EME International Seminar Series

筑波大学 University of Tsukuba

The Percolative Scale-Free Nature of the Boiling Crisis

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Abstract:

We will present the results of theoretical and experimental investigations suggesting that the boiling crisis is the outcome of an instability in the bubble interaction process.

This instability is described by a percolation model using three inputs: nucleation site density, footprint radius of individual bubbles, and product of growth time and bubble departure frequency. At critical combinations of these parameters, the probability distribution of the bubble footprint areas becomes scale-free (i.e., it is a power-law with a negative exponent smaller than 3). This observation is the signature of the boiling crisis. Beyond this critical point, discrete bubbles merge abruptly into one large vapor cluster covering the entire boiling surface.

We demonstrate this hypothesis with experimental results obtained using high-resolution optical techniques (e.g., infrared thermometry and vapor phase detection) on plain and engineered surfaces in both pool and flow boiling conditions.

Bio:

Dr. Matteo Bucci is Associate Professor of Nuclear Science and Engineering at MIT. He has joined the MIT faculty in 2016, where he teaches undergraduate and graduate courses in nuclear reactor engineering and design, and two-phase heat transfer. His thermal-hydraulics group at MIT focuses on two major research axes related to nuclear reactor safety and design: (1) New understanding of heat transfer mechanisms in nuclear reactors, (2) Engineered surfaces and coatings to enhance two-phase heat transfer. His group also develops and uses advanced diagnostics, such as high-speed infrared thermometry, and post-processing algorithms to perform unique heat transfer experiments. Matteo has published over 40 articles in the areas of two-phase flow and heat transfer, and surface engineering technology. For his research work and his teaching, he won several awards, among which the MIT Ruth and Joel Spira Award for Excellence in Teaching (2020), ANS/PAI Outstanding Faculty Award (2018), the UIT-Fluent Award (2006), the European Nuclear Education Network Award (2010), and the 2012 ANS Thermal-Hydraulics Division Best Paper Award (2012). Matteo is Editor of Applied Thermal Engineering and a consultant for the nuclear industry.

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