Electrochemical characterization of graphene oxides using screen-printed electrodes

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The development of novel nanomaterials such as graphene has opened a new field of study in the field of electrochemical sensing[1]. These materials provide very interesting properties when used as transducers of electrochemical sensors such as a large surface area, a high electron transfer ability or a high potential window, among others beneficial properties.

However, both the structural and electrochemical characterization of these nanomaterials is crucial since the results obtained in applications of electrochemical sensing rely heavily on the synthesis and the functional groups of these materials[2]. Therefore, the characterization should be as complete as possible to find the best conditions and the most suitable graphene for different electrochemical sensing applications.

In this work, the electrochemical characterization of screen-printed electrodes modified with several graphene oxides (GO-SPEs) and electrochemical reduced graphene oxides (ERGO-SPEs) was carried out. A study was performed to check the suitability of these graphene materials for electrochemical sensing.

The methodology for the fabrication of the GO-SPEs and ERGO-SPEs was: a drop of graphene oxide (in ethanol/water) was deposited onto the working electrode of the SPE and left to dry until complete evaporation. Electrochemical reduction of the deposited GO film was optimized using different currents and reduction times to generate electrochemically reduced graphene oxide (ERGO). The electrochemical behavior and electrochemical characteristics of the ERGO-SPEs were studied using cyclic voltammetry for a model analyte (dopamine in H2SO4 0.1 M).

As shown in Figure 1, the electrochemical reduction of GO, improved the different analytical parameters such as the peak intensity (ip) and the separation between the peak potentials. This improvement of the electrochemical redox behavior allows the dopamine system become a reversible situation starting from an irreversible situation when unmodified SPEs or modified with GO were used.

Furthermore, it was found that the electrochemical process is controlled by diffusion of dopamine on the ERGO since the peak current follow a linear trend with the square root of the scan rate.

A study by X-ray photoelectron spectroscopy (XPS) was performed to verify the functional groups that were reduced in the formation of the better ERGO film (Figure 2). This study showed that this ERGO had a greater amount of C_{sp2} and C_{sp3} with a significant reduction of the C-O-C groups, in relation to the initial GO.

This study shows how some graphenes are most suitable than others to detect a target analyte and how the best conditions must be found to get outstanding results in electrochemical sensing.

References

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Figures

Figure 1: Cyclic voltammetry of a solution containing 0.1 mM dopamine in H_2SO_4 using a) unmodified SPE, b) GO-SPE, c) ERGO-SPE.

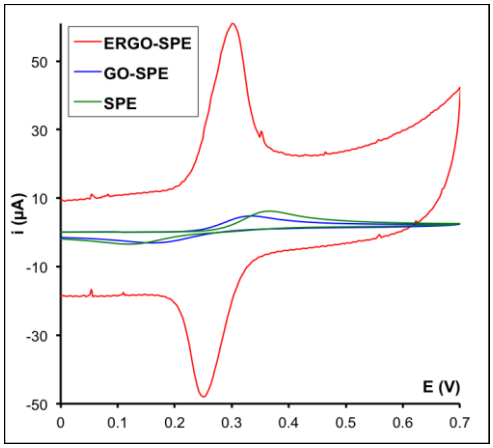

Figure 2: XPS spectra of A) GO and B) ERGO materials.