A Novel Nanomodified Dual-Bore Carbon Fiber Microelectrode Biosensor for Simultaneous Real-Time Electrochemical Detection of Neurotransmitter and Neurotoxin Biomarkers of Alzheimer's and Parkinson's Disease

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Neurodegenerative diseases such as Parkinson's & Alzheimer's are increasing worldwide exponentially. While many studies focus on factors such as aging & genetics, the effects of environmental toxins such as cadmium & lead, are less well studied. In addition, limited information is available on real-time changes of multiple neurotransmitters in the brain during co-transmission events when more than one neurotransmitter is released at the same time. Most existing brain measurements are performed on post-mortem tissue or in vitro due to the lack of suitable techniques for real-time analysis in living systems. This project focuses on developing an novel electrochemical sensor capable of detecting both a neurotransmitter & toxic metal simultaneously, in real time. A dual-sensor system is fabricated using carbon fiber microelectrodes to detect serotonin (5-HT), a key neurotransmitter involved in neurodegenerative diseases, & cadmium, a toxic metal known to cause neurological damage. To improve selectivity, one electrode is modified with Nafion, to enhance serotonin detection by reducing interference from 5-hydroxyindoleacetic acid (5-HIAA). The Nafion coating repels negatively charged 5-HIAA, allowing more selective detection of 5-HT. The second electrode is modified by electrodepositing gold nanoparticles to improve the sensitivity & selectivity for cadmium detection. The surface-modified electrodes are characterized using scanning electron microscopy & energy-dispersive X-ray analysis to confirm successful surface modification. All experiments are performed in Tris buffer, which mimics cerebrospinal fluid. Fast-scan cyclic voltammetry is used as the analytical technique due to its ultra-fast temporal resolution, making it suitable for future in vivo brain measurements

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