Nano-Scale Topography and its Effect on Cellular Behavior

CNF Project # 1375-05
Principal Investigator: Kam W. Leong

Abstract:

Silicon wafers with nanometer scale topographical features were designed for use in soft lithography to fabricate replica patterns on PDMS for the study of nano-scale topography effects on cellular behavior in vitro.

Summary:

Cells interact with their native extra-cellular matrix (ECM), with features at the nanometer scale. Our lab has shown that nanoscale patterns significantly change smooth muscle cell morphology, proliferation and cell migration [1].

To study the cellular response to nanometer-sized topographical features, the fabrication of patterns with well defined features that may be reproduced with high fidelity, in large quantities and at low cost, is critical. In the past year, we fabricated silicon wafers with the desired nanopatterns to be used as a mold in soft lithography to reproduce the patterns on poly(dimethylsiloxane) (PDMS).

One pattern consists of rectangular pits of 300 nm x 500 nm. Each rectangular pit is 150 nm apart from the next. Other patterns comprise line gratings with widths ranging from 50 to 100 nm. Efforts are being made to vary the height dimension of the replica PDMS patterns (relief modification), which may be used to determine the extent of cell sensing of topographical relief.

One cellular study involves evaluating the biological response of monocyte and macrophage cultured on these PDMS replica patterns, which could define the role of nanotopography in dictating foreign body reaction to implants. Another study involves the trans-differentiation of adult human stem cells cultured on these nanopatterned PDMS [2].

References:


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Principal Investigator: Kam W. Leong
Users: Sulin Chen, Evelyn Yim

Affiliations: Department of Biomedical Engineering, Duke University, Durham, NC; Biomedical Engineering, Johns Hopkins School of Medicine, Baltimore, MD

Primary Funding: NIH
Contact: kam.leong@duke.edu, sulin@jhmi.edu, eyim@duke.edu

Figure 1, above: Scanning electron micrograph of the rectangular pit pattern produced by JEOL at magnification of 75000X.

Figure 2, below: AFM 3D surface plot and cross-section images of line gratings on silicone wafer with width (w): trough (t):height (h) dimensions of (a, b) 50nm:150nm:100nm; and (c, d) 100nm:200nm:100nm.

Figure 3: Fluorescent (a) and phase contrast (b) images of macrophage cells elongating along 500 nm PLA gratings at the boundary of patterned glass.