Polymer-Based Microstructures for Controlled 2D and 3D Cell Networks

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Context The analysis of neuronal cells embedded in networks of controlled geometry has grown rapidly over the past decade and stays important for biological studies and medical research. The positioning of individual cells has become a key technique for cell engineering applications such as cell therapy and brain regeneration.

Objectives & Methods We developed different kinds of polymer-based microstructures for positioning and fixing cells in specific places. Cells could develop extensions freely or with guidance, and create a network in two or three dimensions. Several approaches, based on various structures and polymers, have been investigated: mechanical constraint, high-topography surface functionalization and stackable structures. We are currently working on the last approach for controlled 3D cell network [1]. The long-term objective is to create a hybrid system (electronic and polymer-based structures) for biological and medical applications.

Results We successfully developed an innovative technique, previously used in microfluidics, to realize honeycomb arrangements of cell containers interconnected by microchannels using SU-8. These structures are fabricated using a single UV-photolithography exposure. Each container is centered on a nanopillar array for cell positioning [2], as shown Figure 1. We have also developed a new technique for patterning functionalization layers on substrates with high topography [3]. The technique is based on the peel-off of a parylene layer deposited on a structured sacrificial photoresist. We have successfully demonstrated the guided growth of neuron-like PC12 cells on different patterns of cell-growth promoting proteins on micro¬pillars, in microwells, and in-between, as shown in Figure

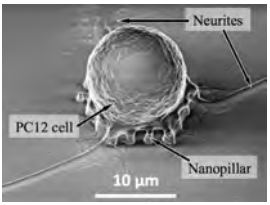

Fig. 1. Scanning electron micrograph of a neuron on a nanopillar array with neurite growth

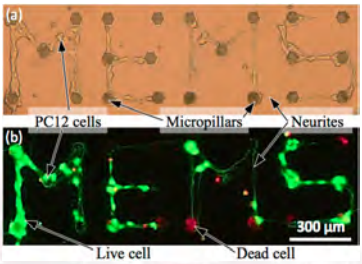

Fig. 2. (a) Optical micrograph of neuron-like PC-12 cells grown on micropillar arrays with neurites guided by laminin lines to form 'MEMS' and (b) its equivalent in fluorescence microscopy after live-dead test. and guided by SU-8 honeycomb structure and microchannels.

References

[1] F. Larramendy et al., IEEE Transducers 2015.
[2] F. Larramendy et al., J. Micromech. Microeng, 2015.
[3] F. Larramendy et al., IEEE MEMS 2015.