BIOCOMPATIBILITY STUDIES FOR A NOVEL INTRAOPERATIVE APPROACH BASED ON ELECTROCHEMICAL MONITORING AT THE BRAIN-ELECTRODE INTERFACE

Jaione Romero[1, 5], Addaikkappan Periyakaruppan[1], Mohamad Raad[1, 5], Emily Rand[1], Michael Marsh[3], Russell J Andrews[1], M. Meyyappan[1], Kendall H. Lee[3, 4], Jacob Cohen[2], Jessica E Koehne[1]

[1]Center for Nanotechnology, NASA Ames Research Center, Moffett Field, CA 94035

[2]Office of the Chief Scientist, NASA Ames Research Center, Moffett Field, CA 94035

[3]Department of Physiology and Biomedical Engineering, Mayo Clinic, Rochester, MN 55905

[4]Department of Neurosurgery, Mayo Clinic, Rochester, MN 55905

[5]Science and Technology International Education Program, VA 23666

Abstract

Deep brain stimulation (DBS) is a functional electrical stimulation method that has been used to treat patients with different neurological disorders ranging from Parkinson´s disease, epilepsy, essential tremor and chronic pain to psychiatric disorders such as depression, schizophrenia and obsessive-compulsive disorder. Previous studies have shown that DBS evokes release of neurotransmitters linked to the pathologies mentioned above; thereby there is a growing need for new and advanced neurochemical detection tools. A multiplexed biosensor based on arrays of vertically aligned carbon nanofibers (VACNFs) grown by plasma enhanced chemical vapor deposition is found to be effective for the simultaneous detection of dopamine and serotonin in the presence of excess ascorbic acid. The sensor has multiple sensing pads containing VACNFs. The nanofibers act as an ensemble of nanoscale carbon electrodes that detect neurochemicals by various voltammetry techniques. Here, we provide initial sensor validation testing and biocompatibility studies between the nanomaterials that make up the sensor and PC-12 cells. We compared PC-12 cell growth on different types of substrates: plain silicon wafer, VACNFs, polypyrrole-coated VACNFs and a polystyrene surface as positive control. The data shows that the live versus dead cell ratio was similar for all the substrates tested although the number of cells present on each surface was varied. The biocompatibility tests being conducted may provide insight into the compatibility of this biosensor in the brain as well as detect any potential nervous tissue injury that this medical device may cause.