How to approach a “stranger”: unveil the mysteries of boiling by advanced techniques

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Abstract:

Boiling is a very efficient heat transfer process used for heat management in many thermal systems, e.g., nuclear power plants, chemical plants, or refrigeration systems. To thoroughly understand the fundamentals of boiling heat transfer, we would like to measure various local parameters, e.g., time-dependent heated wall temperature and heat flux distributions, and bubble time and length scales. However, many experimental investigations still rely on discrete measurements, e.g., thermocouples or resistive temperature detectors, which cannot provide the necessary, in-depth view of the physical process. Thus, boiling is still a mysterious, controversial phenomenon.

In this talk, I will present new, high-resolution diagnostics to investigate heat transfer phenomena, with a particular emphasis on boiling. In my research, I have fostered the development of infrared (IR) thermometry, quasi-2D liquid thin film sensor, and surface-engineered IR heaters, which enable simultaneous and co-located measurements of the parameters that we want to know, on different types of surface, from nano-smooth to as rough as nuclear reactor claddings.

I will present three successful applications. The first one is an investigation of heat transfer phenomena in exponential power escalations simulating reactivity initiated accidents. The second example involves a newly discovered local heat transfer oscillation in annular flow and the associated suppression of nucleate boiling. Last but not least, I will present a novel micro-engineered IR heater to study how boiling occurs on surfaces with the same roughness and scratch pattern as nuclear fuel claddings. I will also discuss the opportunity to deploy such advanced techniques to study the thermal-hydraulic behavior of accident tolerant fuel (ATF) material or new design concepts such as molten salt reactors.

Bio:

Guanyu Su is a postdoctoral associate in the Nuclear Science and Engineering department at MIT. His research focuses on experimental and analytical multi-phase flow and heat transfer, accident tolerant fuel, nano/micro-engineering, and advanced diagnostics. Guanyu received his MSc and PhD in Nuclear Science and Engineering from MIT. During his study at MIT, he has led five research projects involving various topics, such as testing the heat transfer parameters

for ATF materials, demonstrating industry-scalable surface coatings for CHF enhancement, developing multi-spectrum and multi-physics diagnostics for thermal-hydraulic investigations.