Title: In-vivo Dopamine Sensing PEDOT:CNF Neural Probe Design and Simulation

Abstract

The electrochemical analysis is one of the most popular implementations of a dopamine-sensing brain implant. Its performance depends significantly on the interaction between the dopamine molecule and the working electrode. Carbon nanofiber is an allotrope of carbon nanotube and is effective in increasing the contact surface with dopamine molecules. Considering its simple fabrication protocols using photolithography, physical vapor deposition, and electrochemical deposition, this material is suitable for in-vivo implementation. We propose a needle-like probe design to target substantia nigra. We use COMSOL simulation to confirm that carbon nanofiber implementation increases the redox current while maintaining its linearity to the user-controlled dopamine concentration. We analyze the average and total current density with respect to the carbon nanofiber density and dopamine concentrations. Finally, these findings underline the importance of optimizing dopamine concentration, scan rate, and electrode surface area to achieve sensitive and accurate dopamine detection.