MSE 520: SEMINAR SERIES

MATERIALS SCIENCE & ENGINEERING | WINTER 2018

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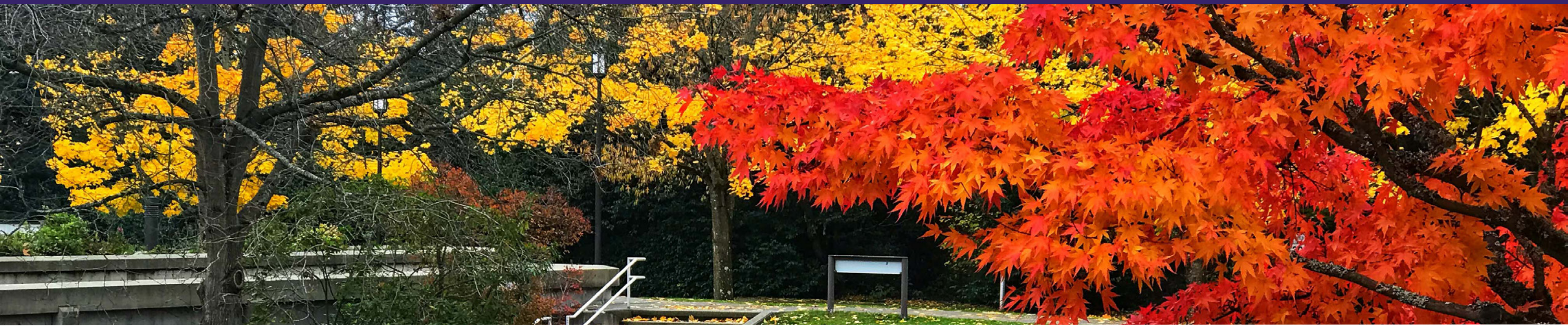

Solvent-Based Growth, Manipulation, and Integration of Inorganic Nanomaterials with Controlled Composition and Morphology

Careful control over composition, morphology, and surface chemistry are critical in virtually every materials system, and it is vital that these attributes are preserved in any scalable production process. This talk will explore the important role that the above characteristics play in two of our group's main research areas. First, the supercritical-fluid-based growth of high-capacity alloying conversion electrode materials for Li- and Na-ion batteries will be discussed. These nanostructured materials have short internal diffusion pathways, possess robust mechanical characteristics, and can be processed in either liquid dispersion or solid/powder form; however, high capacity conversion electrode materials that undergo large volume changes upon electrochemical alloying require the formation of a robust solid-electrolyte interphase (SEI) layer to facilitate long-term cycling. We show that careful control over surface chemistry helps to facilitate robust SEI formation, demonstrate that nanowire-based conversion electrodes can maintain capacity retention in the complete absence of fluorinated additives, fluorinated electrolytes, and fluorinated binders, and show that electrode processing plays a critical role in overall device performance. In addition, the effects of structural anisotropy and surface oxidation on the electrochemical alloying of high-rate-capability conversion electrodes will be explored. Second, our group's recent efforts to control optical resonances and photothermal transduction in copper chalcogenide nanocrystals through morphological and compositional tuning will be discussed. These materials have been studied widely in recent years due to their intrinsic plasmon band in the near infrared spectral range, and we demonstrate compositional tuning of the localized surface plasmon resonance frequency via careful control over chalcogen composition, defect density, and oxidation, as well as the introduction of additional optical resonances through the gradual incorporation of metallic impurities.

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Vincent Holmberg received bachelor's degrees in chemistry and chemical engineering as a Barry M. Goldwater scholar at the University of Minnesota in 2006 and earned his master's and PhD degrees in chemical engineering as a NSF Graduate Research Fellow and a Hertz Fellow at The University of Texas at Austin, followed by a Marie Curie ETH Zürich Postdoctoral Fellowship in the Optical Materials Engineering Laboratory at the Swiss Federal Institute of Technology. He received the 2012 Hertz Thesis Prize for his doctoral work (1 of 47 awarded in the United States over the past 30 years), as well as a PhD Thesis Award from the International Society for the Advancement of Supercritical Fluids in 2014. His research focuses on the scalable production of nanostructured materials for electrochemical energy conversion and storage, as well as the development of functional magnetic, plasmonic, and photonic nanomaterials. He has served as an assistant professor in the Chemical Engineering department at the University of Washington since 2015 and was a finalist for the University of Washington Distinguished Teaching Award in 2017.

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