

POTENTIODYNAMIC BEHAVIOR OF THE BORON-DOPED DIAMOND ELECTRODES IN Na₂SO₄ WITH pH 2 TO 12

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The study with boron-doped diamond films has become very interesting due to its possible application as a sensor or electrode in electrochemistry process[1]. The electrode response depends on its microstructure and the doping level[2]. Thus, the diamond/electrolyte interface structure changes with the electrolyte pH. Boron-doped polycrystalline diamond films have been grown on silicon substrate in the usual hot filament-assisted CVD reactor. The films were grown at 800°C during 6 hours. Boron source was obtained from a H₂ line forced to pass through a bubbler containing B₂O₃ dissolved in methanol. The CH₄ flow is kept at 0.5 sccm for all experiments and the H₂ and B₂O₃/CH₃OH/H₂ flows are controlled in order to obtain the desired B/C ratios. The electrochemical measurements were carried out using a three electrodes conventional cell. Cyclic voltammetric behaviour was studied for diamond electrodes at different levels, using Na₂SO₄ (1 mol/L) with the pH agreement in 2 to 12 range. With pH 2 to 5, for all electrodes, it was observed anodic current peak around 0 V, as shown in figure 1 for the B/C=5000 ppm electrode. At pH=6, only the 5000 ppm B/C electrode showed the anodic peak due to its better morphological and structural characteristics. With pH 7 to 12, no anodic peak current was observed around 0 V. All the I_xE curves showed the oxygen evolution reaction close to 1,4 V. The figure 2 shows the dependence of the current density for all electrodes with different doping levels on electrolyte pH. It was observed a decrease with pH increase, for all electrodes with different doping levels. This anodic peak in the 2-6 range can be explained by the model proposed by Srinivasan and Gileadi [3] for pseudo-capacitance peaks related with the electrochemical adsorption/desorption of interfacial species on the electrode surface under potentiodynamic control. In this model was deduced that the anodic current peak increases linearly with scan rate, and the correspondly peak potential increases linearly with the logarithm of scan rate, as shown in the figures 2 and 3. The adsorption of soluble species on a diamond surface was inferred by Martin et al. from XPS measurements [2]. Accordingly, this adsorption occurs through the interaction of the electrolyte with the polycrystalline diamond surface terminated in H, according the following reaction:

$C-H + H^+ + e^- \rightarrow C^* + H_2$. The free radical formed in reaction probably reacts with water to add some functional group with oxygen to the surface.

Acknowledgments

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References

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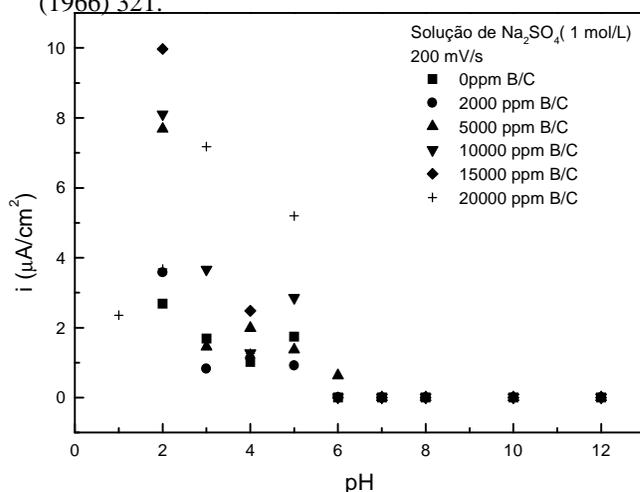


Figure 1: Anodic peak current intensity dependence on pH for diamond electrodes at different doping levels.

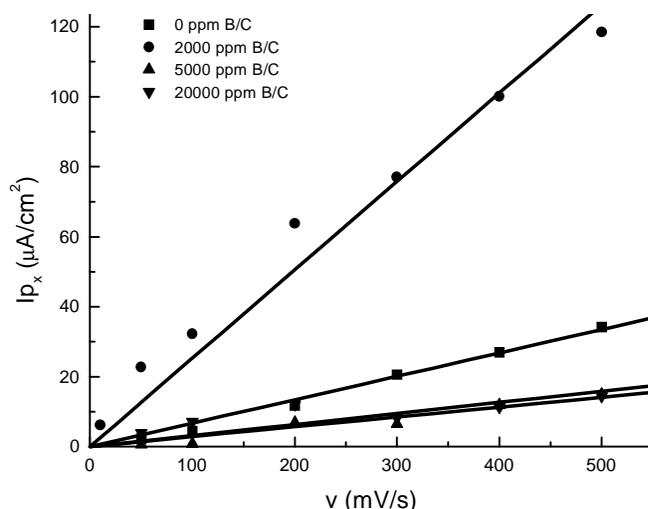


Figure 2: Anodic peak current intensity dependence on scan rate for diamond electrodes at different doping levels.

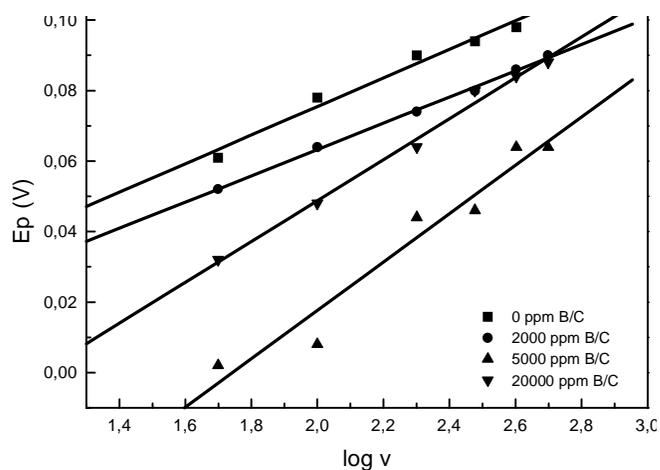


Figure 3: Anodic peak potential dependence on scan rate for diamond electrodes at different doping levels.