Controlling ice formation

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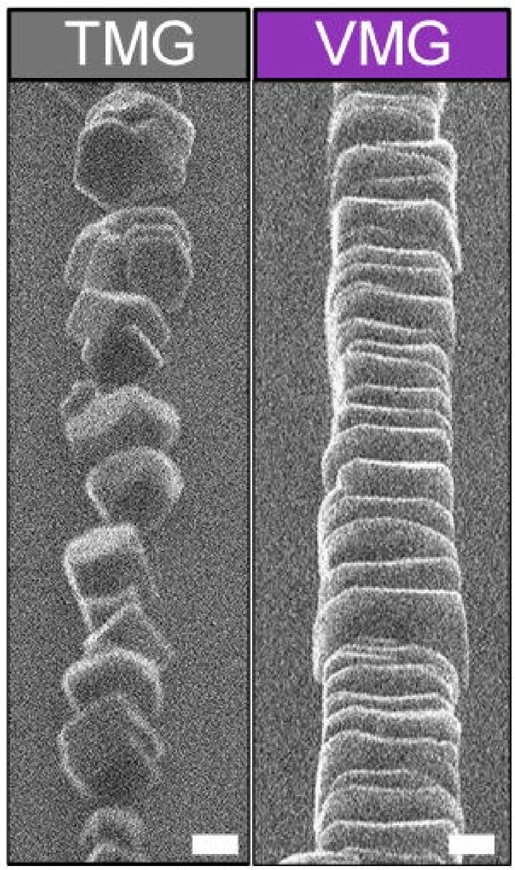

Ice crystals form along the microgrooves of the new surfaces. Credit: Lo et al. ©2017 American Chemical Society

(Phys.org)—Researchers have demonstrated that ice crystals will grow along straight lines in a controlled way on microgrooved surfaces. Compared to the random formation of ice crystals on smooth surfaces, the ice on the microgrooved surfaces forms more slowly and melts more quickly, which could lead to improved anti-icing and deicing methods. Ice formation is currently a major problem in a wide variety of areas, including solar panels, refrigeration systems, power transmission systems, and aircraft, and the new surface may help reduce ice build-up in these systems.

The researchers, Ching-Wen Lo, Venkataraman Sahoo, and Ming-Chang Lu at National Chiao Tung University in Taiwan, have published a paper on the surfaces for controlling ice formation in a recent issue of *ACS Nano*.

"In the work, we demonstrated the control of ice nucleation and ice crystal growth kinetics by manipulating the local roughness scale," Lu said. "The control of nucleation and the confinement of ice growth kinetics can improve anti-icing and deicing performances on a surface. We anticipate that the concept can pave the way towards the development of new engineered anti-icing surfaces."

The key idea behind the microgrooved surfaces is that ice crystals preferentially form, or "nucleate," on the microgrooves. So by adjusting the shape and number of microgrooves, the researchers could control the formation of ice crystals on the surface. They showed that ice forming on a special V-shaped microgroove surface takes longer to cover the surface and melts faster compared to ice that forms on smooth surfaces.

This is not the first type of anti-icing surface to be developed. In the past few years, researchers have been designing superhydrophobic surfaces in efforts to prevent ice formation. Since superhydrophobic surfaces repel water, they are also "ice-phobic," exhibiting lower ice adhesion than normal surfaces. However, at very low temperatures most of these surfaces still experience frost formation. When frost accumulates and covers the entire surface, the surface loses its ice-phobic property. One of the advantages of the new microgrooved surfaces is that they can control ice formation due to frost.

A surface that can reduce ice build-up has the potential to impact a wide variety of areas. The negative effects of ice include reducing the efficiency of solar panels and refrigeration systems, damaging the electrical insulation on power transmission systems, compromising aircraft safety, and harming agricultural crops.

"One of the applications is to alleviate the icing issue on solar panels," Lu said. "Icing and snow accumulation on the solar panels can deteriorate their energy conversion efficiency. Our future plan is to design a surface with full control of the ice formation process, including nucleation, crystal growth, and ice spreading."

Understanding and controlling ice formation may even help address the problem of melting glaciers.

"In addition, the ultimate goal of the research is to have full control of the ice formation process," Lu said. "The insight learned from this work might be applied to alleviate the adverse impact caused by global warming, for example, the loss of ice sheets."

More information: Ching-Wen Lo, Venkataraman Sahoo, and Ming-Chang Lu. "Control of Ice Formation." *ACS Nano*. DOI: 10.1021/acsnano.6b07348