IN-SITU LABEL-FREE OPTICAL DETECTION OF CELLS CULTURED IN 3D MICROINCUBATORS

S. Surdo[1], F. Carpignano[2], G. Silva[2], A. I. Scovassi[3], F. Aredia[3], S. Merlo[2], G. Mazzini[3,4], G. Barillaro[1]
[1]Dipartimento di Ingegneria dell'Informazione, Università di Pisa, Via G. Caruso, 16 – 56122 Pisa;
[2]Dipartimento di Ingegneria Industriale e dell'Informazione, Università di Pavia, Via Ferrata 1 – 27100 Pavia;
[3]Istituto di Genetica Molecolare, CNR, Via Abbiategrasso 207–27100 Pavia.
[4] Dipartimento di Biologia e Biotecnologie "L. Spallanzani", Università di Pavia, Pavia, Italy

In this work, we show that high aspect-ratio silicon microstructures can play, at the same time, the roles of a cell-selective three-dimensional microincubator for cell culture and optical label-free transducer of cell morphology mapping. Silicon microincubators, integrating a periodic array of narrow (5-μm-wide), deeply etched (50-μm-deep) gaps separated by 3-μm-thick silicon walls, are fabricated by electrochemical micromachining (ECM) technology [1], and used for culturing several both epithelial and mesenchymal cell lines. Fluorescence microscopy analyses highlight that the microincubator shows cell-selective capabilities, being mostly cells with mesenchymal phenotype able to actively colonize the deeply etched gaps and grow attached to the vertical silicon walls [2]. The microincubator also features reflectivity spectral properties typical of one-dimensional (1D) photonic crystals (PhCs) structures in the near infrared range, with high reflectivity regions separated by deep reflectivity notches. According to 1DPhC optical properties, the presence of cells inside the gaps of the microincubator strongly affects the reflectivity signal, which can be measured *in-situ* with a fiber-optic setup orthogonally to the silicon wall surface (x-y plane). By spatially mapping the reflected power spectrum in the vertical x-y plane, it is thus possible to infer on the extension of cells growing into the microincubator attached to silicon walls. In particular, the intensity ratio between reflectivity maximum and minimum at two different wavelengths around 1.55 μm is closely related to the cell spreading on the silicon wall inside the deeply etched gaps of the microincubator. These results clearly envisage future *in-situ* label-free analyses of cellular activities involving changes in cell morphology and/or adhesion (e.g. apoptosis), in a three-dimensional environment.

[1] M. Bassu, S. Surdo, L. M. Strambini, G. Barillaro, Adv. Funct. Mat., 22 (2012), 1222-1228;
[2] F. Carpignano, G. Silva, S. Surdo, V. Leva, A. Montecucco, F Aredia, A. Scovassi, S. Merlo, G. Barillaro, G. Mazzini, Plos ONE 7 (2012) DOI: 10.1371/journal.pone.0048556.

Work partially funded by FAMT, Pavia, Italy, and Fondazione CARIPLO.