Design and characterization of super-low ice adhesion surfaces

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Preventing the formation and accretion of ice on exposed surfaces is of great importance for Arctic operation, renewable energy, electrical transmission cables in air and shipping. While studies on suppressing ice nucleation by surface structuring and local confinement are highly desired, a realistic roadmap to icephobicity for many practical applications is perhaps to live with ice, but with the lowest possible ice adhesion. From the viewpoint of fracture mechanics, the key to lower ice adhesion is to maximize the ice-substrate interface-crack driving forces at multiple length scales. Herein, we present a novel macro-crack initiator mechanism in addition to the nano-crack and micro-crack initiator mechanisms, and demonstrate a new strategy to design super-low ice adhesion surfaces by introducing ordered sub-structures into smooth durable PDMS coatings to ultimately weaken ice-substrate interface [1]. Our results show that PDMS (weight ratio 10:10) thin films with 1 mm inner holes in two layers approach an ice adhesion strength of 5.7 kPa. The introduction of sub-structures into PDMS thin films promotes macro-crack initiators, and is able to further reduce ice adhesion strength by ~50% compared with that of PDMS thin films without sub-structures, regardless of layer thickness, curing temperature, weight ratio and the size of inner hole. Therefore, rationalizing the three crack-initiator mechanisms and their interactions at multi-length scales may provide an effective strategy towards designing super-low ice adhesion surfaces.

Reference:

[1] Zhiwei He, Senbo Xiao, Huajian Gao, Jianying He and Zhiliang Zhang, Multiscale crack initiator promoted super-low ice adhesion surfaces, *Soft Matter*, (2017) 13, 6562-6568.