

Colloquium Thermo- and Fluid Dynamics

The roaming condensation and explosive freezing of droplets

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In this lecture I will discuss the peculiar behavior of droplets on superhydrophobic surfaces, focusing on two very common phase change phenomena in nature and technology, namely, condensation and freezing. When condensate microdroplets coalesce, they can spontaneously propel themselves omnidirectionally on the surface independent of gravity, and grow by feeding from droplets they sweep along the way. I will explain the physics behind this roaming phenomenon of coalescing condensate microdroplets on solely nanostructured superhydrophobic surfaces, where the droplets are orders of magnitude larger than the underlying surface nanotexture. This phenomenon is then utilized to prevent condensate flooding of the surface, impressively improving heat transfer. Going down in temperature, I will discuss the fascinating phenomenon of explosive vaporization, manifesting itself during the freezing of supercooled droplets at low environmental pressure. I will then present surface topography designs harvesting the natural occurrence of this phenomenon to cause spontaneous ice expulsion from superhydrophobic surfaces in a fully passive manner, inherent to the surface design.



Dimos Poulikakos has been Full Professor of Thermodynamics at the ETH Zurich since 1996, where he founded the Laboratory of Thermodynamics in Emerging Technologies. After receiving his degree in mechanical engineering from the National Technical University, Athens, he studied at the University of Colorado at Boulder where he earned his M.S. in 1980 and his Ph.D. in mechanical engineering in 1983. Before joining ETH Zurich, he was full professor of Mechanical Engineering at the University of Illinois at Chicago. He has made pioneering contributions to nanotechnology, interfacial transport phenomena, thermodynamics and energy conversion methods, with a broad palette of applications. Among many international recognitions, he was awarded the James H. Potter Gold Medal in Thermodynamics (2000), the Heat Transfer Memorial Award for Science (2003), the Nusselt-Reynolds Prize (2009) and the Max Jacob Award (2012). He is Fellow of ASME, Member of the Swiss National Academy of Engineering, and represents Switzerland in the world assembly of heat transfer conferences.

Date: Wednesday, 13 December 2023

Time: 16:15 – 17:30

Place: ETH Zurich, ML F 36

Host: Prof. Filippo Coletti, IFD