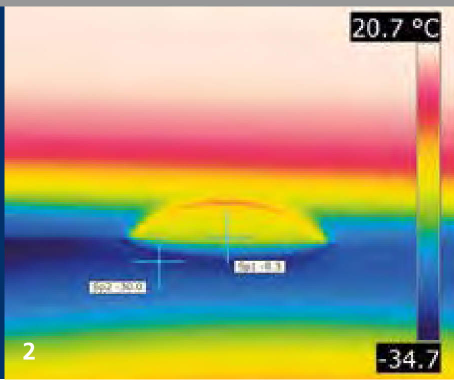
Fraunhofer IGB

FRAUNHOFER INSTITUTE FOR INTERFACIAL ENGINEERING AND BIOTECHNOLOGY IGB



1 *Wind power plant in winter.*
2 *Thermographic image of a supercooled but still fluid drop of water on a plasma-functionalized nanostructured film.*
3 *Wing with layer of ice.*

ANTI-ICE COATINGS

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB
Nobelstrasse 12
70569 Stuttgart, Germany

Contacts

Dr. Jakob Barz
Phone +49 711 970-4114
jakob.barz@igb.fraunhofer.de

Hon.-Prof. Dr. Christian Oehr
Phone +49 711 970-4137
christian.oehr@igb.fraunhofer.de

www.igb.fraunhofer.de

www.nanodyn.org

Meeting the ice challenge

When ice adheres to a surface, it can cause a lot of problems in a multitude of areas – for example, in the air transport industry where huge amounts of chemicals or energy are needed to free aircraft wings, rotor blades and sensors from ice. Ice is a problem on the blades of wind turbines because it lowers the energy efficiency of the plant. This sometimes forces operators to shut down their plant or to use energy to thaw the ice instead of producing it for more profitable purposes. Uneven deposits of ice can even lead to dangerous imbalances on wind turbines which could result in gear damage.

Innovative surface coatings and composite materials can help alleviate such problems in the near future. Together with partners from industry and research, the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB has developed an innovative anti-ice treatment for surfaces which helps reduce the large-scale icing of surfaces.

Anti-ice surface treatment

Passive anti-ice coating with plasma technology

Plasma technologies are used to apply ice-resisting micro and nanostructured layers, for example on polyurethane (PU) or other material surfaces. The surface to be treated is placed in a vacuum chamber where a plasma modifies the surface. When water is poured on the modified surface after treatment, it turns into a ball-shaped drop which drips off due to its minimized degree of interaction with the surface. The water on treated surfaces does not freeze even

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when temperatures fall below zero because it stays supercooled. Even when the water freezes, the anti-ice coating diminishes ice adhesion, for example on PU films, by more than 90 percent compared with uncoated PU surfaces.

Embossing processes

Ice adhesion can be reduced even further by embossing the optimum microstructure on a film's surface. Using embossing processes, we can create extensive topographies with a high aspect ratio (i.e. relation between the height of the structure and its lateral dimension). The structures are then coated with the passive anti-ice treatment in subsequent processes.

Combinations with actively heatable layers

The passive coating can be combined with a heatable surface layer to make the anti-ice treatment even more effective. A combination of active and passive anti-ice surface functionalization can react intelligently to changing ambient conditions.

4 Chair-lift cables covered with ice.

5 Small wind power plant for urban areas.

Applications

The anti-ice treatment has been tested successfully on a self-adhesive impact and shock-proof PU film which can be glued to objects for protection without having to coat the component itself. A major advantage of gluing over coating is that the treatment is clean and does not involve solvents. It is also extremely flexible in terms of time and place as the anti-ice film can easily be stored for later use and is uncomplicated to replace or remove. The foils are weather-proof, and resist rain and hailstones without problems.

The anti-ice functionalized foils can be used for a multitude of applications e.g. on aircraft wings, the rotor blades of wind turbines, solar panels, overhead power lines, parts of buildings or their facades and even on sports equipment. It is simple to glue anti-ice foils to cooling units or ice-box parts and to replace these whenever necessary. Flat materials, such as textiles and molded parts up to a certain size, can be treated directly in a plasma chamber. Large-scale applications are carried out with our close network of business partners.

Methods and test apparatus

Two ice chambers are available to the Fraunhofer IGB for customer-specific tests of anti-ice coatings.

Climate and test chambers:

- relative atmospheric humidity: < 1 % to 80 %
- high speed camera: 1000 images per second
- examination of ice formation (Icing behavior of surfaces)
- measurement of the adhesive force of ice on surfaces (de-icing)
- measurement of surface energy and wetting properties (contact angle)
- air and substrate temperature up to –30 °C
- automatic running of temperature and atmospheric humidity cycles
- adapting test chambers to customer requirements (e.g. wind and rain simulation)
- high-resolution thermography (contactless, spatially resolved measurement of surface temperatures with infrared thermography (system by FLIR Co.), thermographic video recordings)

Project partners

Bremen University, BCCMS
Cerobear, Herzogenrath
ROWO Coating, Herbolzheim
PINK Thermosysteme, Wertheim-Bestenheid
EADS, Munich