“Robots That Eat, Breathe and Bleed”

Virtual Seminar
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James H. Pikul
Assistant Professor
Mechanical Engineering and Applied Mechanics
University of Pennsylvania

Abstract
Modern robots lack the multifunctional, interconnected chemical systems found in living organisms and, consequently, exhibit reduced efficiency and autonomy. At the same time, new advancements in chemistry are enabling synthetic materials with capabilities that surpass biological materials. This talk will discuss how advances in electrochemistry and soft materials can transform the way we build and use robots, with the ultimate goal of surpassing the capabilities of living organisms. Specifically, fundamental insights will be applied to improve the performance and capabilities of structural materials and energy storage in robots. The discussion on energy storage will cover materials and manufacturing techniques, funded by DARPA’s SHRIMP program, that triple the energy density of batteries for small scale robots, approaches that break the scaling laws of energy storage technologies by allowing robots to eat metal in their environment, and multifunctional synthetic vascular systems that increase the energy density of robots by up to 4x that of robots that only use lithium ion batteries. The talk will finish with a discussion on how old tools like self-assembly enable metals with the strength of titanium and density of water, and how new approaches to healing, through transport mediated in water, allow bone-inspired room-temperature healing of metals.

Bio
James H. Pikul is an Assistant Professor in the Department of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania. He earned his B.S. (2009) M.S. (2011) and Ph.D. (2015) in Mechanical Science and Engineering from the University of Illinois at Urbana-Champaign, where he was a Department of Energy Office of Science Graduate Research Fellow and University of Illinois Carver Fellow. He won the Materials Research Society Gold Award for his work on the design and fabrication of high power microbatteries and high specific strength cellular solids. His research group at the University of Pennsylvania seeks to make transformative advances in energy storage, multifunctional materials, and robotics by understanding and exploiting nanoscale to macroscopic characteristics of electrochemistry and soft matter. He applies these advances to enable new robotic functionality, including adaptive shape-transformations, metal healing, and biomimetic power systems. James is a Moore Inventor Fellow, Scialog Fellow, TMS Early Career Faculty Fellow, and has received the Office of Naval Research Young Investigator Award and the NSF CAREER Award. His research has generated significant interest in popular media, having been featured in BBC, National Geographic, Discovery News, Scientific American, NBC news, Washington Post, and Newsweek, among others.

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