Materials Science& Engineering Doctoral Defense

Applications of Biogenic Silica Nanostructures from Diatoms

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abstract

Biogenic silica nanostructures, derived from diatoms, possess highly ordered porous hierarchical nanostructures and afford flexibility in design in large part due to the availability of a great variety of shapes, sizes, and symmetries. These advantages have been exploited for study of transport phenomena of ions and molecules towards the goal of developing ultrasensitive and selective filters and biosensors. Diatom frustules give researchers many inspiration and ideas for the design and production of novel nanostructured materials. In this doctoral research will focus on the following three aspects of biogenic silica: 1) Using diatom frustule as protein sensor. 2) Using diatom nanostructures as template to fabricate nano metal materials. 3) Using diatom nanostructures to fabricate hybrid platform.

Nanoscale confinement biogenetic silica template-based electrical biosensor assay offers the user the ability to detect and quantify the biomolecules. Diatoms have been demonstrated as part of a sensor. The sensor works on the principle of electrochemical impedance spectroscopy. When specific protein biomarkers from a test sample bind to corresponding antibodies conjugated to the surface of the gold surface at the base of each nanowell, a perturbation of electrical double layer occurs resulting in a change in the impedance.

Diatoms are also a new source of inspiration for the design and fabrication of nanostructured materials. Template-directed deposition within cylindrical nanopores of a porous membrane represents an attractive and reproducible approach for preparing metal nanopatterns or nanorods of a variety of aspect ratios. The nanopatterns fabricated from diatom have the potential of the metal-enhanced fluorescence to detect dye-conjugated molecules.

Another approach presents a platform integrating biogenic silica nanostructures with micromachined silicon substrates in a micro/nano hybrid device. In this study, one can take advantages of the unique properties of a marine diatom that exhibits nanopores on the order of 40 nm in diameter and a hierarchical structure. This device can be used to several applications, such as nano particles separation and detection. This platform is also a good substrate to study cell growth that one can observe the reaction of cell growing on the nanostructure of frustule.

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