Advanced Coatings and Surface Alert (TechVision)

Anti-icing Coatings in North America

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Anti-icing Coatings Developments in North America
The development of an anti-icing coating will not only benefit the aviation industry, but it could also potentially solve, for instance, a frozen side mirror of vehicles in countries that suffer a harsh winter season. The technology is presently in the demonstration of prototype stage in an operational environment, and once it passes testing and qualification, it will be ready for commercialization.

**Analyst Perspective**

The development of an anti-icing coating will not only benefit the aviation industry, but it could also potentially solve, for instance, a frozen side mirror of vehicles in countries that suffer a harsh winter season. The technology is presently in the demonstration of prototype stage in an operational environment, and once it passes testing and qualification, it will be ready for commercialization.
Ice formations on surfaces such as bridges, antennas, and buildings can be very dangerous. It could topple the antennas, destroy satellite dishes, and pose dangers for people walking under bridges.

Normal de-icing methods use chemicals and are based on electro-thermal heating. Neither method is environmentally friendly.

The coating includes chemicals of different sorts of chloride salts, acetate compounds, glycol based solutions and some other substances.

When applied the coatings offer a non-stick, slick, and hydrophobic surface.

The water droplets will accumulate on the surface of the coating, and due to its non-stick nature, the coating will pull away the beads of ice that are forming. Hence there is very little surface area for the ice to attach.

The top 3 industries for applications of the EC 3000 series are buildings and construction, communication, and automotive.

Ecological Coatings provides a series of coatings ranging from anti-graffiti to zebra and mussel protection.

The EC 3000 series is a popular technology that is adopted by various industries. Its impact in NA market is expected to be quite high especially in winter season.

Ecological Coatings LLC offers support to Habitat for Humanity and the Center for Coastal Studies.
As a nano-based coating can be applied in various industries ranging from automotive to healthcare, NANOMYTE® SuperAi, which is currently engineered for the building and construction industry, has potential to be adopted across numerous industries.

**Technology Profile**

This sole-component, transparent, and nanocomposite coating provides a thick, hard, and smooth finish. Due to its superhydrophobic property (water contact angle between 100 to 105°), ice adhesion is greatly reduced.

**Innovation Attributes**

- User-friendly coating as it can be applied by spraying, dipping or brushing.
- Fast curing time. Require only 1 hour or less at temperature in the range of 100-150°C.
- The coated surface becomes extremely slippery and hydrophobic thus preventing accumulation of water and reduce ice adhesion onto the surface.

**Applications**

Other than metal surfaces, buildings, and infrastructure, SuperAi coating can be applied to a variety of substrates including plastics, glass, and ceramics.

**Partnership**

NEI Corp has partnered with many local, international, or multinational companies, as well as US Defense laboratories, national laboratories, and universities.

**Accolades**

NEI Corp has been awarded 8 small projects from the United States Department of Energy. Also, the US Environmental Protection Agency has granted NEI Corp a Small Business Innovative Research (SBIR) grant for the research and development of coatings for the nation’s water infrastructure.
Ice-repellent Coatings for Automobiles

Unmet Needs/ Trends

- Surfaces or equipment that have been frozen by ice need to be regularly thawed, which could damage the surface and the paint.
- Existing anti-icing coating is costly to implement, for instance to make them less prone to ice adhesion, manufacturers are trying to etch minuscule patterns on surfaces.

Potential Applications

The main principal application of this coating is in automotive but further development could make the coating adopted in various industries such as aviation.

Analyzer Perspective

Advancement of this new ice-repellent formula could benefit many industries. In fact, the formula is easy to adjust to fit different needs. It is currently in the research stage and is expected to be commercialized in 2025.

Innovation Attributes

The new ice-repellent formula is cost-effective as the chemicals used are inexpensive, able to stop the formation of ice, and has improved the coated surface durability in terms of mechanical abrasion, peel tests, and repeated freeze-thaw cycles.

Future Plans

Based on the research results, the scientists are planning to further develop the technology for use across multiple industries.

Funding

This research has been funded by several government bodies such as the Office of Naval Research and the Air Force Office of Scientific Research.

Tech Profile

The research has been conducted by a team from the University of Michigan consisting of 6 team members with Anish Tuteja who leads the team.

Who

The coating formula has been developed by the Materials Science and Engineering department at the University of Michigan, United States.

Where

The coating is composed of chemicals such as polydimethylsiloxane (PDMS), polymethylhydrosiloxane (PMHS), and silicone oil mixed together into a spray-on coating.

2025

Even though it is not able to repel water, the formation of ice onto the surface is avoided.

Potential Applications

What

The coating formula has been developed by the Materials Science and Engineering department at the University of Michigan, United States.

2025

Future Plans

Based on the research results, the scientists are planning to further develop the technology for use across multiple industries.

Funding

This research has been funded by several government bodies such as the Office of Naval Research and the Air Force Office of Scientific Research.
Strategic Insights

Technology Roadmap

- **Hydrophobic and superhydrophobic coatings**: 2015
- **Nanocoatings for extreme temperatures**: 2018
- **Biomimetic anti-icing coatings**: 2020
- **Multifunctional anti-icing coatings**: 2022
- **Multi-functional anti-icing nano-coatings**: 2025

Intellectual Property (IP)

- From 2010 to 2015, a total of 239 patents were published for anti-icing coatings in the North American region.
- Key focus industries are aviation, automotive, and buildings and infrastructure.
- Key focus areas in terms of materials/technologies include inexpensive chemicals such as PDMS and PMHS, and lightweight and environmentally friendly coating.
- The key assignees are Harvard College, Searete Llc, and Akzo Nobel Chemicals International Bv.
- These figures show that significant research is underway for further development of this technology.
Need to solve ice deposition on surfaces

Drivers & Challenges

Market Potential

High growth technology adoption

R&D and Funding Trends

On-going researches further developing the technology

The 2020 scenario

Most research funded by government bodies in North America

Multifunctional anti-icing coating

- The deposition of ice on surfaces incurs loads of problems. Higher energy consumption and low energy output are two of the concurrent problems.
- Equipment costs pose the major challenges that need to be overcome in this technology.

- Increased demand, especially from the aviation industry, will surely result in high growth potential in the market.
- Researches are focused on improving technology by adding variations to address the unmet needs.
- Government bodies such as the US Department of Energy, US Environmental Protection Agency, and NASA are funding and collaborating with researchers for advancement of the technology.

- Enhanced and developed anti-icing coatings have various functions. Use of these coatings beyond de-icing will include strengthening surfaces from abrasion and as a finish coat that offers aesthetic value.
## Key Patents

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<thead>
<tr>
<th>No.</th>
<th>Patent No.</th>
<th>Publication Date</th>
<th>Title</th>
<th>Assignee</th>
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<tbody>
<tr>
<td>1</td>
<td>US20160061056A1</td>
<td>March 03, 2016</td>
<td>Gas turbine engine anti-icing system</td>
<td>Wang Liang</td>
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<td>An anti-icing system (100) for an engine section stator (26) of a gas turbine engine (10), the system (100) comprising: an environmental control system pre-cooler heat exchange system (116) configured to exchange heat between air bled from a compressor (14, 16) of the engine (10) and bypass duct air; and a conduit (132) configured to exchange heat from the pre-cooler heat exchange system (116) to a further a heat transfer medium, the conduit (132) being configured to transfer the heat from the heat transfer medium to the engine section stator (26).</td>
<td></td>
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<tr>
<td>2</td>
<td>US 9206506 B2</td>
<td>Dec 8, 2015</td>
<td>Anti-icing Coating For Power Transmission Lines</td>
<td>Advenira Entpr Inc</td>
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<td></td>
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<td></td>
<td>Provided are methods and systems for forming piezoelectric coatings on power line cables using sol-gel materials. A cable may be fed through a container with a sol-gel material having a piezoelectric material to form an uncured layer on the surface of the cable. The layer is then cured using, for example, infrared, ultraviolet, and/or other types of radiation. The cable may be suspended in a coating system such that the uncured layer does not touch any components of the system until the layer is adequately cured. Piezoelectric characteristics of the cured layer may be tested in the system to provide a control feedback. The cured layer, which may be referred to as a piezoelectric coating, causes resistive heating at the outer surface of the cable during vibration of the cable due transmission of alternating currents and environmental factors.</td>
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### Key Patents (continued)

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<th>Patent No.</th>
<th>Publication Date</th>
<th>Title</th>
<th>Assignee</th>
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<tr>
<td>3</td>
<td>US20150344759A1</td>
<td>Dec 03, 2015</td>
<td>Coated ice melting compositions</td>
<td>Morton Salt Inc</td>
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<td></td>
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<td>Ice melting compositions, methods for manufacturing ice melting compositions, and methods for melting ice are disclosed. The ice melting compositions can include a coarse deicing particle nucleus and a fine deicing particle coating substantially surrounding the coarse deicing particle nucleus. The fine particle coating can be attached or bonded to the coarse particle nucleus with a binder. The coarse particle nucleus and the fine particle coating can have a variety of particle sizes.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>US20160009972A1</td>
<td>Jan 14, 2015</td>
<td>Ice-resistant paint for wind turbine blades, procedure for its preparation, use and wind turbine blade coated with the ice-resistant paint</td>
<td>Carter James Thomas</td>
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<td>Ice-resistant paint comprising an ice-resistant base component that in turn comprises a main component entailing a high solid paint with a synthetic polyurethane-based binding component dissolved in a main organic solvent, and a hydrophobe component consisting of hydrophobic ice-resistant functional nanoparticles selected from among nanoparticles functionalized with a polymer and nanoparticles functionalized in sol-gel, where the ice-resistant paint comprises a mixture of the main component with a dispersion of functional nanoparticles dispersed in a dispersing composition constituting the main solvent and a dispersant, and forms a base matrix, where the dispersing composition and functional nanoparticles form a dispersion of nanoparticles in which the functional nanoparticles are in the base matrix, and the dispersion of dispersing nanoparticles mixed with the main component to form an ice-resistant base component of the ice-resistant paint.</td>
<td></td>
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<tr>
<td>No.</td>
<td>Patent No.</td>
<td>Publication Date</td>
<td>Title</td>
<td>Assignee</td>
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<tr>
<td>5</td>
<td>US 9150767 B2</td>
<td>Oct 6, 2015</td>
<td>Deicing Composition</td>
<td>Akzo Nobel Chemicals Int Bv</td>
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The present invention relates to a deicing composition comprising (i) a deicing agent selected from the group consisting of sodium chloride, calcium magnesium acetate, calcium chloride, magnesium chloride, potassium chloride, potassium acetate, sodium acetate, sodium formate, potassium formate, (ii) a native protein, and (iii) a thickener. It furthermore relates to a process for preparing said deicing composition and to a process for deicing a surface using said deicing composition.
INDUSTRY CONTACTS
Industry Contacts

Katy Delaney
Director Media Relations,
Battelle Memorial Institute,
505 King Ave.,
Columbus, Ohio 43201.
Phone: +1 614 424 7208
E-mail: delaneyk@battelle.org
URL: http://www.battelle.org/

Dr. Ganesh Skandan
Chief Executive Operations,
NEI Corporation,
400 Apgar Dr, Suite E,
Somerset, NJ 08873.
Phone: +1-732-868-3141
E-mail: sales@neicorporation.com
URL: http://www.neicorporation.com/

Nicholas Patenaude
President,
Ecological Coatings LLC,
P.O. Box 4202,
Clifton Park, NY 12065,
Phone: +1-518-383-9585
E-mail: info@ecologicalcoatings.com
URL: http://www.ecologicalcoatings.com/

Anish Tuteja
Associate Professor,
University of Michigan
500 S State St, Ann Arbor,
MI 48109.
Phone: +1-734-615-2972
E-mail: atuteja@umich.edu
URL: http://umich.edu/