Electrochemical reduction of graphene oxide (GO) on a gold microelectrode array

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Keywords: *Graphene oxide, electrochemical deposition, gold microelectrode, impedance spectroscopy.*

Abstract

This work describes an electrochemical modification of a gold microelectrode array using reduced graphene oxide (GO).

Introduction

Graphene is a nanostructured material based on sp^2 carbon sheets, showing excellent optical, electronic and mechanical properties[1]. Then, graphene-based electrochemical sensors have great potential to be applied in several chemical compounds, and this work describes a modification of a gold microelectrode array using electrochemically reduced graphene oxide (ER-GO).

Results and Discussion

The modification target was an array of 14 gold microelectrodes[2], showed in Figure 1. The electrochemical reduction of graphene oxide (0.5 mg mL^{-1}) was carried out in 50 mmol L^{-1} Na_2SO_4 solution, using ten cyclic voltammetry sweeps (E_i = E_f: + 1.0 V, E_{inv} : - 1.2 V vs $Ag/AgCl_{(KCl\ 3M)}$; scan rate: 50 mV s^{-1}).

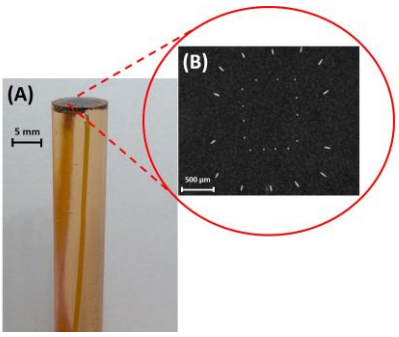

Figure 1. Microelectrode body (A) and SEM image for gold microelectrode array (B).

The ER-GO gold microelectrode array was characterized using Raman spectroscopy, which reveals both D and G peaks for graphene oxide (1338 cm^{-1} and 1595 cm^{-1}, respectively). Electrochemical impedance spectroscopy (EIS) was also applied for studying the interface electrode/solution of microelectrode array. In Figure 3, both spectra of the non-modified microelectrode array (blue) and modified microelectrode array (black) shows significant differences between the surfaces, and the charge transfer resistance calculated for modified microelectrode array (91.8 Ω cm^2) was 2.75 times lower than non-modified electrode array (252.6 Ω cm^2) for $[Fe(CN)_6]^{3-}$ /$[Fe(CN)_6]^{4-}$ electrochemical reaction. Also the surface area almost doubled, from $1.66x10^{-3}$ cm^2 for non-modified electrode to $3.02x10^{-3}$ cm^2 for modified electrode.

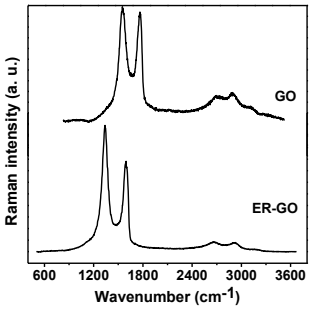

Figure 2. Raman spectra for GO and ER-GO.

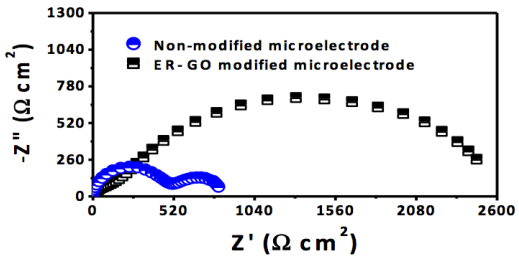

Figure 3. Electrochemical impedance spectra for non-modified microelectrode (blue) and ER-GO modified microelectrode (black).

Conclusions

The Raman spectra confirm the ER-GO onto gold microelectrodes surface. The charge transfer resistance obtained by EIS was changed for modified microelectrode if compared to non-modified electrode towards to $[Fe(CN)_6]^{3-}$/$[Fe(CN)_6]^{4-}$ redox pair, indicating the improvement in the electrochemical performance of the modified microelectrodes.

Acknowledgments

MACKPESQUISA and FAPESP (SPEC 2015/18275-1)

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