Fraunhofer IWES

Data and facts

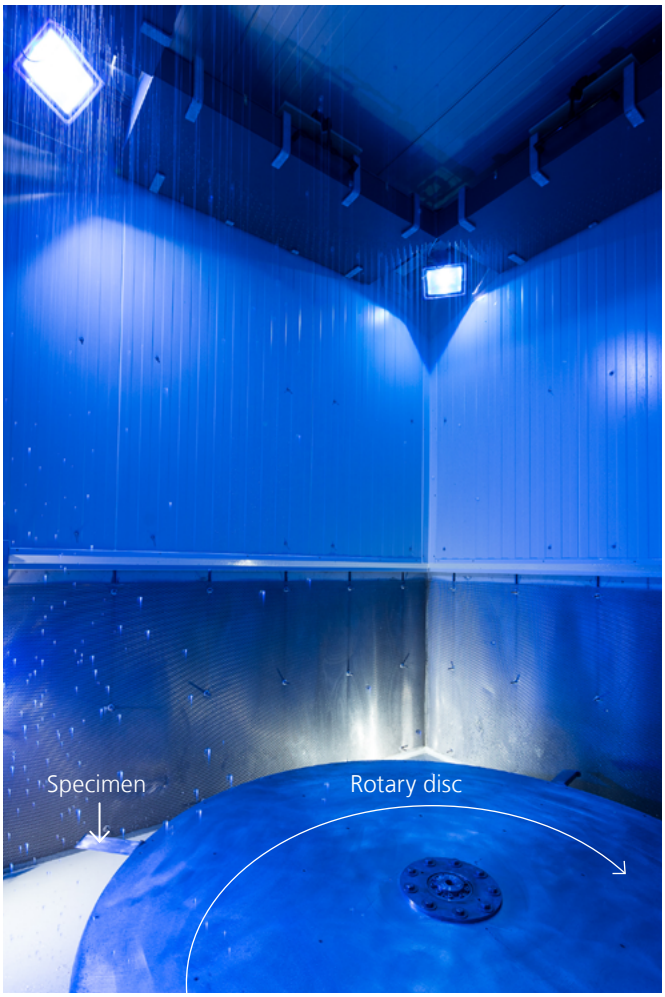
Testing of Protective Coatings for Wind Turbine Rotor Blades

When high speed water droplets strike a surface, even the most durable coatings and materials can suffer erosion damage over time. Cracks in these coatings markedly increase the risk of accelerated wear. These effects are especially relevant for components such as rotor blades of wind turbines or aerodynamic parts of aircraft in harsh environmental conditions, erosion due to rain, hail, salt and dust becomes a critical life cycle and performance risk.

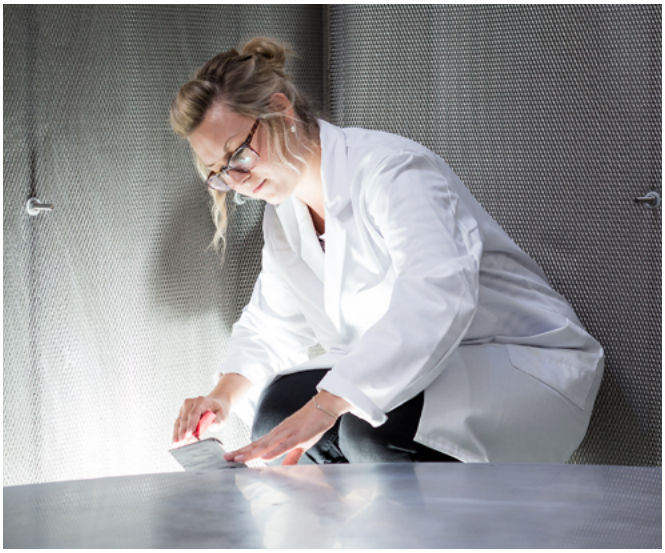
To avoid costly repairs, reduced efficiency or shortened life span, early verification of rain erosion resistance is indispensable. Products for verification can be a rotor blade leading edge, a composite structure or a protective coating system.

Our infrastrucure at a glance

- Test procedures align with DNV-RP-0171 standards for erosion protection systems.
- A rotating disk equipped with three aerodynamically shaped specimens, each 230 mm in length, enables testing under realistic operating conditions.
- More than 1,300 needle shaped nozzles that generate controllable rain intensity and droplet distribution.
- Velocity capability up to 160 m/s, simulating the high-speed leading-edge tip of a wind turbine blade.
- High-resolution laser-based inspection systems document surface erosion.



The IWES Leading Edge Lab deliver data to evaluate the resistance of rotor blade coatings to rain erosion.



Technical specifications – IWES Leading Edge Lab

- Testing room temperature: 7°C to 25°C
- Water temperature: 7°C to 18°C
- Droplet size: 2.5-3 mm diameter
- Water flow: 60-120 l/h
- Ice system: -10°C
- Maximum tip speed: 160 m/s (1097 RPM)
- Image options:
  - Automatic high-resolution laser-based surface inspection and high-resolution images (16 MP)
  - Manual high-resolution images
  - Video recording of the impact with high-speed camera

Rotor blades and other high speed aero components are increasingly exposed to conditions that intensify erosion risk: increasing rotor speeds (leading to higher droplet impact energies), offshore installations (salt, humidity) and larger blade spans (higher tip speeds). Even small amounts of material abrasion or crack formation can degrade the aerodynamics of a blade, increase noise emissions, reduce energy yield and lead to higher maintenance costs. By providing realistic, accelerated test data, Fraunhofer IWES enables manufacturers, developers and operators to stay ahead of these risks.

Our competences

With over a decade of experience in material characterization and rain erosion testing, the Rain Erosion Group at Fraunhofer IWES is recognized as one of Germany's scientific leaders in this field. Our fully equipped laboratory and in-house rain erosion test rig enable in-depth analysis of erosion mechanisms across various coating systems. Close collaboration with wind farm operators ensures that our research and testing reflect the latest industry demands supporting innovation, reliability, and real-world applicability in the wind energy sector.

Testing procedure

Fraunhofer IWES offers a full-service workflow for rain erosion testing, using standardized or customer-specific parameters. We supply aerodynamically shaped GFRP specimens representing leading-edge geometries. You apply your erosion protection system, such as coatings, tapes, films over layered topcoats and filler or directly on GFRP surface then return the prepared specimens to us. The coated samples are mounted on rain erosion test rig and accelerated to a tip speed defined by you, under controlled rain conditions. To assess material degradation, the test is paused at intervals of your choosing for inspection. This enables detailed monitoring and comparison of erosion performance over time.

Further information

The Fraunhofer Institute for Wind Energy Systems IWES conducts application-oriented research for a sustainable future. The focus topics of the Fraunhofer IWES are offshore, hydrogen, test infrastructure and digitalization. The research work in these future-oriented key technologies plays a central role in the innovation process and strengthens the business location for the benefit of our society by transferring the research results to industry. More than 400 employees at nine locations are developing innovative methods to accelerate the expansion of the wind energy and hydrogen economy, minimize risks, and increase cost efficiency.

Supported by:

Federal Ministry
for Economic Affairs
and Energy

on the basis of a decision
by the German Bundestag

Picture credits: Page 1: cover photo @ Fraunhofer IWES / Tim Schumacher, photo bottom @ Jan Meier, page 2: photo @ Jan Meier
11/2025

Contact

Stefan Krause
Infrastructure Manager
Characterization of
Composite Materials
Phone: +49 471 14290-326
stefan.krause@
iwes.fraunhofer.de

Sara Ghiasvand
Research Associate
Characterization of
Composite Materials
Phone: +49 471 14290-475
sara.ghiasvand@
iwes.fraunhofer.de

Fraunhofer Institute for Wind Energy Systems IWES
Am Seedeich 45, 27572 Bremerhaven, Germany
www.iwes.fraunhofer.de