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Autore	MEJIA MORALES, JULIAN
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Sommario

In the past years, growing demand for label-free cell analysis has emerged. This demand answers the need for cell analysis in its developing stages and, perhaps more importantly, to study physiological cell states in a simpler way than using fluorescence-based analyses. Mechanical and optical properties of cells are emerging as powerful biomarkers to discriminate cells. The cell deformation induced by acoustic pressure is measured with the Acoustofluidic Interferometric Device, developed in this thesis. It allows for studying the deformability of the cell in a way similar to what is done for the analysis of the Young modulus. Deformability is an integral biomarker that summarizes cell gene expression, and the cell refractive index is related to the density of proteins in the cytoskeleton. The Acoustofluidic Interferometric Device, developed for the measurement of optomechanical cell properties on a cytometric basis. The device is thoroughly described and characterized in this thesis. The device enables the assessment of size, deformability, and refractive index (or a combination of them) of non-adherent cells utilizing a low finesse Fabry-Perot resonator and acoustic manipulation. When an acoustically focussed cell (or another micro-sized particle) crosses the Fabry-Perot cavity axis, it will perturb the resonator’s fringe pattern governed by the

Airy’s transmission function. Such perturbation can be characterized and analyzed by means of the parameters ρ (radii of the circular interference fringes), Full Width at Half Maximum of the individual fringe, and by the distance between fringes (Free Spectral Range). The analysis of the perturbation enables the assessment of the cell’s optomechanical properties. Measurement of Algae and Yeast cells’ deformability has been carried out to test the instrument’s performance and compared to the equivalent perturbation introduced by Microgel beads and Polystyrene spheres as controls. The experiment is based on the cell-induced fringe pattern perturbation analysis. Images of the perturbation are acquired under two different conditions; 1) acoustic focussing and 2) acoustically induced deformation. 180 independent intensity profiles are retrieved and analyzed for each image, allowing for statistical analysis of the parameters: cell focal length and perturbed resonator Finesse. The results show a change in the optomechanical properties of the Algae, Yeast, and Microgel. Notoriously, the Polystyrene sample remains virtually unchanged, as expected since Polystyrene is much stiffer than a cell and cannot be deformed by the instrument’s pressure field. These results show that the acoustofluidic technique presented here is useful to detect and measure different optomechanical properties which, potentially, can be used as label-free biomarkers in clinical diagnosis.

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