Optical Sensors for Biomolecules Using Nanoporous Sol-Gel Materials

by

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An important consideration for space missions to Mars is the ability to detect biosignatures. Solid-state sensing elements for optical detection of biological entities are possible using sol-gel based biologically active materials. We have used these materials as optical sensing elements in a variety of bioassays, including immunoassays and enzyme assays. The sol-gel approach produces an optically transparent 3D silica matrix that forms around the biomolecule of interest, thus stabilizing its structure and functionality while allowing for optical detection. This encapsulation process protects the biomolecule and leads to a more "rugged" sensor. The nanoporous structure of the sol-gel matrix allows diffusion of small target molecules but keeps larger, biomolecules immobilized in the pores. By immobilizing an appropriate biomolecule in the sol-gel sensing element, we have successfully detected analytes such as amino acids and hormones. In the case of the amino acid glutamate, the enzyme glutamate dehydrogenase was the immobilized molecule, whereas in the case of the hormone cortisol, an anti-cortisol antibody was immobilized in the sensing element. In this previous work with immobilized enzymes and antibodies, excellent sensitivity and specificity were demonstrated in a variety of formats including bulk materials, thin films and fibers. We believe that the sol-gel approach is an attractive platform for bioastronautics sensing applications because of the ability to detect a wide range of entities such as amino acids, fatty acids, hopanes, porphyrins, etc.