Microcantilever Chemical Sensors

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Although silicon microcantilevers have been used as physical sensors since the seventies, their potential as chemical and biochemical sensors remained unexplored until recently. In addition to mass loading, molecular adsorption on microcantilever surfaces is accompanied by large changes in surface stress. Variation in surface stress can be observed via deflection of a microcantilever if the adsorption is confined to one side. Microcantilever deflection can be detected with sub-Angstrom precision using optical, piezoresistive, piezoelectric, capacitive, and electron tunneling techniques. We have demonstrated that microcantilevers can detect analytes with a sensitivity of parts-per-trillion.

In addition to high sensitivity and miniature size, the microcantilever sensor platform also offers two different methods of sensing in a single measurement: resonance frequency variation due to mass adsorption and cantilever bending due to adsorption-induced stress. Currently available micromachining technologies could be used to make multielement/multitarget sensor arrays involving hundreds of cantilevers without significantly increasing the size, complexity, or cost of an overall sensor package. Chemical selectivity can be achieved by orthogonal arrays of individually modified cantilever elements. Advantages of these extremely sensitive devices include miniature size, simplicity, low power consumption, low manufacturing cost, fast response, and the ability to operate in air or liquid. Microcantilevers can be the basis for a universal platform for real-time, in-situ measurement of many physical, chemical, and biochemical properties.

Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. for the U.S. Department of Energy under contract number DE-AC05-96OR22464.