Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Freezing-driven droplet self-removal from nanoengineered surfaces[1] GUSTAV GRAEBER, THOMAS SCHUTZIUS, DIMOS POULIKAKOS, ETH Zurich — Wetting and surface icing are important in nature and technical applications. To design surfaces capable of passively repelling water and ice, further research at the intersection of interfacial thermofluidics, nucleation thermodynamics, and materials engineering is required. We show and explain a previously unexplored freezing-driven droplet self-removal mechanism. We find that a sessile droplet being cooled mainly from its free surface can experience non-simultaneous freezing starting at the droplet free surface, while the droplet-substrate contact remains mostly liquid and freezes last. The ice-liquid phase boundary motion, which proceeds radially inward during freezing, coincides with an inward motion of the vapor-liquid-substrate contact line and can lead to complete dewetting. Concurrently, the confinement and inward growth of the solid ice shell, combined with the volumetric expansion due to the phase change, the incompressibility of ice and liquid, as well as the soft, unfrozen droplet-substrate interface result in the unfrozen core to be displaced towards the substrate causing droplet lifting and removal. We demonstrate the passive, self-cleaning mechanism on a variety of substrates, ranging from smooth and hydrophilic to nanoengineered and superhydrophobic.

[1]Partial support of the Swiss National Science Foundation under Grant 162565 and the European Research Council under Advanced Grant 669908 (INTICE) is acknowledged.

Gustav Graeber
ETH Zurich

Date submitted: 27 Jul 2017 Electronic form version 1.4