DANISH TECHNOLOGICAL INSTITUTE

Product Catalog

Industrial Materials Technology

Contents

Materials technology for a stronger industry

Metallic materials are the backbone of modern industry. Their properties decide whether a product lasts for decades or fails in operation - and whether a business gains or loses its competitive edge. Mastering these materials demands deep technical expertise, cutting-edge analysis tools, and real-world experience with industrial challenges.

This is where we come in.

At the Danish Technological Institute, we blend advanced analytical methods, extensive metallurgical know-how, and years of hands-on industry experience. We handle metallic materials throughout their entire lifecycle: from selecting materials and quality control to mechanical testing, corrosion testing, and thorough investigations into causes of failures when issues arise. Our Aarhus laboratories are equipped with state-of-the-art machinery for tensile testing up to 1200 kN, fatigue testing up to 500 kN, electron microscopy, optical emission spectroscopy, and a large test area for evaluating real-world structures. And if the task can't be brought to us, we bring our mobile equipment to you - for on-site inspections and analyses.

We are DANAK-accredited across a wide range of methods and provide impartial documentation our customers can rely on. But we're much more than a testing lab. We aim to be the preferred development partner for everyone working with metallic materials - engaging early in your projects, understanding your challenges, and turning our expertise into tangible, strategic value. Whether you're investigating a failure, documenting a new construction, or seeking to extend your product's lifespan.

This catalog offers a glimpse into our technical services - from advanced microstructure analysis to full-scale functional testing. But behind every service lies our true product: safety, quality, and competitiveness.

We look forward to helping strengthen your business.

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Standardised tests

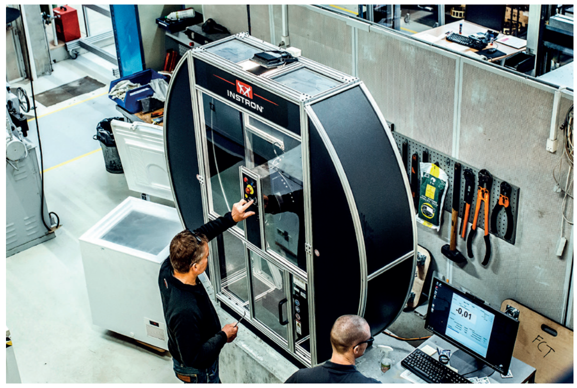
Tensile testing:

We offer capacities up to 1200kN and use an optical extensometer to measure elongation. Testing performed according to:

- ISO 6892-1 (Accredited)
- ISO 6892-2 up to 250 degrees
- ASTM E8
- 15630-1, -2 & -3 (Accredited)
- Custom test profiles

Impact toughness testing:

Our lab is equipped to perform impact toughness tests accredited to ISO 148-1. Testing is available down to –196 degrees Celsius.



Deformation testing:

Our laboratory offers a variety of solutions for deformation testing. This includes:

- Bend test to 15630-1 (Accredited)
- Bend test to 8491 (Accredited)
- Bend test to 5173 (Accredited)
- Mandrel expansion to 8493 (Accredited)
- Flattening to 8492

Hardness testing:

We can perform these accredited hardness tests:

- DS/EN ISO 6506-1 – Metallic materials – Brinell hardness test – Part 1: Test method
- DS/EN ISO 6507-1 – Metallic materials – Vickers hardness test – Part 1: Test method (HV0.1 – HV10)
- DS/EN ISO 6508-1 – Metallic materials –
- Rockwell hardness test – Part 1: Test method (B and C scales)

Optical microscopy:

We offer these accredited microscopy analyses:

- DS/EN ISO 17639 – Destructive testing of welds in metallic materials – Macro and micro examination of welds

Optical emission spectroscopy:

We are accredited to perform the following chemical analyses:

- DS/EN ISO 15079 – Copper and copper alloys - Analysis using optical emission spectroscopy with spark excitation (S-OES)
- ASTM E1086 – Standard Test Method for analysis of austenitic stainless steel by spark atomic emission spectrometry
- ASTM E415 – Standard Test Method for analysis of carbon and low-alloy steels using spark atomic emission spectrometry

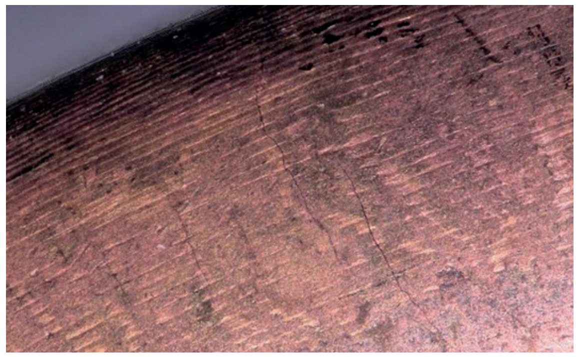
Corrosion and corrosivity testing:

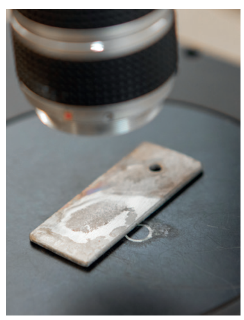
We offer the following accredited corrosion tests:

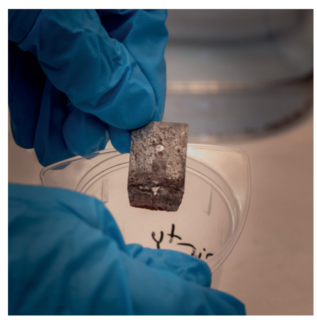
- Arbeitsblatt GW 541, October 2004, Annex A – Testing stainless steel tubes for corrosion-promoting residues
- AS 2345 – Determining dezincification resistance in copper alloys
- DS/EN ISO 6509 – Corrosion of metals and alloys – Determination of dezincification resistance in zinc-containing copper alloys
- ISO 6957 – Copper alloys – Ammonia stress corrosion resistance test
- DS/EN ISO 3651-2 – Determining resistance to intergranular corrosion in stainless steel Part 2: Ferritic, austenitic, and duplex (ferritic-austenitic) stainless steels corrosion testing in sulfuric acid environments

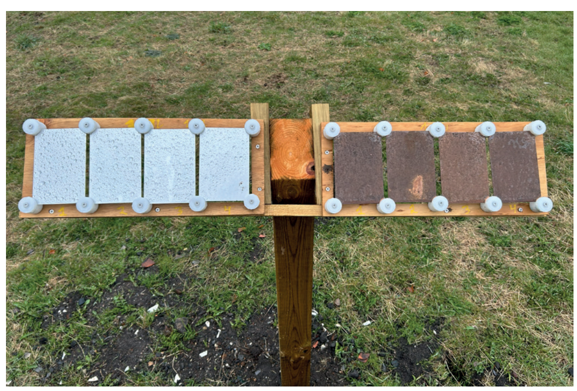
Additionally, we routinely carry out the following corrosion tests:

- UN Section 37 (C 1) – used to determine if a liquid is corrosive to aluminum and steel during transport
- ASTM G36-24 – accelerated comparative test for evaluating susceptibility to stress corrosion cracking (SCC) in metals and alloys
- ISO 9226 and ASTM G116-99 – field exposure tests to assess atmospheric corrosivity at specific locations









Functional testing

In our testing lab, we have servo-hydraulic machines with capacities up to 1200 kN in tension and 5000 kN in compression, as well as portable actuators of about 30 tons that can be placed anywhere on our 140 m² strongfloor testing platform. This setup allows us to create flexible test configurations, so structures and products can be loaded in nearly any direction – whether with static, cyclic, operation-like loads, or with combined stresses at selected points.

Tests can be run using custom load programs, controlled either by force or deformation. We handle sequences, block programs, and tailored load profiles that reflect the actual functional demands of the product. During testing, we use both traditional measurement systems (load cells, displacement sensors, strain gauges) and optical extensometers, as well as Digital Image Correlation (DIC) for full-field deformation measurement. We also continuously record temperature and humidity. Additionally, depending on the item, we can conduct functional testing at reduced temperatures and under exposure to moisture or corrosive environments.

Our data collection systems can log at high sampling rates, ensuring even fast load and response events are captured in detail. Results are usually provided in a report with analysis, graphs, and assessment of requirement fulfillment, and can also include raw time-series data, images, and DIC documentation for further use in the customer's own calculations and documentation, upon agreement.

Dynamic testing

At the Danish Technological Institute, we have several servo-hydraulic testing machines with capacities up to 500 kN and frequencies up to 30 Hz. This allows us to design everything from simple, cyclical sinusoidal loads to sophisticated test programs with varying amplitudes and frequencies, controlled by force or deformation. Thanks to our flexible setups, we can tailor testing procedures for both small samples and larger components, supporting you whether you're in the early development phase or facing a specific approval or quality task. We're happy to partner with you throughout the process – from concept to documented solution – and assist from the initial considerations about load levels and test design to the final documentation of service life and performance.

We test both standardised test rods and real-world components, so results can be used directly in your certification, quality control, or product development. In addition to classic materials, we conduct dynamic testing on welded joints, bolts and screw connections, 3D-printed items, as well as complete components and partial constructions.

We have specialized expertise in fatigue testing of bolts and additively manufactured (3D-printed) parts, where we can help document strength, service life, and durability under realistic, cyclic loads.

For dynamic testing, we use strain gauges, optical extensometers, and advanced image-based techniques like Digital Image Correlation (DIC). This allows us to track deformations and damage progression right where it matters most – giving you deeper insight into how your component behaves under load.

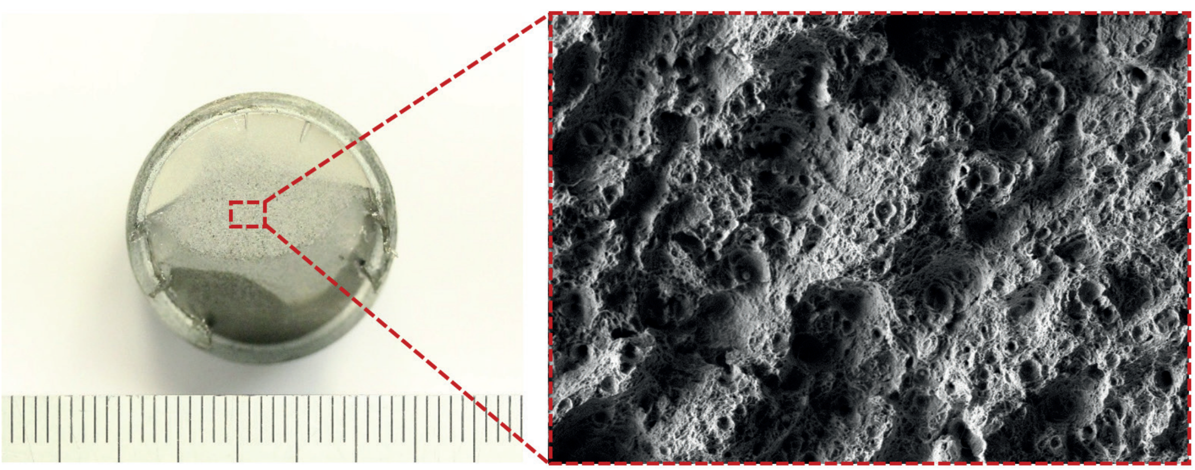
We can help you develop test programs based on operational and load data or your own calculation models, ensuring that the laboratory tests truly reflect real-world loading conditions. After testing, our engineering experts are available to help interpret measurement data, generate and use SN-curves, and assess service life and safety margins – so you can turn test results directly into actionable design and approval decisions.

Fracture and failure analysis

The Danish Technological Institute conducts fracture and failure analyses on metallic components and structures, including those from the offshore and wind industries, as well as machinery in general. The goal is to pinpoint fracture mechanisms and the main contributing factors – ranging from material and manufacturing conditions to operational stresses.

Depending on the nature of the damage, the examination may involve a visual inspection of the fracture – often complemented by fractographic studies of the fracture surfaces, for example, to determine whether the failure was caused by overload or fatigue. Additionally, metallographic analysis can be used to characterize microstructure, inclusions, welding defects, carbide distribution, and any corrosion products. Tensile, impact, and hardness tests can help verify and compare material properties with specifications and any known stress levels.

The results are compiled into a technical report, where we can also offer to translate our conclusions into specific recommendations for material selection, corrosion protection, and inspection or lifecycle strategies, helping you prevent similar issues in the future.



Hardness testing

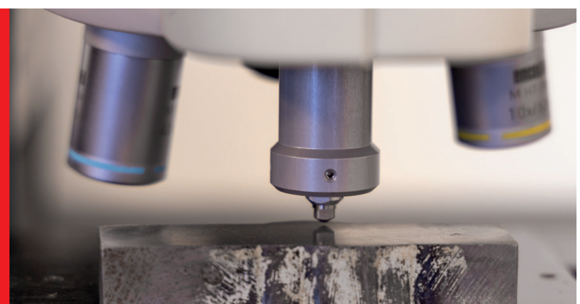
We provide accredited hardness testing using the Vickers, Rockwell, and Brinell methods, covering both micro and macro hardness across a wide range of materials – from soft copper alloys to high-strength steel, welds, and surface-hardened systems.

Hardness measurements are used to document, for example, heat treatment condition, strength and wear properties, verification of material certificates, process and incoming inspections, as well as for root cause analysis. Test samples can be anything from standard specimens to machine parts, and we can process your items in our workshop as needed.

The Vickers method uses a diamond pyramid with a defined test force, making it suitable for both bulk and micro areas – including case depth profiles, weld heat-affected zones (HAZ), and thin coatings.

The Rockwell methods use either a diamond cone or ball indenter with both a preliminary and main load, determining hardness based on the permanent indentation depth. This allows for fast, repeatable testing in production using the appropriate HR scales (HRC, HRB).

The Brinell method uses a hard metal ball and relatively high forces, resulting in large impressions that provide a representative average for coarse or heterogeneous structures such as nodular cast iron. By offering all three methods, we can always select the most technically appropriate solution for your component, ensuring results are directly useful for your design and quality processes.



Brinell

- The sample is loaded with either 62.5 kgf or 187.5 kgf for 10–15 seconds, and the resulting indentation is measured optically.
- This method creates a large impression, providing a representative average hardness for rough surfaces and heterogeneous materials (such as ductile iron, etc.).

Vickers

- Test loads range from 0.1 to 10 kgf (HV0.1 – HV10).
- Typically requires a ground or polished surface and enough sample thickness relative to the diagonal length.
- Ideal for hardness profiles, surface layers, welds, and small areas where high resolution is needed.

Rockwell

- Hardness is determined by indentation depth.
- HRB is suitable for softer metals (e.g. mild steel and copper, aluminum, or brass alloys), while HRC is ideal for hardened steel, high-strength alloys, and similar.
- This is a fast and straightforward method – perfect for automated process and batch testing.

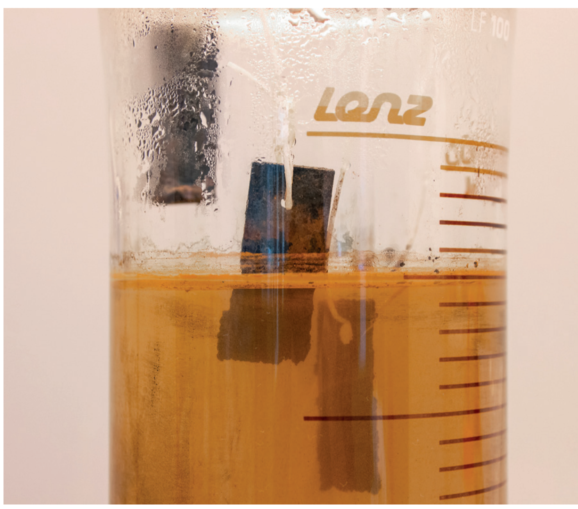
Corrosion testing

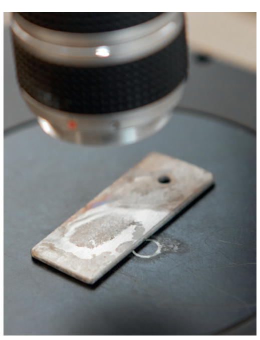
Corrosion resistance is essential for safe operations in plumbing, construction, wastewater management, marine and offshore sectors, as well as many other industries.

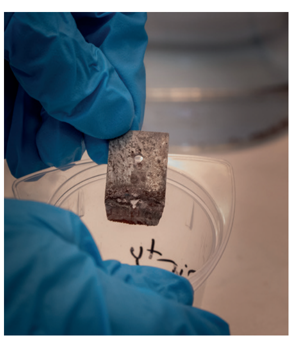
During the planning phase, the resistance of many components to atmospheric corrosion is specified based on corrosion classes C1–CX as defined in DS/EN ISO 9223. However, there can be significant uncertainties with this approach, which impact both investment costs and maintenance planning. We can help reduce these uncertainties through on-site exposure testing or technical consulting.

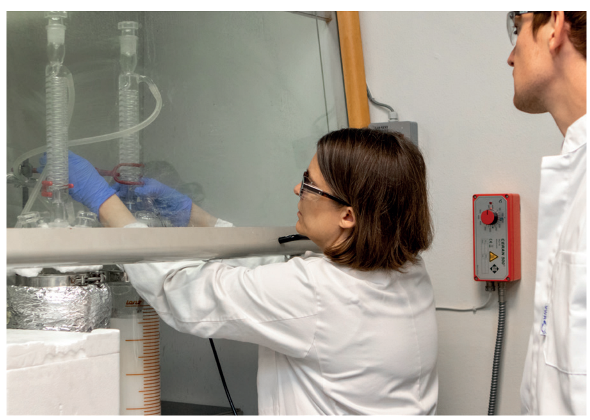
We offer accredited testing as part of product certification, ensuring the quality of various products and supporting access to regulated markets. Additionally, we provide customized laboratory tests for demanding environments or innovative uses of metallic materials. Beyond quality assurance, these tests can be used to optimize material selection, for example, by comparing different alloys for their corrosion resistance under specific environmental conditions.

Drawing on our expertise and research, we provide guidance and support when it comes to assessing corrosion risks and selecting materials. We can also assist with laboratory analyses and inspections if damages occur and the root cause must be identified.









On-site mechanical testing

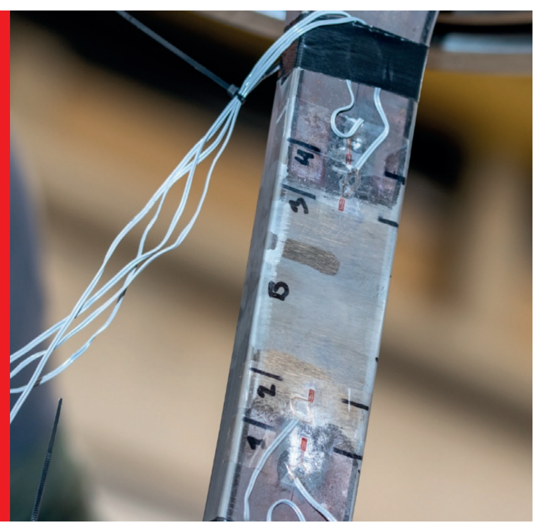
If your product needs to be tested during operation or under specific conditions that are easier to replicate outside the lab, we can help. Our extensive experience covers a wide range of equipment that can be brought and used directly on-site.

On-site testing provides valuable insight into how a product performs in real-world operating and usage conditions. We can run tests on individual components, assemblies, and larger structures. Working closely with you, we define the testing framework – specifying which properties to measure or verify, and how the test will be conducted to meet current requirements and specifications. If special equipment is needed, we can source it or design and manufacture it ourselves, ensuring you get a complete turnkey solution with expert support throughout the process. An on-site test typically lasts one or several days, during which we perform measurements and collect data. Afterward, we process the data and select the results most relevant to your needs. Findings and conclusions are compiled into a report, which we review with you in a follow-up meeting to address any technical questions together.

Equipment for on-site testing:

We have an extensive range of equipment ready for use in the field, which includes:

- Displacement meters
- Strain gauges
- Load cells for both tension and compression
- Optical measuring devices for displacement, speed, and acceleration
- Hydraulic equipment



On-site metallurgical inspection

Condition assessment:

We carry out on-site inspections of structures exposed to corrosion with a focus on quantitative condition assessment. The process may include wall thickness and coating thickness measurements, as well as chemical analysis of collected samples using X-ray spectroscopy, for example to identify corrosion products and foreign particles as part of a root cause analysis.

Layer thickness measurement:

We perform coating thickness measurements on corrosion-protective coatings (paint, galvanizing, etc.) on steel structures. Using the Elcometer 456, we measure coating thickness and verify it against requirements in relevant standards or specifications, and for galvanized steel we can also estimate the remaining service life of the zinc layer.

Hardness measurement:

Fire exposure can alter the metal's microstructure and reduce the load-bearing capacity of steel structures. Using the Proceq Equotip 550, we perform hardness measurements on e.g. steel trusses to document any mechanical property changes due to heat exposure and provide a basis for an engineering assessment of whether components can be retained or must be replaced.

Corrosion category (ISO 9226):

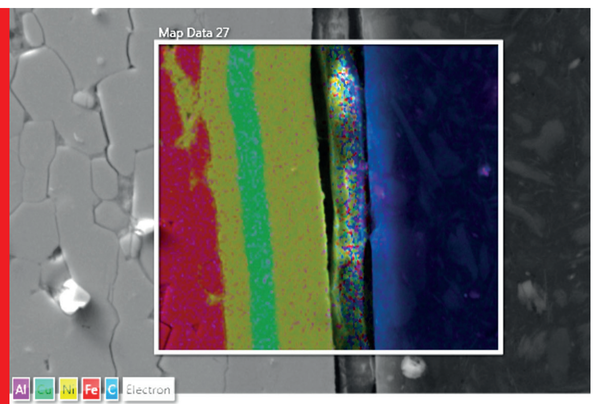
We measure the corrosion category for specific locations in accordance with ISO 9226 as a basis for material selection and corrosion protection. On-site, we expose four metal coupon types for one year and determine the corrosion category based on the coupons' mass loss due to corrosion.

Chemical composition analysis

Danish Technological Institute provides chemical analysis of metallic materials using X-ray spectroscopy (SEM-EDX) and optical emission spectrometry (OES). These methods can be applied individually or together depending on the issue, as well as accuracy and local resolution requirements — from identifying unknown alloys and verifying material certificates to in-depth investigations for failure analysis and corrosion studies.

SEM-EDX merges high-resolution electron microscopy with X-ray spectroscopy and is ideal for localized or spot chemical characterization. This technique enables mapping of element distribution within microstructures, such as precipitates, inclusions, coatings, and corrosion products; it also helps clarify the links between microstructure and damage mechanisms.

OES is typically used for chemical analysis of entire components or test samples, providing precise identification of alloy elements in materials like steel and copper alloys. This method is frequently used to prepare conformity declarations.



OES

- Emission lines from plasma created at the surface of the sample are compared to calibration curves based on known reference materials.
- This method can detect alloying elements down to about 10 ppm.
- Certified for determining chemical composition in selected steel and stainless steel alloys, as well as copper and copper alloys (see section **Standardised tests**).

SEM-EDX

- This method takes advantage of the fact that the energy of X-rays emitted from an atom is unique to each element.
- it can measure the concentration of heavy elements with an accuracy of around 0.1 weight percent.
- With a pressurized chamber (VP-SEM), the chemical composition of non-conductive materials can also be analysed.

Particle identification

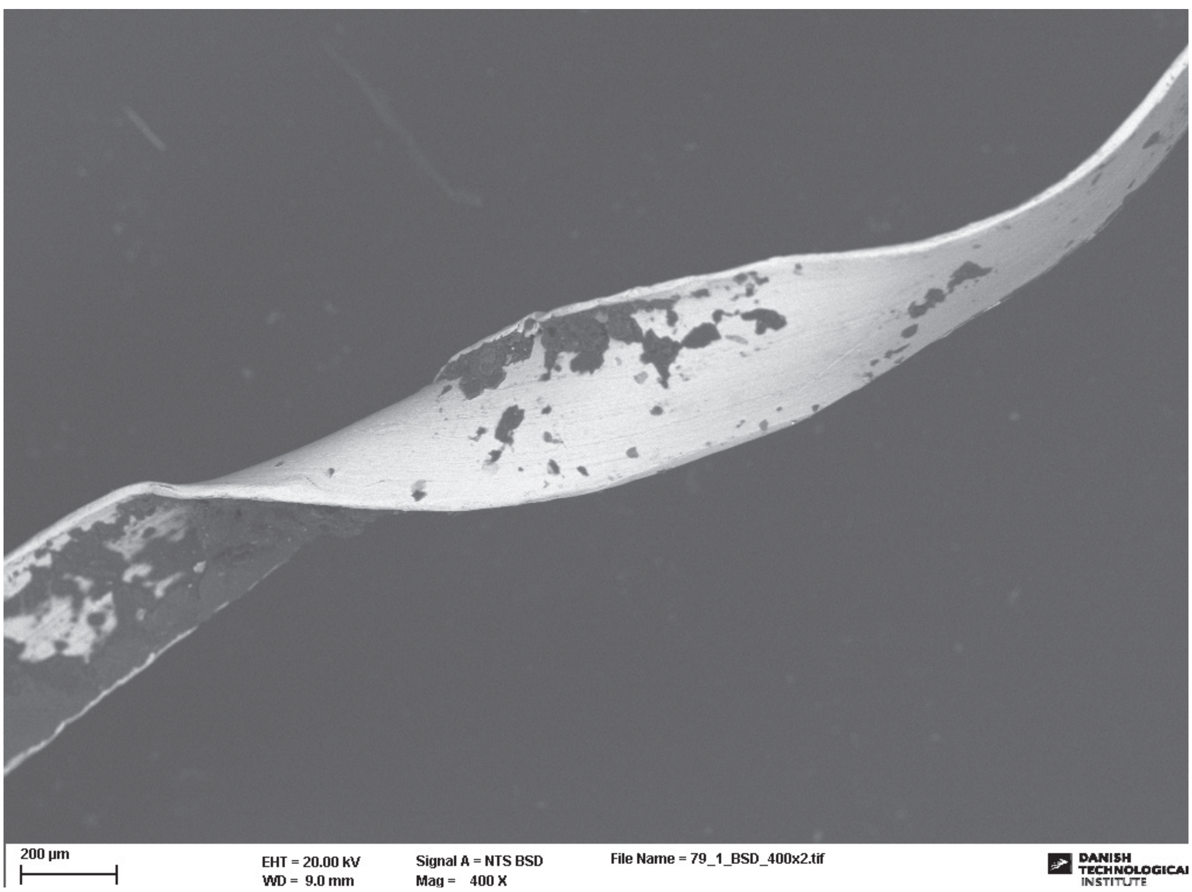
Particle contamination can, for example, occur due to wear, maintenance, or repairs on production equipment. It may also result from malfunctions in cleaning systems. Such contamination typically poses risks to operations and product quality, which can only be resolved by identifying and removing the source of the particles.

We have extensive experience in analyzing the chemical composition, shape, and surface characteristics of particles. Additionally, we provide guidance on the typical uses of alloys in various components and on processing methods that can generate specific particle types. With this insight, potential sources of contamination can be identified or narrowed down, offering an ideal starting point for corrective action.

Our analyses can be performed on particles as small as a few micrometers in size and for all types of alloys. Sample preparation such as concentration, filtration, or precipitation can be carried out at the Danish Technological Institute.

Analysis Methods

- Determination of elemental composition and spatial distribution using scanning electron microscopy with X-ray spectroscopy (SEM-EDX)
- Optical microscopy up to 2500x magnification
- Scanning electron microscopy (SEM) with secondary electron (SE) or backscattered electron (BSD) detection, up to 80,000x magnification



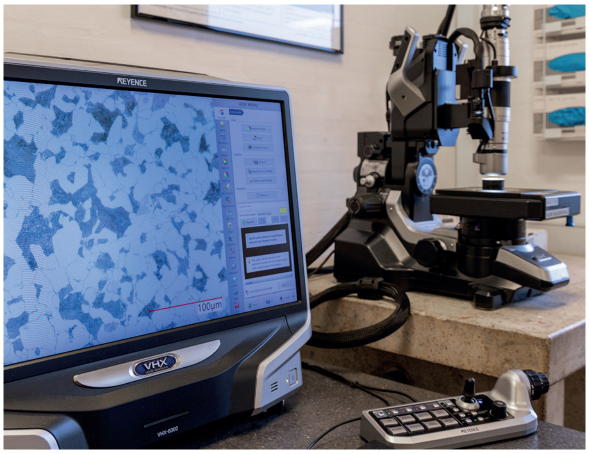
Microstructure characterization

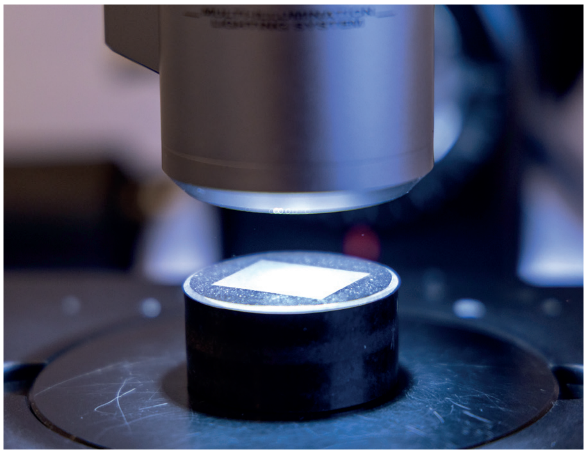
The Danish Technological Institute provides metallographic analysis of metals and alloys using light optical microscopy and scanning electron microscopy (SEM). We prepare, grind, and polish the samples, then use controlled etching to highlight features like grain structure, phase distribution, segregation, and inclusions.

With SEM, we can enhance optical investigations by offering higher local resolution and greater detail for example when examining particles, defects, and fracture surfaces.

Microstructure characterization can be crucial for tasks such as quality control and verification of material condition (including heat treatment, weld structure, microstructure, and porosity in additively manufactured components), as well as for assessing grain size, shape, and any unwanted phases.

For fracture and failure analysis, we can combine microstructural examinations with fractographic SEM studies to clarify the relationship between fracture progression, microstructure, inclusions/weld defects, and potential damage mechanisms. The results are compiled in a technical report highlighting the correlation between the observed microstructure and the specified requirements or the particular failure issue.



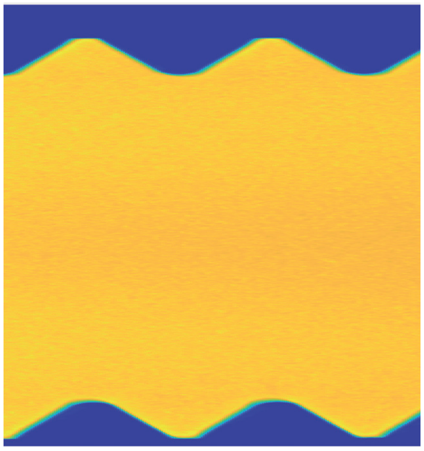


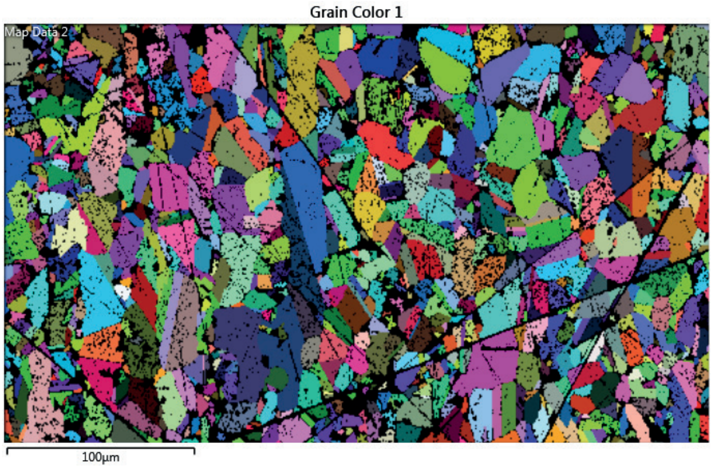
Advanced characterisation

We have the equipment and expertise to perform a variety of advanced analysis methods, providing in-depth information on materials and components.

The available insights depend on the component and material composition, and typically include microstructure, chemical analysis, residual stress, layer thickness, and spatial structure distribution This knowledge can deepen your understanding of component properties and support both product development and quality control.

Danish Technological Institute is happy to provide precise measurements and expert insights, and brings years of experience facilitating projects in advanced laboratories, collaborating with leading specialists across various methods. Reach out to learn more about advanced characterization possi-bilities for your specific product.



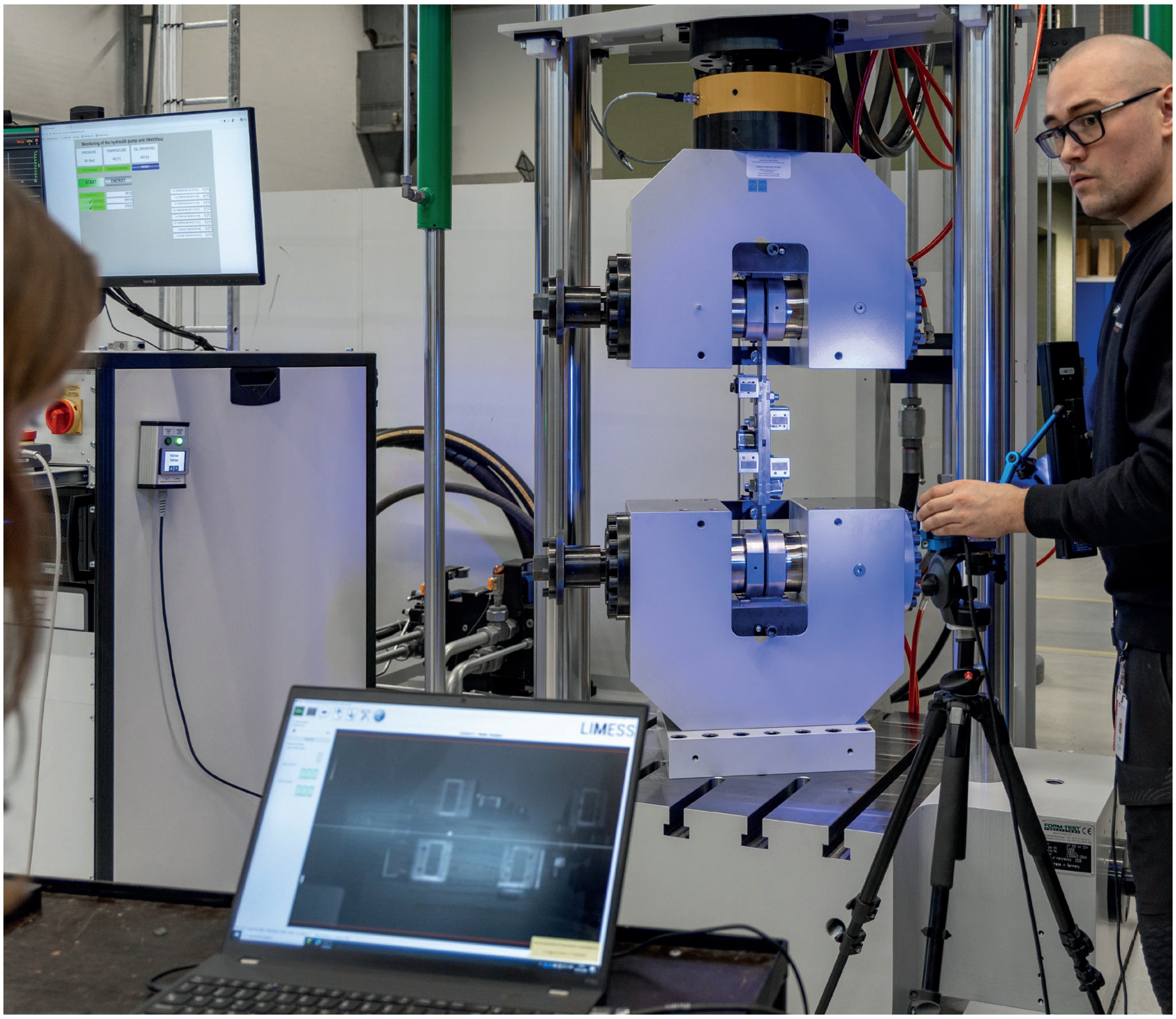


Electron backscatter diffraction (EBSD)
Used, for example, for in-depth grain structure analysis and identifying defects.

Radiography
Used to detect joints, cracks, and geometric flaws that are not visible on the surface.

Residual stress measurements
Helps understand how manufacturing methods influence internal stresses in materials, which can affect the risk of failure and reduce the component's lifespan.

X-ray diffraction
Can be used to analyze different phases within a material, for example, phases that impact corrosion resistance and mechanical properties after heat treatment.



Slip test according to EN 1090-2, Annex G

The slip test is used to determine the slip factor (μ) in pre-tensioned friction joints. The test documents the shear load at which relative movement begins between the plates and confirms whether friction can be considered as the main load path in the construction.

The test is carried out on a splice joint made up of four bolted plates subjected to tension. During the test, the following are recorded:

- Bolt pre-tension (clamping force)
- Relative movement between the plates (typically measured at several points)
- The applied tensile load

The slip factor is determined based on the measured slip load and the effective bolt pretension.

The method is used for:

- Determining the actual slip factor for specific surface combinations, including sandblasted, painted, or metallized surfaces
- Verifying assembly practices and tensioning levels, including assessing variations in bolt pre-tension
- Quantifying slip initiation (typically at 0.15 mm relative movement) and documenting the joint's shear stiffness before slip 19
- Statistical determination of the characteristic slip factor according to EN 1090-2

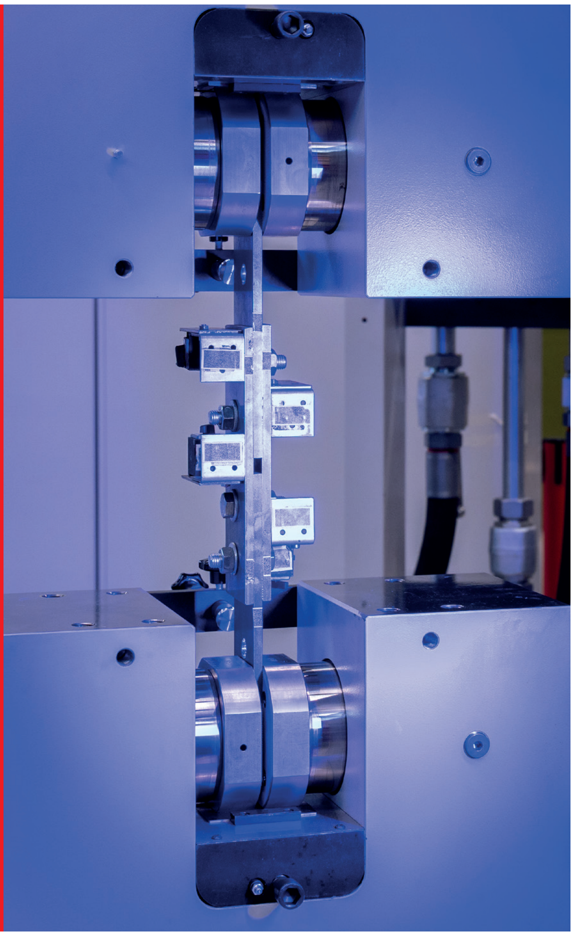
The test can be carried out on surfaces that are mechanically processed, coated, or fitted with friction plates - Bolt sizes up to M20 (and larger, depending on the setup) can be tested. DTI can handle the preparation of test plates, assembly, test execution, as well as subsequent data processing and evaluation.

The slip test is commonly used when qualifying new surface treatments, switching suppliers, making process changes, or for project-specific documentation when standard table values are not considered sufficient

A slip test according to EN 1090-2, Annex G includes:

- 4 static tests up to 0.15mm displacement
- 1 creep test at 90% of the slip load found in the previous 4 tests
- Additional creep tests may be conducted based on the results of the first creep test

The test is carried out with continuous monitoring of force, displacement, and bolt tension to fully document the process and ensure compliance with Annex G requirements.



> **Keep looking ahead! Try to glimpse the paths the future will carve for progress, and place yourselves right where you sense the Institute's support will be needed. Don't expect to reach new horizons by following old, worn tracks. The journey often leads along unknown trails and shortcuts.**
>
> – Gunnar Gregersen,
> Founder of Danish Technological Institute