

Department of the Navy SBIR/STTR Transition Program

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Topic # N14A-T013

Durable Low Adhesion Anti-Icing and Ice-Phobic Surfaces

HygraTek LLC

WHO

SYSCOM: ONR

Sponsoring Program: Code 33

Transition Target: Navy ship hulls operating in the Arctic; UAV deicing; Extreme cold weather heat pumps, wind turbines, solar panels, high voltage power lines

TPOC:

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Other transition opportunities: US Army CBD (Quoc Truong retiring, new program manager Walter Zukas); NASA (Tony Nerone and Eric Kreeger)

Notes: Applications include extreme cold operations of ships, drones both in air and water, aviation, radar; camera, sensor; and freezer operations for food and medicine storage



<https://navaltoday.com/2017/02/08/uss-mccampbell-sailors-battle-ice-ahead-of-japan-port-call/>

WHAT

Operational Need and Improvement: Maintaining tactical operation of surface vessels within extreme cold temperatures, such as in arctic operations or during ice storms. Icing events create operational challenges ranging from personnel safety, and radar, camera, and sensor loss of effectiveness, along with deteriorating vessel performance. An icephobic coating is a passive method to reduce ice adhesion, avoiding heating to melt ice and its associated equipment and energy requirements.

Specifications Required: The coating needs to be applied in the field using standard painting/coating methods and equipment. The developed coating will maintain an ice adhesion strength < 20 kPa even after severe Taber® abrasion (ASTM D4060), acid/base exposure, accelerated corrosion (ASTM B117), thermal cycling and peel testing (ASTM D3359). Further, these extremely low ice adhesion values will be maintained after 100 icing/de-icing cycles, and in a temperature range from -5 °C to -35 °C. The durability must survive the equivalent of one year of ship-board use independently verified by CRREL

Technology Developed: HygraTek developed a coating having the lowest ice adhesion values reported with long term durability. The resulting coating doesn't have any nanoscale additives to avoid susceptibility to leaching, performance degradation after subsequent icing events, or loss of effectiveness due to normal abrasion wear and tear. In addition to reduced ice adhesion, the coating is easy clean and has reduced solids adhesion including dust, dirt, and scaling. The coating also has a potential reduction of biofouling, as solids of all types are repelled. Our coating maintains icephobic properties even during surface wear and coating abrasion as long as a coating layer remains.

Warfighter Value: This coating extends the operational theater to extreme cold weather environments. Additionally, icephobic coatings are also effective in food storage freezers to reduce energy consumption associated with evaporator defrost cycles. A significant amount of electricity is also utilized for air conditioning and cooling, all of which can benefit by ice making for either energy storage or ice slurry made up to 20% more efficient with the icephobic coating.

WHEN

Contract Number: N68335-16-C-0119 **Ending on:** December 25, 2017

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Ice adhesion testing	Low	Low adhesion < 30 kPa with repeated icing events	4	June 2017
Physical characterization and corrosion testing	Med	Hydrophobic, super-icephobic (< 30 kPa ice adhesion after 1000 hours accelerated corrosion testing ASTM B117-11)	4	October 2017
Durability testing emulating field environment	Med	Long-term (> 1 year) icephobic performance < 30 kPa ice adhesion after 1,000 abrasion cycles following ASTM D6040)	4	December 2017
Large scale ice adhesion testing in simulated environment	Med	Scaling results identical to small scale tests at -30 °C conditions using ice formed from fresh and salt water, 3cm x 3cm gives same low ice adhesion (<30 kPa) as 1m x 1m	5	December 2017

HOW

Projected Business Model: Our business model is to primarily direct sell to DoD approved painting/coating application contractors for in field vessels, leveraging global coating manufacturers as contract master-batch suppliers. Alternatively, direct sales to system integrator Primes will be pursued for new DoD programs. Large volume coating component supply already exists, and the existence of large volume industrial applications will further increase supply channels.

Company Objectives: The Navy SBIR/STTR Transition Program (STP) Forum is accelerating our in-field performance results to enable implementation into other DoD applications and already leading to industry interest in extreme cold weather applications ranging from helicopter to high-voltage power line demand. Our short-term objective is to earn and solidify a Phase III agreement with at least one other DoD program of record currently experiencing or anticipating icing challenges and at least one joint development agreement with a major coatings manufacturer. The coating features of repelling ice are also fundamental to repelling dust, mud, etc. and are presently leading to continue our industrial demand from a major consumer appliance manufacture. The icephobic coating has lead to a new engineering design concept for wind turbines, windshield wiper blades, and camera systems for autonomous vehicles. It is a long-term objective to partner with manufacturers of such equipment to provide high-value add solutions.

Potential Commercial Applications: This technology is applicable to other cold weather or freezing applications, such as commercial/consumer freezers, ice makers, wind turbines and high-voltage power lines. Additionally, industrial aviation applications include wing/blade and engine components. A significant energy saving/management application is ice thermal storage, enabling extreme temperature heat pump operation including for electric vehicles, and eliminating/reducing evaporator defrost cycles. The deliverable coating is suitable to a wide range of icing applications enabling rapid commercialization in industrial, commercial, and consumer markets.

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