ThermoMechanical Imaging and Characterization of Single Bacteria Cells

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We have developed a high throughput spectrometric technique addressing single biological entity (bacteria) resolution. This novel technique will be used to develop a novel imaging technique based on mechanical frequency shift of a nanomechanical resonator to generate a mechanical image of single particles and bacteria. The physical principle behind this technique is the modulation of the light absorption by the particle, which is translated into a thermo-mechanical effect on the nanomechanical resonator. This idea was recently demonstrated by using plasmonic gold particles of 100 nm in diameter [1] and to mechanically image viruses and bacteria cells (in press) of 700 nm in diameter. We will show not only the optomechanical coupling that emerges in the cavity formed by a plasmonic nanoparticle onto a free-standing silicon nitride membrane, but also the thermomechanical coupling by using dielectric particles. The optical absorption depends on the scatterer material; therefore, it is possible to unambiguously discern in between different dielectric particles and bacteria cells of the same size by simply analyzing the mechanical frequency shift while shinning with a laser [2]. The optical absorption can also be tuned by playing around with the optical resonances of a photonic crystal, which allows to actively tune the mechanical resonance frequency [3].

References

[1] D. Ramos, O. Malvar, Z. J. Davis, J. Tamayo, and M. Calleja "Nanomechanical Plasmon Spectroscopy of Single Gold Nanoparticles", *Nano Letters* **18**, 7165-7170 (2018)].
[2] D. Ramos et al, (*in press*) 2020.
[3] D. Ramos et al. (*in preparation*).

Figures

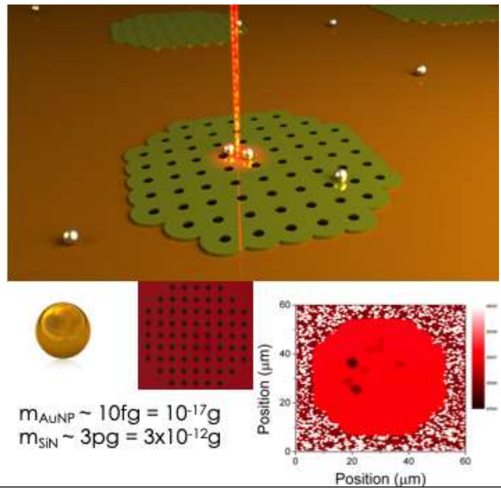

Figure 1: Figure. a. Schematic depiction of the system used for the mechanical imaging of gold nanoparticles of 100 nm in diameter and the experimental mechanical image of the whole membrane (adapted from [D. Ramos et al., *Nano Letters* **18**, 7165-7170 (2018)]).

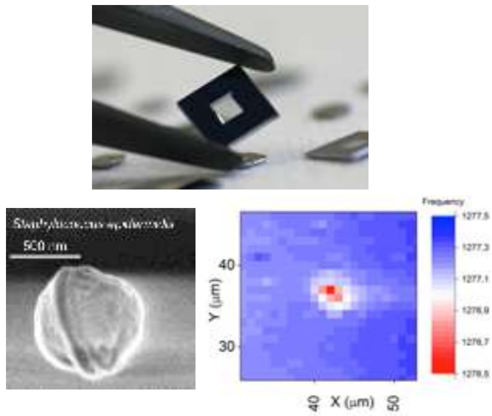

Figure 2: Membranes used for the mechanical image of *Staphylococcus epidermidis* (SEM image taken at CSIC) and the first experimental mechanical image (*in press*).