HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
New Technologies, Processes and Operating Modes Enabling Future Human Missions (7)

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CARBON NANOFIBER BASED ELECTRODE FOR BIOSENSOR APPLICATIONS

Abstract

Since 1958, NASA has accomplished many great scientific and technological achievements in air and space. NASA leads in the scientific research, stimulating people's interest in aerospace exploration, technology and in science. Therefore, the development of new technology for the improvement of new space shuttles to go to space is as important as to develop new catalyst for energy devices as well as to develop new sensors to monitor the astronaut's health. Therefore, carbon based material possess very attractive properties for the development of electrodes for electrochemistry application. Among the carbon based materials, carbon nanofibers (CNFs) have received a great attention for biosensor applications because they have good electrical conductivity, high surface area, biocompatibility. We are using a carbon nanofiber (CNF) embedded in silicon dioxide nanoelectrode array platform, developed by the Nanotechnology group at NASA-Ames Research Center for protein immobilization. The proteins (cholesterol oxidase and alcohol dehydrogenase) are covalently bound to the tips of the CNFs by using 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC) and N-hydroxy-sulfo-succinimide (sulfo-NHS) forming an amide linkage between the proteins' amine residues and carboxylic acid groups on the CNFs tips. This work presents the surface and electrochemical characterization of the CNF electrode. The atomic force microscopy (AFM) images show the different surfaces obtained during the development of the CNF. AFM characterization of the polished CNF electrodes indicated that the CNFs had a mean diameter of 100 nm and protruded 12 nm from the silicon dioxide. X-ray photoelectron spectroscopy (XPS) was utilized to study the electrode's surface before and after the modification with the EDC/sulfo-NHS and the selected protein (ChOx). As expected, peaks corresponding to the EDC/sulfo-NHS molecules were observed in the N (1s) and S(2p) binding energy region. On the contrary, the unmodified surface did not show binding energy peaks in these same energy regions. After the addition of the protein, no peak was observed in the S(2p) binding energy region. In contrast, the peak from the N(1s) region increased due to the protein's presence on the surface of the chemically modified CNF electrodes. Electrochemical Studies (CV) were performed to understand the biosensor catalytic response toward different H2O2, NADH and NAD+/ethanol concentrations. Also, CV in 2.5 mM Fe(CN)6-3/-4 0.1M PB pH 7.5 and in 0.1M H2SO4 was done to study the surface before and after modification.