

Title	Microscale Thermal-Fluids Engineering for Next-generation Energy and Electronic Systems
Speaker	Prof. Yangying Zhu University of California, Santa Barbara
Date & Time	<i>Thursday, September 12, 2019</i> <i>11:00 AM</i>
Place	2005 Mechanical Engineering Laboratory

Abstract

Effective management of heat has become a critical challenge in many energy and electronic applications due to the increasing power density and shrinking length scales. For example, next-generation lithium-based batteries for electric vehicles are designed to be charged at ~ 10 times of the electric current used now, which means ~ 100 times higher joule heating; high-performance gallium nitride based power electronic devices require heat dissipation of $\sim 1000 \text{ W/cm}^2$, which is $1/6$ of the heat flux at the surface of the Sun. Improving the thermal performance of these systems is necessary to ensure safe and efficient operations and requires manipulating the heat and fluid transport at the microscopic length scale. In this talk, I will discuss how we can leverage micro-scale modeling, fabrication and characterization capabilities to provide new insight into thermal effects in lithium-based batteries and achieve aggressive cooling of electronics. First, I will discuss the discovery of a microscopic heat-triggered battery failure mechanism through *in situ* local temperature sensing using micro-Raman spectroscopy and a novel graphene transducer. The high spatial resolution and the *in situ* capability enabled direct observation of the correlation between local temperature hotspot and accelerated Li growth, which led to internal shorting of the Li battery. Second, I will describe the development of a two-phase microchannel heat sink that significantly enhanced temperature stability and achieved a 60% enhancement in the heat flux dissipation for electronics. These improvements were realized through integrating micropillar structures into microchannels, which are optimized with thermo-fluid modeling to maximize capillary wicking. These examples demonstrate the potential of combining fundamental thermo-fluid science and advanced micro/nano engineering approaches to address many of the pressing thermal challenges in next generation energy and electronic systems.

About the Speaker



Yangying Zhu started as an assistant professor in the Mechanical Engineering department at University of California, Santa Barbara in July, 2019. Her work focuses on advanced thermal management and characterizations of energy and electronic systems. She obtained her PhD from MIT, advised by Prof. Evelyn Wang, where she developed microsystems for aggressive cooling of electronics. During her postdoc with Prof. Yi Cui at Stanford University, she investigated thermal effects in lithium-based batteries. She received the Meredith Kamm Memorial Award for Outstanding PhD Thesis and the graduate Women of Excellence Award from MIT.

Host: Prof. Nenad Miljkovic