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Microfluidic-enabled electrochemical studies of boron-doped ultrananocrystalline diamond microelectrodes for chronic neurochemical sensing

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Electrochemical microsensors play an important role in investigating the effect of neurochemicals in human brain function. Abnormal levels of neurochemicals cause several neurodegenerative diseases. The current microelectrodes foul rapidly in brain microenvironment and results in significant reduction in chemical sensitivity and sensor's useful lifetime. Here, we present boron-doped ultrananocrystalline diamond (BDUNCD) microelectrodes that could aid in long-term monitoring of neurochemicals because of their wide electrochemical potential window, extremely low background current and excellent chemical inertness. The research goal is to reduce the rate of electrode fouling arising from reaction byproducts (e.g., melanin) and extend the lifetime to several weeks, which does not exist now. We microfabricated a custom microfluidic platform to study the BDUNCD surface fouling mechanism by depositing and mapping silver particles on BDUNCD microelectrode surfaces that were fouled at different conditions. The rate of fouling was studied using Fast Scan Cyclic Voltammetry (FSCV) and Amperometry (AM) techniques. For the first time, in situ electrode cleaning methods were developed to extend the electrode lifetime by >4-fold. Finally, chemical sensitivity enhancements were investigated by modifying BDUNCD with carbon nanotubes (CNT) and polymer coatings. For this study, we developed a droplet microfluidic device to study the changes in sensitivity and response time to two neurochemicals (dopamine and serotonin) using three different microelectrode surfaces.

Biography

An-Yi Chang is currently pursuing his PhD with his major in Micro- and Nanoscale Systems at Louisiana Tech University, USA. He has earned his MS in Chemical Engineering from Louisiana Tech University, USA. His research emphasis on biological microfluidics, particularly, designing microfluidics to study cell reactions and drug release in microenvironments. Presently, he is working in Institute for Micromanufacturing (IFM) and concentrating on developing microfluidics for on-chip biosensing of neurochemical sensing with boron-doped nanocrystalline diamond microelectrodes (BDUNCD).

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