NANOMECHANICAL SENSORS TO STUDY AT THE NANOSCALE BIOMEDICAL CHALLENGES

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Movement is life. Studying living biological systems and their nanoscale movements we can achieve a novel insight in their metabolic status and in how they react to external stimuli. To investigate these movements, we have developed a novel nanoscale sensor, called the nanomotion sensor, which we applied to characterize the innate correlation between life and movement. Due to its sensitivity, the nanomotion sensor can be used to study bacterial species [1], yeasts and fungi and their response to drugs as well as to chemical or physical stimuli. We will show how the fast response of the sensor, leads to exciting applications in the medical practice, with evident advantages for patients care. For instance, by combining it with rapid isolation of bacteria from clinical samples, we have optimized a protocol to produce a complete characterization of a bacterial infection directly from a clinical source [2]. We will discuss how the extremely high sensitivity of this system can be applied to other systems, including from the study of conformational changes in proteins and protein complexes [3]. Finally, we will present the latest results in the nanomotion characterization of single mammalian cells. As an example, we monitored neurons exposed to amyloid proteins, demonstrating at the single cell level the effect of the different protein aggregation forms [4]. We have also applied this technique to achieve a rapid characterization of the response of cancer cells to anti-tumoral drugs, with evident impact in the field of oncology. In fact, just as in the case of the characterization of bacteria, by using the nanomotion detector we determined the susceptibility to a particular therapeutic option for a given cancer in a time-range of hours. In very general terms, all these pioneering results indicate that there is a close correlation between movement and life and that a sensor capable of transducing these movements can deliver a new point of view in the analysis of living systems and allow a new means to characterize the metabolic activity. This has also led us to propose this nanomotion sensor as an innovative technique to detect life in extreme environments [5].

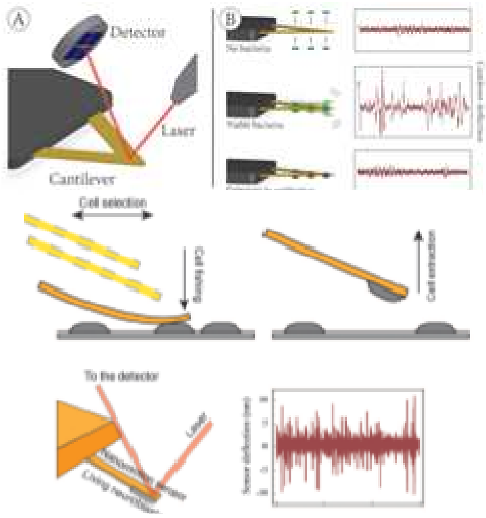

Figure 1. Setup of a nanomotion experiment. Depiction of typical bacteria or single cells analyses.

[1] Longo et al., Nat. Nanotech., 8, 522-526, (2013)
[2] Longo et al. Clin. Microbiol. Infect., 23, 400-405, (2017)
[3] Alonso-Sarduy et al. PLoS ONE 9, e103674 (2014)
[4] Ruggeri et al. Cell Death Disc., 3, 17053 (2017)
[5] Kasas et al., PNAS, 112 (2), 378–381 (2015)