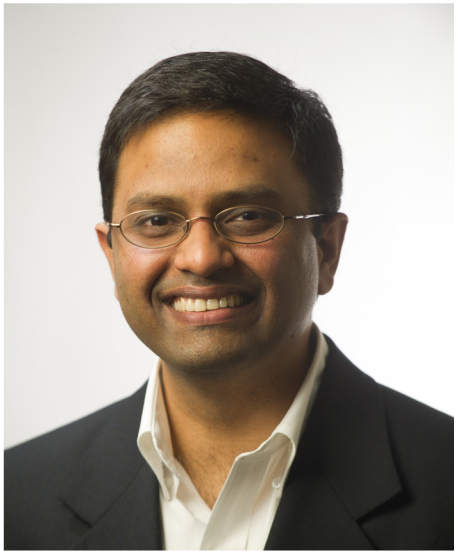
MITMECHE

MECHANICAL ENGINEERING COLLOQUIUM SERIES 2014-2015

Mechanical Engineering Lecture in Energy

Interfacial Engineering for Efficiency Enhancements in Energy-Water-Food



Kripa K. Varanasi

Associate Professor
Department of Mechanical Engineering
Massachusetts Institute of Technology

on Friday, October 3rd at 4:00pm in 3-370

Thermal-fluid-interfacial interactions are ubiquitous in multiple industries including Energy, Water, Agriculture, Food Processing, Transportation, Buildings, Medical, and Consumer Packaging. In this talk, we show how surface/interface chemistry and morphology can be engineered across multiple length scales ranging from atomic to macroscale for significant efficiency enhancements in a wide range of thermal-fluid processes. We study the thermodynamics and wetting dynamics of droplets as a function of surface texture and surface energy and establish various wetting regimes and conditions for wetting transitions. We show how breaking symmetry can fundamentally alter drop impact hydrodynamics and reduce the contact time of bouncing drops below previously established theoretical limits. This approach can have implications for controlling transport phenomena involving impacting droplets, for example in icing. We then present the behavior of surfaces under phase change, such as condensation, and freezing at nano, micro and macroscales, and find that their non-wetting properties can be compromised due to nucleation within texture features. Based on these insights, we introduce lubricant-impregnated surfaces that can exhibit remarkable slippery properties and robustness when compared to air-pocket based superhydrophobic surfaces. We discuss unconventional contact line morphology, cloaking states, thermodynamics and hydrodynamics, phase transitions such as condensation and crystallization and show how surfaces can be designed to be slippery to even complex fluids such as ketchup, mayonnaise, blood, paints, and crude oil. Finally, we discuss the influence of atomic and electronic structure on interfacial wetting interactions and use these fundamental insights to develop hydrophobic ceramic materials to address the critical need for robustness. Manufacturing and scale-up approaches, robust materials, entrepreneurial efforts to translate these surface technologies into useful products, and applications of nanoengineered surfaces in various energy, water, food, consumer packaging, medical, and transportation industries, and will be discussed.

Refreshments will be served before the seminar.
Please contact Tony Pulsone at pulsone@mit.edu with any questions.

MITMECHE

http://mechecolloquium.scripts.mit.edu/home/