Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Condensation on Slippery Asymmetric Bumps KYOO-CHUL PARK, Harvard University, PHILSEOK KIM, SLIPS Technologies, Inc., JOANNA AIZENBERG, Harvard University — Controlling dropwise condensation by designing surfaces that enable droplets to grow rapidly and be shed as quickly as possible is fundamental to water harvesting systems, thermal power generation, distillation towers, etc. However, cutting-edge approaches based on micro/nanoscale textures suffer from intrinsic trade-offs that make it difficult to optimize both growth and transport at once. Here we present a conceptually different design approach based on principles derived from Namib desert beetles, cacti, and pitcher plants that synergistically couples both aspects of condensation and outperforms other synthetic surfaces. Inspired by an unconventional interpretation of the role of the beetle's bump geometry in promoting condensation, we show how to maximize vapor diffusion flux at the apex of convex millimetric bumps by optimizing curvature and shape. Integrating this apex geometry with a widening slope analogous to cactus spines couples rapid drop growth with fast directional transport, by creating a free energy profile that drives the drop down the slope. This coupling is further enhanced by a slippery, pitcher plant-inspired coating that facilitates feedback between coalescence-driven growth and capillary-driven motion. We further observe an unprecedented six-fold higher exponent in growth rate and much faster shedding time compared to other surfaces. We envision that our fundamental understanding and rational design strategy can be applied to a wide range of phase change applications.

Kyoo-Chul Park
Harvard University

Date submitted: 02 Aug 2016 Electronic form version 1.4