Johns Hopkins University
Department of Mechanical Engineering
2021 Spring Virtual Seminar Series: Class 530.803

Thursday, March 4, 2021 | 3:00 PM – 4:00 PM

REGISTRATION LINK | ZOOM LINK | **Passcode:** 446835

"Magnetic Soft Composites with Integrated Multiphysics Responses"

Presented by Professor Renee Zhao

Assistant Professor, Department of Mechanical and Aerospace Engineering
The Ohio State University

Magnetic soft composites are a type of stimuli-responsive materials that can generate large deformation and locomotion under external magnetic fields. They have recently attracted great interest due to the increasing demand for programmable materials that can be easily controlled to achieve complex functionalities for untethered morphing and reconfigurable structures. In particular, these composites are considered to be competitive candidates for developing soft robots as biomedical devices for drug delivery and minimally invasive surgeries for two major reasons: the magnetic untethered control (1) offers a safe and effective operation method for biomedical applications, which typically require remote actuation in enclosed and confined spaces; and (2) separates the power source and controller from the device, making miniaturized robots possible. However, it is still a great challenge to design and fabricate high performance multifunctional magnetic soft composites for advanced engineering applications, due to the lack of design guidance on materials, fabrication, and stimulation control. In this talk, a mechanics-guided methodology is first introduced and integrated with advanced fabrication such as 3D printing to guide the design of structures with precise actuation control for multifunctionality of magnetic soft composites. It is accomplished by implementing a new constitutive model for magnetic soft composites into finite element analysis. This methodology is used to guide the design for a few novel applications, including symmetry-breaking actuation for soft robots, magnetic shape memory polymers for untethered shape morphing and locking, and magnetic origami robots for functional deformation and locomotion. Then, the artificial intelligence is integrated with the finite element analysis to guide the 3D printing of magnetic soft composites for desired shape morphing during magnetic actuation. At the end of this talk, future directions in fundamental research and novel applications of magnetic soft composites will be discussed.

Ruike (Renee) Zhao is currently an Assistant Professor in the Department of Mechanical and Aerospace Engineering at The Ohio State University. She received her PhD degree in solid mechanics from Brown University in 2016. She was a postdoc associate at MIT during 2016-2018 prior to joining OSU in August 2018. Her research concerns the fundamental science and the development of stimuli-responsive polymeric soft composites for soft robotic systems with integrated multifunctionality including shape-changing, locomotion, and navigation. By combining mechanics, polymer engineering, and advanced material manufacturing techniques, the functional soft composite systems will enable biomedical applications with a focus on developing miniaturized biomedical devices for minimally invasive surgeries. Renee is a recipient of the ASME Haythornthwaite Research Initiation Award (2018) and the NSF Career Award (2020).