Solvay Seminars in Macromolecular Science & Engineering

Macromolecules Innovation Institute (MII)

VIRGINIA TECH

Prof. Nenad Miljkovic

"Advancing Energy and Water Technologies via Micro/Nanoengineered Surfaces"

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Host: Jonathan Boreyko

Abstract: Micro and nanoengineered surfaces have exciting, untapped potential to improve energy and water technologies. In this talk, I provide a few examples of how we leverage micro and nanoscale surface engineering to develop accretion control surfaces (icing and fouling), advanced separations, and scalable and durable nanomanufacturing paradigms. First, I discuss our recent discovery of the importance of volatile organic compounds on surface functionalization and nucleation phenomena. We use the insights gained to develop a paradigm shift in micro/nanostructuring to demonstrate scalable and self-healing atmospheric-mediated superhydrophobicity. Next, I discuss our recent work that harnesses novel surface designs to control and manipulate phase-change processes. Low surface tension condensates pose a unique challenge since they often form a film, even on hydrophobic coatings. Lubricant infused surfaces (LIS) represent a potential solution, where a lubricant immiscible with the low surface tension condensate is infused into a rough structure on the condenser surface to repel the condensate. We used LIS to demonstrate a 3x improvement in heat transfer for ethanol and hexane compared to filmwise condensation and provide detailed designed guidelines for LIS. Next, I briefly discuss how micro/nanoengineered materials can be scaled up and applied to real life meter-scale industrial equipment through rational nanomanufacturing considerations. For anti-icing heat exchanger applications, we show that nanostructuring of the aluminum surface can delay frosting by 3x and increase overall heat pump system efficiency by 50%. Finally, I end my talk by briefly discussing novel approaches enabled through rational micro/nanostructuring, including: high temperature braze flow control in manufacturing, low and high temperature fouling, and advanced thermal management of power electronics.

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Bio: Dr. Nenad Miljkovic is currently an Assistant Professor of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign, where he leads the Energy Transport Research Laboratory. His group's research intersects the multidisciplinary fields of thermo-fluid science, interfacial phenomena, and renewable energy. Their work focuses on bringing about efficiency enhancements in various industries including energy (power generation, oil & gas, HVAC&R, renewables), water, transportation, and electronics cooling, by fundamentally altering thermal-fluid-surface interactions. In 2012, he was the recipient of the ASME Micro/Nano Heat Transfer Heat and Mass Transfer International Conference Best Paper Award, and in 2013 he received the Wunsch Foundation Silent Hoist and Crane Award for outstanding graduate research during his PhD.

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