Mass and stiffness nanomechanical spectrometry

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The identification of microorganisms such bacteria, viruses and fungi, is a fundamental problem in analytical chemistry and biology. Mass spectrometers (MS) identify species by their molecular mass with extremely high sensitivity (~ Da). However, reduced dynamic range (up to MDa) that is below the mass of intact microorganisms, limits conventional MS. Nanomechanical resonators have demonstrated its capacity for measuring the mass of analytes with outstanding sensitivity and high dynamic rage[1,2].
We present a mass and stiffness nanomechanical spectrometer that overcome the limitations of convencional MS. We developed a theory of the mechanical coupling between biological particles and resonant beams that predicts not only the mass but also the stiffness of the adsorbed particles by tracking the resonance frequency shifts of several vibration modes in real-time [3]. We measured gold nanoparticles, *Escherichia coli* and *Staphylococcus epidermidis* delivered by electrospray ionization to a microcantilever resonator placed in vacuum. The system is able to perfectly guide, soft-landing and focus the particles beam on the surface of the nanomechanical resonator.

References

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[2] S. D. Medina et al. Neutral mass spectrometry of virus capsids above 100 megadaltons with nanomechanical resonators, Science, 362, 918-922 (2018)
[3] O. Malvar et al. Mass and stiffness spectrometry of nanoparticles and whole intact bacteria by multimode nanomechanical resonators. Nature Communication, 7, 13452 (2016)
[4]

Figures

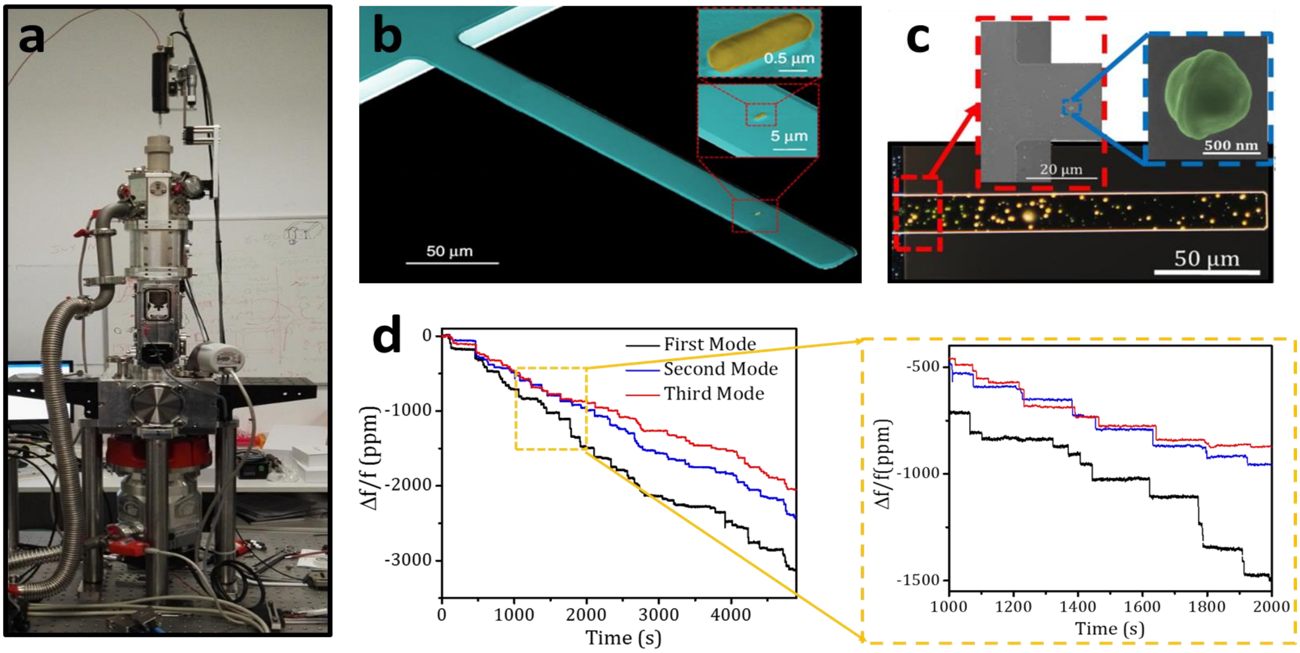

Figure 1. (a) Nanomechanical mass and stiffness spectrometer. (b) False color SEM image of an *E. coli* on a cantilever surface. (c) Dark field microscope picture of a cantilever after deposition of *S. epidermidis*. Insets show SEM images of the bacterial cells on the cantilever surface. (d) Relative frequency jumps of the first three flexural modes during an experiment.