ICAM2009
11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

Copper electrodeposition of on boron doped diamond by cyclic voltammetry

L. C. D. Santos(1)*, J. T. Matsushima(1), A. B. Couto(1), M. R. Baldan(1), N. G. Ferreira(1)

(1) LAS, Instituto Nacional de Pesquisas Espaciais, S. J. Campos, Brazil, e-mail: laura@las.inpe.br
* Corresponding author

Abstract – This work presents the boron doped diamond electrode modification from the copper electrodeposition by cyclic voltammetry. The electrochemical kinetics and inversion potential of such electrode was studied in the sweep rate range from 20 to 100mV/s in 10^{-3} molL^{-1} of $CuSO_4$ solution in three support electrolytes of H_2SO_4, $HClO_4$ e Na_2SO. The objective was to verify the electrode response reproducibility according to the reversibility criteria, where with the sweep rate increase the intensity of anodic and cathodic peak current also increased.

Boron doped diamond (BDD) electrodes have attracted attention to apply in electrosyntesis and electroanalysis due to their singular properties, such as high corrosion resistance, wide potential window (~3.0 V) for a large range of electrolytes, high chemical inertness, low background current and high electrochemical activity, that is reproducible without pre-treatment [1]. In this sense, the nanoparticles deposition on BDD may promote to surface roughness increase leading to an increase of the electrode active surface area and its sensitivity. This work studies the BDD modification from the electrodeposition of copper nanoparticles using cyclic voltammetry [2].

The work electrode used in all experiments was the BDD film grown on si substrate using a hot filament chemical vapor deposition reactor. The films were deposited during 6 h at temperature of 780 ºC from a gas mixture of H_2 (99 sccm) and CH_4 (1 sccm) for a pressure of 50 Torr. The boron content was controlled using an additional H_2 flow passing through a bubbler containing B_2O_3 dissolved in methanol in the required B/C ratio corresponding to 10^{20} born atoms/ cm^3. To improve the electrode response for copper electrodeposition the BDD was submitted to cathodic pre-treatment at -3V in 0.5 moL^{-1} H_2SO_4 with different times between 1 and 16 min. The cathodic treatment during 1 min promoted an improvement in the electrochemical response as may be observed in Fig. 2. The Cu electrodeposition on BDD was performed using 10^{-3} molL^{-1} of $CuSO_4$ solution in three different support electrolytes of H_2SO_4, $HClO_4$ e Na_2SO at 0.1 molL^{-1}.

For a better understanding of the Cu electrochemical behavior the process was analyzed varying the inversion potential. Fig. 3 depicts the Cu voltammetric curves for different inversion potentials. It was observed that from the inversion potential of -0.3 V both the deposition and dissolution processes take place in the same regions. This behavior indicates that the formed Cu deposit is linked with the same energy with the substrate (BDD electrode).

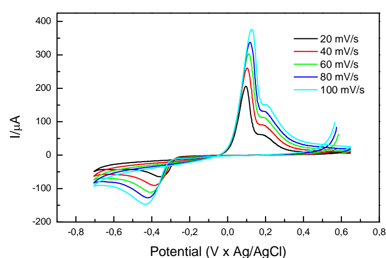

Figure 1: Cyclic voltammograms of Cu on BDD using a solution containing 1 x 10^{-3} mol L^{-1} $CuSO_4$ in H_2SO_4 0.1 mol L^{-1} for different scanning speeds.

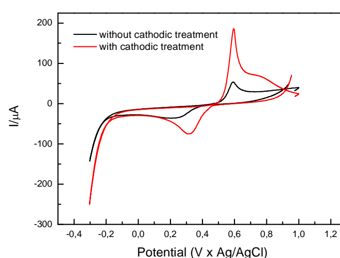

Figure 2: Cyclic voltammogram of Cu on BDD using a solution containing 1 x 10^{-3} mol L^{-1} $CuSO^4$ in H_2SO_4 0.1 mol L^{-1}, with and without cathodic treatment.

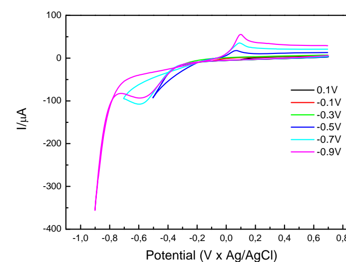

Figure 3: Cyclic voltammograms of Cu on BDD using a solution containing 1 x 10^{-3} mol L^{-1} $CuSO^4$ in H^2SO^4 0.1 mol L^{-1} for different potentials inversion. v = 100 mVs^{-1}

[1] M.D. Koppang, M. Witek, J. Blau, G.M. Swain, Anal. Chem. , 71, 1188 (1999).
[2] K. Kamada, K. Maehara, M. Mukai, S. Ida, Y. Matsumoto, J. Mater. Res. 18 (2003) 2826.