ELECTRODEPOSITION OF Te AND Cu THIN FILMS ON BORON DOPED DIAMOND (BDD) ELECTRODE

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This study was motivated by the relevance of Cu-Te system applications such as, highly efficient solar cells, photo-diode devices and various hetero-junction electronic components where they are used as p-type semiconductors [1]. Copper tellurides also exhibit technological interest due to their potential application in thermoelectric devices [2]. However, these compounds have rarely been the subject of study, and have been prepared only through dry methods, such as, sputtering and chemical vapor deposition. In this work the electrodeposition method was used to obtain the Cu, Te and Cu-Te thin films. The advantages of electrodeposition include the fact that most compound semiconductor is obtained at or near room temperature, which is considered low temperature deposition. Electrodeposition also promotes controlled growth and it is generally a low cost methodology when compared to the dry methods. Besides, BDD electrodes have received great attention due to its unique characteristics such as, inert surface with low adsorption properties, remarkable corrosion stability (even in strong acidic media), and wide working potential window in aqueous and non-aqueous electrolytes. In this way, the aim of this work is to study the electrodeposition process of Te, Cu, as well as Cu–Te system on BDD electrodes. The electrolytes were prepared with $HClO_4$, $CuSO_4$, TeO_2 and water purified by reverse osmosis. Prior to the experiments, the solutions were dearated with N_2 for 10 min. BDD films were grown on Si substrate by chemical vapor deposition (CVD) in a hot filament reactor during 6 hours. It was utilized a gaseous mixture of 99% vol. H_2 and 1% vol. CH_4 with a pressure of 50 torr. The boron doping was obtained from H_2 forced to pass through a bubbler containing B_2O_3 dissolved in CH_3OH. The H_2 and $B_2O_3/CH_3OH/H_2$ were controlled in order to obtain the desired B/C ratio in CH_3OH. From the Mott Schottky plot, the doping level was estimated to approximately 10^{20} boron atoms.cm^{-3} [3]. BDD films were used as working electrode. A platinum wire serves as a counter electrode and Ag/AgCl electrode was used as reference. The cyclic voltammetric experiments were performed using a potentiostat/galvanostat Autolab PGSTAT 302.

RESULTS AND DISCUSSION

Cyclic voltammogram for Cu electrodeposition from a 1.0×10^{-2} mol L^{-1} $CuSO_4$ + 0.05 mol L^{-1} $HClO_4$ solution on BDD electrode is presented in the Figure 1. The electrode potential was swept negatively from 1.0V to -0.65V and then was swept in reverse direction. During the cathodic sweep a defined peak at -0.16V can be observed and its associated to deposition process of the Cu on BDD electrode. During the sweep in the reverse direction can be observed two dissolution peaks (A1 and A2). These peaks may be attributed to different Cu interactions with the substrate. The crossover between anodic and cathodic currents appears on the reverse

potential sweep at the crossover potential (Figure 1). The presence of the crossover is diagnostic for the nuclei formation on the electrode. Te deposition on BDD electrode was performed from 1.0×10^{-3} mol L^{-1} $CuSO_4$ + 0.05 mol L^{-1} $HClO_4$ solution by scanning the potential from 1.0V to -0.65V (Figure 2). Two well-defined peaks were observed at -0.33V (B1) and 0.43V (B2) related to Te deposition and dissolution processes respectively. For Cu-Te system (not shown) can be observed that the electrochemical behavior changed slightly. The deposition process occurs at different potentials when compared with Cu or Te. This behavior may be associated with formation of a new compound with contribution of the two metals.
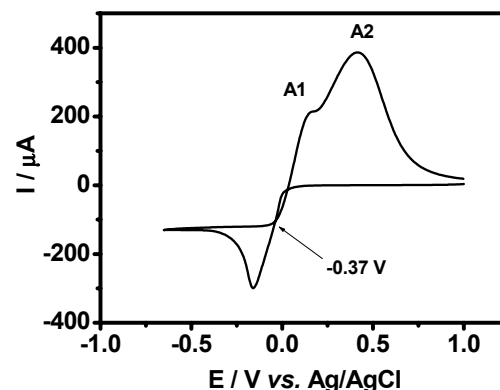

Figure 1: Cyclic voltammogram for Cu electrodeposition on BDD electrode from a solution of 1.0×10^{-2} mol L^{-1} $CuSO_4$ + 0.05 mol L^{-1} $HClO_4$. Scan rate: 10 mVs^{-1}.
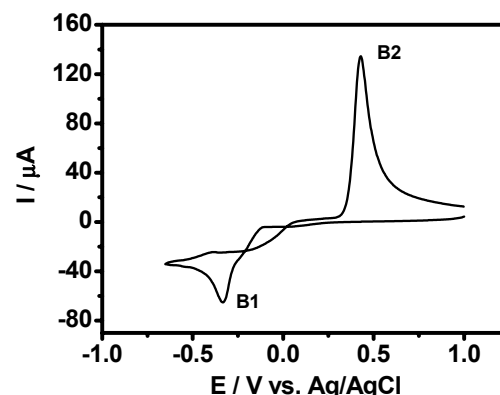
Figure 2: Cyclic voltammogram for Te electrodeposition on BDD electrode from a solution of 1.0×10^{-3} mol L^{-1} $CuSO_4$ + 0.05 mol L^{-1} $HClO_4$. Scan rate: 10mVs^{-1}.

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