled by controlling the electropolymerization conditions, such as applied potential, current density, monomer concentration, electrolyte solutions and pH [8, 9]. Recently, it has been reported that properties of PPy films depend significantly on their final morphology. Therefore, synthesis of novel morphologies of PPy deposits could improve some of these properties. In this study, PPy thin films were deposited on indium tin oxide (ITO) electrode under potentiostatic control from a solution containing 0.01 M pyrrole (C_4H_5N) dissolved in acetonitrile (CH_3CN). The influence of the applied anodic potential on the morphology, electrochemical behavior, as well as the electronic conductivity of the resulting PPy films was investigated. For this purpose, PPy films deposition was performed at three applied potentials 0.8, 1 and 1.2 V/SCE for 2 min. The obtained films were characterized by scanning electron microscopy (SEM) and atomic force microscopy (AFM).

Key-words: Chronoamperometry; Electrochemical polymerization; Polypyrrole; Thin films.

Results:

Electropolymerization of PPy

PPy thin films were first prepared by potentiodynamic method. Figure 1 shows the experimental voltammetry curve obtained during the first cycle. The potential scan was carried out between -1 to 1.25 V at scan rat of 100 mV/s.

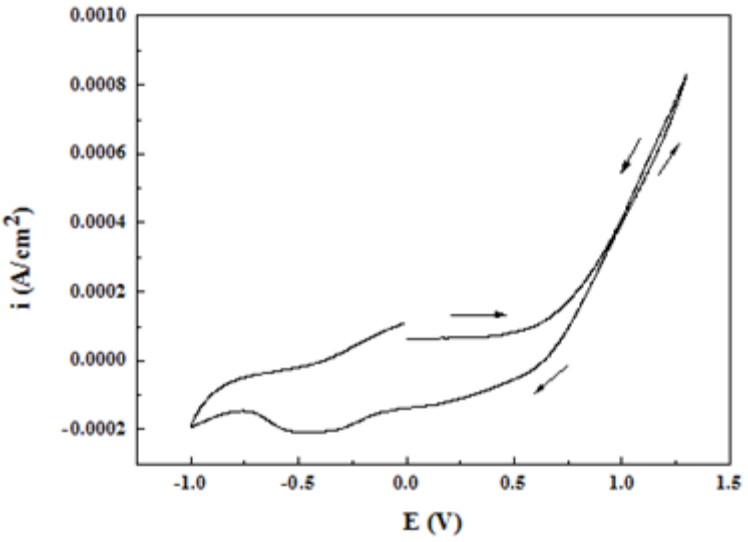
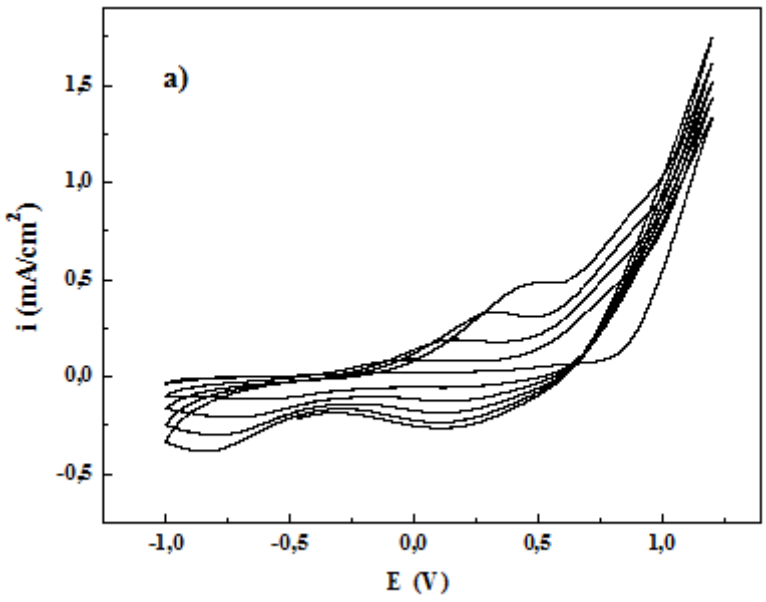


Figure 1. First cyclic of electropolymerization process of PPy on ITO with potentiodynamic method scan rate 100 mV/s.

Figure 2 shows cyclic voltammograms obtained during 5 and 10 continuous cycles respectively scan rat was 100 mV/s.



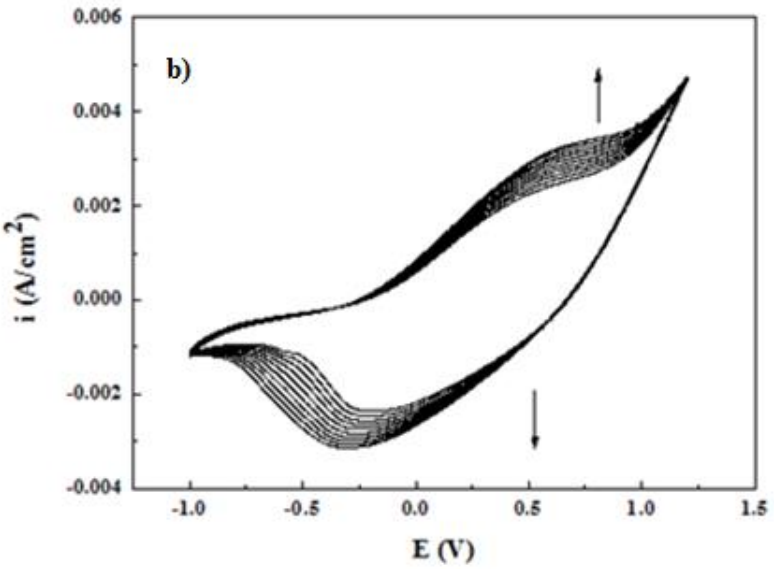


Figure .2. Cyclic voltammograms of ITO electrode in 5 mM pyrrole + and CH3CN/LiClO4 solution scanned for a) 5 and b) 10 cycles in the potential range from -1 V to 1.25 V at scan rate of 100 mV/s.

Potentiostatic deposition of PPy

The influence of deposition potential on the electropolymerization ofpyrole on ITO substrate was investigated. Figure 3 shows the chronoamperometric curves of PPy electrodeposition at different applied potentials (0.75, 0.85 and 0.95 V) during 180 s deposition time.

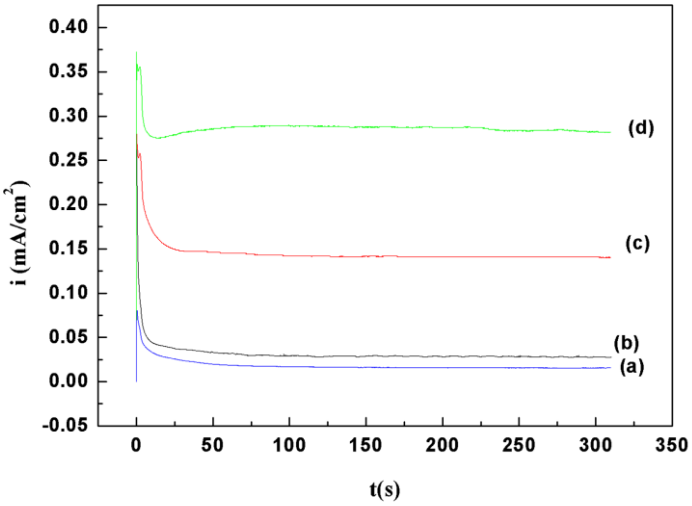


Figure .3. Chronoamperometric curves of polypyrrole electrodeposited on ITO substrates at different applied potentials: a) 0.9V, b) 1V, c) 1.1 V and (d) 1.2 V for 320 s.

Morphological characterization of the PPy

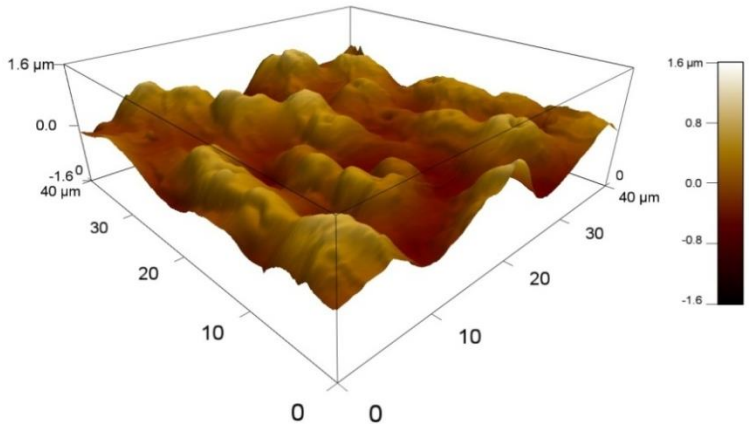


Figure. 4. 3D AFM image of PPy thin films deposited at 1V/SCE for 2 min.

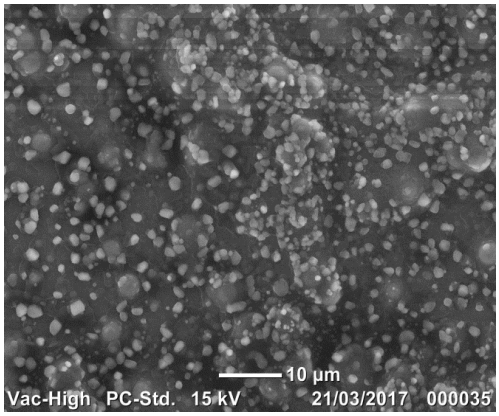


Figure. 5. SEM micrograph of PPy thin film deposited at 1V/SCE for 2 min.

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