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ICING LABORATORY WITH INTEGRATED WIND TUNNEL

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Status quo

For aircraft, ships, rail vehicles, cars, refrigeration units, wind turbines, and air-conditioning systems – ice formation often endangers safety and incurs high repair and maintenance costs.

Range of services offered

Preventing ice forming on surfaces is a major challenge. The Paint/Lacquer Technology group at Fraunhofer IFAM is developing a range of technologies for anti-icing and deicing. Besides extensive experience developing and qualifying coatings, an essential part of the work involves carrying out tests under realistic icing conditions. Fraunhofer IFAM has a full range of test facilities for its own development work and for external projects with industry and other R&D organizations.

Icing laboratory

One of these test facilities is the icing laboratory with its integrated wind tunnel. Temperatures down to -30°C and controlled air humidity mean that the icing laboratory (Fig. 2) has unique conditions for studying a wide range of situations. For example, ice adhesion on various surfaces can be analyzed and icing on a wide range of components studied. The latter include, for example, heat exchangers and HVAC (heating, ventilation, and air-conditioning) units.

Wind tunnel

The integrated wind tunnel is a feature of the icing laboratory. Atmospheric icing can be simulated at wind speeds up to 350 km/h and at temperatures down to -30°C under controlled air humidity, for example the icing of wind turbine rotor blades and aircraft wing sections.



In nature, atmospheric icing is caused by the presence of supercooled water droplets in clouds. In the icing wind tunnel this cloud is generated by a water injection system. This system allows wide variation of the relevant parameters such as the liquid water content (LWC) of the cloud and the median volume diameter (MVD) of the supercooled water droplets. In this way different types of ice – clear ice (Fig. 4) and hard rime (Fig. 5) – can be generated in the icing wind tunnel. Key parameters at a glance:

- Wind speeds up to 350 km/h
- Temperatures down to -30°C
- Controlled air humidity
- Liquid water content from 0.5 g/m³;
Measurement systems: LWC300, rotating cylinder
- MVD between 15 and 45 µm;
Measurement system: PDA (Fig. 6)

Range of services: Icing wind tunnel

Realistic icing conditions allow a variety of practical tests to be undertaken. The icing process under clear ice and hard rime conditions can be analyzed on various surfaces and the ice adhesion determined. 3-D scanners enable the recording of the ice formation and measurement of the ice density. In addition, the functioning of heating systems and measurement systems under icing conditions is possible. This is facilitated by IR cameras.

- 4 *Clear ice.*
- 5 *Hard rime.*
- 6 *PDA measurement system.*