ADVANTAGES OF CARBON NANOTUBE/POLYSULFONE VS GRAPHITE/POLYSULFONE IMMUNO-COMPOSITES SCREEN-PRINTED ELECTROCHEMICAL BIOSENSORS

Samuel Sánchez [a], Martin Pumera [b] and Esteve Fàbregas[a]*
[a]Grup de Sensors i Biosensors, Universitat Autònoma de Barcelona, 08113 Bellaterra, Barcelona, Spain.
[b] ICYS, National Institute for Material Science, 1-1 Namiki, Tsukuba, Japan
Samuel.sanchez@uab.es

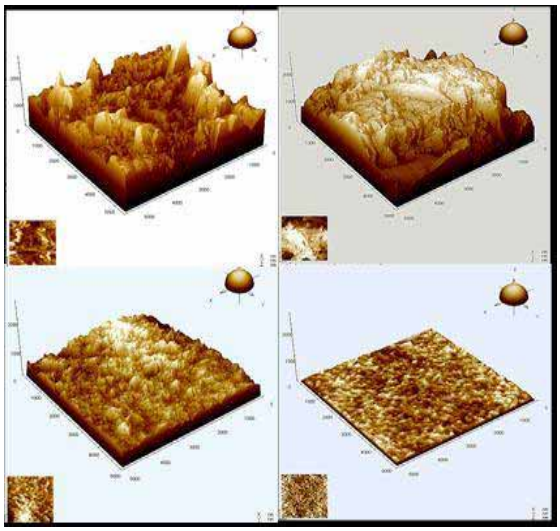
The fabrication, evaluation and attractive performance of multiwall carbon nanotube/polysulfone composite thick-film screen-printed electrochemical sensors are reported. The knowledge of new materials, such as Polysulfone (PS), allows us to expand the abilities of constructing amperometric and potentiometric sensors [1-4]. Polysulfone showed high resistance in extreme pH conditions as well as good thermal stability [5]. Moreover, polysulfone is soluble in dimethylformamide, and membranes are easily prepared by conventional phase inversion technique [1-5].
There is a great interest in preparing new nanomaterials composed of carbon nanotubes (CNT) and organic binders for electrochemical and materials science applications. The coupling of polymers with carbon nanotubes forming a composite is acquiring importance due to its simplicity of construction and its ability to incorporate conducting materials into porous polymers in order to form electrochemical sensors [6]. Recently, it has been demonstrated that CNT-based inks are highly suitable for the microfabrication of thick-film electrochemical sensors [7, 8].
The fabricated carbon nanotubes/polysulfone (CNT/PS) strips combine the attractive advantages of carbon nanotubes materials and disposable screen-printed electrodes. Such screen-printed CNT sensors, based on thick-film fabrication, are mechanically stable with good resistance to mechanical abrasion and they offer large scale mass production of highly reproducible low-cost electrochemical biosensors [6-8]. Furthermore, biocompatibility of CNT/PS composite allows easy incorporation of immunoreagents by phase inversion technique [1, 8-9, 11].

The combination of MWCNT and polysulfone results into a novel composite material, consisting of an interconnected CNT-polymer network, and possessing mechanical flexibility, high toughness, and high porosity, while retaining the attractive electrochemical behavior of CNT electrodes and biocompatibility of polysulfone.

(Bio) sensors prepared with carbon nanotubes coupled with polysulfone show much higher sensitivity than those prepared with graphite/polysulfone. The membrane was characterized by SEM/EDX, laser profilometer and by AFM. The purity of the materials was evaluated by TGA. The roughness value is doubled when MWCNTs are used instead of graphite into the PS membranes and the incorporation of antibodies enhances the dispersion of the carbon with the polymeric membrane reducing the roughness in all cases [10].

This biosensor was based on the competitive assay between free and labelled anti-RIgG for the available binding sites of immobilized rabbit IgG (RIgG). The RIgG was incorporated into the polysulfone membrane by the phase inversion technique. Horse radish peroxidase (HRP) enzyme was used as label and hydroquinone as mediator. The

sensitivity is six times higher for MWCNT than for graphite electrodes, showing lower unspecific adsorption [10].



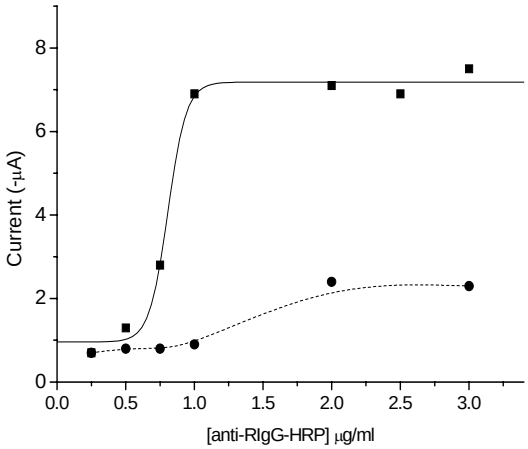


Figure 1. Atomic Force Microscopy of composites in 3D images: A) MWCNT9/PS, B) MWCN50/PS, C) MWCNT200/PS and D) graphite/PS. The instes show the 2D images of corresponding composite.

Figure 2. Calibration plot for a) MWCNT200/PS/RIgG and b) graphite/PS/RIgG screen-printed immunosensors modified with 5 μg/ml of RIgG and incubate with different concentrations of anti-RIgG-HRP. Conditions: Operating potential, -0.2 V; CNT loading, 6.5%, graphite loading 17.6%; supporting electrolyte, PBS buffer (0.1 M, pH 7.0); 1.8 mM hydroquinone used as mediator; stirring rate, ~500 rpm. Incubation time: 30 min.

Results indicated that MWCNT can be used, better than graphite, to prepare attractive soft immunocomposites for amperometric immunosensing. MWCNT200 was selected as the best conducting material in connection with polysulfone polymer for this bio-composite membrane due to its higher sensibility, easy to dissolve homogenously into the PS/DMF solution, suitable surface roughness and mechanical and physical properties. MWCNT9 and MWCNT50 presented very high roughness, were difficult to homogenize in PS/DMF solution and showed lower amperometric response.

References:

[1] Sánchez, S. Fàbregas, E. Biosens.Bioelectron. **22** (2007) 965-972.
[2] Prieto-Simón, B., Fàbregas, E. Biosens.Bioelectron. **22** (2006) 1. 131-137.
[3] González-Bellavista, A., Macanás, J., Muñoz, M., Fàbregas, E. **115** (2006) Sens.Actuators B. 691
[4] Macanàs, J. Muñoz, M. **534** (2005). Anal. Chim. Acta. 101-108.
[5] Mulder, M. 2000. Kluwer Academic Publishers, Dordrecht, The Netherlands.
[6] Wang, J., Musameh, M. Anal. Chem. **75** (2003) 2075-2079.
[7] Wang, J., Musameh, M., *Analyst*, **129** (2004) 1.
[8] Wang, J., Tian, B., Rogers, K.R. Anal. Chem. **70** (1998) 1682.
[9] Sánchez, S. Pumera, M., Cabruja, E. Fàbregas, E. **132.**(2007), Analyst, 142-147.
[10] Sánchez, S. Pumera, M., Fàbregas, E. (2007), Biosens.Bioelectron. Revision.
[11] Pumera, M., Sánchez, S.Ichinose, I., Tang, J. 2006. Sens.Actuators B. doi: 10.1016/j.snb.2006.11.016.