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Poly-3-thiophenes layer-by-layer films: sensors applications

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Abstract – Polythiophenes are conjugated polymers that possess good environmental and chemical stability. Polythiophene derivatives can be used in several applications, solar cells, transistors and sensors. Here we present the of sensor application of layer-by-layer films of water-soluble polythiophene. LbL films were used as modified electrodes in cyclic voltammetry detections of metals and an herbicide (atrazine) with good sensitivity.

Conjugated polymers are one of the most important and curious classes of materials. They show typical polymer properties as plasticity besides the conductivity, photoconductivity and fluorescence properties of semiconductors[1]. Polythiophenes are one of these materials which exhibit good environmental and chemical stability. The Layer-by-Layer (LbL) film forming method offers a wide variety of layered structures where the number of layers and layering sequence are easily controlled[2]. In the present study, we built-up LbL film with the two polythiophenes: poly (3-thiophene acetic acid) (PTAA) and a copolymer of an azothiophene 2-[N-ethyl-N-[4-[(4-(4-nitrophenyl]amino] ethyl]-3 thienylacetate (3-AzoT) and 3-thiophene acetic acid (3-TAA), named here as PAzoT-co-PTAA. The aim using the copolymer is to modulate the color of the films for further used in optical devices, e.g. electrochromic sensors. The films were formed onto solid substrates alternating the polythiophene derivative in alkaline media (polyanion) with the polycation poly(alyllamine hydrochloride) (PAH). The resulting films were tested as electrochemical sensors for metals and herbicides. The film growth on glass substrates was followed by visible spectroscopy, monitoring the absorbance at 460 nm (figure 1, for PTAA). Detection of metals (example showed in figure 2) as Hg^{+2}, Pb^{+2}, Cd^{+2}, Cu^{+2} and the herbicide atrazine was performed by cyclic voltammetry using LbL films deposited onto glass coated with indium-tin oxide (ITO) as modified electrodes. The platinum foil was used as auxiliary electrode and calomel as working electrode. All sensors presented good sensitivity, with slightly differences between the two polythiophenes derivatives, which are sufficient for use in sensors for environmental control.

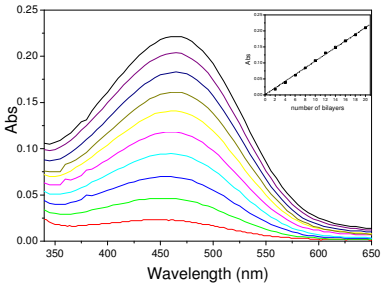

Figure 1:UV-Vis spectra of PTAA/PAH films with different number of bilayers. The inset shows the linear relationship of the absorbance at 460 nm

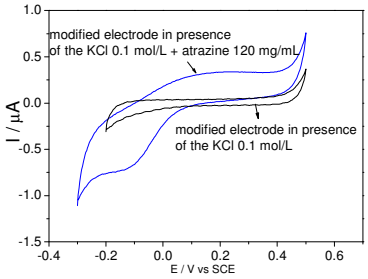

Figure 2: Voltammetric cyclic in the presence of the KCl 0.1 M (black) and KCl 0.1 M plus atrazine (blue) Reference Electrode (SCE). v = 100 mV s^{-1}; electrode: azothiophene 2-[N-ethyl-N-[4-[(4-(4-nitrophenyl]amino] ethyl]-3 thienylacetate (3-AzoT).

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