STEVENS INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY

University Seminar Series

Sponsored by Nanotechnology Seminar Program

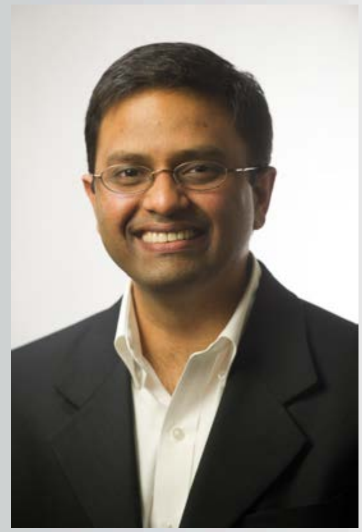
Nanoengineered Surfaces for Efficiency Enhancements in Energy and Water

By Prof. Kripa K. Varanasi

Department of Mechanical Engineering, MIT

ABSTRACT: Thermal-fluid-surface interactions are ubiquitous in multiple industries including Energy, Water, Agriculture, Transportation, Electronics Cooling, Buildings, etc. Here we show how surface/interface morphology and chemistry can be engineered for significant efficiency enhancements in a wide range of thermal-fluid processes including, drop impact, condensation, boiling, and freezing. We show how breaking symmetry can fundamentally alter 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 both macroscale and microscale (using ESEM) and find their non-wetting properties can be compromised due to nucleation of water or frost within texture features. Based on these insights we introduce lubricant-impregnated surfaces that can exhibit remarkable non-wetting properties and robustness compared to air-pocket based superhydrophobic surfaces. We discuss unconventional contact line morphology, thermodynamics and dynamics of droplet shedding on these surfaces and show how even complex fluids off the surface easily. Finally, we discuss the influence of electronic structure on interfacial wetting interactions and use these insights to develop a new class of ceramic materials that are intrinsically hydrophobic.

BIOGRAPHY: Kripa Varanasi is a Doherty Associate Professor in Mechanical Engineering at MIT. He received his B.Tech from IIT, Madras, India and his MS (ME and EECS) and Ph.D from MIT. Prior to joining MIT, Dr. Varanasi was a lead research scientist and project leader in the Energy & Propulsion and Nanotechnology programs at the GE Global Research Center, Niskayuna, NY, and was the PI for the DARPA Advanced Electronics Cooling program. The focus of his research is in the development of nano-engineered surface, interface, and coating technologies that can dramatically enhance performance in energy, water, agriculture, transportation, buildings, and electronics cooling systems. His work spans various thermal-fluid and interfacial phenomena including phase transitions (condensation, boiling, freezing), nanoscale thermal transport, separation, wetting, catalysis, flow assurance in oil and gas, nanofabrication, and synthesis of inorganic bulk and nanoscale materials guided via computational materials design. Dr. Varanasi has filed more than 50 patents in this area. He has received the NSF Career Award and DARPA Young Faculty Award. He has co-founded LiquiGlide to commercialize the slippery coating technology for which his team received the audience choice award at the MIT 100K and First prize at MassChallenge Entrepreneurship competitions. Time Magazine and Forbes Magazine have named LiquiGlide one of the Best Inventions of the Year. He was most recently awarded the 2013 Outstanding Young Manufacturing Engineer award by the Society of Manufacturing Engineers and Bergles-Rohsenow Heat Transfer Award by ASME.



EVENT DETAILS

DATE:
Wednesday,
September 17, 2014

TIME:
11:00 AM

LOCATION:
Carnegie 315
Stevens Institute of Technology

ATTENDANCE:
Public