Au Nanoparticles built-in Mesoporous TiO_2 Composite for Voltammetric Detection

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Abstract

Over the past years, self-organizing electrochemical methods have been greatly refined to prepare highly ordered metal oxide structures with various morphologies such as nanopores [1], nanotubes [2] or nanoshells [3] on metals such as Ti [4]. In view of direct functional applications, anodic TiO_2 nanotubes have attracted in the last ten years by far the widest interest due to their facile fabrication process and their potential applications in a wide range of functional. On the one hand, investigations target a further increase in the control over defined tube geometries (tube length, wall thickness, diameter, and order). On the other hand, these directional high surface area structures are of interest in virtually any application where up to now TiO_2 nanoparticles are used. Composite materials made of mesoporous Thin Titania Oxide Films (TF) containing metallic nanoparticles are of high interest in equally various fields, including catalysis, biosensing and non-linear optics [6-8].

Recently, V.López-Puente et al. [8] have developed the methodology for the fabrication of such composite materials onto glass slides containing a submonolayer of gold nanoparticles (AuNPs) with mesoporous Pluronic F127 TF and its application as a novel surface-enhanced Raman scattering (SERS) substrate. Comprising a submonolayer of AuNPs covered with a mesoporous thin film, which can act as a molecular sieve by size exclusion and avoid contamination of SERS spectra in biological media. The seeded growth of the nanoparticles through the mesoporous film allowed the formation of sharp tips, which improved the SERS efficiency of the material. The obtained composite materials combine the interesting optical properties of metal nanoparticles with the filtering ability and chemical stability of mesoporous TF films [8, 9].

We have applied this procedure onto a conductive material such as carbon and the characterization of the surface by SEM was carried out (Figure 1). We also present the study of screen printed carbon electrodes (SPCE) modified with these composite films, comprising AuNP embedded in mesoporous Thin Titania Oxide Films (TF-AuNP) and with each of its different building blocks: TiO_2, Pluronic F127 and AuNPs. The specific surface area of TF-AuNPs on SPCE can further enhance the electrochemical reaction of hydroxybenzenes (hydroquinone, catechol, pirogallol) and dopamine, an excitatory chemical neurotransmitter, leading to the increase of voltammetric sensitivity and selectivity (Figure 2). The present work explores an interesting and significant application TF-AuNP composite in electroanalysis and future prospects of its biosensing application.

References

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Figures

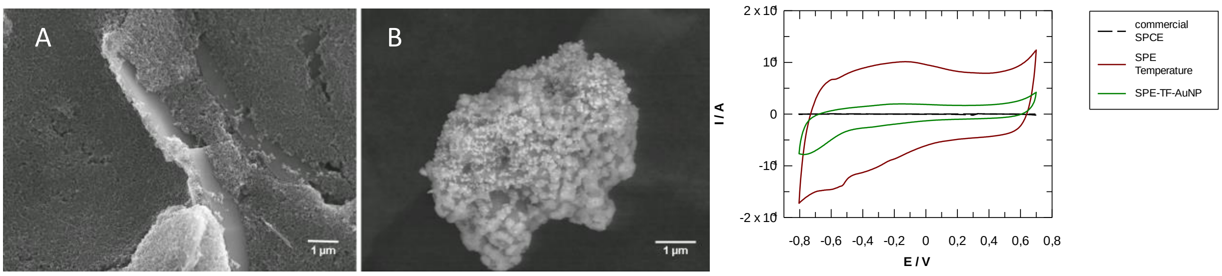

Figure 1 - SEM images of SPE carbon working electrode before (A) and after growth reaction (B) for 15 nm AuNP@TF samples and (C) Cyclic voltammograms in PBS 0.1 M (pH 7.4) at a scan rate of 100mV/s of 15 nm AuNP@TF samples before and after growth for electrochemical applications.

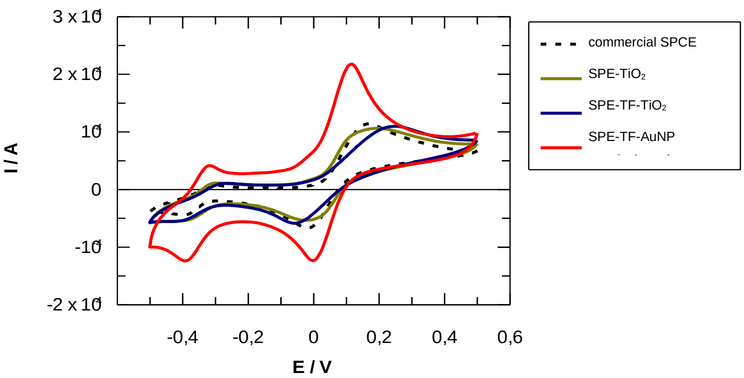

Figure 2 – Cyclic voltammograms of dopamine 1 mM in PBS 0.1 M (pH 7.4) at the differently modified SPCEs, by cycling between -0.5 V and 0.5 V (three cycles) at a scan rate of 100 mV/s.