Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Enhanced Anti-Frosting Strategies for Macrotextured Surfaces
CHRISTIAN MACHADO, KYOO-CHUL PARK, Northwestern University — Condensation frosting is a nearly ubiquitous two stage process that affects thermal systems: first, vapor-liquid phase change occurs on a surface cooled to the saturation limit of the fluid; then, the condensed fluid undergoes a liquid-solid phase change when the surface temperature is below the liquid's freezing point. Oftentimes, frost propagation on various types of surfaces is undesired, resulting in a reduction of heat transfer for thermal systems, mechanical degradation caused by freezing and thawing, and reduction of functional surface area. Most prior research has focused on reducing the adhesion between the surface-ice interface, so that removal can be facilitated easily. The problem still exists, though, of creating a surface design that intrinsically resists the formation of frost. Building upon our previous work identifying the formation of a frost-free zone on macrotextured surfaces, we introduce new experimental results that substantially increase the surface area of the frost-free zone, and establish its stability over long term frosting conditions. By focusing on the impact of diffusion flux coupled with heat transfer at millimetric length scales, these surface designs create thermodynamically stable frost-free regions.

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Date submitted: 09 Aug 2020 Electronic form version 1.4