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Tropical Inspiration for an Icy Problem

Toxic touch of poison dart frog helps Arizona State University researchers create new bi-layer surface to prevent ice accumulation on aircraft wings

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EMBARGOED until 4:00 p.m. PT on Sunday, November 23, 2014

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WASHINGTON, D.C., November 23, 2014 -- Ice poses major impediments to winter travel, accumulating on car windshields and airplane wings and causing countless unsuspecting pedestrians to dramatically lose their balance.

A team of researchers from Arizona State University (ASU) has developed a new way to prevent ice buildup on surfaces like airplane wings, finding inspiration in an unusual source: the poison dart frog.

They will present their results at the 67th annual meeting of the American Physical Society (APS) Division of Fluid Dynamics, held Nov. 23-25 in San Francisco. A press briefing featuring this and several other talks will be streamed live over the Web from the conference at 1:00pm PST on Monday, November 24 in room Foothill F of the San Francisco Marriott Marquis. For more information, email jbardi@aip.org

Because ice on airplane wings can add weight and decrease lift, making takeoffs and landings more dangerous, airplanes are sprayed with antifreeze prior to departure in wintry weather. The antifreeze lowers the freezing point of water and therefore reduces ice accumulation during the flight. But antifreeze can be expensive, especially when used in large quantities, and its local supplies are often depleted during high-demand periods like winter storms. Furthermore, overuse of antifreeze can have negative environmental consequences by corroding materials and making its way into water supplies.

Researchers have suggested alternatives. Some have created superhydrophobic coatings that make freezing raindrops bounce off surfaces instead of forming ice and sticking. Others have designed lubricant-impregnated textured surfaces, covered in a thin film of oil that repels droplets. While these surfaces work well in freezing rain, they don't effectively stop ice resulting from fog or frost.

The ASU researchers took a hybrid approach. While on a trip to Panama, lead researcher Konrad Rykaczewski learned that the poison dart frogs he saw used an efficient self-protection mechanism: when provoked, they secreted toxins through their skin to deter hungry predators.

"This was exactly the functionality that we wanted from the anti-icing surfaces: we wanted to secrete antifreeze only in response to the presence of ice on the surface, irrelevant of form -- frost, glaze or rime," said Rykaczewski. Rime forms when droplets of water vapor deposit directly as ice on surfaces.

He and his team "mimicked the bi-layer architecture of a frog's skin," he said, combining a porous top layer with an antifreeze-infused bottom layer.

The top layer is superhydrophobic, preventing freezing rain from forming ice on the surface. When ice starts to form through other means -- like frost caused by condensation buildup -- the bottom layer kicks into action. The antifreeze underneath leaches through the porous boundary between the two layers, melting the ice away. "In most cases the antifreeze is released via diffusion due to contact with liquid water," said Rykaczewski, though he and his team are still determining the exact mechanism.

The group tested the surface under a variety of icing conditions, from freezing fog to condensation frosting.

"The results were quite impressive," said Rykaczewski. "Ice accumulation was delayed ten times longer on our samples than on superhydrophobic or lubricant impregnated-surfaces in all the icing scenarios. Furthermore, we also saw about a ten-time delay in ice accumulation during freezing rain when compared to surfaces flooded with antifreeze."

Rykaczewski's surface uses antifreeze more efficiently, releasing the substance only when ice has started to form instead of requiring planes to be preventatively doused in it. The team, which also included ASU graduate students Xiaoda Sun, Viraj Damle and Shanliangzi Liu, is currently exploring fundamentals of the antifreeze release mechanisms, looking for ways to optimize the system and make it practical for large-scale use.

The presentation, "Bioinspired Antifreeze Secreting Frost-Responsive Pagophobic Coatings," is at 4:12 p.m. PT on Sunday, Nov. 23, 2014 in the Moscone West Convention Center, Room 3020. ABSTRACT: http://meetings.aps.org/Meeting/DFD14/Session/D13.9

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MEETING INFORMATION
The 67th Annual Division of Fluid Dynamics Meeting will be held at Moscone West Convention Center in San Francisco, Calif. from Nov. 23-25, 2014. More meeting information: http://apsdfd2014.stanford.edu/

REGISTERING AS PRESS
Any journalist, full-time or freelance, may attend the conference free of charge. Please email: jbardi@aip.org and dfdmedia@aps.org and include "DFD Press Registration" in the subject line.

ONSIGHT AND ONLINE PRESS ROOMS
Workspace will be provided on-site during the meeting. The week before the meeting, news, videos and graphics will be made available on the Virtual Press Room: http://www.aps.org/units/dfd/pressroom

LIVE MEDIA EVENT
A press briefing featuring a selection of newsworthy research talks will be webcast live from the conference at 1:00pm PST on Monday, November 24 in room Foothill F of the San Francisco Marriott Marquis. For more information, email jbardi@aip.org

ABOUT THE APS DIVISION OF FLUID DYNAMICS
The Division of Fluid Dynamics (DFD) of the American Physical Society (APS) exists for the advancement and diffusion of knowledge of the physics of fluids with special emphasis on the dynamical theories of the liquid, plastic and gaseous states of matter under all conditions of temperature and pressure. DFD Website: http://www.aps.org/units/dfd/index.cfm