

Nanomechanical Cantilever Array Sensors for Chemical and Biochemical Detection

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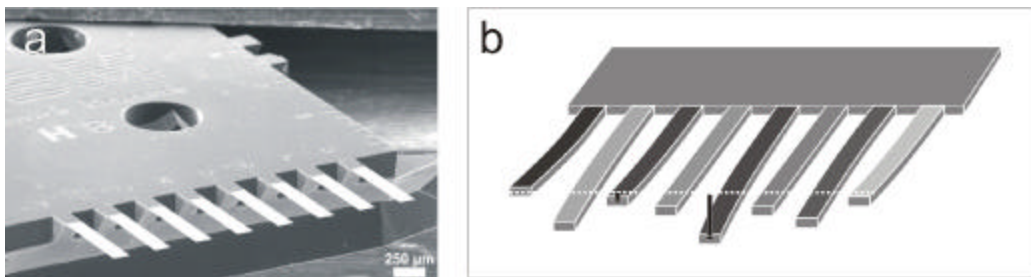
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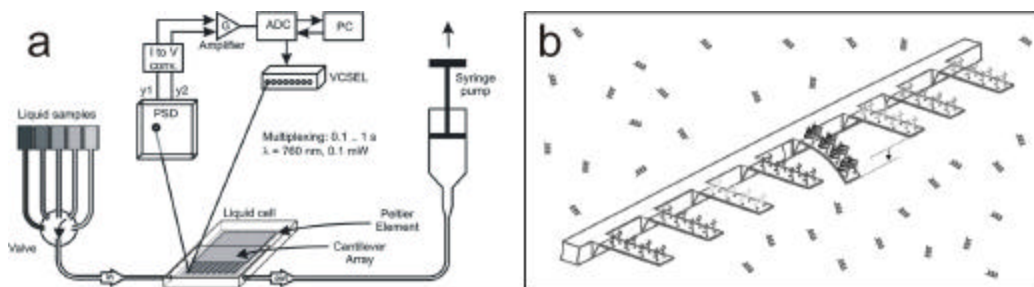
<http://monet.physik.unibas.ch/nose>
<http://www.zurich.ibm.com/st/nanoscience/cantilever.html>

A microfabricated array of eight silicon cantilevers coated with sensitive layers is used to transduce physical or chemical processes into mechanical motion due to changes in surface stress, i.e. bending of a cantilever. Such devices represent ultrasensitive nanomechanical sensors for the detection of chemical and biochemical reactions in both gas-phase and liquid environments. The sensitive layer can either be very specific for detection of molecular recognition or only partially specific to produce responses patterns for various analytes, provided each of the cantilevers is coated with a different partially sensitive sensor layer. The cantilever deflections are read out optically using an array of vertical cavity surface emitting lasers (VCSELs). Such a device has been applied as an artificial nose to characterize volatile vapors.



(a) Scanning electron microscopy image of a microfabricated array of silicon cantilevers (length: 500 μm , width: 100 μm , thickness: 500 nm). (b) Schematic drawing of a cantilever array with different sensitive layers. From the deflection pattern of the individual cantilevers, a fingerprint for the characterization of volatile analytes is derived.

In liquid, the cantilever sensors allow rapid, quantitative and qualitative detection of non-labeled biomolecules, e.g for sequence-specific DNA hybridization with single base mismatch sensitivity. Single-stranded thiolated DNA 12-mer oligonucleotides were anchored onto gold-coated cantilevers and hybridized with the corresponding complementary strand in buffer solution, resulting in cantilever bending predominantly due to steric crowding. The sensitivity of the device was improved to picomolar concentrations of DNA complements. In label-free protein detection we recently investigated two cardiac biomarker proteins (creatin kinase and myoglobin) using an array of cantilevers functionalized with covalently anchored anti-creatin kinase and anti-myoglobin antibodies. These proteins play an important role in the field of early and rapid diagnosis of acute myocardial infarction.



(a) Schematic view of the experimental setup for cantilever deflection measurements in liquids. (b) Schematic drawing of a cantilever array functionalized with single-stranded thiolated oligonucleotides. Hybridization with the complementary strands results in bending of the cantilever with the matching DNA sequence.

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