Elastic Effects of Coating Films on Resonance Response of Microcantilevers

T. Thundat, Zhiyu Hu, G. Y. Chen, , and R. J. Warmack
Life Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6123; Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37996-1200

Very sensitive chemical sensors can be based on the resonance response variation of microcantilevers coated with thin layers of chemically specific coatings. It has been found that the elastic effects of thin layers play a major role in resonance response such as resonance frequency and cantilever deflection. Depending on the nature of analyte-substrate interactions (adsorption or absorption), the adsorption-induced stress in the thin film can be either surface stress (N/m) or bulk stress (N/m2) of the coating resulting in varied responses. Successful design of a working microcantilever sensor depends upon understanding the basic physics behind these elastic effects. Experimental results of adsorption of mercury vapor on gold coated cantilevers and moisture absorption on gelatin coated cantilevers are analyzed and theoretical calculations are presented. It is proposed that extremely sensitive microcantilever sensors can be designed by taking advantage of the elastic effects in surface thin films.

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