

Nanoscale Meniscus Dynamics in Evaporating Thin Films

Dr. Ali Beşkök

Associate Dean for Research Innovation and Industry Partnerships
George R. Brown Chair in Mechanical Engineering
Southern Methodist University
abeskok@smu.edu

Evaporation studies are focused on heat transfer and flow dynamics near the solid–liquid–vapor contact line, particularly focusing on the meniscus, which encompasses the adsorbed layer, thin-film, and bulk meniscus regions. Continuum models assume no evaporation from adsorbed layers due to the strong intermolecular forces. However, recent molecular dynamics (MD) simulations have unveiled the significant role of adsorbed layers in thin-film evaporation. Leveraging a recently published energy-based interface detection method, we present nonequilibrium MD simulation results for thin-film evaporation from a phase-change-driven nano pump using liquid argon confined between parallel platinum plates. Unlike the transient simulations often encountered in literature, the simulation system achieves a statistically steady transport. In this context, we showcase the shapes of the evaporating menisci for different channel heights, under different heat loads and surface wettability conditions, and elucidate the underlying flow physics through velocity vectors and temperature contours. This comprehensive investigation advances our understanding of thin-film evaporation and its mechanisms, offering insights that span from nanoscale phenomena to broader thermal management applications.



Bio: Prof. Ali Beşkök received his B.S. in Mechanical Engineering from Middle East Technical University, Ankara, Türkiye in 1988. He received an MS degree in Mechanical Engineering from Indiana University Purdue University in Indianapolis in 1991, and M.S. and Ph.D. degrees from Princeton University, Mechanical and Aerospace Engineering in 1994 and 1996, respectively. Dr. Beşkök was a Visiting Scholar at Brown University, Center for Fluid Mechanics from 1994 to 1996, and a Post-Doctoral Research Associate at Massachusetts Institute of Technology, Research Laboratory of Electronics from 1996-1998. He joined Texas A&M University Mechanical Engineering Department as an Assistant Professor in 1998 and became an Associate Professor in 2004. In 2007, he moved to Old Dominion University, Mechanical and Aerospace Engineering Department as the Batten Endowed Chair Professor of Computational Engineering. He was also the founding director of the ODU Institute of Micro and Nanotechnology. In August 2013, he moved to Southern Methodist University as the chair of the Mechanical Engineering Department and served at this capacity until June 2019. Currently, he is the George R. Brown Chair in Mechanical Engineering, and the Associate Dean for Research Innovation and Industry Partnerships at SMU Lyle School of Engineering.

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