A simple route towards micro-engineered soft hydrogels for cell-based assays

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Many cues of the cell environment impact on cell physiological processes such as growth [1], differentiation [2], motility [3], mitosis [4], etc. Among these cues, cells can feel mechanical properties of their environment, and subsequently adapt their physiological state trough biochemical cascades, a process called mechanotransduction [5,6]. Understanding how mechanical signals are transduced in living cell requires to reproduce and tune independently specific cues of natural cell environment.

In this way, we developed a new technique to control separately the matrix stiffness, cell shape and protein density, which are involved in the cell mechanotransduction response. In order to overcome the natural protein anti-binding properties of polyacrylamide (PAAm) gels, we modified intrinsically the chemical reactivity of PAAm gels that lead to the presence of functional protein binding sites. We show that these modified PAAm hydrogels can be easily functionalized with extracellular proteins via microcontact printing, hereby leading to control the cell geometry. We report that this technique allows to control the protein surface density independently of the substrate stiffness as well as to create dual protein patterns. We developed therefore a simple and efficient method to finely control and tune independently mechanotransduction cues to decipher their role on cell behaviour.

Taking advantage of this new technique, we studied how the geometric confinement influences cellular mechanical properties. First, we used traction force microscopy to quantify the traction force field as a function of cell adhesion areas and protein coatings. Second we used magnetic tweezers to estimate the evolution of the Young modulus of adherent cells in response to changes of specific environmental cues

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