Nanofabrication and Electroanalysis of Carbon-MEMS: A Suspended Nanometric Gap for Sensitive Biosensing

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To detect biomarkers, diagnostic devices must obtain small enough feature sizes to manipulate biomolecules that are just a few nanometers in size. Electrodes separated by a nanometric gap have emerged as a powerful method in detecting very small quantities of these biomolecules. The purpose of my project was to develop an electrochemical nanogap biosensor using simple and scalable microfabrication techniques for viable applications in point-of-care diagnostics. A polymer solution composed of poly(ethylene oxide), tetraflouroburate, and SU-8 photoresist was created to electrospin orderly pattered carbon nanofibers. I fabricated the fibers using a near-field electrospinning setup, optimized by testing different SU-8 solutions and patterns. Various fabrication techniques were investigated such as focus ion bean ablation and joules heating induced breaking to produce a nanometric gap from the suspended fibers. The nanofibers, heated up to 900 °C, undergo a pyrolysis process leaving a monolithic glassy carbon structure as a biocompatible working electrode. Technical drawings of nanometric geometries were reproduced using SEM measurements and further analyzed through parametric simulations based on governing mass transport equations. Cyclic voltammetry experiments confirmed the working electrode’s superior performance, while requiring significantly lower fabrication costs when compared to current detection methods.

Awards Won:

Second Award of $2,000