



Ryan Koppes

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**“Scalable,
multifunctional fiber
probes for optical
neural interfaces and
tissue regeneration.”**

Thursday, Feb 19
50 Dodge Hall
11:15am – 12:30pm

*Refreshments will be
served*

ABSTRACT Whether mapping detailed, cell-specific brain activity or developing new, electrically active neural scaffolds for regeneration, interfacing with soft neural tissue is paramount. Current technologies for high resolution multichannel *in vivo* neural recordings (e.g., silicon-based probes and metal microwire arrays) elicit a strong foreign body response, leading to a localized loss of neural activity and decreased signal-to-noise ratio over time. These failures are typically attributed to the extreme difference in stiffness and poor chemical compatibility between probes and neural tissue. This seminar will focus on the utilization of the thermal drawing process to engineer flexible polymer probes for interfacing with the central nervous system and designing highly scalable nerve guidance channels for peripheral nerve repair. In addition, the recent development of optogenetics has allowed for temporally precise and cell-type specific interrogation of neural activity with visible light. Through incorporation of optical waveguides and recording electrodes, we have employed our polymer fibers to simultaneously activate and record from optically sensitive neural tissue. Interfacing with the spinal cord, optical stimulations were directly correlated to lower limb muscle activity as indicated by electromyography (EMG) recorded in the gastrocnemius muscle. In the brain our highly flexible, multifunctional polymer probes were well suited for longterm implantation, delivery of optical stimulation and recording, and exhibited a high level of biocompatibility. Alternatively, thermal drawing has shown promise as a viable method to robustly produce nerve guidance channels containing complex architectures and

dimensions that demonstrate promise in enhancing axonal extension during *in vitro* validation of neural interfaces. Translatable knowledge from this work will broadly impact the field of neuroscience and tissue engineering; however the implications will have a profound influence on the design and application of relevant material interfaces for a variety of applications. I will also discuss my work in biomechanics and tissue engineering towards 1) electromechanical conditioning of engineered single-fiber musculoskeletal tissue *in vitro*, and 2) the mechanical characterization of the *Drosophila* jump muscle for investigating poorly understood muscle phenomena. Finally, I will discuss my future perspectives for utilizing optogenetics, thermally drawn neural probes, biomechanics, and tissue engineering to fabricate closed-loop neuromodulation technologies that will allow the underlying mechanisms of vagus nerve stimulation for cardiac regulation and repair to be elucidated and controlled.

BIOGRAPHY Dr. Ryan Koppes received her Ph.D. in Biomedical Engineering from Rensselaer Polytechnic Institute in 2013. His doctoral research with Dr. David Corr focused on soft musculoskeletal biomechanics and tissue engineering. In 2013, Dr. Koppes joined the Bioelectronics Laboratory with Dr. Polina Anikeeva in Material Science and Engineering at MIT, where he works as a Translational Fellow on neural interface technology utilizing a multimaterial thermal drawing process and optogenetics. His recent work has been published in Nature Biotechnology and Advanced Functional Materials.