Fluidic force microscopy to access the interactions between gaz/liquid and biological interfaces

Irem Demir[1,2], Ines Lüchtefeld[3], Claude Lemen[4], Pascal Guiraud[5], Etienne Dague[6], Tomaso Zambelli[7], and Cécile Formosa-Dague*[8]

[1]Toulouse Biotechnology Institute – Institut National des Sciences Appliquées - Toulouse – France
[2]Laboratoire dánalyse et dárchitecture des systèmes – Centre National de la Recherche Scientifique – France
[3]Institute for Biomedical Engineering (ETH Zurich) – Switzerland
[4]Toulouse Biotechnology Institute – Centre National de la Recherche Scientifique – France
[5]Toulouse Biotechnology Institute – Institut National des Sciences Appliquées - Toulouse – France
[6]Laboratoire d'Analyse et d'Architecture des Systèmes (LAAS) – CNRS : UMR8001 – 7 Avenue du Colonel Roche 31400 Toulouse, France
[7]Institute of Microbiology and Institute of Biomechanical Engineering (ETH Zürich) – Hönggerberg HCI F429 Wolfgang-Pauli-Strasse 10 8093 Zurich, Switzerland
[8]Toulouse Biotechnology Institute – Institut National de la Recherche Agronomique : UMR0792, Institut National des Sciences Appliquées - Toulouse, Centre National de la Recherche Scientifique : UMR5504 – France

Abstract

The interactions between gaz/liquid interfaces (bubbles) and cells are involved in many bioprocesses. For example in bioreactors, breathing microorganisms interact with their growth medium but also with the gases present in the medium under the form of bubbles. While many studies are dedicated to the modelling of such processes, none of them have yet looked into the interactions between the cells and the bubbles. Thus questioning these interactions is highly original, and provides relevant data that can be used in many biotechnological applications. But accessing such interactions presents several technological challenges, the main one being to produce microsized bubbles, stable over time. In this presentation, we show recent developments in which we produce stable bubbles using FluidFM technology that combines AFM with microfluidic AFM probes1. In this system, a microsized microfluidic channel is integrated in an AFM cantilever and connected to a pressure controller system, thus creating a continuous and closed fluidic conduit that can be filled with air, while the tool can be immersed in a liquid environment. An aperture at the end of the cantilever allows the air to be pushed out of the probe into the liquid, resulting in the creation of a bubble. Force feedback is then ensured by a standard AFM laser detection system that measures the deflection of the cantilever and thus, interactions can be probed directly with cells. Finally, the bubbles produced using this technique can be functionalized with surfactants, which allows to modulate the interactions between the bubble and cells.

Keywords: Fluidic force microscopy, Gaz/liquid interface, Living cell, Interaction, Functionalization

*Speaker