

POLYANILINE/GOLD NANOPARTICLE FILMS: ASSEMBLY AND ELECTROCHEMICAL PROPERTIES

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INTRODUCTION: Recently, much research work concentrated on how to shift the redox activity of polyaniline (PANI) from acidic conditions to a neutral pH environment in order to apply it for bio-purpose. One approach is to introduce acidic groups into the PANI chain and to form a so-called “self-doped” PANI[1]. Another method is to dope PANI with negatively charged polyelectrolytes either by electrocopolymerization [2] or by the layer-by-layer(LBL) method [3]. All the obtained PANI films showed good redox activity at neutral pH and some of them have been successfully utilized to immobilize enzymes[4].

Here, we report another novel method to shift the redox activity of PANI to neutral conditions, i.e., to dope PANI with mercaptosuccinic-acid-capped gold nanoparticles(MSAG) instead of the normally used polyelectrolytes, by using the LBL self-assembly method. The obtained PANI/MSAG multilayer films showed excellent redox activity in neutral solution and good electrocatalytic efficiency toward the oxidation of NADH, as well as potential applications for biosensing.

METHODS: The preparation of water dispersible MSAG followed Kimura’s method[5].The average particle size (TEM)was around 2 ± 0.5 nm. PANI (Aldrich, MW ~65000) can be made water soluble according to the procedure used by Rubner[6]. The LBL self-assembly process was carried out by first modifying the freshly prepared Au substrate with 3-mercaptopropylsulfonic acid (MPS). Next, the modified Au substrate was alternately exposed to the PANI solution (1mM, pH2.6) and the MSAG solution (30 μ g/ml, in MilliQ water), each for 15min, with rinsing steps in between, until the desired number of layers was achieved.

RESULTS: The LBL self-assembly process was monitored in situ by both SPS and cyclic voltammetry(CV)(Fig.1). Both the gradual SPS minimum angle shifts and the almost linear peak current increase with the increase of the number of bilayers indicate a progressive deposition of PANI and MSAG layers in each cycle. Also from the cyclic voltammograms, it is clear that the PANI/MSAG multilayer films show very good redox activity in pH 7.1 PBS buffer. The films are very stable upon repeated potential scans. CV

measurements at different scan rates showed that the redox process is surface-controlled.

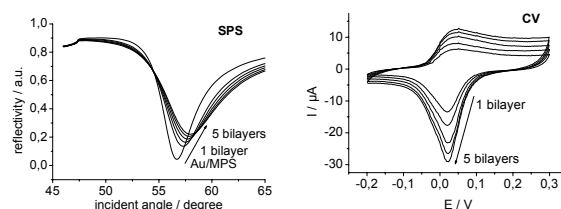


Fig. 1: SPS spectra and CVs of different bilayers of PANI/MSAG recorded in situ in 0.1M PBS buffer (pH 7.1). Scan rate was 50mV/s.

It has been shown that PANI doped by negatively charged polyelectrolytes can electrocatalyze the oxidation of NADH[2-4]. The electrocatalytic capability of PANI/MSAG films toward the oxidation of NADH was also clearly observed (Fig.2).The anodic catalytic peak current increases with the increase of NADH concentration. Further experiments show that the catalytic peak current increases almost linearly with the increase of the film thickness up to at least 12 bilayers.

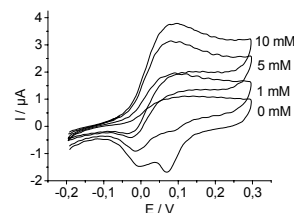


Fig. 2: CVs of 5 bilayers of PANI/MSAG measured in 0.1M PBS buffer, pH 7.1 in the presence of different amounts of NADH, scan rate 5mV/s.

DISCUSSION & CONCLUSIONS: The stable and good redox activity of the prepared PANI/MSAG multilayer films in neutral pH solution suggests their use in bioengineering and biosensor development.

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