LITHIUM ELECTROCHEMICAL INTERCALATION INTO BORON DOPED CVD DIAMOND ELECTRODES GROWN ON CLOTH OF CARBON FIBERS AND NO WOVEN OF CARBON FIBERS

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For electrochemical application it has been found that the doped diamond electrode have presented small background current, wide potential window and good response to redox systems [1,2]. The surface of as-deposited B doped diamond is hydrogen terminated, that turn it a very stable surface and explain its superior electrochemical response respect to the other carbons form, e.g. glassy carbon (GC) and highly oriented pyrolitic graphite (HOPG). The lithium insertion in diamond appears like a natural investigation because of the role of carbons in lithium-ion battery [3-6]. Lithium insertion into boron doped diamond films is also of particular interest in order to achieve an n-type semiconductor, due to the high band gap of diamond.

In the present study, we investigated the lithium intercalation into boron-doped diamond electrodes by electrochemical characterization. The boron-doped diamond electrodes were grown on two kinds of carbon fibers with different texture, so called cloth of carbon fibers (diamond/cloth electrode) and no woven (felt) of carbon fibers (diamond/felt electrode). It was studied the lithium intercalation as a function of the boron content on diamond films associated with the grain size and film thickness. Scanning electron microscopy and Raman spectroscopy were also used to characterize the film morphology and quality. Boron doped-diamond films were grown by hot-filament-assisted CVD technique at 1100 K from a 0.5% H_2/CH_4 mixture at a total pressure of 6.5 x 10^3 Pa. The films were deposited after seeding pre-treatment during 12 hours. Boron was obtained from H_2 forced to pass through a bubbler containing B_2O_3 dissolved in methanol. This system permits the control of boron concentration using a flow controller for the gas inlet. For all experiments the H_2 and $B_2O_3/CH_3OH/H_2$ flows were controlled in order to obtain the desired B/C ratios. These doping level studied correspond to acceptor concentrations in the range of 6.5 x 10^{18} to 1.5 x 10^{21} cm^{-3}, obtained from Mott-Schottky plots measurements in previous work [1]. The electrochemical characterization was carried out by cyclic voltammetry and charge/discharge curves. The electrolyte used was 1mol.L^{-1} of $LiPF_6$ in mixture of ethylene carbonate (EC), dimethyl carbonate (DMC) and diethyl carbonate (DEC) (1:1:1 wt). The reference and work electrode were metallic lithium and the cell was assembled a dry-box. The results show that the insertion of lithium $Li_x(B_zC_{1-z})_6$ is reversible and presents specific capacity, which depend on B-concentration.

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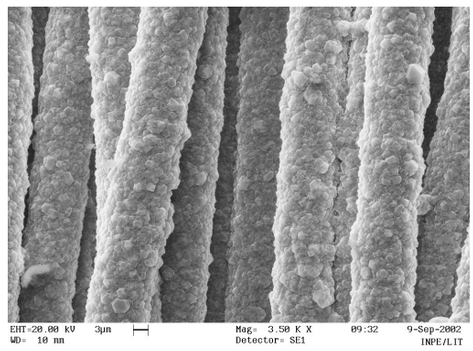

Figure 1. SEM image of boron-doped diamond film grown on cloth of carbon fibers (3500X).

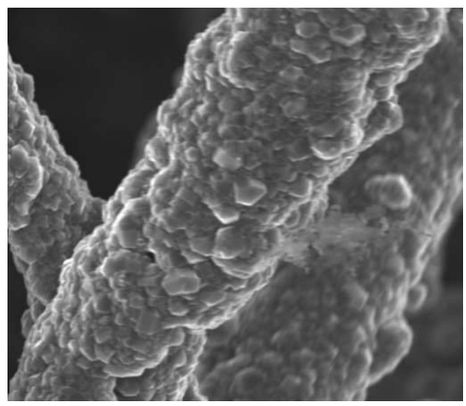

Figure 2. SEM image of boron-doped diamond film grown on no woven of carbon fibers (3500X)

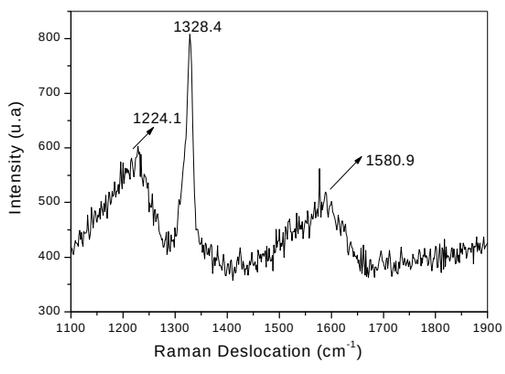

Figure 3. Raman spectrum of diamond film showed in figure 1. The evidenced band at 1200 cm^{-1} is characteristic for boron–doped diamond films.