DEVELOPMENT AND CHARACTERIZATION OF NEW AMPEROMETRIC SENSORS AND BIOSENSORS BASED IN POLYMER-METAL NANOCOMPOSITE MATERIALS.

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The special optical, electrical or magnetic properties of nanoobjects make them very attractive for the development of new devices with enhanced properties. In this sense, the high catalytic activity of noble metal nanoparticles (MNPs) could be used to improve the working characteristics of molecular recognition devices such as amperometric sensors and biosensors. However, the high reactivity of MNPs in many instances results in their high trend wide coalescence and uncontrolled growth. This is the main drawback, which hampers their future application in various fields of science and technology, since aggregation leads to the loss of their characteristic properties. One of the possible solutions of this problem is the development of Polymer Stabilized Metal Nanoparticles (PSMNPs) or Polymer-Metal Nanocomposite Materials (PMNCMs), which have been thoroughly studied during the last years [1].

As the result, some new strategies for the preparation of PSMNPs have been developed. For example, the inter-matrix synthesis of metal nanoparticles inside a polymeric matrix by sequential loading-reduction process developed in our research group has been demonstrated to be applicable for preparation of highly stable monometallic Cu-, Pt- and bimetallic (core-shell) Pt@Cu-PSMNPs and their application in sensor constructions [2,3]. The preparation procedure includes the loading of functional groups of the polymer (i.e. sulfonic) with metal ions (the MNPs precursor) followed by their reduction with an appropriate reducing agent (e.g., sodium borohydride). This results in the formation of MNPs inside the polymeric matrix, which prevents their aggregation. In this presentation we report the results obtained by the synthesis of Pt- and Pt@Cu-PSMNPs in sulfonated poly(etheretherketone) matrix and electrochemical characterization of respective PMNCMs.

The shape and the size of synthesized Pt- and Pt@Cu-PSMNPs was characterized by the analysis of Transmission Electron Microscopy (TEM) images of respective PMNCMs samples after their dissolution in organic solvent. As can be seen in Fig. 1 and 2, the shape of Pt-PSMNPs is absolutely irregular while that of Pt@Cu-PSMNPs in majority of cases is spherical with a narrow size distribution (see Fig. 3)

The catalytic activity of the developed PMNCMs was evaluated by their deposition on the surface of Graphite-Epoxy Composite electrodes (GECE) followed by amperometric determination of hydrogen peroxide with PMNCM-modified GECE. Surprisingly, the PMNCM containing core-shell PSMNPs, with a lower amount of noble metal, showed a far higher sensibility (almost by one order of magnitude) than those containing monometallic Pt-PSMNPs.

The PMNCM-based amperometric sensors developed were also used in the design of new biosensors for direct determination of glucose. The enzyme was immobilized on the surface of PMNCM-modified GECE by using the layered supramolecular structure. The PSMNP-SPEEK nanocomposite material deposited onto a GECE was modified by the sequential deposition of different layers of polyethilenimine and glucose oxidase by dip-coating technique to obtain a sandwich-like structure. The resulting amperometric biosensor demonstrates a good linear response in the range from $1x10^{-4}$ to $3x10^{-3}$ M of glucose.

References:

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[2] D.N. Muraviev, J. Macanás, M. Farre, M. Muñoz, S. Alegret, Sensors and Actuators B, **B118(1-2)** (2006) 408-417.
[3] J. Macanás, J. Parrondo, M. Muñoz, S. Alegret, F. Mijangos, D.N. Muraviev, Physica Status Solidi, in press.

Figures:

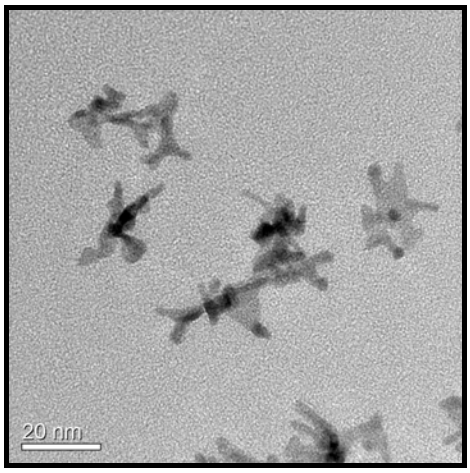

Fig 1. Typical TEM image of Pt-PSMNPs with irregular morphology.

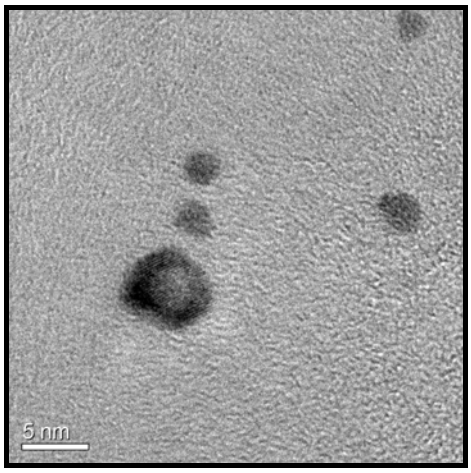

Fig 2. Typical TEM image of Pt@Cu-PSMNPs showing their spherical shape.

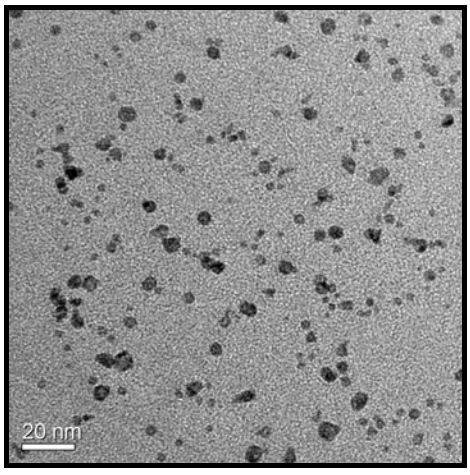

Fig 3. TEM image of Pt@Cu-PSMNPs reveals quite homogenous size distribution.