Solid State Technology and Devices Seminar

Conductive Hydrogels for Next-Generation Bio-Electronic Interfaces

Dr. Vivian Feig
Brigham and Women's Hospital
Harvard Medical School and MIT

Friday, November 13, 2020

Abstract: Electronics open the door to a wealth of promising biomedical therapies, from implanted devices that therapeutically stimulate organs, to regenerative medicines that use electrical cues to guide stem cell differentiation towards target lineages. Yet, severe mismatch in mechanical properties at the bio-electronic interface remains a major challenge. Conventional conductors are significantly stiffer (E~ GPa) than soft tissues (E~ kPa), which can lead to inflammatory encapsulation of implants and misdirection of differentiating cells. Moreover, conventional rigid conductors cannot accommodate the dynamic motions of bodily surfaces, hindering the effective transmission of electrical signals across the bio-electronic interface. Finally, in stark contrast to the 3D nature of cell-cell and cell-environment interactions, typical electronic interfaces are planar, which not only limits the potential density of bio-electronic interactions but can also negatively impact cell fate. My research addresses these limitations through the design of next-generation conductive hydrogels capable of possessing tissue-level stiffness, high stretchability, and the capability to interface with biological targets in 3 dimensions. I further demonstrate how controlling the gelation kinetics of these materials allows them to be patterned by various means, including a new method I developed called electrogelation patterning that enables high spatial resolution features and conformal coatings. Taken together, these novel strategies for designing and patterning conductors represent significant steps towards therapeutics that can harness the full potential of electrical functionality in medicine.

Bio: Dr. Vivian Feig obtained her B.S. in Chemical Engineering from Columbia University in 2012 and then spent 3 years working for the ExxonMobil Chemical Company, where she developed a fascination with polymers. Combining her interest in polymeric materials with a desire to make an impact in the biomedical space, she came to Stanford University in 2015 to pursue a Ph.D. in Materials Science and Engineering with Prof. Zhenan Bao. As a National Defense Science and Engineering Graduate (NDSEG) fellow, Dr. Feig designed new conducting polymer-based materials to address the challenge of intimately coupling electronics with biological systems. Her research culminated in numerous honors, including the Materials Research Society (MRS) Arthur Nowick Graduate Student Award and selection to the American Chemical Society (ACS)'s Excellence in Graduate Research symposium. Currently, Dr. Feig is receiving postdoctoral training with Profs. Giovanni Traverso and Robert Langer at the Brigham and Women's Hospital (Harvard Medical School) and MIT, respectively, where she is developing stimuli-responsive systems for ingestible long-term drug delivery.