Nanobiotechnology in Space Applications

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A sensor platform based on vertically aligned carbon nanofibers (CNFs) has been developed. Their inherent nanometer scale, high conductivity, wide potential window, good biocompatibility and well-defined surface chemistry make them ideal candidates as biosensor electrodes. Here, we report two studies using vertically aligned CNF nanoelectrodes for biomedical applications. CNF arrays are investigated as neural stimulation and neurotransmitter recording electrodes for application in deep brain stimulation (DBS). Polypyrrole coated CNF nanoelectrodes have shown great promise as stimulating electrodes due to their large surface area, low impedance, biocompatibility and capacity for highly localized stimulation. CNFs embedded in SiO_2 have been used as sensing electrodes for neurotransmitter detection. Our approach combines a multiplexed CNF electrode chip, developed at NASA Ames Research Center, with the Wireless Instantaneous Neurotransmitter Concentration Sensor (WINCS) system, developed at the Mayo Clinic. Preliminary results indicate that the CNF nanoelectrode arrays are easily integrated with WINCS for neurotransmitter detection in a multiplexed array format. In the future, combining CNF based stimulating and recording electrodes with WINCS may lay the foundation for an implantable "smart" therapeutic system that utilizes neurochemical feedback control while likely resulting in increased DBS application in various neuropsychiatric disorders. In total, our goal is to take advantage of the nanostructure of CNF arrays for biosensing studies requiring ultrahigh sensitivity, high-degree of miniaturization, and selective biofunctionalization.