General Method for the Preparation of Very Stable, Self-Assembled Monolayers on the Surface of Gold Coated Microcantilevers for Application to Chemical Sensing

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Microcantilever-based sensors have been shown to be extremely sensitive, however silicon or silicon nitride microcantilevers coated on one surface with gold do not have any particular chemical selectivity. Chemical selectivity has been achieved by coating the gold surface of the microcantilevers with a selective film such as a self-assembled monolayer (SAM) of an alkane thiol having a head group suitable for molecular recognition. Our approach to the design of selective sensors is to immobilize agents for selective molecular recognition in a matrix that mimics the organic medium in a solvent extraction system. In this manner, the matrix can enhance both the separation and the achievement of chemical selectivity. The transduction part of the microcantilever sensor is based on binding the molecular recognition agent to one surface of the cantilever so that the adsorption-induced stress change can be detected via bending of the microcantilever. Calix[4]arenes have been widely used as a three-dimensional platform for selective molecular recognition. We have shown that calix[4]arene-crown-6 ethers in the 1,3-alternate conformation bind cesium with remarkable strength and selectivity, and this was the basis of a microcantilever sensor for Cs^+ in solution. New chemistry has been developed for the attachment of SAMs of calix[4]arenes in the 1,3-alternate conformation as dialkanethiols. This attachment has been shown to form SAMs that are stable for a period of over a month in solution. The 2,4-arene rings allow for attachment of molecular recognition groups in a well defined geometry. In addition to attachment of crown ethers for metal ion separation, we have attached ureas and thioureas for recognition of explosives by hydrogen bonding to nitro groups and cationic ion exchangers for recognition of perchlorate by selective ion exchange. The general synthetic scheme will be presented and the performance of SAM modified cantilever sensors will be discussed.

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