ABSTRACT

CARBON BASED ELECTRODES: FROM DETECTION OF BIOLOGICALLY SIGNIFICANT COMPOUNDS TO APPLICATION IN NEURODEGENERATIVE DISEASES

By
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Carbon is a truly remarkable element that is essential to life on Earth, and its unique properties have made it an indispensable component in an astonishingly diverse array of applications. Whether serving as a fuel source or as a key component in electronic devices, carbon's ability to exist in different forms, each with their distinct physical and chemical properties, contributes to its widespread and continued use. Electrode production is one of the areas where carbon found its significant use.

This thesis represents a unique combination of fundamental and applied electrochemistry using carbon-based electrodes. It explores a wide range of topics, from evaluating electrode microstructure as a critical factor affecting its electroanalytical behavior, to the use of carbon-based electrodes in Alzheimer's disease (AD) research.

The first part of this Thesis focuses on the electrochemical performance of carbon-based electrodes with distinct microstructures. Specifically, this section discusses two novel electrode materials: boron-doped diamond and nitrogen-incorporated tetrahedral amorphous carbon. The microstructure of each electrode was investigated, and the role of electrode microstructure in determining biologically significant compounds was explored, with a particular focus on tyrosine, tryptophan, pyocyanin, and isatin. This section of the Thesis provides valuable insights into the electrochemical behavior of carbon-based electrodes, and highlights the importance of electrode microstructure in the detection of biologically relevant molecules.

In contrast, the second part of this Thesis delves into the application of carbon-based electrodes in neuroscience research. Carbon electrodes have been essential in advancing our understanding of the central nervous system, with carbon-fiber microelectrodes (CFME) becoming the gold standard for single-unit recording in neuroscience research. This section

identifies several critical challenges related to the detection of neurochemically significant compounds, which were addressed using fast scan cyclic voltammetry at CFME. This resulted in the development of two novel methods for the detection and quantification of neurologically relevant compounds, namely oxytocin and glutamate. Furthermore, the CFME was used in a study investigating the potential role of dopamine in AD, where a possible link between cognitive decline and alterations in dopamine levels in an AD zebrafish animal model was described. This section of the Thesis provides valuable insights into the practical application of carbon-based electrodes in neuroscience research, showcasing their potential in identifying and quantifying neurochemically important compounds.