BEN-GURION UNIVERSITY OF THE NEGEV
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אוניברסיטת בן-גוריון בנגב
ת.ד. 653, באר-שבע 84105

DEPARTMENT OF MECHANICAL ENGINEERING

SEMINAR

to be held on Thursday, January 31, 2019, 11:00

in the Seminar Room (#117) of the Mechanical Engineering Building (#55)
at the Campus of the Ben-Gurion University of the Negev

Steady and unsteady thermal transport at solid-solid and solid-liquid interfaces

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Abstract:

Transient heat fluxes in cutting-edge computing systems, electro-magnetic switches, and diode-pumped lasers can exceed 50 MW/m^2, which is nearly the heat flux radiated by the Sun. To manage extreme thermal loads, the State-of-the-Art is to boil and evaporate liquid coolants on micro- and nano-structured heat sinks. However, a major technical challenge coincides with the reality that modern cooling techniques cannot manage extreme heat fluxes under transient conditions. For example, thermo-fluid transients due to on/off device operation or system exposure to an extreme environment result in highly unstable thermo-fluid behavior, ultimately placing a liquid-cooled device in danger of catastrophic failure via thermal runaway -- i.e., a rapid, uncontrolled increase in device temperature.

This talk will cover the Research Groups' journey in understanding the fundamentals of micro- and nano-scale heat and mass transport at materials interfaces. In particular, solid-solid and solid-liquid interfaces exposed to different heating and flow-field conditions. The talk will cover two conjugated topics: (1) transient boiling at macro- to nano-scales and (2) the thermo-physics and thermo-chemistry of hemiwicking flow. With regards to the former, a majority of the talk will describe the application of optical pump-probe diagnostics to characterize the local, transient heat transfer coefficient in confined geometries. For example, the local, transient heat transfer coefficient (HTC) that corresponds to (i) a developing thermal boundary layer over a micron-sized hot-spot and (ii) bubble ebullition during subcooled flow boiling in a microchannel heat sink. In particular, a differential form of the anisotropic Time-Domain Thermoreflectance (TDTR) technique was developed to measure the HTC as a function of flow-field velocity, hot-spot heat flux, and degree of subcooling. The second part of talk will discuss our efforts in predicting and engineering the transient wetting of micro- and nano-structured surfaces. Questions to consider include: is there a fundamental limit to the speed that you can wet or dewet a surface? If so, is this speed dictated by the 2^{nd} law of thermodynamics?

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About the speaker – Shawn Putnam joined the Mechanical and Aerospace Engineering Department at the University of Central Florida (UCF) in 2012. A native of the northern logging town of Cloquet, Minnesota, Dr. Putnam received B.Sc. degrees in 2001 in both Physics and Applied Mathematics from the University of Minnesota, Duluth. In 2007, he received his Ph.D. in Materials Science and Engineering (MSE) from the University of Illinois Urbana-Champaign (UIUC). His Ph.D. research focused on the thermodiffusion and thermal conductivity of nanoparticle suspensions. Following his Ph.D. studies, Dr. Putnam served as the lead thermal and materials scientist at the Air Force Research Laboratory (AFRL) at Wright-Patterson AFB in Dayton OH. His postdoctoral work at AFRL broadened the use of optical pump-probe diagnostics for micro-/nano-scale studies of thermo-fluid transport at liquid interfaces. While at AFRL, Dr. Putnam was also a part-time lecturer at University of Dayton in Dayton OH. His expertise spans a multidisciplinary skill set in thermo-fluid sciences, optical metrology, and materials science and engineering. His current research at UCF focuses on interfacial phenomena using optical diagnostics to characterize biomolecular binding and heat and mass transport at materials interfaces, where the latter is or has been funded by the NSF CAREER award, the Binational Science Foundation (BSF), and the Office of Naval Research (ONR) Thermal Sciences program. In addition of his research endeavors, Dr. Putnam has a passion for pioneering improved student education and training methodologies via the incorporation of digital testing centers and assessment, project-based learning modules, and elements of mixed-mode instruction.

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