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Frost pattern on surfaces with millimetric serrated features[1]

KYOO-CHUL PARK, YUEHAN YAO, TOM ZHAO, EMMA FELDMAN, CHRISTIAN MACHADO, NEELESH PATANKAR, Northwestern University — Numerous studies have focused on a low surface energy coating and a micro/nanoscale surface texture to design functional surfaces that delay frost formation and reduce ice adhesion. However, the scientific challenges for long-term icephobic surfaces have not been fully addressed because of degradation such as mechanical wearing. Inspired by the suppressed frost formation on concave regions of natural leaves, here we report findings on the frosting process on surfaces with various serrated structures. Dropwise condensation, the first stage of frosting, is enhanced on the peaks and suppressed in the valleys when the wavy surface is exposed to humid air, causing frosting to initiate from the peak. The condensed droplets in the valley are then evaporated, resulting in a non-frost band. The effects of surface topography on the frost pattern are systematically studied by varying the serrated geometry defined as the vertex angle, and numerically modeling the spatial distribution of diffusion flux of water vapor on the wavy surface. Under different ambient humidity levels, the magnitudes of diffusion flux at the non-frost boundaries of the surfaces are nearly identical, implying that the critical value of diffusion flux is the key to understanding the non-frost pattern.

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