Biosensors based on nanomechanical systems

Javier Tamayo, P.M. Kosaka, V. Pini, J.J. Ruz, O. Malvar, C. Dominguez, M. Encinar, A. Calzado, D. Ramos, A. San Paulo, and M. Calleja

Bionanomechanics lab, Institute of Microelectronics of Madrid, CSIC, Isaac Newton 8 (PTM), Tres Cantos, 28760 Madrid, Spain,

http://www.imm-cnm.csic.es/bionano/en

* Address correspondence to
jtamayo@imm.cnm.csic.es

The advances in micro- and nanofabrication technologies are enabling increasingly smaller mechanical transducers capable of detecting the forces, motion, mechanical properties and masses that emerge in biomolecular interactions and fundamental biological processes. Thus, biosensors based on nanomechanical systems have gained considerable relevance in the last decade. This talk will provide insight into the mechanical phenomena that occur in suspended mechanical structures when either biological adsorption or interactions take place on their surface. The talk will guides through the parameters that change as a consequence of biomolecular adsorption: mass, surface stress, effective Young's modulus and viscoelasticity. The mathematical background needed to correctly interpret the output signals from nanomechanical biosensors will also be outlined. Other practical issues reviewed are the immobilization of biomolecular receptors on the surface of nanomechanical systems and methods to attain that in large arrays of sensors. I will describe then some relevant realizations nanomechanical systems that harness some of the mechanical effects cited above to achieve ultrasensitive biological detection. In this context, I will show our developments in optical instrumentation to obtain complete information about the nanomechanical phenomena that emerges in nanomechanical systems. The results open the door for the development of hybrid optomechanical devices for biological sensing. I will show several applications running in our laboratory that include: i) protein biomarker detection, ii) cancer cell nanomechanics, iii)DNA detection, and iv) protein nanomechanical spectrometry.

References:

1. Domínguez, C.M. et al. Label-free DNA-based detection of mycobacterium tuberculosis and rifampicin resistance through hydration induced stress in microcantilevers. *Analytical chemistry* **2015**.
2. Kosaka et al. Detection of cancer biomarkers in serum using a hybrid mechanical and optoplasmonic nanosensor. *Nature Nanotechnology* **2014**.
3. Ruz, J. et al. Physics of nanomechanical spectrometry of viruses. *Scientific Reports* **2014**, *4*