Optomechanical multiplexed detection with large arrays of cantilevers

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There is an increasing interest in micromechanical sensors that feature a compact size combined with very high sensitivity and short response times. Cantilever-based sensing is emerging as a capable sensing platform with the advantage of being relatively cheap to mass-produce. Micro-fabrication technologies have allowed for the design of micro-cantilevers optimized for various types of sensing applications, as well as for the manufacturing of large arrays of cantilevers, making it possible to use various sensors in parallel. These cantilever-based sensors are proving to be quite competitive with current sensing technologies due to their high sensitivity and fast response time, given their small size (micrometers to nanometers).

In most cantilever-based sensing applications, one surface of the cantilever beam is rendered sensitive to a specific target molecule of interest, while the opposing surface is chemically passivated. When these target molecules interact with the sensitized surface of the cantilever, a surface stress can be induced. The difference in surface stress induced on the sensitive relative to the passive surface of the cantilever results in a measurable mechanical deflection. Cantilever deflections are monitored as a direct measure of adsorption-induced surface stress.
In the MecWins platform, the displacement of the read-out laser beam provides a fast acquisition and the capability to detect the full 3D profile of cantilever arrays of any size, shape and number of elements. Any cantilever design and cantilever number can be addressed by Mecwins technology.

We present here for the first time measurements performed in an completely automatic way of arrays of 4x4 groups of 8 cantilevers that make possible the detection of a total of 128 different molecules. As a key application for DNA detection, the biosensing principle applied by Mecwins is based on the role of hydratation forces in controlled biolayers[1]. In the experiment involving DNA, a solution containing end-thiolated single stranded DNA (ssDNA) molecules is introduced into a cell containing the above mentioned chip, which has one surface coated with gold. The ssDNA molecules adsorb on the gold surface of the cantilever through the strong gold-thiol bond forming a self-assembled monolayer (SAM). Figure 1 shows the profile of 11 chips with a total of 88 cantilevers. Figure 2 presents the response of the 88 cantilevers to a hydration cycle. The key capabilities of this novel instrumentation are: a highly multiplexed detection together with an accurate control of the gas environment.

References:

[1] Mertens, J., Rogero, C., Calleja, M., Ramos, D., Martín-Gago, J.A., Briones, C. & Tamayo, J., Nature Nanotechnology **3** (2008) 301.

Figures:

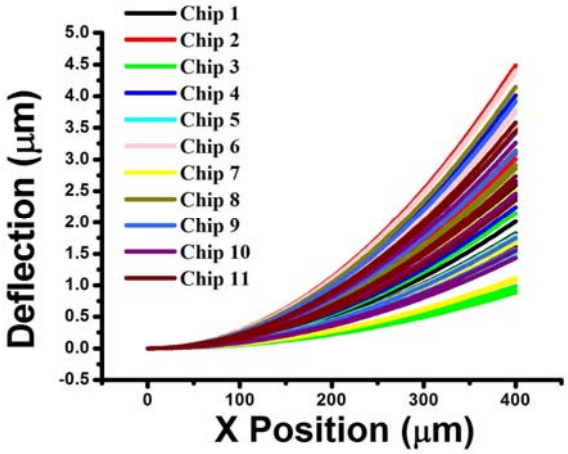

Figure 1. Simultaneous measurement performed by the Mecwins platform in 11 different chips comprising 8 cantilevers each chip. Information from the full profile of 88 cantilevers is obtained.

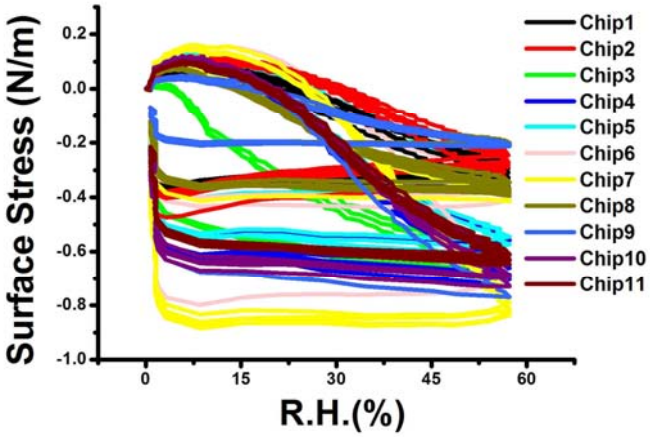

Figure 2. The described instrument is capable of multiplexed measurements in controlled gas environment (a mixture of dry and water saturated nitrogen in this experiment). Here the response of ssDNA sensitised cantilevers is shown. Measurements are performed simultaneously in 88 cantilevers from 11 chips. The results show a very good reproducibility of the DNA layers, with similar responses to changes in relative humidity. The cantilevers also show comparable mechanical responses to the hydration changes.