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Biphilicity and Superbiphilicity for Wettability Control of Multiphase Heat Transfer DANIEL ATTINGER, Iowa State University, AMY RACHEL BETZ, Kansas State University, T. M. SCHUTZIUS, University of Illinois at Chicago, J. JENKINS, C.-J. KIM, University of California, Los Angeles, C.M. MEGARIDIS, University of Illinois at Chicago — Multiphase energy transport, such as in boiling, suggests contradictory requirements on the wettability of the solid surfaces coming into contact with the working fluid. On the one hand, a hydrophobic wall promotes nucleation. On the other hand, a hydrophilic wall promotes water contact and enhances the critical heat flux. An analogous situation appears in the opposite thermodynamic process, i.e. condensation. These apparently contradictory requirements can be accommodated with biphilic surfaces, which juxtapose hydrophilic and hydrophobic regions. Biphilic surfaces were first manufactured in 1964 by Young and Hummel, who sprayed Teflon drops onto a smooth steel surface: they showed enhanced heat transfer coefficient during boiling of water. Our recent work has revisited the manufacturing of biphilic surfaces using micro- and nanofabrication processes (Betz et al. 2010, Schutzius et al. 2012); for instance, we fabricated the first superbiphilic surfaces, which juxtapose superhydrophobic and superhydrophilic areas. Using these surfaces, we measured significant enhancement during pool boiling of both the heat transfer coefficient and the critical heat flux. This enhanced performance can be explained by the inherent ability of the surfaces to control multiphase flow, decreasing nucleation energies and shaping drops, bubbles and jets, to maximize transport and prevent instabilities.

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