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Immobilization of Single Walled Carbon Nanotubes on Conducting Polymers-modified Electrodes

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Abstract – Conducting polymers/carbon nanotubes complexes have been widely investigated as potential transducer materials in biosensing, mostly due to the improved sensitivity, stability and reproducibility exhibited by these modified electrodes [1-3]. In this study we investigate the electrochemical and morphological properties of modified electrodes comprising single walled carbon nanotubes (SWCNTs) assembled with polyaniline and its derivatives in the form of layer-by-layer (LbL) films.

The use of polyaniline as well as its water-soluble derivatives in conjunction with SWCTs represents an efficient strategy to produce modified electrodes for sensing. In this study we show the feasibility of combining different conducting polymers with SWCNTs in the form of ultrathin layered films for applications in sensing. The polyelectrolytes polyaniline (PANI), poly(o-methoxyaniline) (POMA) and poly(o-ethoxyaniline) (POEA) were used as aqueous solutions at a concentration of 0.5 mgmL^{-1} and pH 4.0. The carboxylic acid functionalized SWCNTs were used as aqueous solution at a concentration of 1.0 mgmL^{-1} and pH 4.0. Conducting polymers/SWCNTs LbL films containing up to 5 bilayers were obtained upon immersion of an appropriate solid substrate (e.g., quartz, and ITO-covered glass plates) for 5 min in the polymeric and SWCNT solution, alternately. Assembly of the multilayer films on the modified electrodes was monitored using UV-VIS absorption spectroscopy. FTIR and micro-Raman spectroscopies were employed to investigate the possible interactions between film constituents. Electrochemical measurements were performed in a potentiostat/galvanostat with modified ITO as working electrode, Pt plate as the auxiliary electrode. As reference, an Ag/AgCl electrode was used. Cyclic voltammograms (CVs) were performed by using a phosphate buffer solution (pH=7.0) and a potential range between -0.6 and 0.5 V vs Ag/AgCl. The morphology of the films was investigated by atomic force microscopy (AFM). The CVs from figure 1 exhibited well defined semi-reversible redox peaks characteristics of PANI and its derivatives. A shift in the redox peaks toward lower potentials was also observed for PANI containing films assembled with SWCNTs, in comparison to PANi films assembled with an inert polyelectrolyte, viz., polystyrene sulfonate (not shown). The potencial peak is absent in the CVs POEA/SWCNT films studied. Reference Raman spectra from the polyelectrolytes/SWCNT films are shown in figure 2. Interactions between the conducting polymer and SWCNTs layers in the LbL films are better visualized in POMA-containing films, as revealed by the shift in the D band from SWCNTs, from 1332 cm^{-1} in cast films to 1346 cm^{-1} in the PANI-LbL film.

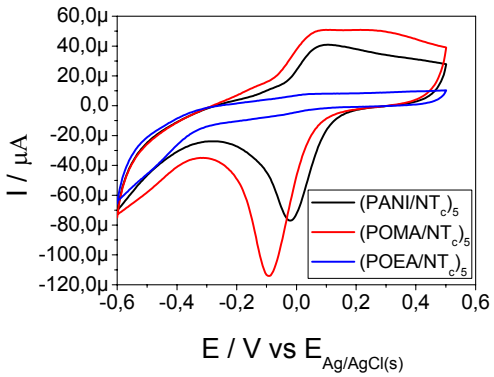

Figure 1: Cyclic voltammograms of the LbL systems employed.

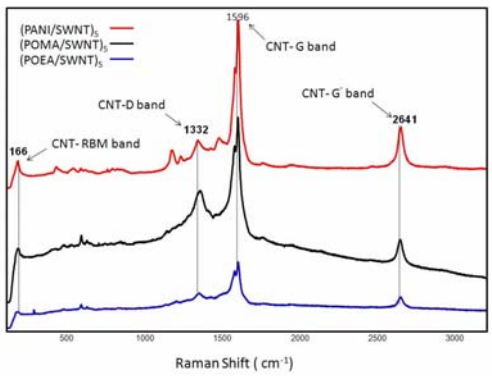

Figure 2: Raman spectra from films containing PANI and derivatives assembled with SWCNTs as polyanions.

References

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