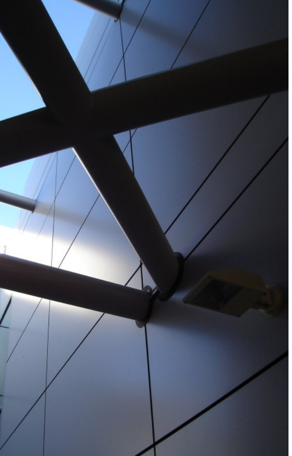

MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Shannon Cristina Gott

Thursday, August 28, 2014, 2:00PM
in Bourns Hall A265

Titanium Vascular Stents With Rationally-Designed Sub-Micrometer Scale Surface Patterning

Doctor of Philosophy, Graduate Program in Mechanical Engineering
University of California, Riverside, August 2014
Dr. Masaru P. Rao, Chairperson

Drug-eluting stents have revolutionized the field of interventional cardiology by reducing incidence of restenosis through local delivery of drugs that inhibit inflammation caused by implantation-induced injury. However, growing evidence suggests that this may also inhibit reestablishment of the endothelium, thus delaying healing and increasing potential for thrombogenic stimulus. Herein, we discuss progress towards realization of next-generation titanium (Ti) stents that seek to mitigate adverse physiological responses to stenting via rational design of stent surface topography at the micro- and sub-micrometer scale.

To better understand the effect of surface topography on cells, we evaluate the in vitro response of EA926 endothelial cells (EC) to variation in precisely-defined, micrometer to sub-micrometer scale groove-based topography, with groove widths ranging from 0.5 to 50 µm. Silicon (Si) and Ti materials are chosen for these studies due to their relevance for implantable microdevice applications, while grating-based patterns are chosen for their potential to induce elongated and aligned cellular morphologies reminiscent of the native endothelium. We show significant improvement in cellular adhesion, proliferation, and morphology with decreasing feature size on patterned Ti substrates. Moreover, we show similar, yet attenuated, trending on patterned Si substrates as compared to patterned Ti substrates. These results suggest promise for sub-micrometer topographic patterning to enhance endothelialization and neovascularisation for implantable microdevice applications.

We also discuss: 1) advances which now allow patterning of features in Ti substrates down to 150 nm, which represents the smallest features achieved to date using our novel Ti deep reactive ion etching (Ti DRIE) technique; 2) creation and evaluation of balloon-deployable, cylindrical, surface-patterned stents from micromachined planar Ti substrates; and 3) integration of these processes to produce a device platform that allows, for the first time, evaluation of surface patterning in more physiologically relevant contexts, e.g. in vitro organ culture. Using elasto-plastic finite element analysis, we also explore planar stents with novel locking mechanisms intended to address radial stiffness deficiencies observed in earlier studies. Collectively, these efforts represent key steps towards our long-term goal of developing a new paradigm for stents in which rationally-designed surface patterning provides a physical means for complementing, or replacing, current pharmacological interventions.