Spring 2021 Joint Colloquium
Materials Department & Materials Research Laboratory

Professor Susan Fullerton
Department of Chemical and Petroleum Engineering
University of Pittsburgh

Friday, May 21st, 2021
11:00 am, via Zoom

Beyond Batteries: Reimagining the Role of Ions in Electronics

The interplay between ions and electrons governs processes as common as the biochemistry essential for life and the performance of devices as ubiquitous as batteries. The energy that powers our smart phones and laptops is stored by ions. Yet when we peer past the battery and examine the device-scale electronics, mobile ions are nowhere to be found. This is a missed opportunity because the coupling between ions in electrolytes and electrons/holes in novel semiconductors is strong. For example, in two-dimensional (2D) materials this coupling has uncovered exciting phenomena such as spin polarization, photogalvanic current, current-induced circularly polarized electroluminescence, and superconductivity. Remarkably, these demonstrations have relied on electrolytes that were not designed for investigating semiconductor physics, but instead for energy storage (*e.g.*, solid polymer electrolytes and ionic liquids). Our group is reimagining how ions can be used in electronics when the electrolyte is custom designed to provide a specific functionality or unlock a new mechanism to control transport. For example, we have developed a "monolayer electrolyte" that is a single molecule thick and is designed for bistability. We have custom-synthesized a single-ion conductor and used it as an electric double layer (EDL) gate on 2D FETs with the goal of controlling strain via field-effect. Together with our collaborators we have develop several new types of "locking" electrolytes that can lock and unlock EDLs via multiple external triggers. Our development of these and other new ion-conductors is grounded in fundamental materials science and driven by applications in the electronics community including non-volatile memory, low-power logic, hardware security, and neuromorphic computing. In this talk I will review the basics of EDL gating and highlight our most recent developments on ion conductors with an eye towards application.

Bio

Susan Fullerton is an Associate Professor, Bicentennial Board of Visitors Faculty Fellow, and Vice Chair for Graduate Education in the Department of Chemical and Petroleum Engineering at the University of Pittsburgh. She earned her Ph.D. in Chemical Engineering at Penn State in 2009, and joined the Department of Electrical Engineering at the University of Notre Dame as a Research Assistant Professor. In 2015 she established the *Nanoionics and Electronics Lab* at Pitt as an Assistant Professor, and was promoted to Associate Professor with tenure in 2020. Fullerton's work has been recognized by an NSF CAREER award, an Alfred P. Sloan Fellowship, a Marion Milligan Mason award for women in the chemical sciences from AAAS, and a Ralph E. Powe Jr. Faculty Award from ORAU. For her teaching, Fullerton was awarded the 2018 James Pommersheim Award for Excellence in Teaching in Chemical Engineering at Pitt.

http://fullertonlab.pitt.edu/

Hosted by Angela Pitenis and Michael Chabinyc.