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Anti- and De-Icing Surface Engineering - TS1 Poster Session

TS1P-ThP-1 A Fracture Mechanics Approach to Ice-Shedding Surfaces, ***Michael Wood (michael.wood3@mail.mcgill.ca)***, *P. Servio, A. Kietzig,* McGill University, Dept. Chemical Engineering, Canada

The adhesion of ice to external structures has been a persistent engineering challenge. This includes the accumulation of ice on metallic structures such as aircraft wings and power transmission equipment. There has therefore been considerable effort put into the development of passive ice-shedding surfaces in the past few decades. To-date there have broadly been two prevailing research paradigms for the engineering of low ice adhesion strength surfaces: (i) application of low surface energy chemical coatings / infusion of sacrificial lubricants; and (ii) limiting ice-substrate contact through superhydrophobic texturing. The results of these efforts have been overall mixed with coatings and lubricants needing continual reapplication and superhydrophobic texturing often leading to ice-substrate interlocking effects. We take a decidedly different approach to the design of low ice adhesion surfaces by choosing microstructures which induce interfacial cracking in combination with cohesive failure of ice within microstructure pores, an approach that allows for ice-shedding surfaces to be made of bare metal. Specifically, in this work we test the ice adhesion characteristics of an ultra-fine woven stainless-steel wire cloth, which we show has an extremely low ice adhesion strength of 12.5 kPa. Our testing shows that the low ice adhesion strength stems from the three-dimensional microstructural network formed by the woven stainless-steel wires which make up the cloth. Compared to a monolithic metal surface, the cloth structure possesses pores at each weaving point which induce the formation of micro-cracks during the ice freezing process. The cloth also possesses microstructural compliance of each woven wire segment which leads to facile opening of each of these micro-cracks. Rather than relying on few cracks which must open from edge-to-edge of the ice-substrate interface on monolithic materials, cracks at the interface with the woven wire cloth need only open from one weaving point to the next. Starting first with this fracture mechanics approach to ice-shedding surface engineering and only then tuning the surface chemistry, we may see new benchmarks set for low ice adhesion strength surfaces.

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