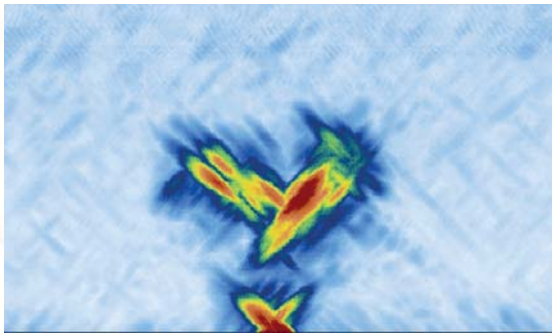
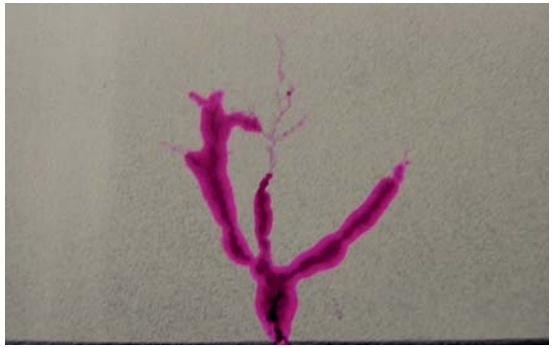
Technical Facilities, Equipment

- Sample preparation equipment for metallography and optical microscopy: Vibration polishing (VibroMet2), fully automatic electrolytic polishing and etching (LectroPol5), fully automatic hardness testing (KB10) with a range of HV 0.0025 – HV10
- Optical Emission Spectroscopy (OES) for determination of the chemical composition of steels and aluminum alloys
- Energy-dispersive X-ray micro analysis EDX (in combination with SEM und TEM)
- Scanning electron microscope JEOL JSM 6400
- Zeiss Auriga Crossbeam electron and ion beam microscope with EBSD system, Focused Ion Beam (FIB), lift-out technique, STEM, energy-dispersive X-ray micro analysis EDX
- System for digital imaging, archiving and documentation (Imagic)
- Transmission electron microscope Jeol JEM 2000FX
- Transmission electron microscope Jeol JEM 2010 F
- Software packages Thermocalc® und DICTRA® for calculation of phase diagrams and precipitation processes (thermodynamic simulation)
- Quantitative microstructure image analysis
- Ultrasonic system GE USN 60 for use with conventional UT probes
- Olympus Omniscan MX2 for use with conventional and Phased Array probes
- Ultrasonic simulation software package CIVA
- Two-axes scanner for automated scanning and position-encoded data collection
- Encoders for semi-automated scanning
- Ultrasonic wall thickness measurement GE DMS 2 TC
- Acoustic emission system Vallen AMSY6 for acquisition with up to 12 channels
- X-ray tubes for radiography with energies up to 300 keV
- Radiographic imaging using conventional X-ray film or high-resolution phosphor imaging plates (Dürr-NDT)
- Videoscope Olympus IPLEX FX
- Equipment for magnetic particle testing and penetrant testing in the lab and on site
- Multi-frequency eddy current system for inspection with up to 4 frequencies, different probes, scanner for position-encoded data acquisition (lab device)

Non-Destructive Testing:



Ultrasonic inspection



Penetrant testing

Radiography

Contakt

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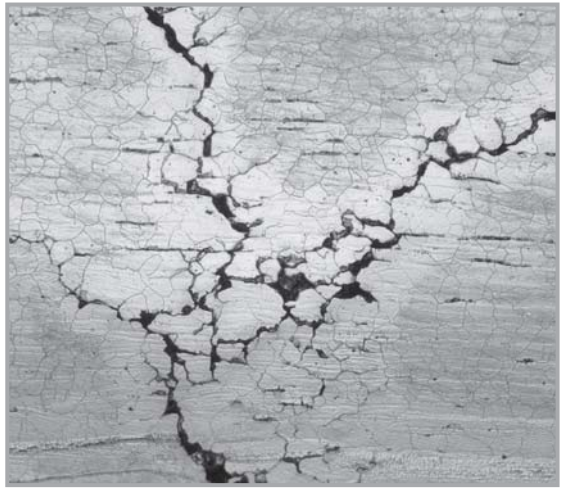
MPA STUTTGART
Materials Testing Institute
University of Stuttgart

Department
Non-destructive Testing and Material Characterization

Units

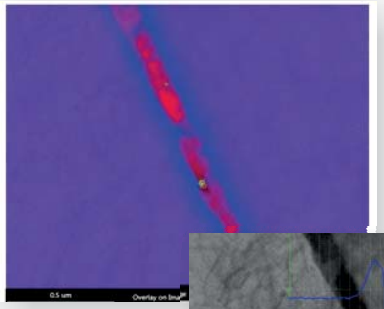
- Non-destructive Testing (NDT)
- Electron Microscopy and Metallography
- Research Network AMICA



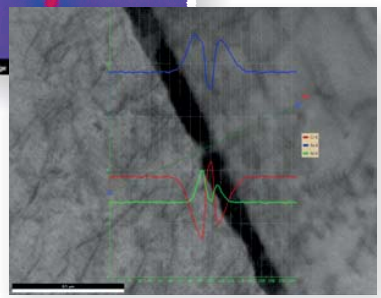
University of Stuttgart
Germany

Material properties and imperfections are a major influencing factor for the behavior of components under operational loads and for the lifetime of components and installations. Characterization and imaging of material properties on multiple length scales is an essential tool in studies of material behavior under the expected loads and of damage mechanism and progression. The Department NDT and Materials Characterization with its equipment and expertise can study and characterize different material properties down to the nm-scale range. The knowledge gained through characterization and imaging can be applied to optimize material properties and fabrication processes, and will contribute to the identification of causes for component failures.

The department's laboratories are accredited according to DIN EN ISO/IEC 17025:2005 for different NDT methods (UT, RT, VT, MT, and PT), metallography, and electron microscopy. The department also holds accreditation according to DIN EN ISO/IEC 17020:2012 as inspection body type A for determination of conformity with requirements of the High Pressure Gas Pipeline Ordinance (Gashochdruckleitungsverordnung - Gas HDrLtgV).



TEM: element mapping across a grain boundary



Linescan:
Cr (red)
Fe (blue)
Ni (green)

Research / Development

- Study of materials microstructure and its relation to material behavior under loads (thermal, mechanical)
- Determination and characterization of features related to damage mechanisms, such as optical microscopy for visualization of creep cavities or study of the evolution of precipitates using scanning electron microscopy (SEM) and transmission electron microscopy (TEM) imaging
- Novel sample preparation techniques for metallography and electron microscopy

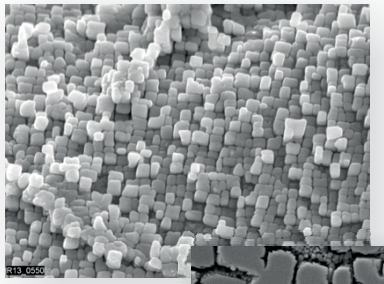
- Scientific and technical studies and projects related to:
  - Application of ECCI technique within the field-emission-SEM AURIGA for determination of dislocation densities
  - Thermodynamic simulation of phases and precipitates in high-temperature creep-resistant steels
  - Evaluation of the impact of microstructural properties on hardness and deformation resistance in nickel alloys for power plant applications

- Studies on ultrasonic inspection of austenitic stainless steel welds, nickel alloy welds, and dissimilar metal welds
- Evaluation of uncertainties in non-destructive testing for probabilistic reliability assessment of components
- Transfer of scientific research results into on-site applications for safe and reliable operation of components and installations

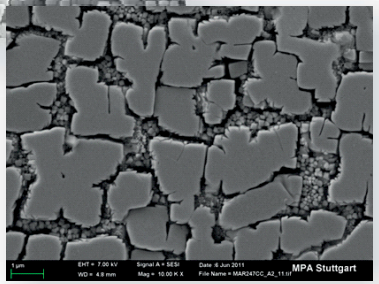
- Stuttgart Research Focus (SRF) Advanced Materials Innovation and Characterization AMICA:
  - Initiation of a shared experimental and numerical infrastructure for multi-scale materials characterization of modern materials
  - Interdisciplinary development and implementation of ideas
  - Linking of experiments and simulation on multiple scales
  - Generation of comprehensive information to determine material properties and component behavior
  - Transfer of basic research into application-relevant developments and services in the field of material characterization

Testing / Imaging / Characterization

- Microstructure characterization using optical and scanning electron microscopy, including quantitative evaluation with automated image analysis techniques
- Hardness testing
- Determination of the chemical composition of steels and aluminum alloys (spectral analysis)
- Imaging of surfaces and characterization of fracture surfaces and cracks using scanning electron microscopy (SEM)
- Transmission electron microscopy (TEM) for high-resolution microstructural imaging, analysis of crystallographic phases, and determination of local chemical composition on a nanometer-scale
- Thermodynamic simulation for determination of phase diagrams and precipitation processes
- Characterization of material condition and material properties, including flaws, for metals and non-metals
- Non-destructive testing of individual parts in small or medium quantities in the lab and on site
- Independent third-party inspections and evaluations (inspection procedures/ execution of NDT / NDT results)



Gamma-prime phase in a cast nickel alloy (SEM image of the fracture surface)



SEM image of gamma-prime phase in a cast nickel alloy; etched with 10% oxalic acid