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Designing Durable Icephobic Surfaces

ANISH TUTEJA, University of Michigan

Ice accretion has a negative impact on critical infrastructure, as well as a range of commercial and residential activities. Icephobic surfaces are defined by an ice adhesion strength τ_{ice} <100 kPa. However, the passive removal of ice requires much lower values of τ_{ice}, such as on airplane wings or power lines (τ_{ice} <20 kPa). Such low τ_{ice} values are scarcely reported, and robust coatings that maintain these low values have not been reported previously. Here we show that, irrespective of material chemistry, by tailoring the crosslink density of different elastomeric coatings, and by enabling interfacial slippage, it is possible to systematically design coatings with extremely low ice-adhesion (τ_{ice} <0.2 kPa). These newfound mechanisms allow for the rational design of icephobic coatings with virtually any desired ice adhesion strength. By utilizing these mechanisms, we fabricate extremely durable coatings that maintain τ_{ice} <10 kPa after severe mechanical abrasion, acid/base exposure, 100 icing/de-icing cycles, thermal cycling, accelerated corrosion, and exposure to Michigan wintery conditions over several months.

In collaboration with: Kevin Golovin, Department of Material Science and Engineering, University of Michigan.