Solvay Seminars in Macromolecular Science & Engineering

Macromolecules Innovation Institute (MII)

VirginiaTech
Invent the Future

Prof. Abraham Stroock

"From Plants to Clouds – How Nanostructured Materials Mediate Transport and Phase Behavior in the Environment"

Cornell University
Department of Chemical and Biomolecular Engineering

Host: Jonathan Boreyko

Abstract: To begin, I will introduce two contexts to motivate fundamental physical questions about the thermodynamics and transport phenomena of water interacting with nanostructured materials: first, the evaporation-driven flow – transpiration – of water from the soil, through plants and into the atmosphere, and its connections to draught response; and, second, the nucleation of condensation and freezing by aerosol particles in the atmosphere, and its connections to cloud formation and atmospheric modeling. Starting from the context of transpiration, I will use experiments in synthetic mimics of the vascular structure of plants to address questions about the breakdown of continuum behavior of liquids in nano-scale confinement, a much-debated topic over the past several decades. In particular, I will use a variety of measurements with a series of liquids to show that continuum thermodynamics and dynamics hold quantitatively in pores that are just 5-10 molecular diameters wide, if account is taken of a monolayer of immobilized molecules. In the context of aerosol-mediated nucleation ice from vapor, I will revisit a long history of measurements that have eluded theoretical explanation. Using experiments with well-characterized synthetic substrates, I will provide strong evidence that freezing on insoluble aerosols proceeds in a two-step process – following the Ostwald step rule – with condensation of a supercooled liquid that subsequently freezes. Importantly, when we account for capillary condensation in nanoscale pore structure, our results provide a coherent structure-property relationship for aerosol-mediated freezing across an important range of conditions found in the atmosphere. I will conclude with perspectives on the translation of these insights and experimental methods toward tools for environmental measurements and for material design in applications for heat transfer and the management of freezing.

Cornell University
Department of Chemical and Biomolecular Engineering
Ithica, NY 14850
Phone: (607) 255-4276
E-mail: abe.Stroock@cornell.edu

Bio: Abraham Stroock is the Gordon L. Dibble '50 Professor and William C. Hooey Director of Chemical and Biomolecular Engineering at Cornell University. His research relates to engineering microchemical process with an emphasis on transport phenomena, thermodynamics, and physiology. Current projects in his laboratory include: 1) the development microfluidic platforms with which to manipulate metastable states of liquid water for the pursuit of fundamental questions in physical chemistry, plant physiology, and environmental transport and with applications in heat transfer and environmental sensing, and 2) the engineering of mammalian microvascular structure for studies of tissue-scale developmental processes and applications in regenerative medicine. He obtained his BA in Physics from Cornell in 1995 and his PhD in Chemical Physics in 2002 from Harvard University. He has received a MIT Technology Review TR35 Award and an NSF CAREER Award.

Sponsored by the
Solvay International Chemical Group

DATE: MARCH 22, 2017
TIME: 11:15AM-12:15PM
LOCATION: 310 KELLY HALL