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Diamond-based MEMS devices for biosensing based on electrochemical and gravimetric[1]

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Diamond offers several potential advantages as a platform material for bioinorganic interfaces, including chemical and bio-inertness, electrochemistry, and high acoustic velocity. Ultrananocrystalline diamond (UNCD), with a unique combination of physical, chemical and electrical properties, is attractive for a variety of biochemical/biomedical applications such as hermetic bio-inert coatings, MEMS compatible biosensors, and electrochemical biointerfaces. Over the past several years we have worked on both the fundamental and applied science related to enabling UNCD-based bioMEMS devices, which has encompassed both the development of UNCD surface functionalization strategies that allow fine control of surface hydrophobicity and bioactivity, as well as the development of material integration strategies and surface micromachining techniques to enable the microfabrication of UNCD structural layers (e.g. cantilevers) that incorporate these functionalized surfaces into MEMS devices which are back-end compatible with CMOS electronics. These devices could thus combine the electrochemical and gravimetric transduction of the selective adsorption of target analytes in MEMS structures fabricated directly on top of a silicon microchip.. In the past year we have successfully demonstrated the use of conducting UNCD thin films as electrochemical biointerfaces, via the successful attachment of a redox enzyme onto the UNCD surface, Glucose oxidase (GOD). The procedure to achieve GOD immobilization involved the electrochemical immobilization of nitrophenyl groups to the UNCD surface and transformation of nitrophenyl to aminophenyl groups and the covalent bonding of GOD to the carboxyl groups using the diisopropylcarbodiimide/ N-hydroxysuccinimide (DCC/NHS) as the catalyst. After immobilization, the activity of the enzyme was demonstrated via the direct electrochemical detection of hydrogen peroxide. We have also developed CMOS-compatible UNCD MEMS cantilevers and fixed-fixed beam structures, using both traditional photolithography and e-beam lithography techniques.

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