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Thermal-Fluids Engineering for Next-generation Energy and Electronics Systems

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ABSTRACT:

Effective management of heat has become a critical challenge in many energy, electronic, and space applications due to the increasing power density, shrinking length scales, and the related safety concerns. Improving the thermal performance of these systems requires understanding and manipulating the heat and fluid transport at the micro/nano scale. In this talk, I will provide examples of how we leverage micro scale engineering and characterization capabilities to achieve aggressive cooling of electronics and provide new insight in battery systems. First, we developed a two-phase microchannel heat sink that significantly enhanced temperature stability and achieved a 60% enhancement in the heat flux dissipation for electronics. These enhancements were realized through integrating engineered micropillar structures, which were optimized with thermo-fluids modeling to maximize capillary wicking capability, into microchannels. The micropillars effectively suppressed liquid film dry-out on the microchannel walls, which is the main cause of heat transfer degradation. Second, we discovered a microscopic heat-triggered battery failure mechanism through in situ local temperature sensing of batteries using a micro-Raman spectroscopy. We found that Li battery internal shorting can be caused by a localized temperature hotspot, which would not be possible to observe with conventional macroscopic or external thermal measurement methods. These micro/nano engineering and characterization approaches allow us to address many of the pressing challenges in next generation thermal systems.

BIOGRAPHY:

Yangying Zhu is currently a postdoctoral scholar advised by Prof. Yi Cui at the Materials Science and Engineering department at Stanford University, where she is investigating the effect of heat in battery and electrocatalysis systems. She obtained her Ph.D. in the Mechanical Engineering department at MIT, advised by Prof. Evelyn Wang. Her Ph.D. thesis focused on developing a microchannel thermal management device integrated with surface microstructures for cooling of electronics. She received the Meredith Kamm Memorial Award and the Graduate Women of Excellence award from MIT.