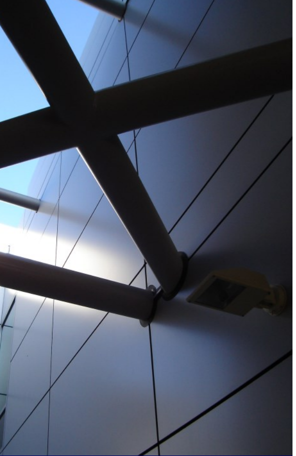

MECHANICAL ENGINEERING
DISSERTATION DEFENSE

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of
Samantha R. Corber

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Titanium Micromachining Process Advancements for Optical Tissue Clearing

Doctor of Philosophy, Graduate Program in Mechanical Engineering
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Dr. Masaru Rao, Chairperson

Optical Clearing Agents (OCAs) increase the transmittance of light through tissues, which represents a key step toward laser-based medical diagnostics and treatments. The stratum corneum (SC) is the key limitation to the transport of topically-applied OCA through the skin. While a bolus, subdermal injection overcomes the SC barrier, it can result in scarring and necrosis of the tissue; signifying a need for alternative drug delivery methods. One such alternative is the microneedle (MN) array, which can bypass the SC and overcome the low profusion of OCA by direct and evenly distributed injection into the tissue.

Current materials being used to fabricate MN, such as silicon, are non-ideal for intradermal drug delivery due to their non-optimal material properties. Titanium (Ti) is a promising surrogate material in this regard, due to its excellent biocompatibility and fracture toughness. The recent development of Ti Deep Reactive Ion Etching (Ti DRIE) has enabled the fabrication of small-scale, Ti-based biomedical devices. However, this micromachining technique was developed for anisotropic deep etching, which limits microdevice design and complexity, but provides opportunity for improvements in sidewall profile control.

Herein, we explore two key objectives to the overall aim of increasing OCA efficacy through MN arrays. First, injection of OCA via a hypodermic needle array device is demonstrated to increase clearing efficacy in excised tissue in a proof-of-concept study. Next, multidimensional features were realized through the development and integration of profile control methods in TiDRIE that ultimately enabled the fabrication of the first dry etched out-of-plane bulk Ti microneedles.