Graphene-based electrocatalysts for the oxygen evolution reaction

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The increasing global warming caused by the combustion of fossil fuels is leading to a search for alternatives environmentally friendly, accessible, and economically attractive. Hydrogen is considered a clean fuel for the future because it acts as a green energy carrier and provides a method for the storage and transport of energy. A variety of processes are available for H_2 production, based on conventional or renewable technologies. Water electrolysis offers a practical route for sustainable hydrogen production by utilizing a renewable electrical energy source for water splitting. The oxygen electrode in electrolyzers plays a central role as its catalytic activity and stability are conditioned by its slow kinetics under operating conditions [1,2].

Graphene-based electrocatalysts emerged as promising materials to improve efficiency in numerous electrochemical reactions since they are low-cost, abundant, and electrical conductors with tunable catalytic activity. Insertion of heteroatoms into graphene network may produce electronic and geometric distortions of the carbonaceous grid, and consequently, the activity toward several electrochemical reactions may be altered. Basically, two types of doping may occur in the graphene network depending on the interatomic distance between carbon-heteroatom compared to C-C. Thus, B-C, N-C and C-C have similar interatomic distance, and therefore, it is expected that after the heteroatom-modification the system will follow a similar modus operandi; on the other hand, P-C, Si-C and S-C show higher interatomic distance than C-C and their modification will display an exohedral doping, i.e., the heteroatom will be located above and/or below the graphene sheet. Another factor to take into account in the catalyst activity is the surface local acidity, which may be altered by the introduction of functional groups in the graphene network [3].

With the aim to solve the principal catalytic problems at the oxygen electrocatalysts in electrolyzers, S- and N-doped graphene-based materials were synthesized, characterized and tested toward the oxygen evolution reaction (OER) in alkaline medium. In-situ Raman spectroelectrochemistry, rotating ring-disk electrode (RRDE), cyclic voltammetry (CV) and linear sweep voltammetry (LSV) techniques were used to determine the catalytic activity of heteroatom-doped graphene catalysts toward the OER. Main results indicate that the OER is strongly influenced by the nature and amount of the doping agent in addition to the interaction with the electrolyte media, which also conditioned Raman signals such as the position of the D- and G-bands and the *Area$_D$/Area$_G$* (A_D/A_G) ratio. Additionally, the percentage of molecular oxygen production is estimated by a novel procedure [1,2].

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