Local control of cell positioning and migration by multiscale substrate patterning.

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The combination of unconventional fabrication technology and biomaterials allows both to realize state-of-the-art devices with highly controlled lateral features and performances and to study the main properties of the biomolecules themselves by operating at a scale level comparable with the one crucial for their activity.

Soft lithography and microfluidic devices offer a tool-box both to study biomolecules under highly confined environments and to fabricate in an easy way topographic features with locally controlled mechanical and chemical surface properties, thus leading to a finer control of the interplay of mechanics and chemistry.

I will present an application of this technology to the control of cell fate that is becoming a key issue in regenerative medicine in the perspective of generating novel artificial tissues. Patterns of Extracellular Matrix (ECM) proteins have been fabricated, by a modified Lithographically Controlled Wetting (LCW), on the highly antifouling surface of Teflon-AF to guide the adhesion, growth and differentiation of neural cells (SHSY5Y, 1321N1, NE-4C) achieving an extremely accurate guidanc.

Local surface topography is also known to influence the cell fate, thus, integrating this paramenter in the substrate fabrication could increase the complexity of the signals supplied to the cells. In this perspective we have developed a novel fabrication technique, named Lithographically controlled Etching (LCE), allowing, in one step, to engrave and to functionalize the substrate surface over different lengthscales and with different functionalities.

In conclusion the development of ultra-thin film organic field effect transistors (OFETs) as label-free biological transducers and sensors of biological systems will be illustrated. OFETs are low-dimensional devices where ordered conjugated molecules act as charge transport material. Unconventional patterning techniques and microfluidics have been adapted to proteins and nucleic acids to dose the molecules on the OFET channel with a high control of the concentration. In another set of experiments, we have also been addressing the signalling from neural cells and networks grown on pentacene ultra-thin film transistosr.