Área: ELE

Fabrication of carbon fiber microelectrodes insulated with polymers.

Daniel V. Braga (IC),[1] Douglas P.M. Saraiva (PG),[1*] Mauro Bertotti (PQ)[1]

dpm.saraiva@gmail.com;

[1]*Department of Fundamental Chemistry, Institute of Chemistry, University of São Paulo - USP; São Paulo – SP, Brazil.*

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Highlights

A simple and easily scalable method for the fabrication of microelectrodes is presented.

Abstract

We herein report a new method for the construction of small outline microelectrodes. The proposed method was based on the insulation of a carbon microfiber with a polymer by dip coating, and polydimethylsiloxane (PDMS), polycyanoacrylate (PCA), and epoxy resin (ER) were examined as insulating materials. After the dip coating step, the electrode was spun perpendicular to its axis to remove any polymer excess from the electrode body and to guarantee a homogeneous coating. The coating was cured with an infrared lamp, and a scalpel was used to release a cross-section of the carbon disc microfiber. Attempts to remove the coating were also based on immersing the coated electrode in concentrated sulfuric acid or other solvents, hence cylindric microelectrodes were obtained. Many parameters require optimization, including the number of polymer layers and their composition, the G-force applied during the rotating step, the duration of the rotation step, and the power of the infrared lamp. Nonetheless, preliminary results were auspicious with microelectrodes prepared with two-layer PCA/PDMS and two-layer PCA/ER coatings. The two-layer coatings granted a high level of insulation, and an excellent electrochemical response to ferricyanide was noticed after exposing the cross-section, as seen in Fig.1. For instance, a well-defined sigmoidal voltammogram with very low hysteresis was obtained as a consequence of the radial diffusion associated to mass-transport at microelectrodes. The microelectrode radius was determined with the equation $i = 4nFDCr$, where i is the steady state current, n is the number of electrons involved in the reaction, F is the Faraday constant, D is the diffusion coefficient of the electroactive species in the medium, C is the concentration, and r is the radius of the disc microelectrode. Using this equation, the radius was determined a 6.4 µm, which represents a slight variation from the nominal fiber diameter (7 µm). One of the more significant strengths of the proposed method is its easy scalability for the simultaneous fabrication of microelectrodes, its simplicity, and the use of inexpensive equipment. Such micrometric electrodes will be further applied for neurotransmitter detection as implanted devices. Thus, biocompatibility, penetration capacity without causing damage to brain tissues, and further surface modification for enhancing the sensitivity and selectivity for neurotransmitter detection will be further studied.

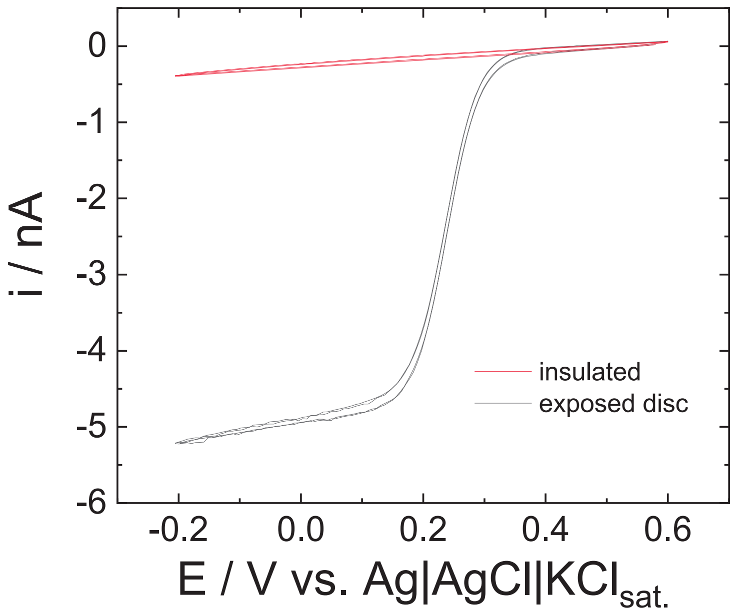

Fig.1 – Voltammograms recorded with insulated and exposed disc microelectrodes in a 5 mM $[Fe(CN)_6]^{3+}$ and 500 mM KCl solution. Scan rate: 0.1 V s^{-1}. Microfiber nominal diameter: 7 µm.

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