Graphene produced by electrochemical exfoliation of graphite: electroanalytical properties

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Among the different methods to produce graphene sheets by exfoliation of graphite, the electrochemical route has been very scarcely investigated. First reported by Liu and coworkers [1], the electrochemical exfoliation of graphite represents a simple one-step method to produce graphene sheets in ionic liquid/water mixtures where hydroxyl and oxygen radicals produced by anodic oxidation of water start the oxidation of the edge planes of graphite, facilitating intercalation of anions from the ionic liquid. More recent studies have shown that graphene sheets can also be obtained by electrochemical exfoliation of highly oriented pyrolitic graphite (HOPG) in aqueous electrolyte solutions containing H_2SO_4 albeit with high amount of defects [2].

Here we have explored the electrochemical exfoliation of graphite rods in electrolytic baths consisting of different ionic liquid/water mixtures, which has a clear influence in the extent of surface functionalization of the graphene sheets (EC-GS). The resulting graphene samples were characterized by X-ray diffraction, thermogravimetric analysis and electron microscopy (Figure 1). It was found that the amount of oxygen-containing functional groups increased linearly with the water content in the exfoliation bath. Conversely, increasing the ionic liquid content in the exfoliation media resulted in ionic liquid-functionalized graphene sheets.

Thin films of the EC-GS were drop cast on glassy carbon (GC) electrodes and their electrochemical activity for several redox couples, such as hydroquinone/o-quinone, ferro/ferricyanide or dopamine/dopamine quinone, was compared to that of films of graphite and reduced graphene oxide featuring the same oxidation level. In all cases, EC-GS showed enhanced electrochemical activity surpassing all the other carbon films in electron transfer rates, including GC (Figure 2), demonstrating that graphene produced by electrochemical exfoliation of graphite is a good electrode material for applications in electroanalysis.

References

[1] N. Liu, F. Luo, H.Wu, Y. Liu, C. Zhang, J. Chen, Advanced Functional Materials, **18** (2008) 1518.
[2] C.-Y. Su, A.-Y. Lu, Y. Xu ,F.-R.Chen, A. N. Khlobystov, L.-J. Li, ACS Nano, **5** (2011) 2332.

Figures

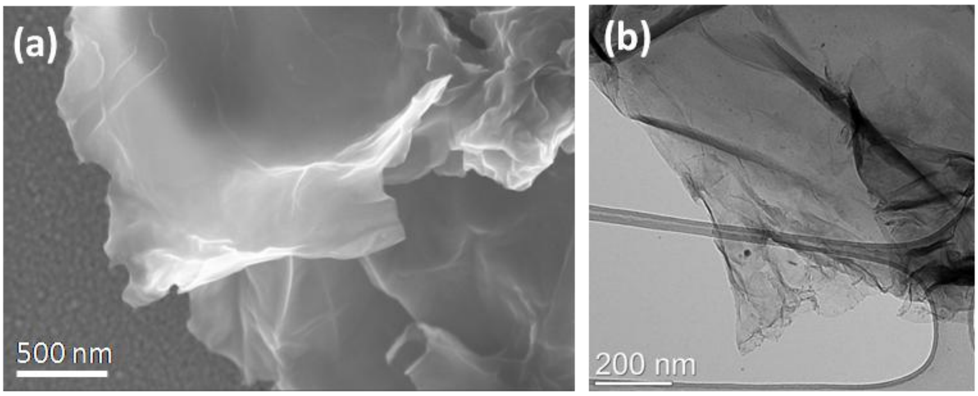

Figure 1. (a) FESEM image of EC-GS; (b) TEM image of rGO.

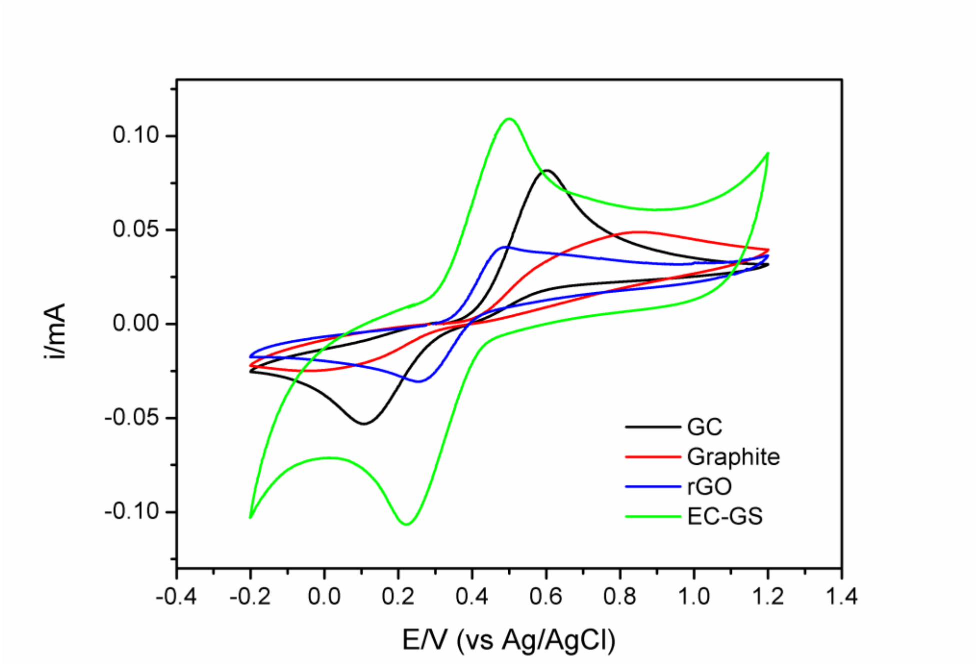

Figure 2. Cyclic voltammograms of bare GC electrode and modified with EC-GS, rGO and graphite in 5 mM hydroquinone (Britton Robinson pH 2) solution.