Effect of Micron Scale Surface Features on Dental Papillae Mesenchyme Cells

CNF Project # 1359-05
Principal Investigator & User: Jian Tan

Abstract:
Dental implants have become a universal treatment for the repair or replacement of natural teeth. The success of dental implants depends on both chemical and physical properties of the implant materials. Because the surface of a material is in direct contact with cells, modification of surface properties can play a crucial role in determining the short and long term effects of the implant [1]. In this study, we focused on the role of micron-scale surface structures in regulating the responses of dental cells that participate in the response to implanted materials. Dental papillae mesenchyme (DPM) cells that were isolated from transgenic mice provide a convenient model system for studying dental cell behaviors on implant materials, as these cells can be induced to differentiate into odontoblasts responsible for dentin formation [2].

Summary:
We produced regular arrays of pillars and parallel ridges on silicon wafers using photolithography and reactive ion etching. The size of the pillars was 4 x 4 x 4 µm, and the space between pillars was varied from 6 to 18 µm. The parallel ridges were 4 µm wide and tall, with various spacing at 6 µm to 18 µm. We found that the presence of micron scale features not only changed cell morphology and cytoskeleton organization but also significantly increased cell adhesion and proliferation rate. The shape and the spatial distribution of the micron scale features had significant impact on cellular behavior. Substantially more mineralized tissue was observed on the patterned surfaces when cells were cultured at non-permissive conditions. Taken together, our study suggests that micron scale surface features are critical parameters in the design of new dental implants.

References:
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CNF Project # I359-05
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Figure 1, above: Pillars (a) and parallel ridges (b) were produced on silicon wafer.

Figure 2, below: DPM cells cultured on micro-patterned surfaces. Actin filaments were stained with AlexFluo 488. Actin orientation was clearly influenced by the patterns. a) Pillars. b) Parallel ridges.