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The correlation between boron content and surface modifications on the nitrate reduction for Boron-Doped Diamond Electrodes

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Nitrate ions represent a great problem of contamination of natural water sources, mainly attributed to the use of high amount of fertilizers. High nitrate concentrations in potable water may cause several health problems and its quantity control becomes a challenge, nowadays[1]. Boron-Doped Diamond (BDD) films have appeared as a new promising electrode for applications in nitrate reduction studies, particularly, due to their wide potential window to detect many electroactive species at high anodic and cathodic potentials. Besides, there are few reports involving the correlation between the electrochemical behavior and the physical, chemical and electronic properties of these electrodes. Such properties can be influenced by the quantity and kind of doping, film morphology features, defects, crystallographic orientations and surface terminations (hydrogen or oxygen). This work propose to investigate the electrochemical reduction of nitrate onto BDD electrodes prepared at different boron doping level and its correlation with H-terminated surface produced by cathodic polarization (water reduction). According to literature[2], H terminated surface can enhance the conductivity and electrochemical activity of BDD electrodes. BDD films were grown by the hot filament chemical vapor deposition (HFCVD), varying the boron/carbon (B/C) ratio in the precursor mixture at 5000 ppm and 10000 ppm. Afterwards, BDD electrodes were subjected to cathodic pre-treatment by applying -3.0 V for 30 min. Comparing the results before and after cathodic pre-treatment it was observed a loss of the reversibility for the $Fe(CN)_6^{4-/3-}$ redox reaction for 5000 ppm-BDD electrode, while for 10000 ppm-BDD electrode this change of reversible behavior was not observed. The better response for the nitrate reduction was also obtained for the 10000 ppm BDD electrode, after cathodic pre-treatment, which may be associated with its higher stability. Furthermore, the boron content increase, during the growth process, produces BDD films with high electrical conductivity and more active surface for nitrate reduction.

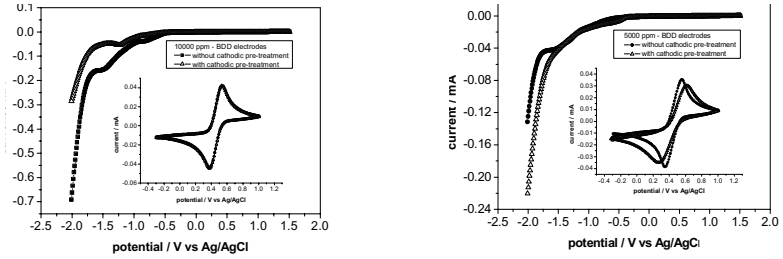

Fig 1: Linear sweep voltammograms of nitrate reduction and cyclic voltammograms for the $Fe(CN)_6^{4-/3-}$ (insets) using BDD electrodes with different boron contents.

[1]. WHO, Guidelines for drinking water quality, Geneva, 1993.
[2]. K. B. Holt, A. J. Bard, Y. Show, G. M. Swain, J. Phys. Chem. B, 108 (2004) 15