

We Innovate Materials

MCL Services

Labs and Equipment

Preparation, Metallography, Lightoptical Microscopy

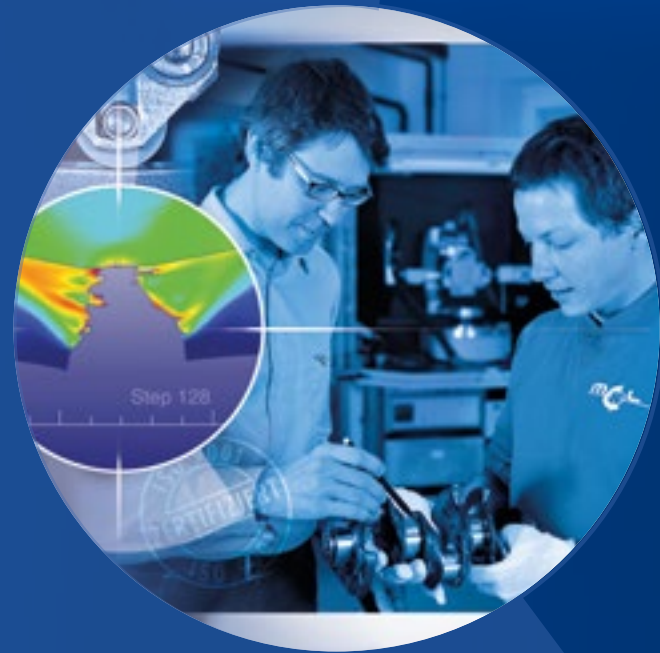
Structure and Phase Analysis, X-ray Diffraction

Scanning Electron Microscopy

Mechanical Materials Testing

Thermal Analysis and Heat Treatment

Microelectronic Test Methods



COMPETENCE & RELIABILITY

We Innovate Materials

Preparation, Metallography & Lightoptical Microscopy

Sample Preparation

Lightoptical Microscopy - Structure Characterization

Hardness Testing

Surface Structures and Topography



COMPETENCE & RELIABILITY

Sample Preparation



Coarse cutting, fine cutting, mechanical specimen preparation
and preparation of metallographic sections

Contact:



Dr. Angelika Spalek
T +43-676 848883 461



Dr. Stefan Marsoner
T: +43-676 848883 400

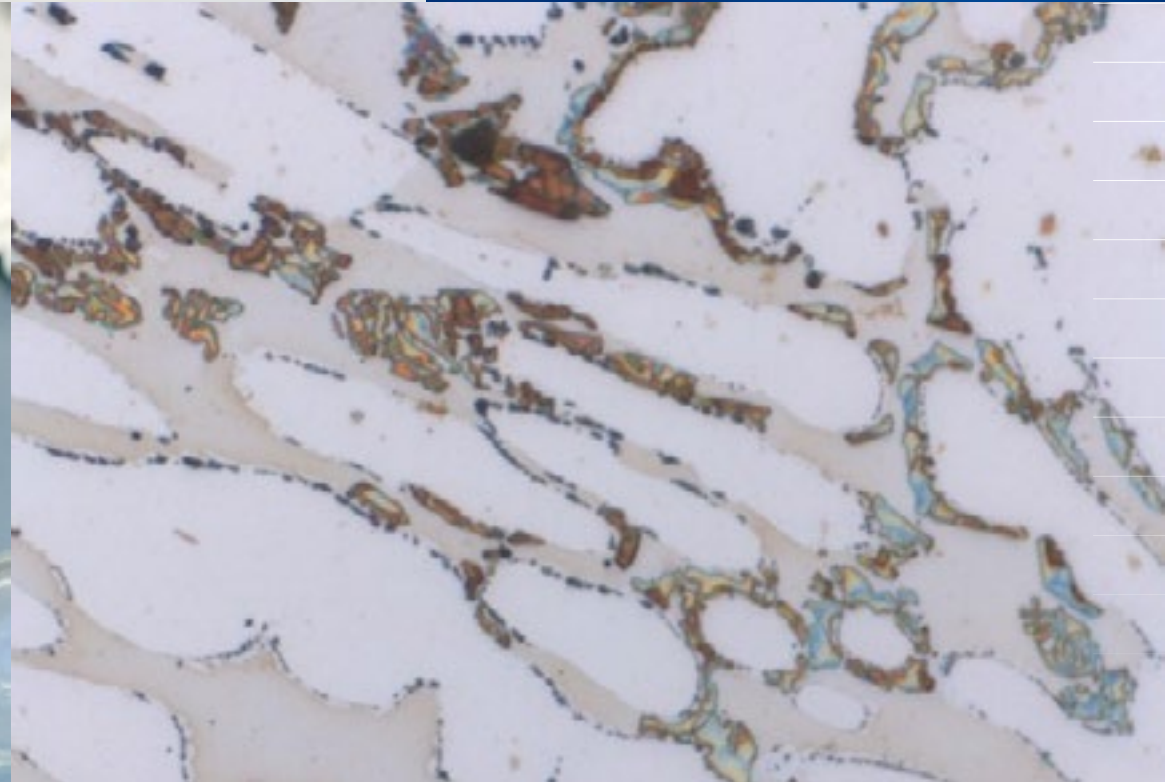
We Innovate Materials

Our Focus / Competences:

- preparation of metallic materials, ceramics, composite materials, special materials, microelectronic components
- coarse cutting of components
- fine cutting of specimen material
- mechanical production of specimens (milling, turning, grinding, eroding (*))
- production of microsections in the size ranging from <0.1 mm to >1 dm for microscopic documentation

(*) in cooperation with our long-term partners/suppliers

Lightoptical Microscopy - Structure Characterization



Characterization of the microstructure of structural parts and functional components

Contact



Dr. Angelika Spalek
T +43-676 848883 461



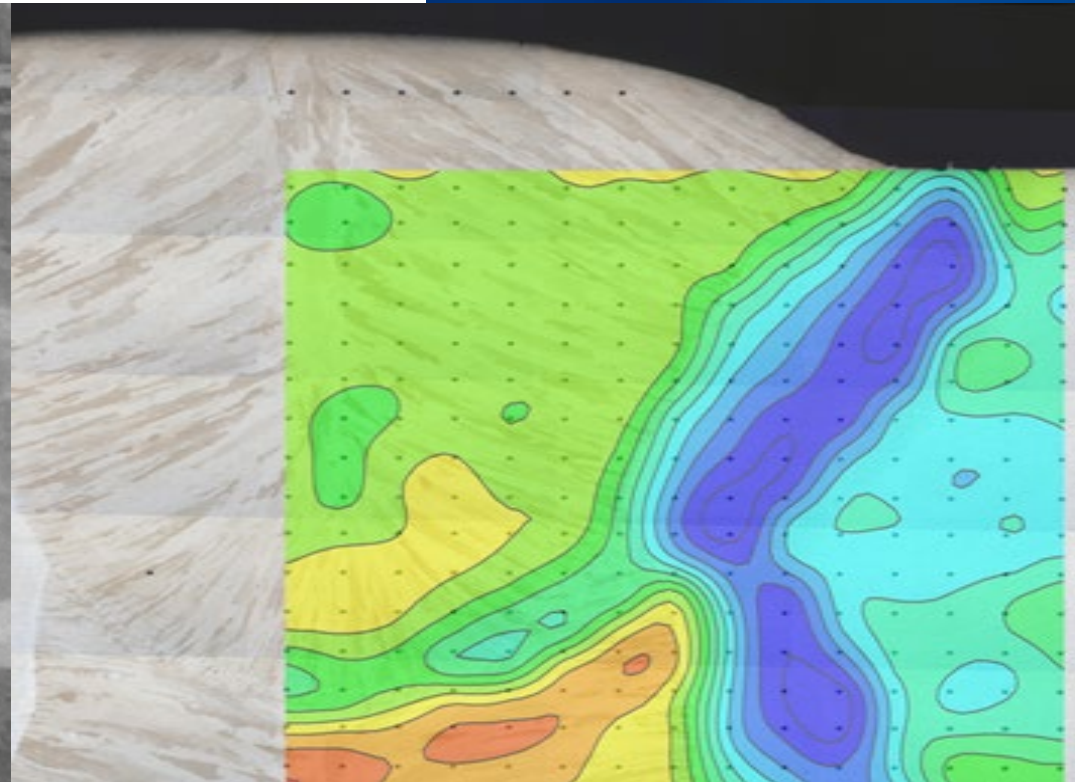
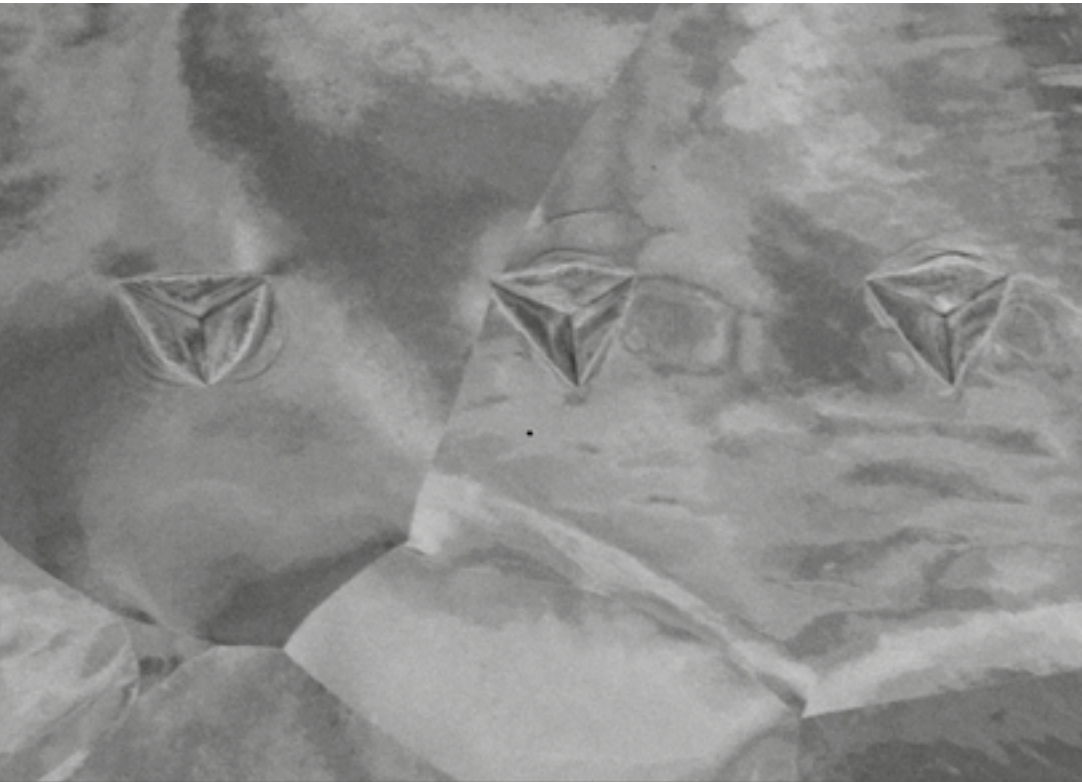
Dr. Florian Summer
+43-676 848883 462

We Innovate Materials

Our Focus / Competences:

- microstructure documentation and analysis
- comprehensive range of etching methods (chemical and electrochemical) for steels, non-ferrous metals, hard metals, ...
- assessment according to various standards
 - content of non-metallic inclusions acc. to DIN 50602, ASTM E45, DIN EN 10247, ISO4967
 - carbide structure in steels acc. to SEP 1520
 - apparent grain size acc. to DIN EN ISO 643 und ASTM E112
 - depth of decarburization acc. to DIN EN ISO 3887

Hardness Testing



Performance of hardness tests from instrumented nano hardness testing to macro hardness testing
(partly within the scope of accreditation according to EN ISO 17025).

Contact:



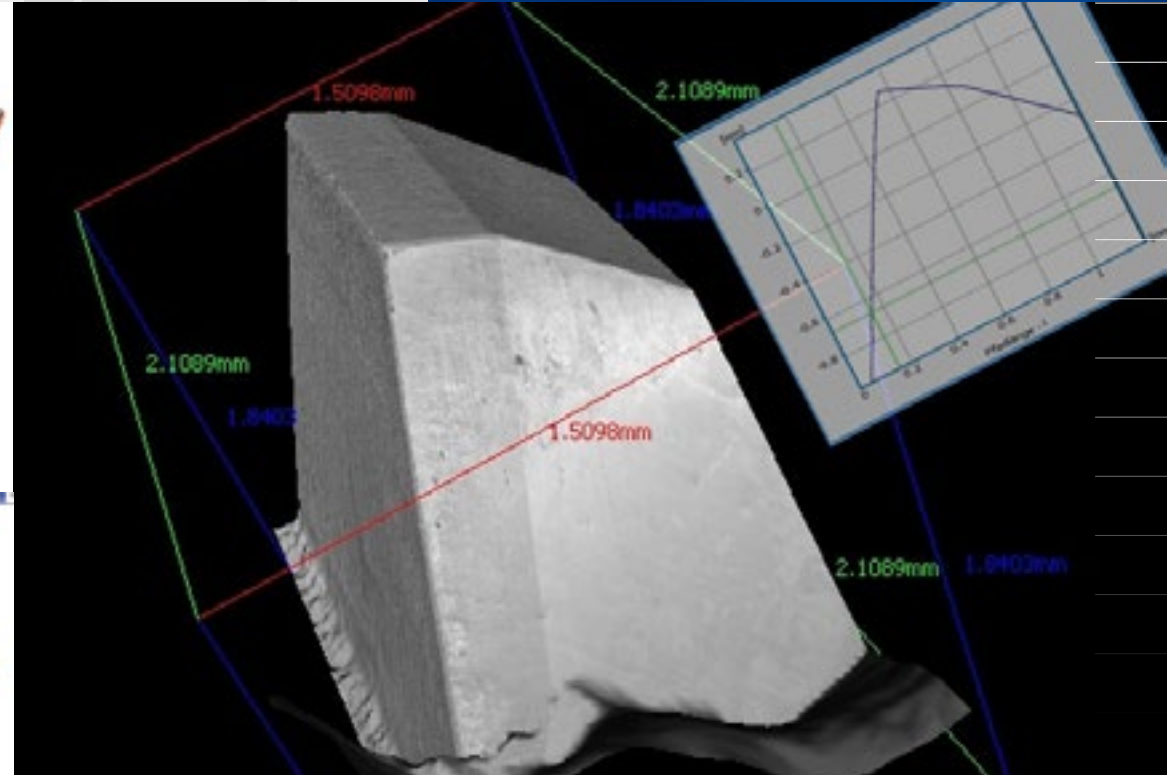
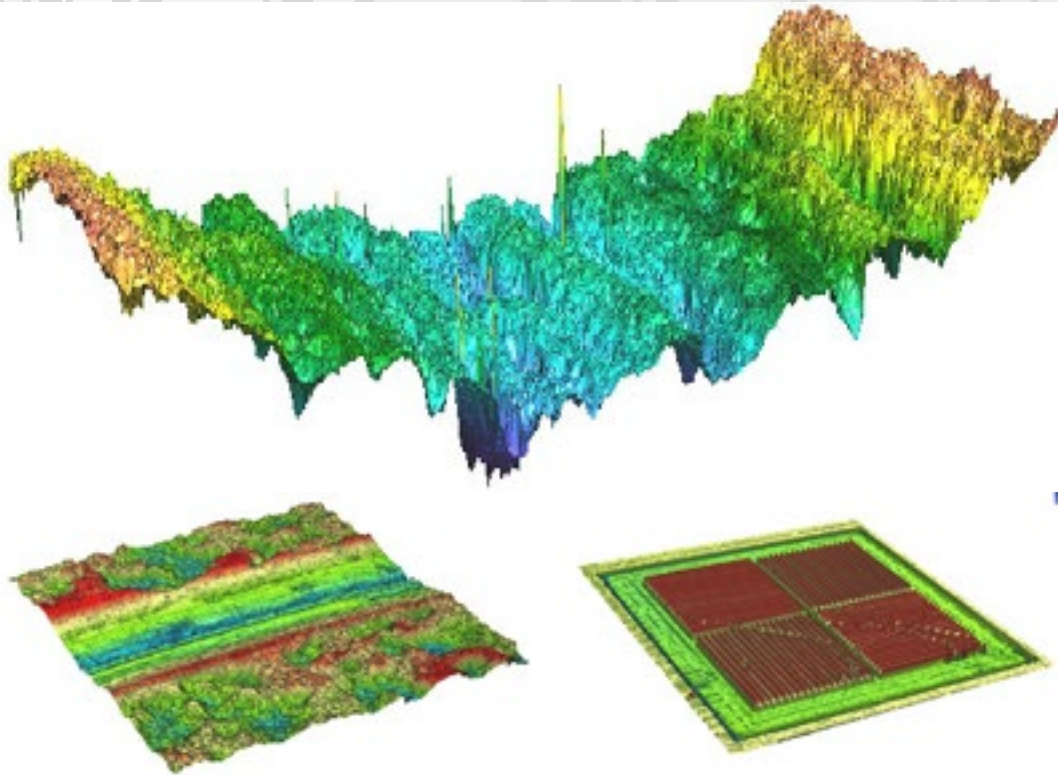
Dr. Angelika Spalek
T: 43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- determination of the core hardness HV, HRC, HB in the accredited testing lab acc. to EN ISO 6506-1 (HB), EN ISO 6507-1 (HV), EN ISO 6508-1 (HRC)
- measurement of hardness profiles and hardness mappings
- instrumented small load hardness measurement
- instrumented nanoindentation
- insitu nanoindentation in SEM

Surface Structures and Topography



2D and 3D - imaging of contours and surfaces from several millimeters to a few nanometers.

Contact:



Dr. Florian Summer
T +43-676 848883 462



Bernhard Sartory
T: +43-676 848883 450

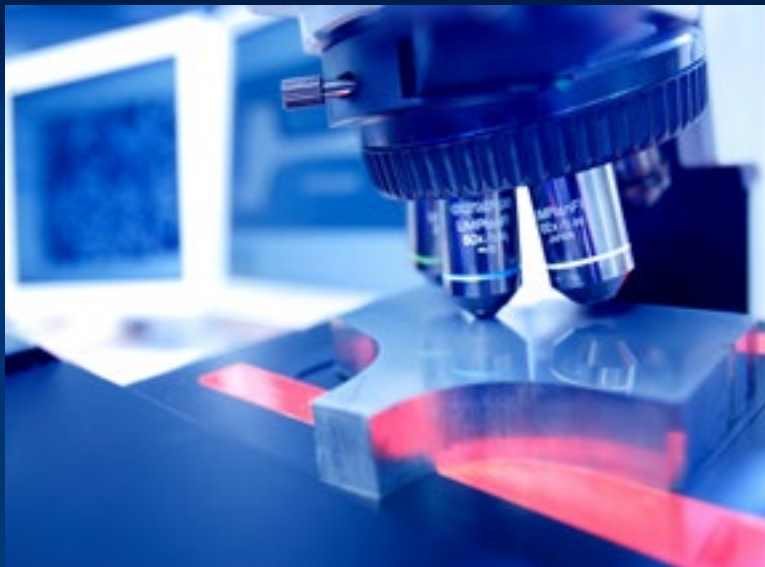
We Innovate Materials

Our Focus / Competences:

- imaging of surfaces, contours or components by means of stereomicroscopy, profilometry and scanning electron microscopy
- roughness measurements (R_a , R_t , R_z)
- wear characterization on samples, components and tools
- 3D topography of contours, damage, etc. incl. measurement in the mm to sub- μ m range in SEM.
- analysis of local deposits, ablations incl. local chemical analysis (EDX).

Service Offer

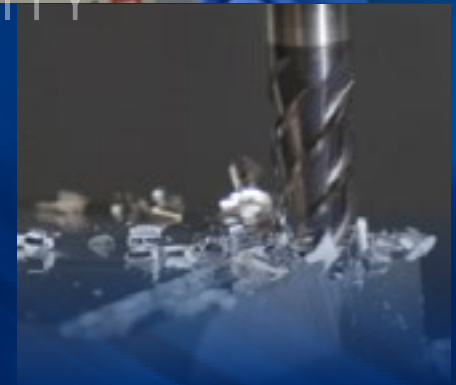
- coarse/fine cutting, mechanical production of specimen material
- preparation of metallographic sections (metallic materials, metal-ceramic composite, electronic components)
- light microscopic examinations (microstructure documentation, microstructure assessment)
 - content of non-metallic inclusions acc. to DIN 50602, ASTM E45, DIN EN 10247, ISO4967
 - carbide structure in steels acc. to SEP 1520
 - apparent grain size acc. to DIN EN ISO 643 and ASTM E112
 - depth of decarburisation acc. to DIN EN ISO 3887
- stereomicroscopic examinations (surface and fractography)
- roughness measurement (Ra, Rt, Rz) by confocal microscopy
- creation of topography images, qualitative and quantitative evaluation in 2D or 3D, also on small to medium-sized components, cutting edges, friction marks, wear surfaces, etc.
- ambulant metallography (on-site-testing)
- one to several days on-site-trainings in the field of metallographic preparation and microstructure evaluation



COMPETENCE & RELIABILITY

Equipment

- coarse and fine cutting machines for sample preparation
- CNC milling and turning machines for sample production
- equipment for hot and cold embedding of microsections
- automated and manual grinding and polishing equipment
- lightoptical microscopy incl. digital image recording and automatic x-y table for analysis of large microsection surfaces
- stereomicroscopy with 3D recording technology
- quantitative image analysis system
- nanofocus µsurf confocal microscope (profilometer) with automatic x-y stage (analysis of large areas)
- various scanning electron microscopes (see SEM folder)



We Innovate Materials

Qualitative and Quantitative Phase Analysis

High-Temperature Properties and Phase Transformations

(X-ray) Residual Stress Measurements

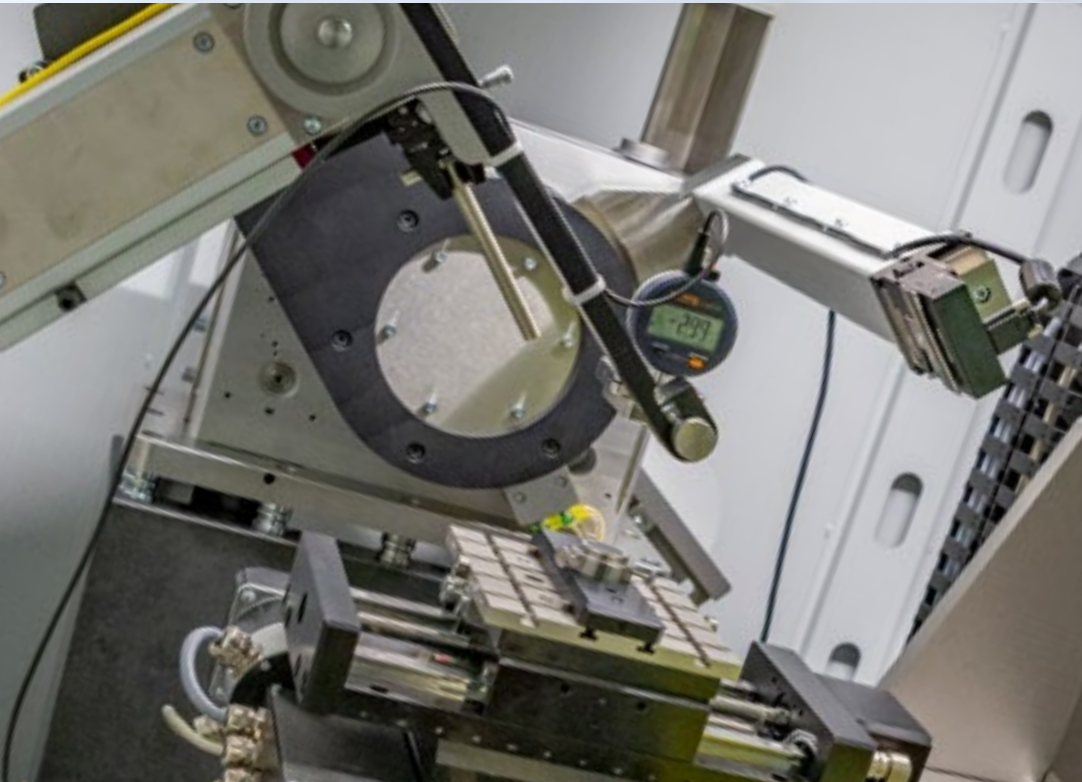
Structure and Phase Analysis

X-ray Diffraction



COMPETENCE & RELIABILITY

Qualitative and Quantitative Phase Analysis



X-ray determination of phase structure and structural parameters
at room temperature
(partly within the scope of accreditation according to EN ISO 17025)

Contact:



Ing. Robert Peissl
T: +43-676 848883 430



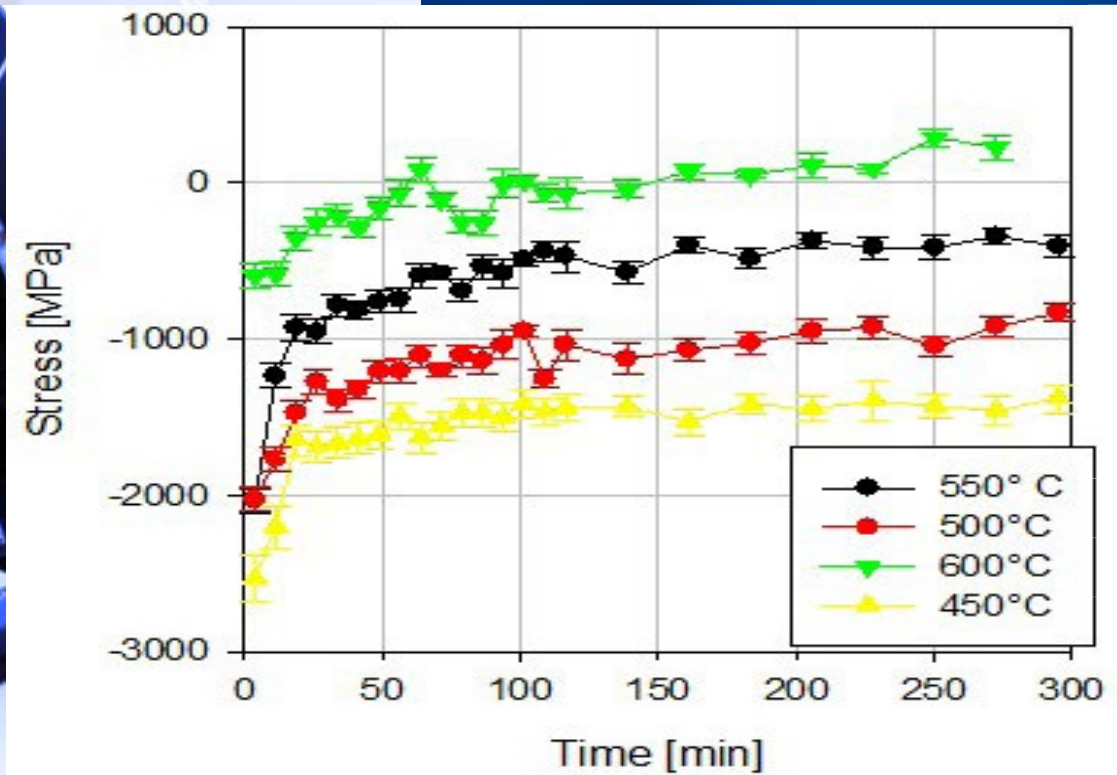
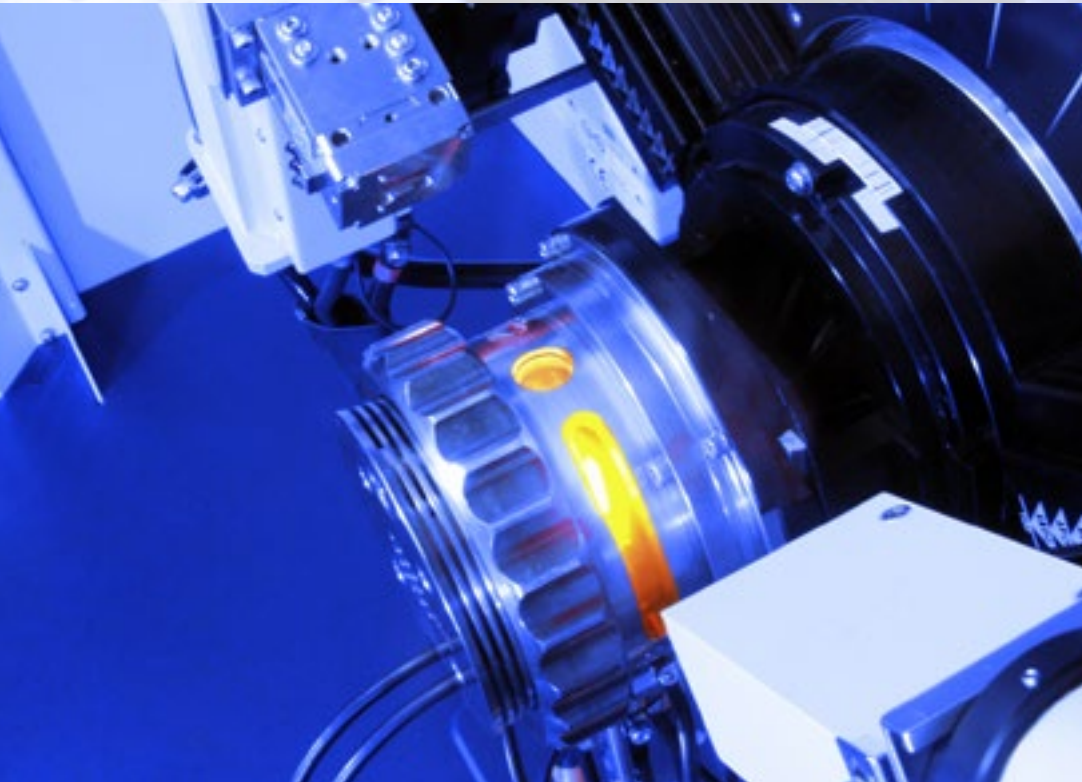
Dr. Stefan Marsoner
T: +43-676 848883 400

We Innovate Materials

Our Focus / Competences:

- qualitative and quantitative phase analysis (incl. Rietveld method)
- determination of lattice parameters (lattice constants, defect density, crystallite size)
- determination of the retained austenite content according to ASTM E 975 (within the scope of the accreditation) or by means of the Rietveld method (laboratory and on-site)
- analysis of ripples, reflectometry e.g. on microelectronic components
- examination of metals, ceramics, coatings

High Temperature Properties and Phase Transformations



Determination of phases, phase transformations, structural parameters and residual stresses at elevated temperatures as well as under different atmospheres.

Contact:



Dr. Florian Summer
T: +43-676 848883 462



Dr. Stefan Marsoner
T: +43-676 848883 400

We Innovate Materials

Our Focus / Competences:

- determination of crystallographic structure parameters as a function of temperature
- determination of phase transformations such as magnetic and lattice transformations, melting, glass transition temperatures
- tracking of phase changes due to annealing processes
- detection of phase reactions (e.g. oxidation, decomposition)

(X-ray) Residual Stress Measurements



X-ray determination of residual stresses
(partly within the scope of accreditation according to EN ISO 17025)

Contact:



Ing. Robert Peissl
T: +43-676 848883 430



Dr. Stefan Marsoner
T: + 43-676 848883 400

We Innovate Materials

Our Focus / Competences:

- X-ray determination of residual stresses, residual stress distributions and residual stress depth profiles on components in the laboratory or at the customer's site (according to EN 15305 within the scope of accreditation)
- residual stress development in layer/substrate composites at temperature-change
- determination of relaxation of residual stresses at elevated temperatures up to 900°C
- determination of residual stresses using the cut compliance method

Service Offer

- qualitative and quantitative radiographic phase analysis (room temperature up to 1400°C)
- determination of lattice parameters (lattice constants, defect density, crystallite size) as f(T)
- determination of phase transformation temperatures
- X-ray phase and structure analysis of thin surface layers
- determination of fiber textures in layer systems
- determination of ripples, reflectometry on microelectronic components
- determination of residual stress depth profiles on specimens and components
- chemical analysis by XRF
- measurements in the laboratory or on-site on large parts, components or materials

Tests offered as part of the accreditation:

- determination of the retained austenite content according to ASTM E975 (accredited) resp. Rietveld method
- X-ray determination of process-related residual stresses according to EN 15305 (accredited)



COMPETENCE & RELIABILITY

Equipment

- X-Ray diffractometer Bruker D8 Discover with ultra-precise Atlas goniometer and a wide range of anode materials, detectors and setups for various applications (e.g. high temperature chamber HTK2000 from Paar for detection of fast phase transformations in inert and oxidic atmospheres (25 to 1400°C))
- X-ray diffractometer Seifert Charon SXL (XRD Eigenmann GmbH): diffractometer for large components for high-precision measurements with a spot size of up to 50µm
- mobile X-ray diffractometer Stresstech Xstress 3000 (G2/ G3) with integrated depth measurement and automatic inspection table, also suitable for measurement of internal surfaces and insitu measurement on testing machines.
- mobile X-ray fluorescence analyzer S1TurboLE from Bruker (Handheld)



We Innovate Materials

Scanning Electron Microscopy

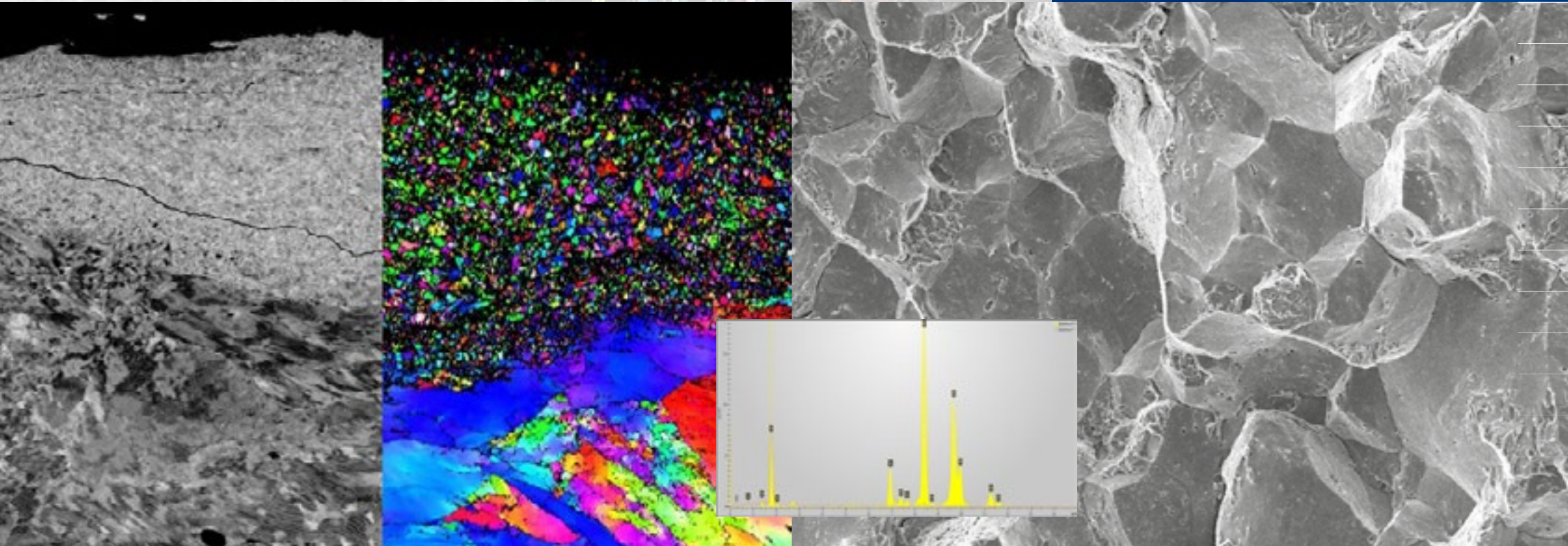


Material and Damage Investigation
3D Microstructure and Contour Analysis
High Resolution Scanning Electron Spectroscopy
Precise Chemical and Structural Analysis
Focus Ion Beam Micromachining
Insitu - Micromechanical Investigations
Insitu - Temperatur Transformation Analytics
Insitu - Temperatur Transformation Analytics
Ex-/Insitu - AFM-Measurements



COMPETENCE & RELIABILITY

Material and Damage Investigation



High resolution examination of material sections, surfaces or fracture surfaces incl. local chemical and crystallographic analysis

Contact:



Dr. Petri Prevedel
T: +43-676 848883 440



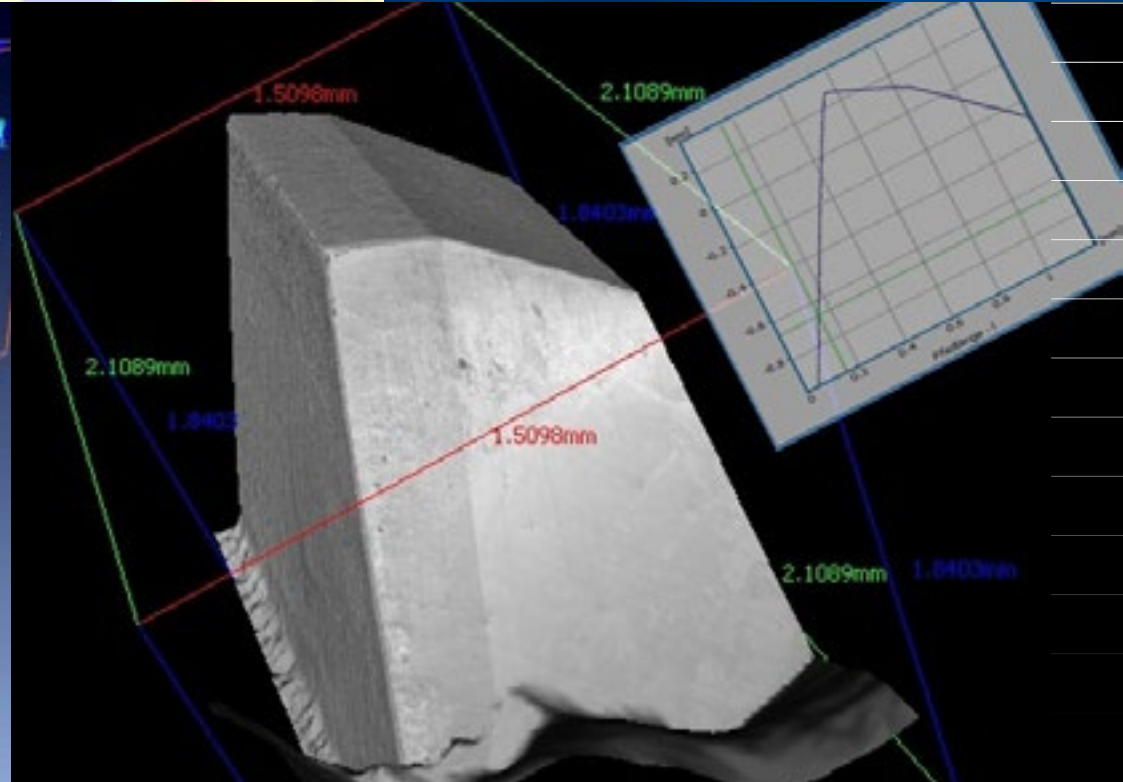
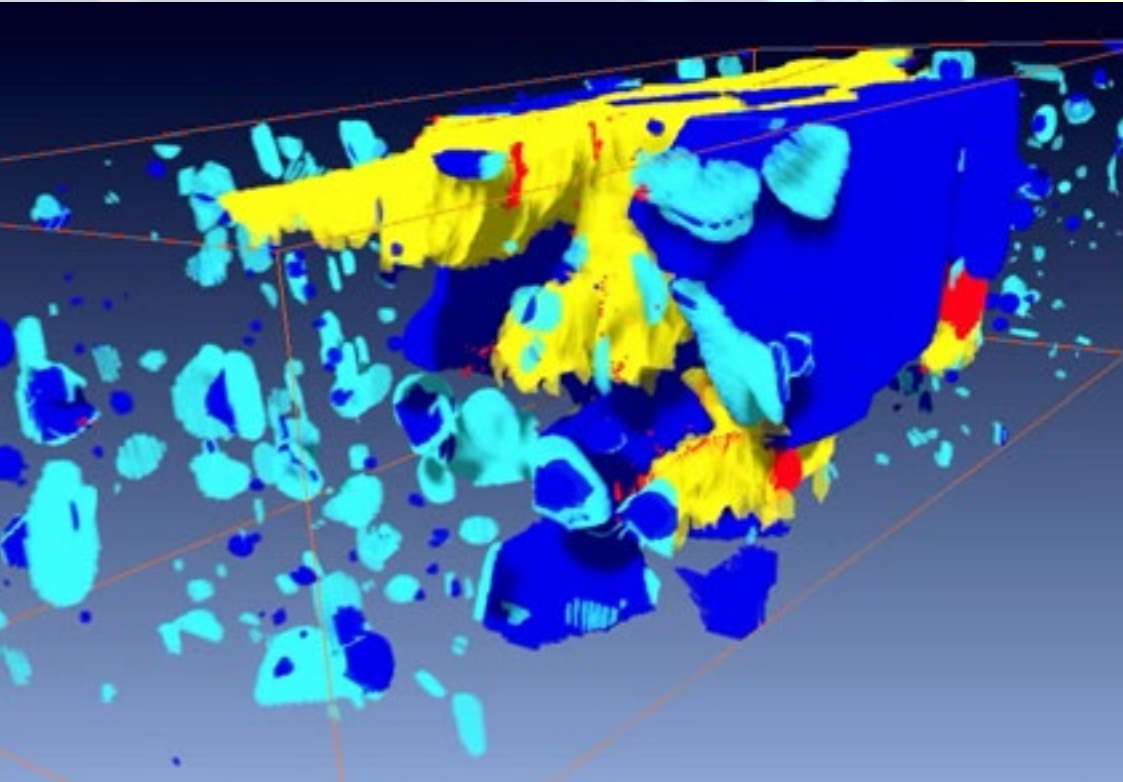
Dr. Angelika Spalek
T: +43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- surface analyses, fracture surface analyses, damage analyses
- analysis of large or difficult-to-clean components (up to 3kg), from microsections up to microelectronic components
- SEM analysis of non-conductive components without additional vapor deposition (e.g. ceramic components, metal/plastic composites)
- local chemical and crystallographic analyses

3D Microstructure and Contour Analysis



High resolution 3-dimensional examination and measurement of contours or structural components

Contact:



Bernhard Sartory
T: +43-676 848883 450



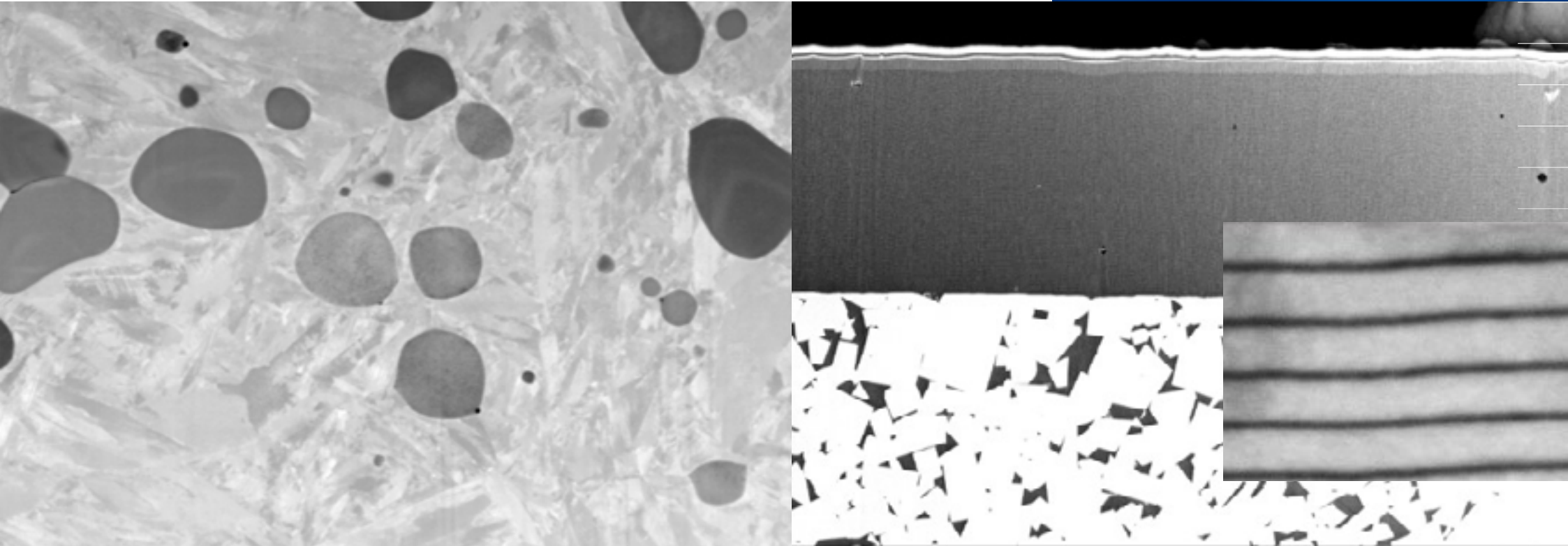
Dr. Angelika Spalek
T +43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- 3D topography of contours, damage, etc. incl. measurement in the mm to sub- μ m range
- 3D tomography of microstructural components by the Slive&View method incl. measurement of local chemistry and structure
- different electron and ion contrasts, EBSD crystal information measurement, 3D chemical element distributions and depth profiles (EDX, EBSD and FIB-SIMS (TOF))

High Resolution Scanning Electron Spectroscopy



High resolution microstructure characterization

Contact:



Bernhard Sartory
T: +43-676 848883 450



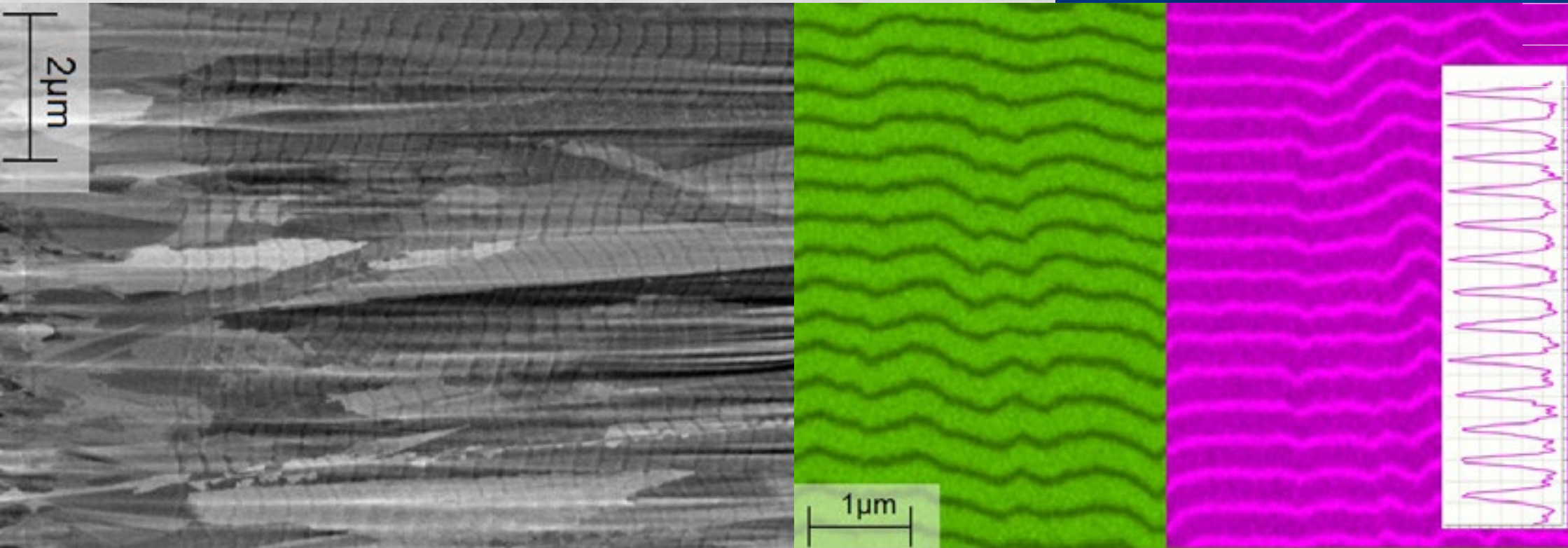
Dr. Angelika Spalek
T +43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- high resolution microstructure characterization with resolutions up to 1,000,000x
- different electron and ion contrasts, EBSD crystal information measurement
- measurement of the crystal structure by EBSD from the cm range down to 20-30nm small structures
- measurement of the local chemical composition as well as element distributions and particle analyses (EDX, WDX, RFA, FIB-SIMS (TOF))

Precise Chemical and Structural Analysis



Precise chemical and structural analysis of finest structural elements down to a few 10nm in size

Contact:



Bernhard Sartory
T: +43-676 848883 129



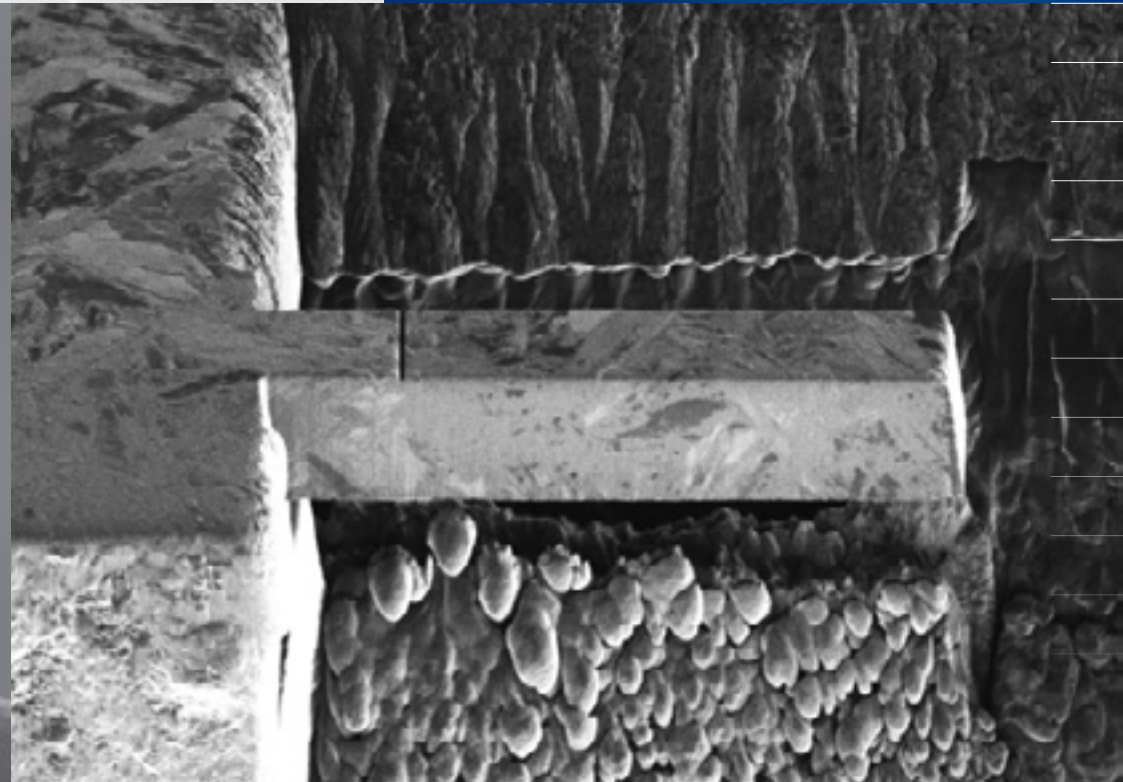
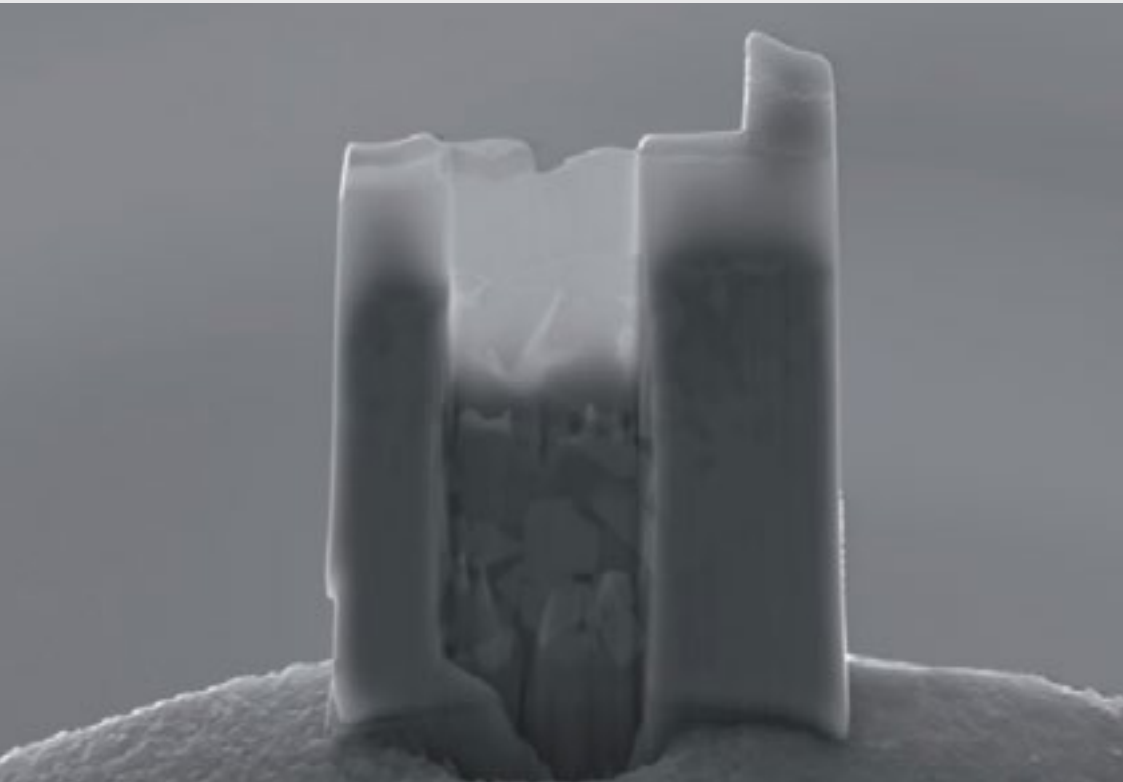
Dr. Stefan Marsoner
T: +43-676 848883 102

We Innovate Materials

Our Focus / Competences:

- precise chemical analysis using EDX, WDX and XRF
- high energy resolution with detection limits of 50-100 ppm
- trace element analyses down to detection limits of 10ppm
- EBSD measurements of grains less than 10nm in size for identification of microstructure or crystal structure
- FIB-SIMS (TOF) surface measurements or depth profiles with a lateral resolution of a few nanometers from main elements to trace analysis

Focused Ion Beam Micromachining



Specimen preparation for micromechanical and microstructural investigations

Contact:



Bernhard Sartory
T: +43-676 848883 450



Dr. Angelika Spalek
T +43-676 848883 461

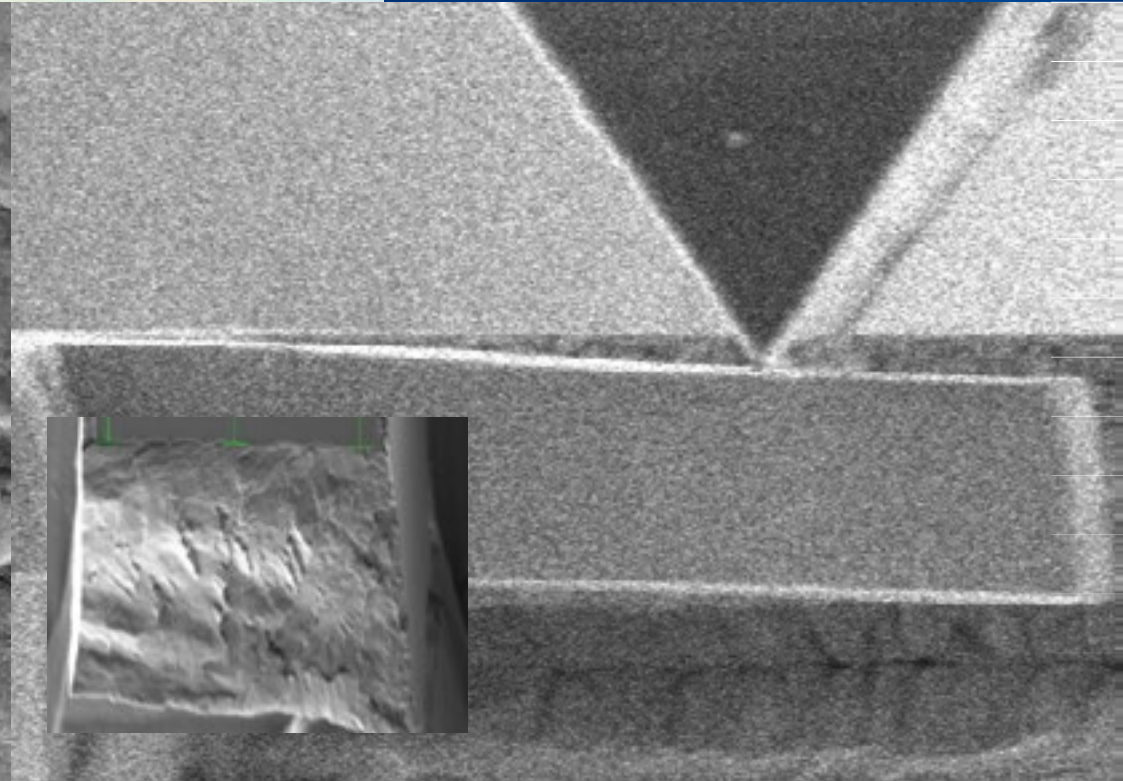
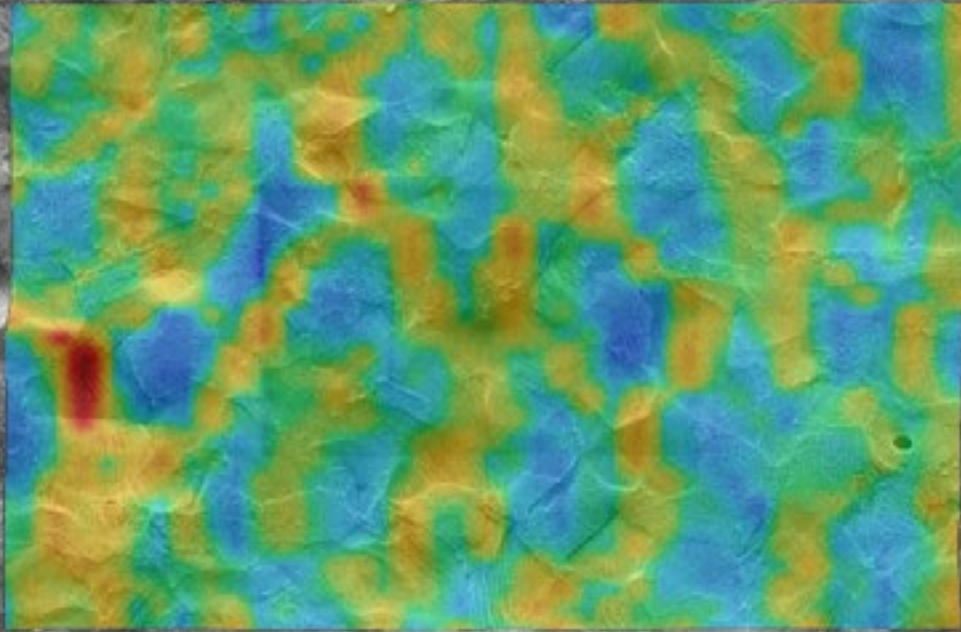
We Innovate Materials

Our Focus / Competences:

- target preparation of thin foils for subsequent electron microscopy and transmission electron microscopy examinations (*)
- target preparation of atom probe tips for subsequent atom probe examinations
- preparation of specimens for micromechanical testing of materials (e.g. thin films or microstructural components)

**advanced TEM, APFIM analyses are performed in cooperation with research partners of the MCL*

Insitu - Micromechanical Investigations



Determination of micromechanical properties of microstructural components or layers

Contact:



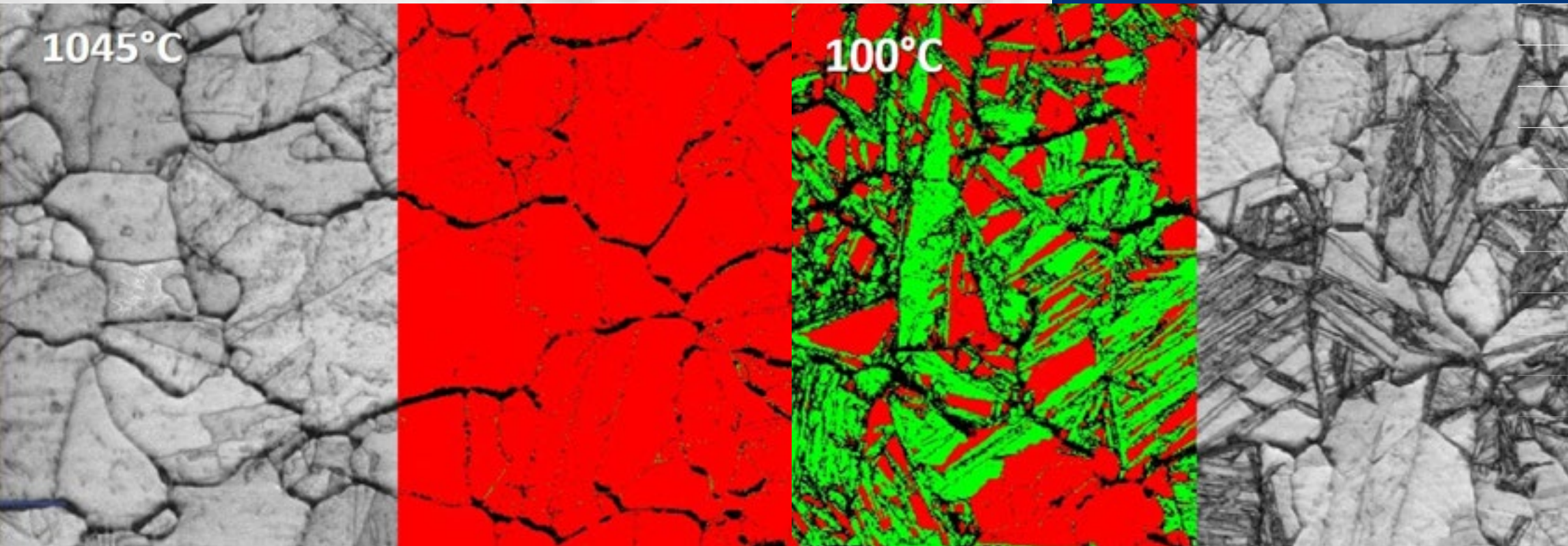
Bernhard Sartory
T: +43-676 848883 450

We Innovate Materials

Our Focus / Competences:

- hardness testing of individual microstructural fractions
- Insitu tensile test to observe local strain changes
- Insitu hardness testing using nanoindenter, recording flow curves and determination of Young's modulus
- Insitu static and cyclic material testing using the nanoindenter, determination of fracture and fatigue properties
- testing of shear resistances at interfaces (e.g. interface of a coating)

Insitu - Temperatur Transformation Analytics



High resolution documentation of the transformation kinetics of individual phase fractions

Contact:



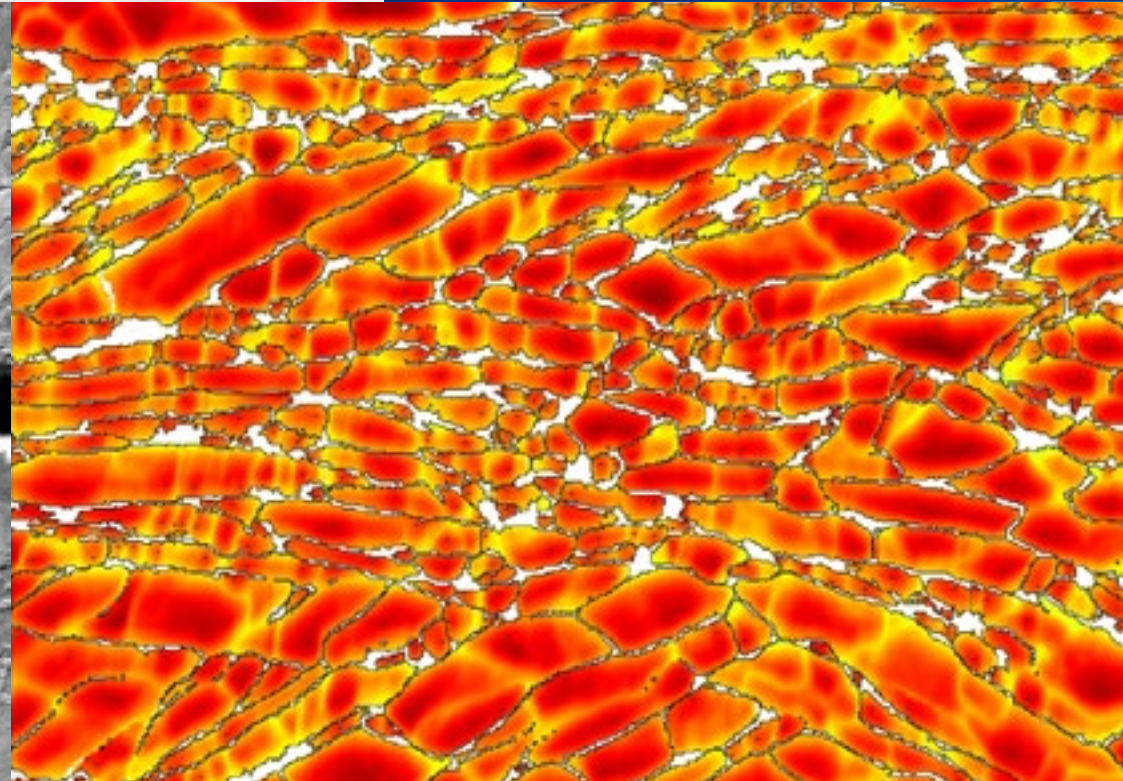
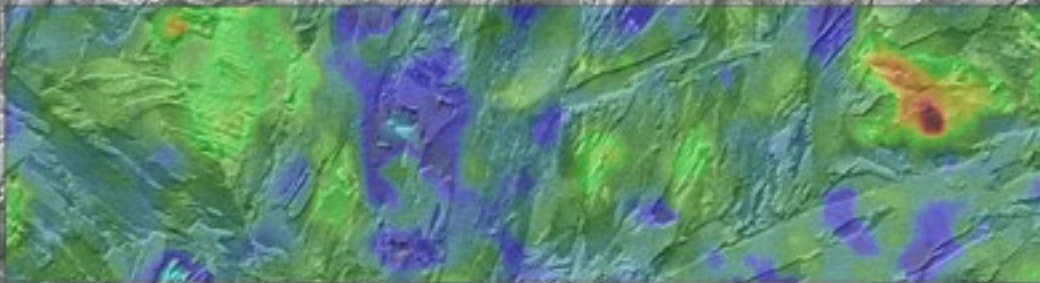
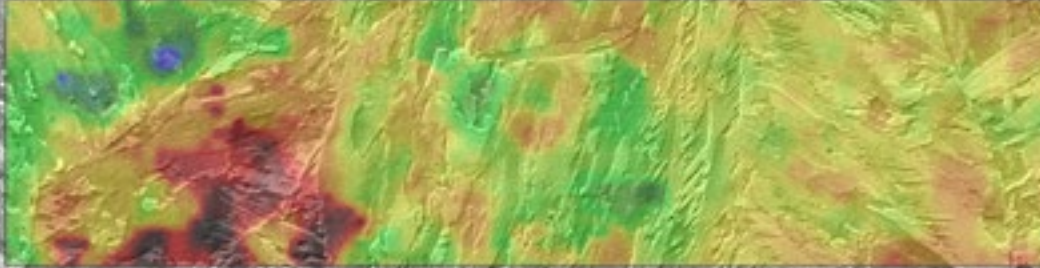
Bernhard Sartory
T: +43-676 848883 450

We Innovate Materials

Our Focus / Competences:

- Insitu heating and cooling experiments in the scanning electron microscope
- temperature range -180°C to 1045°C
- heating rates: -180°C to 400°C max. 20°C/min
250°C to 1045°C max. 250°/min
- temperature-dependent residual stress measurement on coatings
- analysis with various detectors (including EBSD)

Residual stress measurements using electron microscopy



Determination of global and local residual stresses on bulk materials and coatings with a lateral resolution of up to 10 nm

Contact:



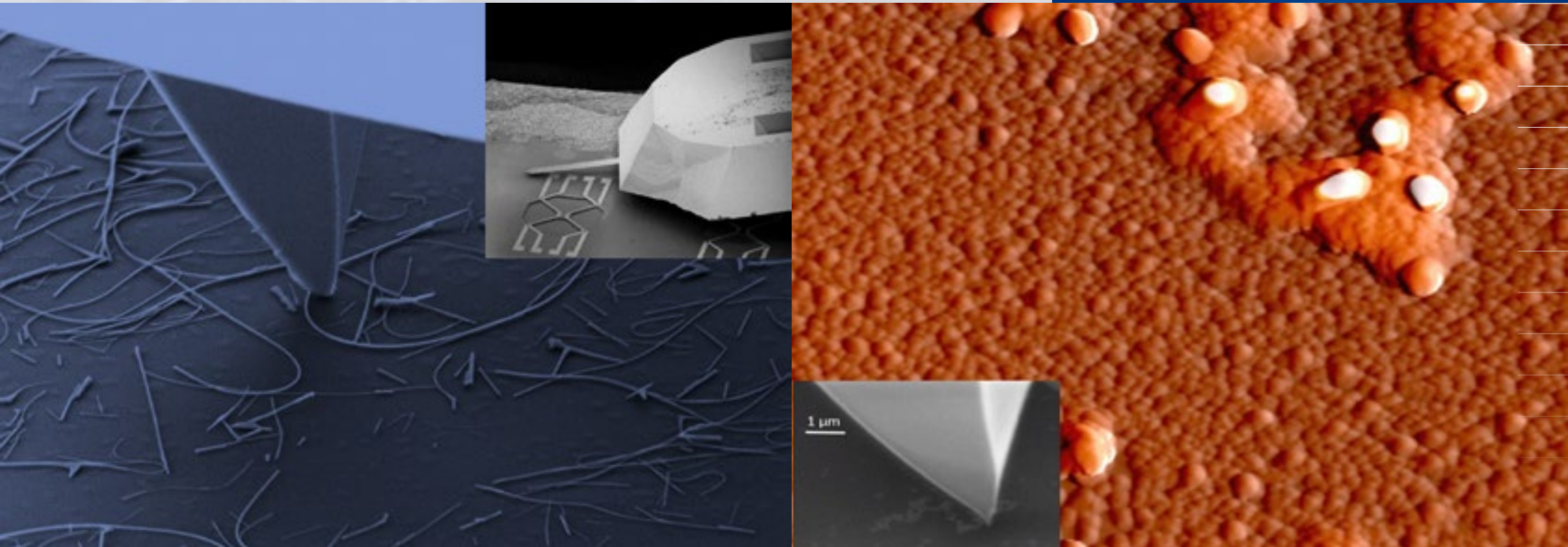
Bernhard Sartory
T: +43-676 848883 450

We Innovate Materials

Our Focus / Competences:

- measurement of residual stresses and residual stress depth profiles of coatings with a depth resolution of up to 10 nm
- temperature-dependent residual stress measurements of microelectronic coatings between -180°C and +400°C
- 2D residual stress distributions of crystalline materials with an accuracy of a few 10nm incl. dislocation density analysis
- residual stress depth profiles on machined sheets, wires and other surfaces

Ex-/Insitu-AFM Measurements



Determination of local electrical, thermal and magnetic properties
and surface topographies

Contact:



Dr. Barbara Kosednar-Legenstein
T +43-676 848883 650



Bernhard Sartory
T: +43-676 848883 450

We Innovate Materials

Our Focus / Competences:

- topography / roughness
- KPFM for the determination of local electrical properties of grains or microstructural components
- SThM for determination of thermal conductivity of grains or microstructure components
- EBIC for determination of local electrical properties and short circuits/interruptions
- MFM for determination of local magnetic properties (e.g.: retained austenite)
- STM for visualization of atoms or atomic lattice
- C-SPM for measuring electrical properties such as resistance or conductivity

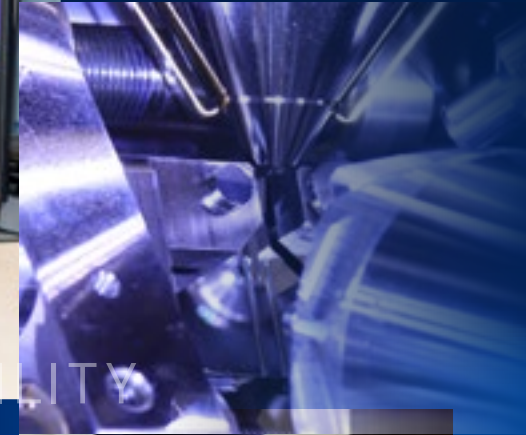
Service Offer

- SEM characterization of surfaces, fracture surfaces, damage and microsections incl. local chemical composition
- material investigations up to 3D microstructures, topography and tomography using SEM-FIB technology
- target preparation of TEM thin films, atom probe tips for further high-resolution investigations
- preparation of microsamples for mechanical in-situ experiments with different geometries (e.g. cuboids, cylinders or micro tensile specimens and cantilever)
- investigation of TEM samples in transmission mode (STEM) incl. chemical and crystallographic analysis
- insertion of small crack-like defects (in the sub- μm to μm range) to study the behavior of short cracks
- local and depth-resolved residual stress measurements
- high temperature investigations in combination with EBSD
- determination of physical parameters in combination with modules and analytics
- SPM-SEM in combination of different modules
- one to several days on-site training in electron microscopy, focused ion beam and correlative microscopy

COMPETENCE & RELIABILITY

Equipment

- scanning electron microscope with large sample chamber of Zeiss type EVO MA25® for the analysis of non-conductive and contaminated samples.
- NEU: Zweistrahlssystem, FE-REM (Zeiss CrossBeam® 550) inkl. Fokussierter Ionenstrahl (FIB)
- high resolution FE-SEM (Zeiss Gemini®-SEM 450) for imaging structures with a few nm and precise chemical analysis
- modular SEM (Zeiss CrossBeam®-SEM 340) with
 - tensile/compression/bending module
 - nanoindenter
 - heating/cryogenic module
 - AFM
- acquisition techniques and analytics: SE, BSD, STEM, secondary ion, InLens and EBSD detector, EDX, WDX, ED-XRF, WD-XRF, EBSD, STEM, TKD (Transmission EBSD), FIB-SIMS (TOF)
- ionslicer for sample preparation (flatmilling, cross sectioning)
- vapor deposition with different substances (graphite, platinum,...) for charge compensation and analysis of non-suffering samples



We Innovate Materials

Mechanical Materials Testing

Hardness Testing

Static Materials Testing - Tension/Compression/Bending

Cyclic Materials Testing - Low Cycle Fatigue (LCF)

Cyclic Materials Testing - High Cycle Fatigue (HCF)

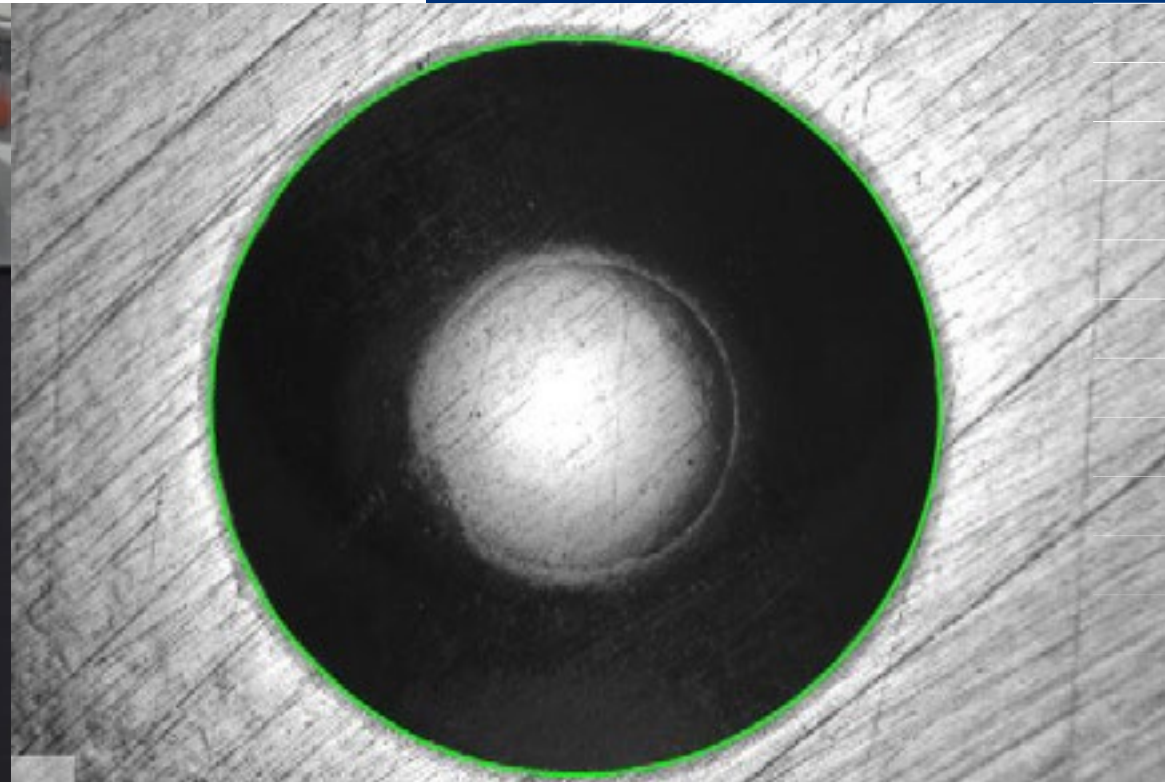
Fracture Mechanics



COMPETENCE & RELIABILITY



Hardness Testing



Performance of hardness tests (Vickers HV, Brinell HB, Rockwell HRC) within the scope of accreditation according to EN ISO 17025.

Contact:



Dr. Florian Summer
T +43-676 848883 462



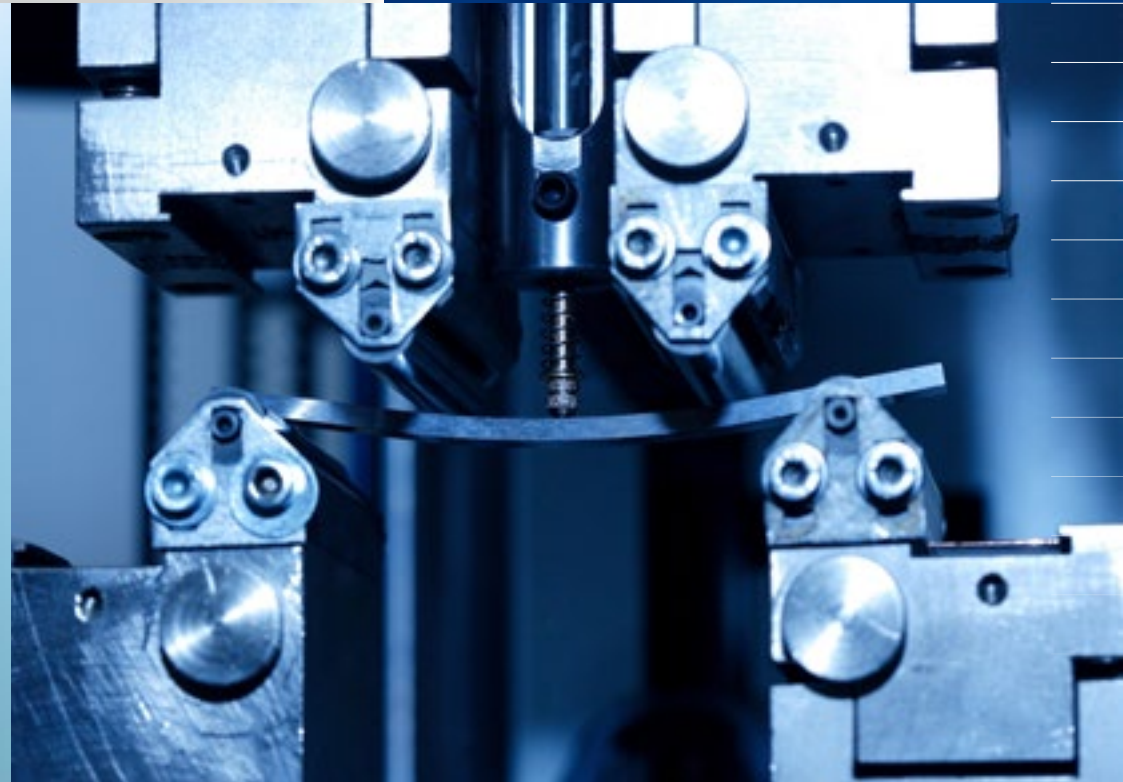
Dr. Angelika Spalek
T +43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- determination of core hardness HV, HRC, HB in the accredited lab
 - EN ISO 6506-1 (HB)
 - EN ISO 6507-1 (HV)
 - EN ISO 6508-1 (HRC)
- measurement of hardness profiles
- hardness measurement of metallic and ceramic materials

Static Materials Testing - Tension/Compression/Bending



Determination of mechanical material parameters for low- to high-strength materials under tension, compression and bending

Contact:



Dr. Florian Summer
+43-676 848883 462



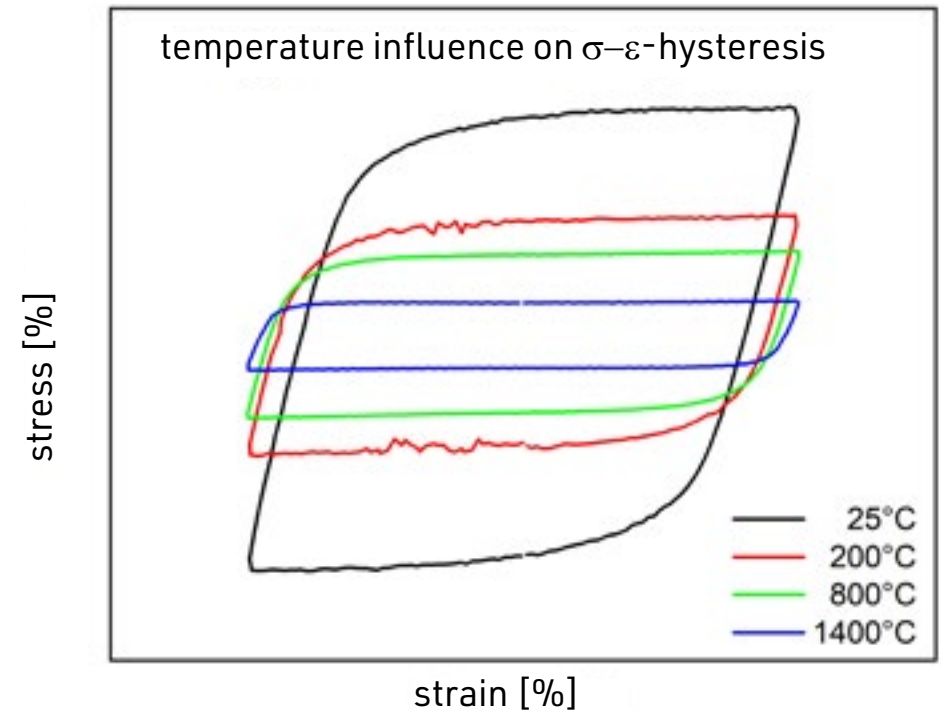
Dr. Stefan Marsoner
T +43-676 848883 400

We Innovate Materials

Our Focus / Competences:

- tensile test acc. to EN ISO and ASTM standards
- compression test acc. to ASTM E9 and DIN 50106
- 3-point and 4-point bending test
- temperature range from -150°C to 1400°C
- combination with local deformation analysis (Aramis)
- specimen fabrication and testing of various specimen geometries and dimensions

Cyclic Materials Testing - Low Cycle Fatigue (LCF)



Determination of cyclic material properties (strain creep curves, cyclic creep,...)

Contact:



Dr. Florian Summer
+43-676 848883 462



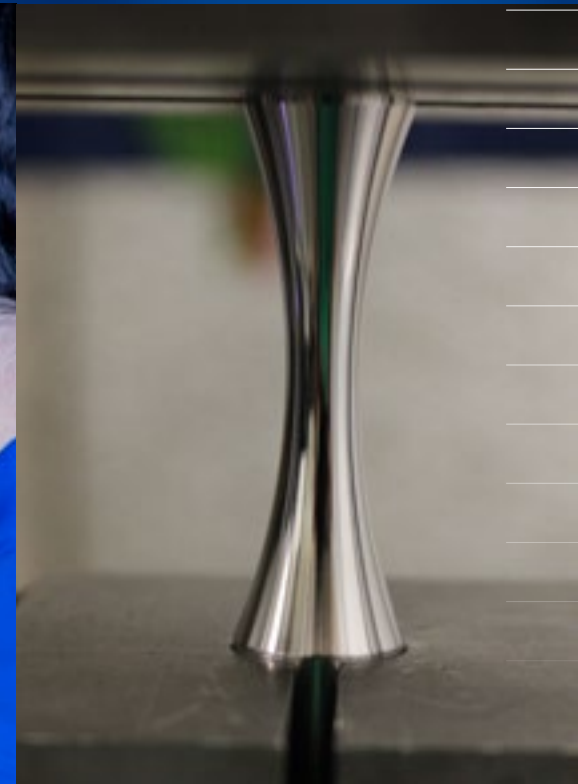
Dr. Stefan Marsoner
T +43-676 848883 400

We Innovate Materials

Our Focus / Competences:

- strain camber curves (ASTM E606, ISO 12106)
- cyclic flow curves
- cyclic creep
- tension/compression ± 250 kN from -150°C to 1400°C
- high precision laser strain measurement
- vacuum / air / inert gas
- individual load block programs
- special tests: coupling heating / cooling with mech. loading (e.g. properties of metastable phases)

Cyclic Materials Testing - High Cycle Fatigue (HCF)



Determination of cyclic material properties (Wöhler curve, fatigue strength) at room temperature and elevated temperatures
(partly within the scope of accreditation according to EN ISO 17025)

Contact:



Dr. Florian Summer
+43-676 848883 462



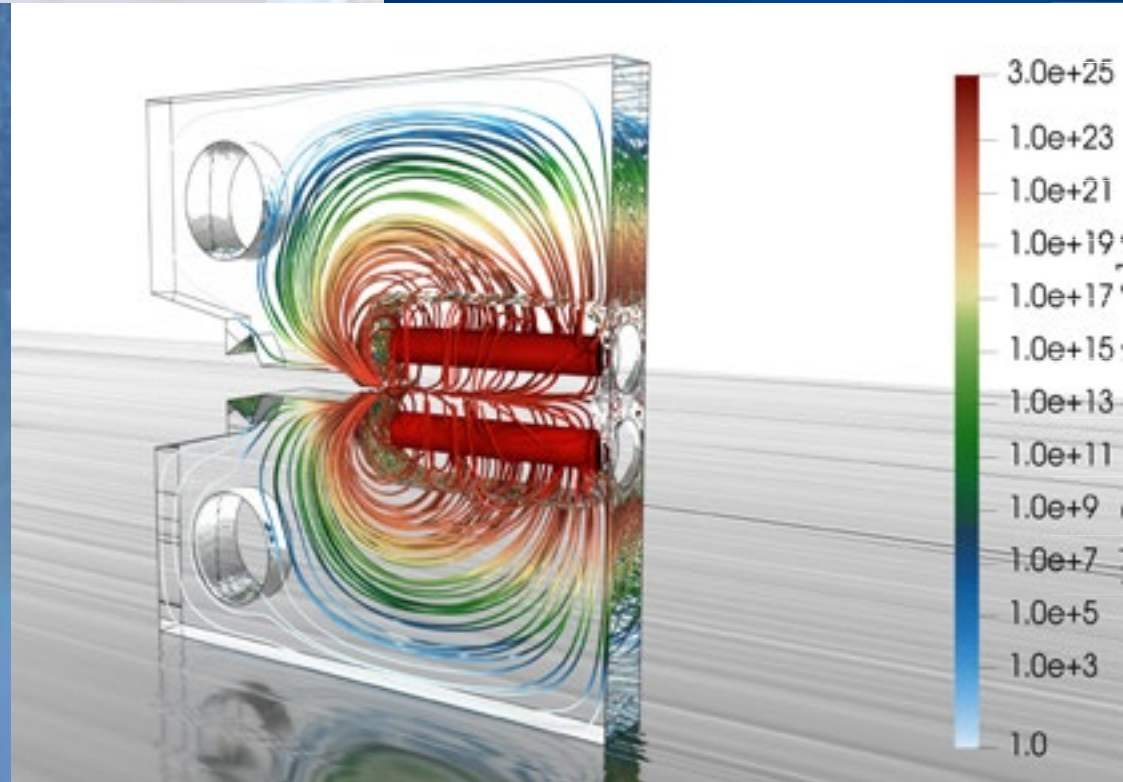
Dr. Stefan Marsoner
T +43-676 848883 400

We Innovate Materials

Our Focus / Competences:

- High Cycle Fatigue tests (HCF) within the scope of accreditation acc. to EN ISO 17025 (DIN 50100, ASTM E466, ISO 1099)
- test frequency up to 180 Hz
- temperature: -150°C (N₂) to 900°C (air)
- statistical evaluation temporal strength / fatigue strength
- tensile-compression, torsion, bending (3PB, 4PB, 8PB)
- different atmospheres (air/protective gas/vacuum)

Fracture Mechanics



Performance of static and cyclic fracture mechanics tests
(partly within the scope of accreditation according to EN ISO 17025)

We Innovate Materials

Contact:



Dr. Stefan Marsoner
T: +43-676 848883 400

Our Focus / Competences:

- static fracture mechanics:
 - K_{IC}, J_{IC}, J_{Δa}-curve, CTOD
- cyclic fracture mechanics:
 - da/dN-curves
 - threshold value determination
 - crack resistance curves
- different test arrangements
 - CT, SE(B), SE(T)
- temperatures between -150°C and 800°C

Service Offer

Hardness Testing

- Determination of core hardness and hardness profiles HV, HRC, HB

Static material testing

- Uniaxial tensile test (-150°C to 1400°C)
- Uniaxial compression test or cylinder crush test according to ASTM E9 or DIN 50106 (-150°C to 1400°C)
- 3-point and 4-point bending test
- further technological tests with special setups acc. to customer requirements

Cyclic Material Testing

- LCF Low Cycle Fatigue tests (-150°C to 1400°C) (strain camber curves, cycl. stress-strain curve, ratchetting, strep-incemental-test, ...). (ASTM E 606, ISO 12106)
- Multiaxial tension-compression-torsion test (RT up to 900°C)
- HCF high cycle fatigue tests (-150°C to 850°C) (stress creep curves statistically validated, tension-compression, bending, torsion)

Fracture Mechanic Investigation

- Static fracture toughness test (KIC, JIC, JDa, CTOD) (-150°C to 800°C) acc. to ASTM E 1820, ISO 12135, EN ISO 15563
- cyclic fracture toughness test (da/dN curves, DKth, Paris range, ...) acc. to ASTM E 647, ISO 12108

Test procedures within the scope of accreditation

acc. to ISO IEC 17025

- determination of core hardness HV, HRC, HB acc. to EN ISO 6506-1 (HB), EN ISO 6507-1 (HV), EN ISO 6508-1 (HRC)
- tensile tests on metallic materials
 - at room temperature: EN ISO 6892-1, ASTM E8 / E8M, ASTM 370
 - at low temperatures: EN ISO 6892-3
 - at higher temperatures: EN ISO 6892-2, ASTM E21
- cyclic tests on specimens acc. to DIN50100, ASTM E466, ISO 1099
- cyclic tests on fasteners acc. to DIN969
- fracture toughness test KIC according to ASTM E 399, ISO 12135
- fatigue crack growth according to ASTM E 647, ISO 121089
- fracture toughness test JIC, Jc, J-R, acc. to ASTM E 1820 / ISO 12135



Equipment

- hardness tester Emco Test DV30G5 and QNess Q10A+
- Zwick universal testing machine Z250 (max. 250 kN)
- Zwick universal testing machine Z150 (max. 150 kN) with high temperature furnace up to 900°C
- Instron Hydropulser 8803 (max. 250 kN) mit vacuum chamber, inductive heating and high precise Laserextensometer Fiedler P50
- Instron tension-compression torsion pulsator 8854 (max. 250kN / 2000Nm) with inductive heating / compressed air cooling and high-precision Laserextensometer Fiedler P50
- Instron Hydropulser 8802 (max. 250kN) with temperature chamber (-150°C to 600°C) and high precise Laserextensometer Fiedler P50
- Schenk Hydropulser PS100 (with modernized Instron-elektronik) (max. 100kN)
- 4 x Russenberger-resonance testing machines Testronic 100 / 150 with HT-oven (up to 900°C) and temperature chamber (up to 300°C) and various setups
- 1x Russenberger resonance testing machine Mikrotron-20
- 4x DCPD-potential probes and 1x ACPD-Potential probe from Matelect and 2x high presice DCPD-measurement system (self-made) (for in-situ crack length measurement)
- variable measurement system for optical 3D displacement and deformation measurement by Aramis



We Innovate Materials

Thermal Analysis and Heat Treatment

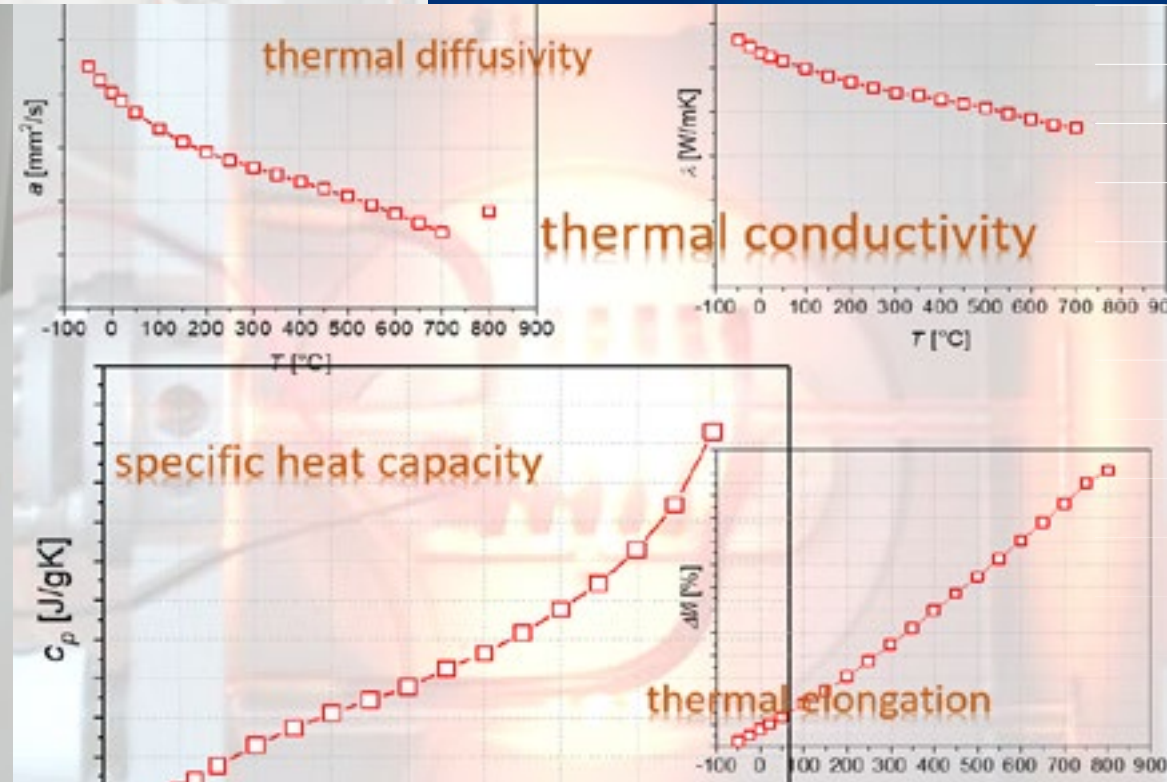


- Recording ZTU / ZTA Charts
- Determination of Thermophysical Properties
- Vacuum and Inert Gas Heat Treatment
- Inductive Heat Treatment
- Recording of BxH Curves
- FE Simulation of Heat Treatment Processes
- Consulting and Process Development



COMPETENCE & RELIABILITY

Determination of Thermophysical Properties



Determination of the basic thermophysical properties of metallic and ceramic materials or their composites

Contact:



Dr. Petri Prevedel
T: +43-676 848883 440



Dr. Angelika Spalek
T: +43-676 848883 461

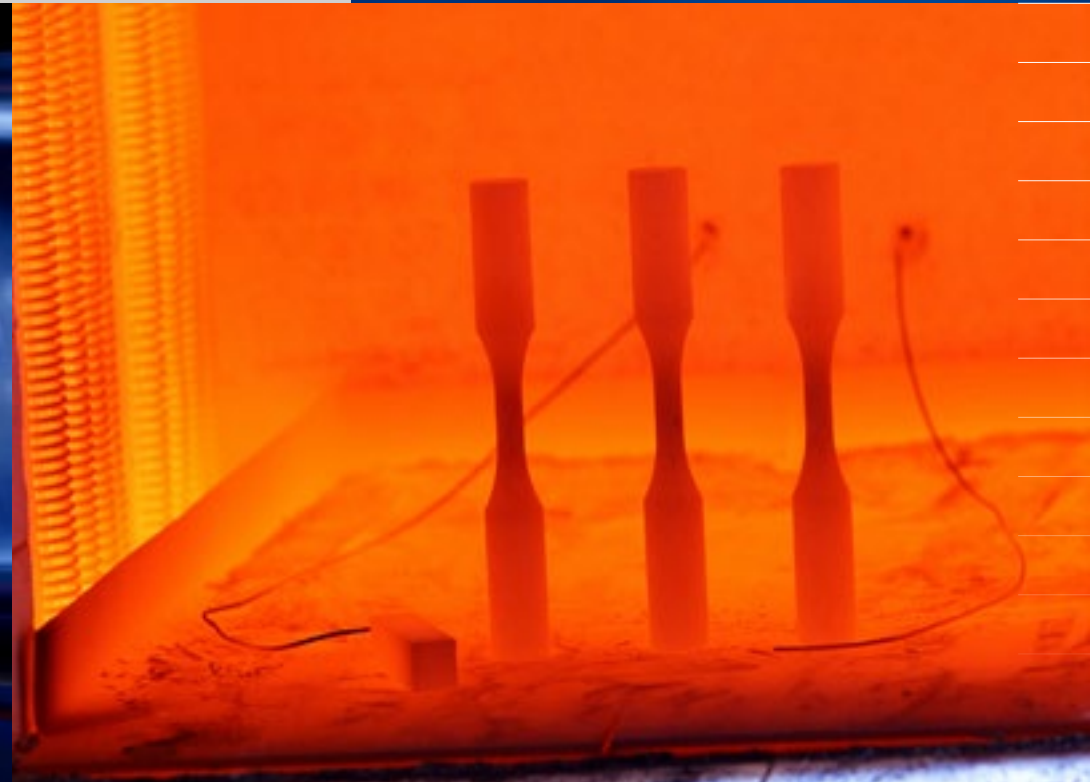
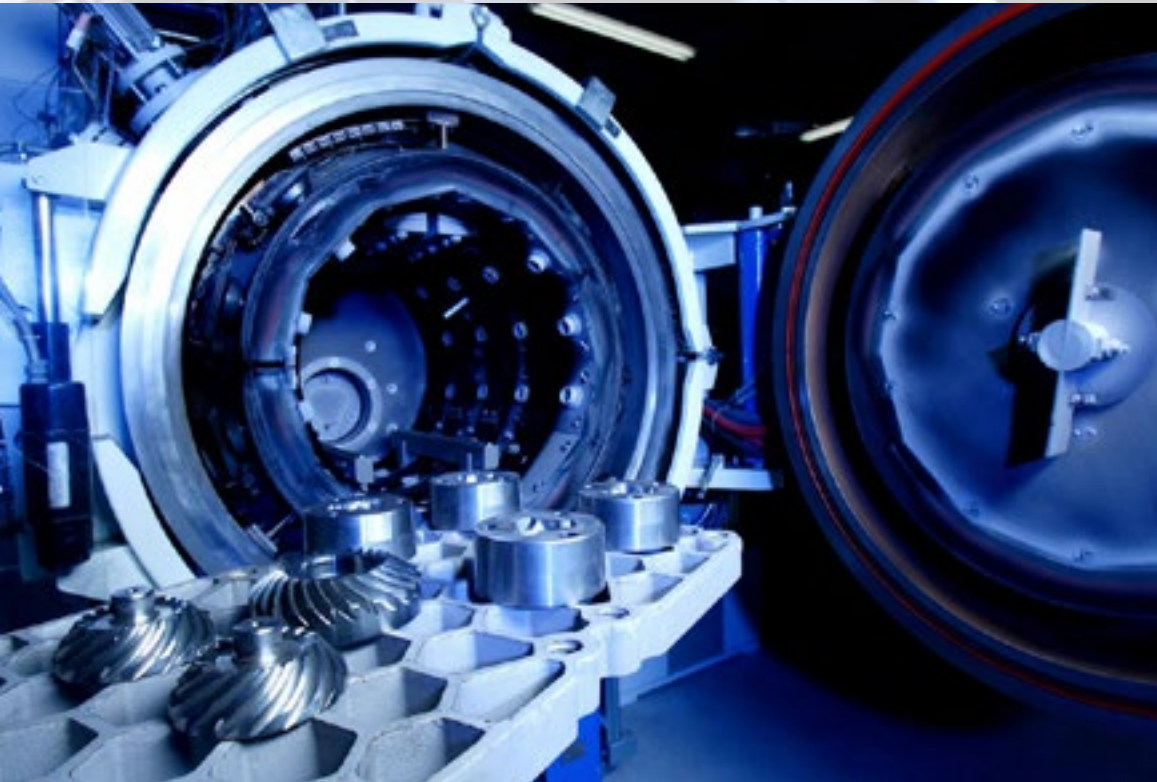
We Innovate Materials

Our Focus / Competences:

- determination of thermal diffusivity (-60°C to 1200°C) acc. to EN 821-2
- measurement of the thermal length change of solid bodies (-150°C to 1200°C) acc. to DIN 51 045-1
- measurement of the specific heat capacity (-150°C to 1100°C) acc. to EN 821-3 (*)
- measurement of the dynamic modulus of elasticity (20°C to 900°C) acc. to EN 820-5 (*)
- calculation of the temperature-dependent thermal conductivity
- measurement of electrical resistance/conductivity (20°C to melting point of metallic samples) (*)

**in cooperation with the Österreichisches Gießerei-Institut (ÖGI)*

Vacuum and Inert Gas Heat Treatment



standard and special vacuum heat treatments (hardening, annealing, tempering, ...) on specimens, components, small series or samples

Contact:



DI Petri Prevedel
T +43-676 848883 440



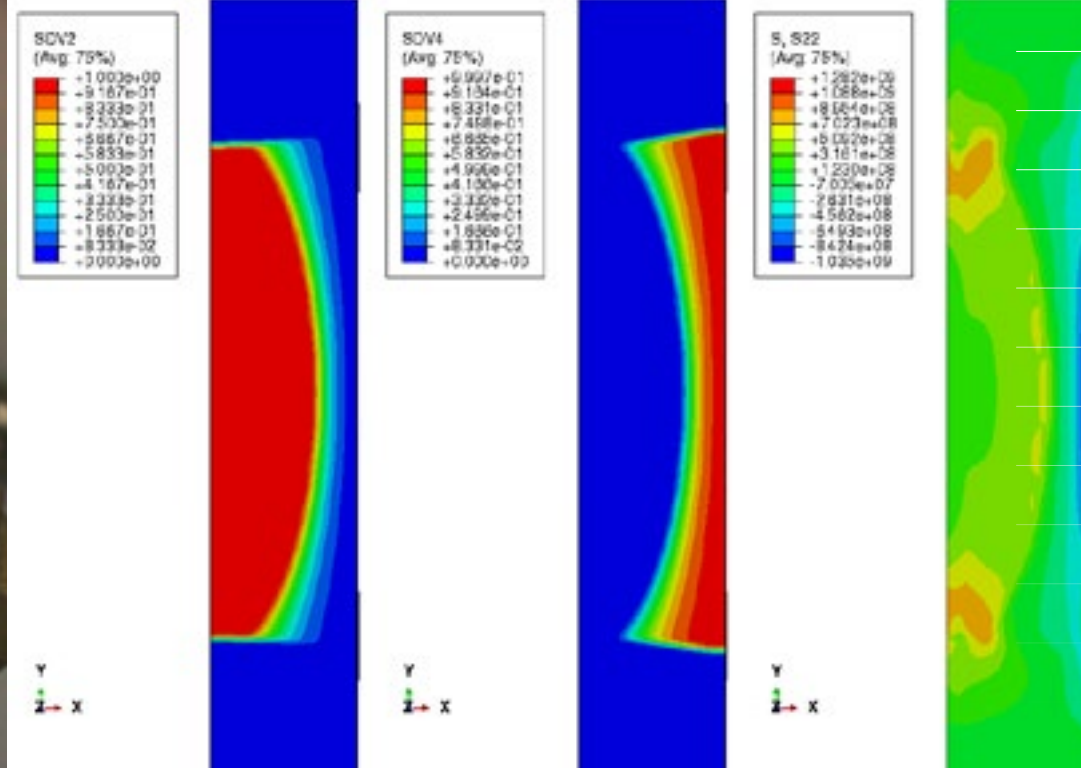
Dr. Angelika Spalek
T +43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- individual, instrumented heat treatment processes under (convective) vacuum
- temperature-controlled heat treatment of samples and components incl. controlled quenching ($t_{\min} = 0.2$)
- tempering or annealing under (convective) vacuum, inert gas (Ar, N₂) or atmospheric conditions

Inductive Heat Treatment



Development of inductive heat treatment processes on bar material

Contact:



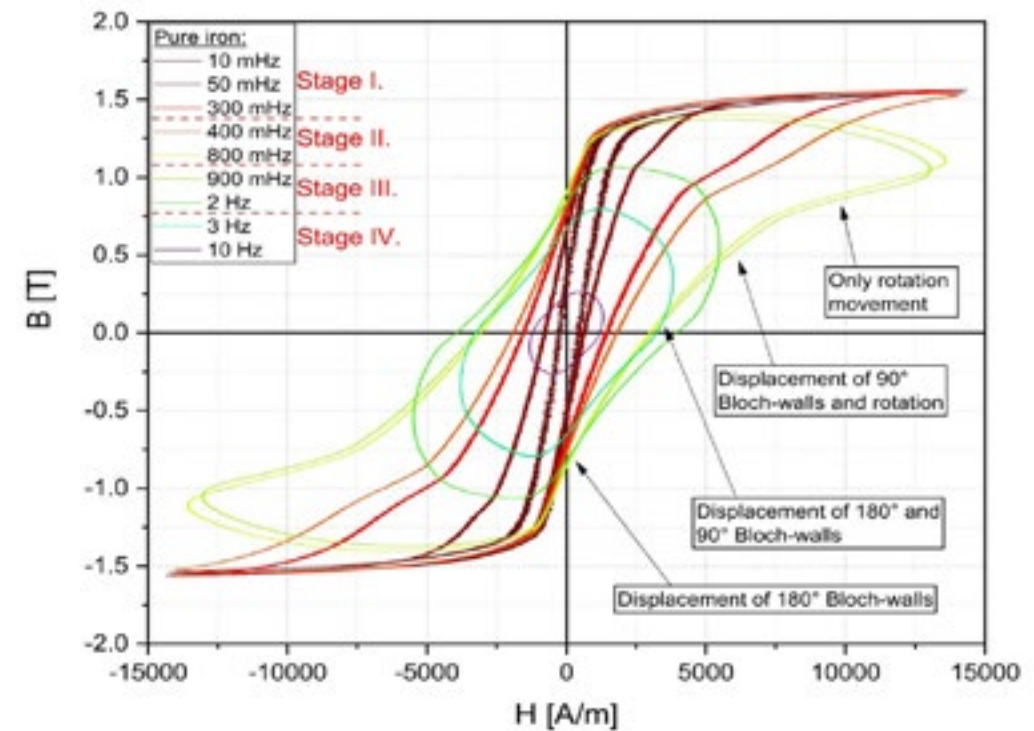
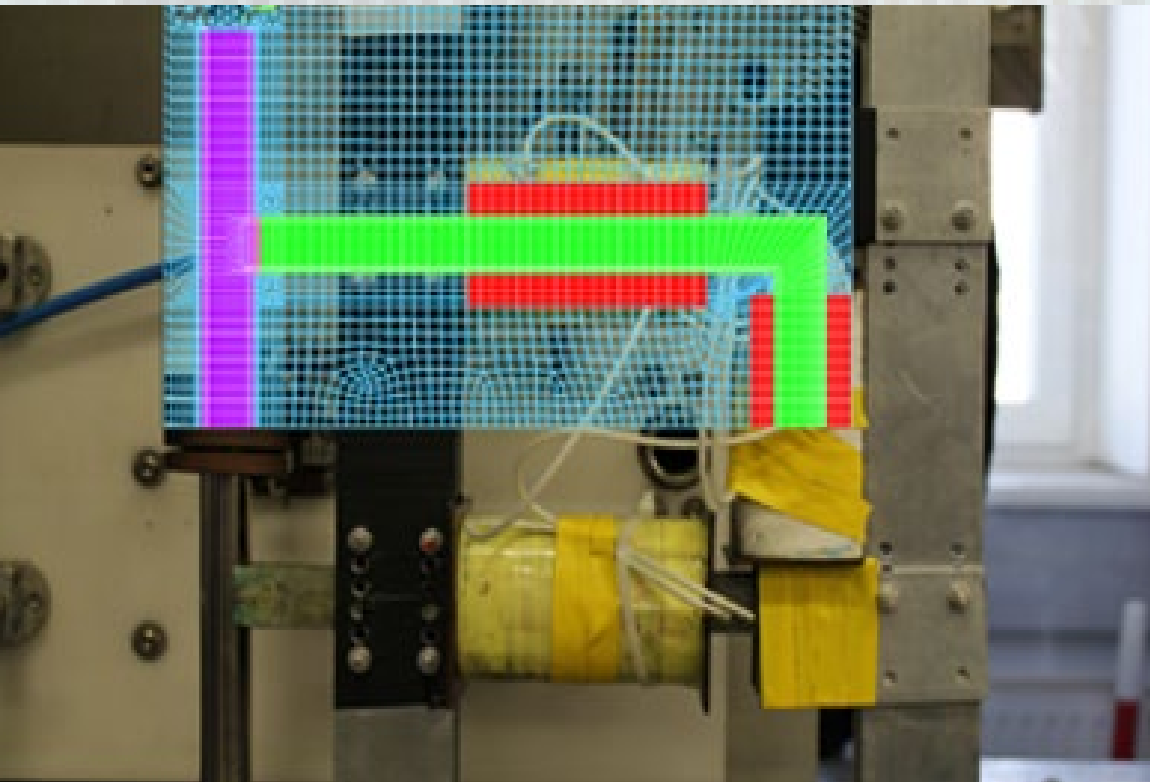
DI Petri Prevedel
T: +43-676 848883 440

We Innovate Materials

Our Focus / Competences:

- instrumented, inductive heat treatment with water or gas quenching for the development of heat treatment processes
- simulation of temperature, microstructure and residual stress distribution and development during inductive heat treatment

Recording of BxH Curves



Recording of temperature-dependent B-H curves for the finite element simulation of inductive heat treatment processes

Contact:

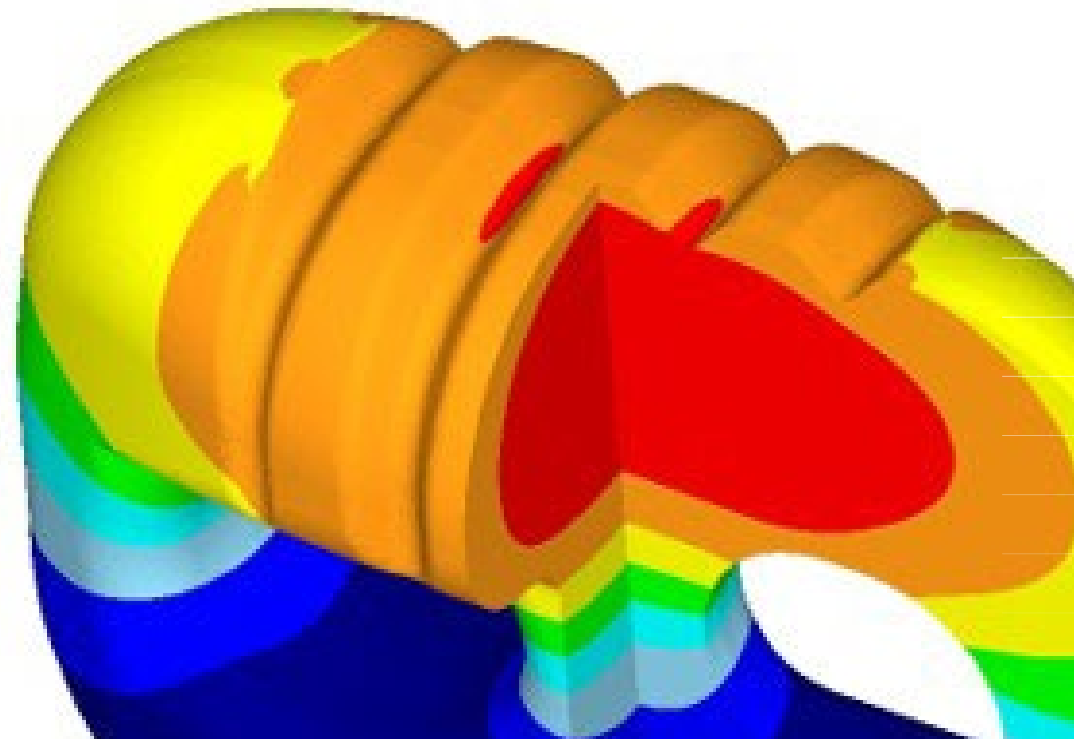
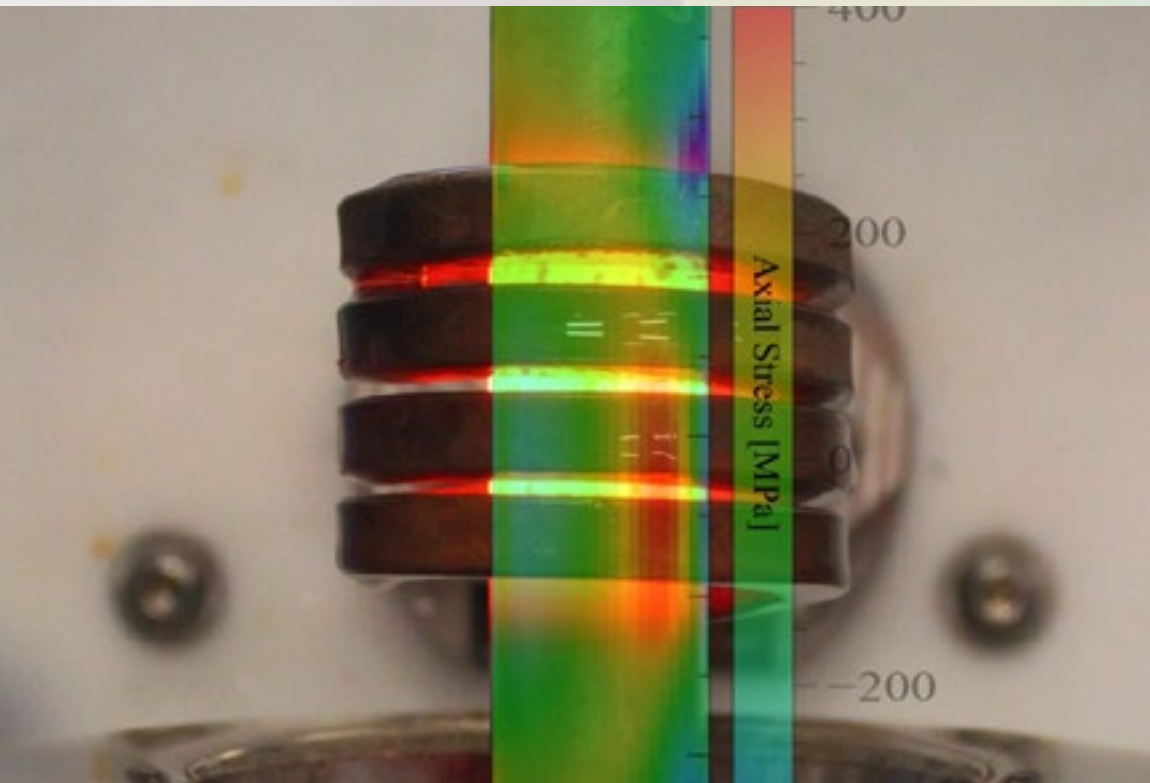


DI Petri Prevedel
P +43-676 848883 440

Our Focus / Competences:

- frequency- and amplitude-dependent recording of material-specific B-H curves (U-yoke).
- application to macroscopic, easy-to-produce industrially suitable specimens (rod DM 22 mm).
- recording of B-H curves at room temperature and elevated temperatures up to 1200°C.

FE Simulation of Heat Treatment Processes



Customized heat treatment simulation considering the influence of shrinkage, creep effects, phase transformation and TRIP strain

Contact:



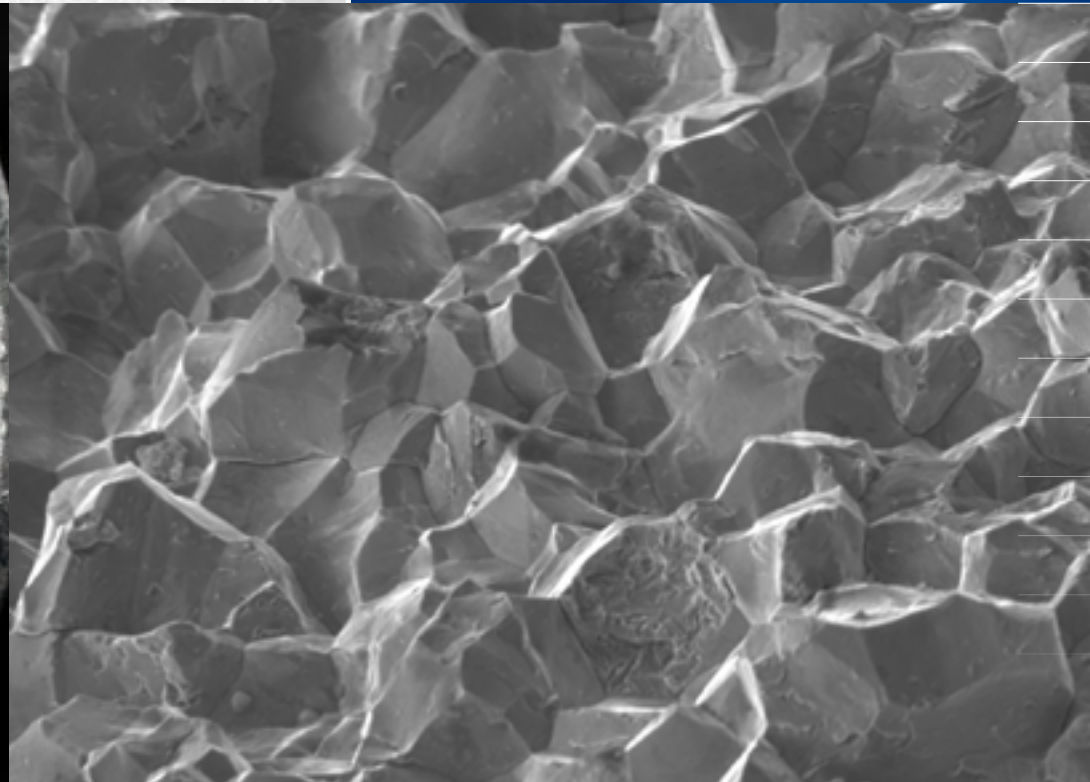
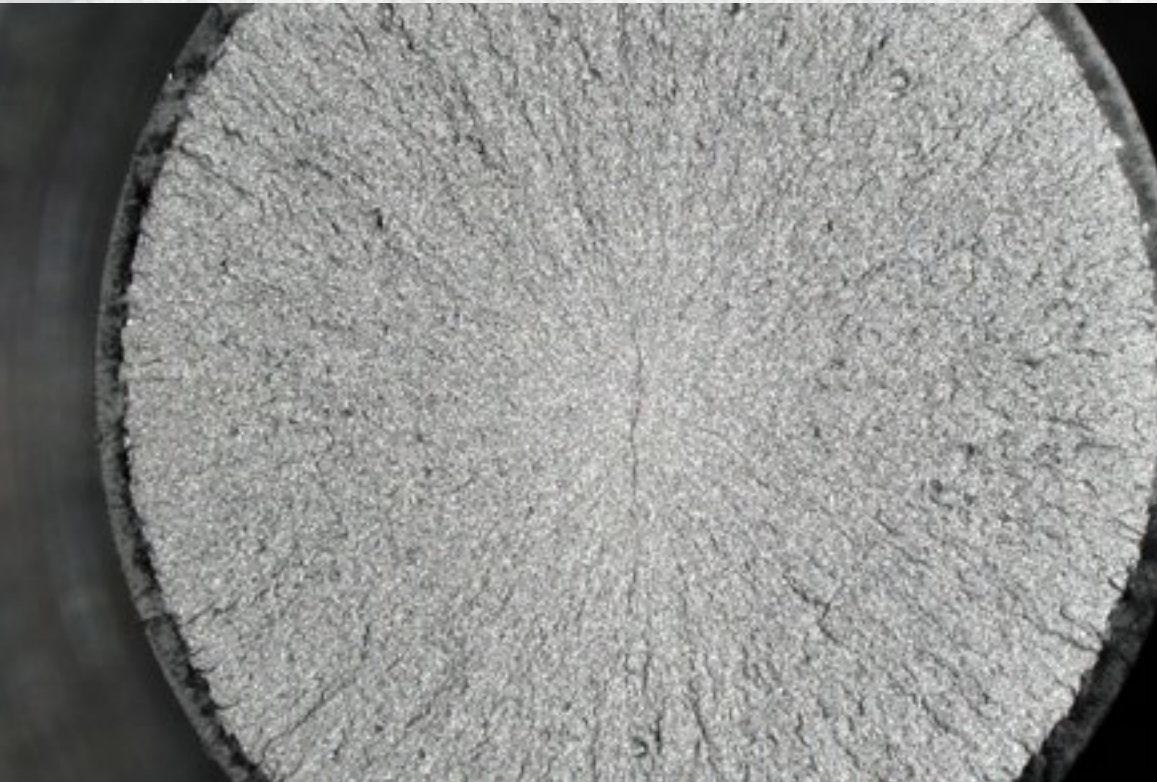
DI Petri Prevedel
P +43-676 848883 440

We Innovate Materials

Our Focus / Competences:

- analysis of (industrial) heat treatment processes with finite element simulation (e.g. crack-prone component positions, critical quenching conditions)
- simulation of the temporal development of stress distributions and stress peaks (e.g. due to shrinkage, phase transformation, TRIP effect)
- determination of the thermophysical data of the materials concerned required for the FE simulation, including the B-H curves for inductive heat treatment

Consulting and Process Development



Consultation on the technical heat treatment of steels and performance of damage investigations on heat-treated components

Contact:



DI Petri Prevedel
T: +43-676 848883 440

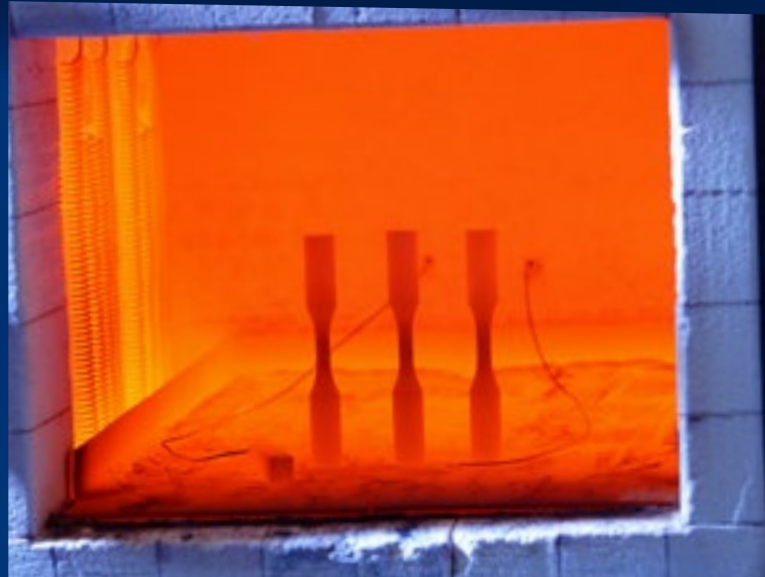


Dr. Angelika Spalek
T +43-676 848883 461

We Innovate Materials

Our Focus / Competences:

- damage investigations on improperly heat-treated components
- improvement and advice on the technical heat treatment of steels
- heat treatment of steels, tool steels (cold, hot and high-speed steels), aluminum, titanium and nickel-based alloys
- sample heat treatments incl. characterization



COMPETENCE & RELIABILITY

Service Offer

- recording of continuous and isothermal transformation diagrams (ZTU / ZTA)
- experimental heat treatments (vacuum, inert gas, inductive) for sampling of components incl. metallographic microstructure analysis and verification of mechanical properties such as hardness, strength, impact energy or fracture toughness
- Finite Element (FE) simulation of heat treatment processes (temporal microstructure, hardness and residual stress development)
- consulting in the field of heat treatment
- damage analysis of improperly heat treated parts, tools and components and development of remedial measures

Equipment

- quenching dilatometer DLI 805L from Bähr with inductive heating system (25-1300°C) and integrated gas cooling (N₂ or He)
- systherms single-chamber vacuum furnace with integrated high-pressure gas quenching system (max. 14 bar), oven chamber: 400 x 400 x 600 mm (B x H x L)
- protective gas furnace (N₂ or Ar) up to 1200°C (oven chamber: 400 x 300 x 600 mm)
- various air circulation chamber furnaces (tempering furnaces) up to 700°C (oven chamber: 220x200x495 mm) and up to 850°C (oven chamber: 350x400x500mm)
- industrial induction hardness equipment ITP for inductive hardening/tempering of test specimens ($l_{max} = 300 \text{ mm}$, $\varnothing_{max} = 30 \text{ mm}$) incl. water-, air- or inert gas quenching; vertical and horizontal operation; instrumentation by thermocouples
- laserflash system LFA 427 from Netzsch (temperature range from -60°C to 1200°C)
- pushrod dilatometer from Netzsch DIL 402 CD (temperature range from -150°C to 1200°C)



We Innovate Materials

Microelectronic Test Methods

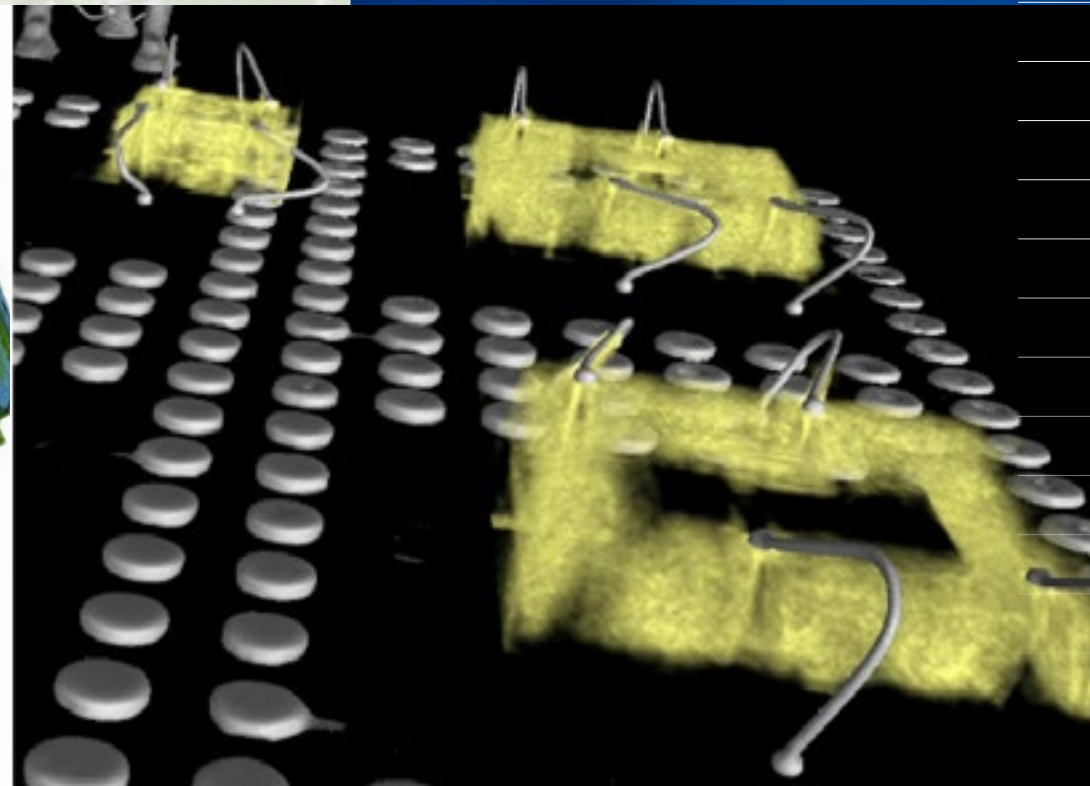
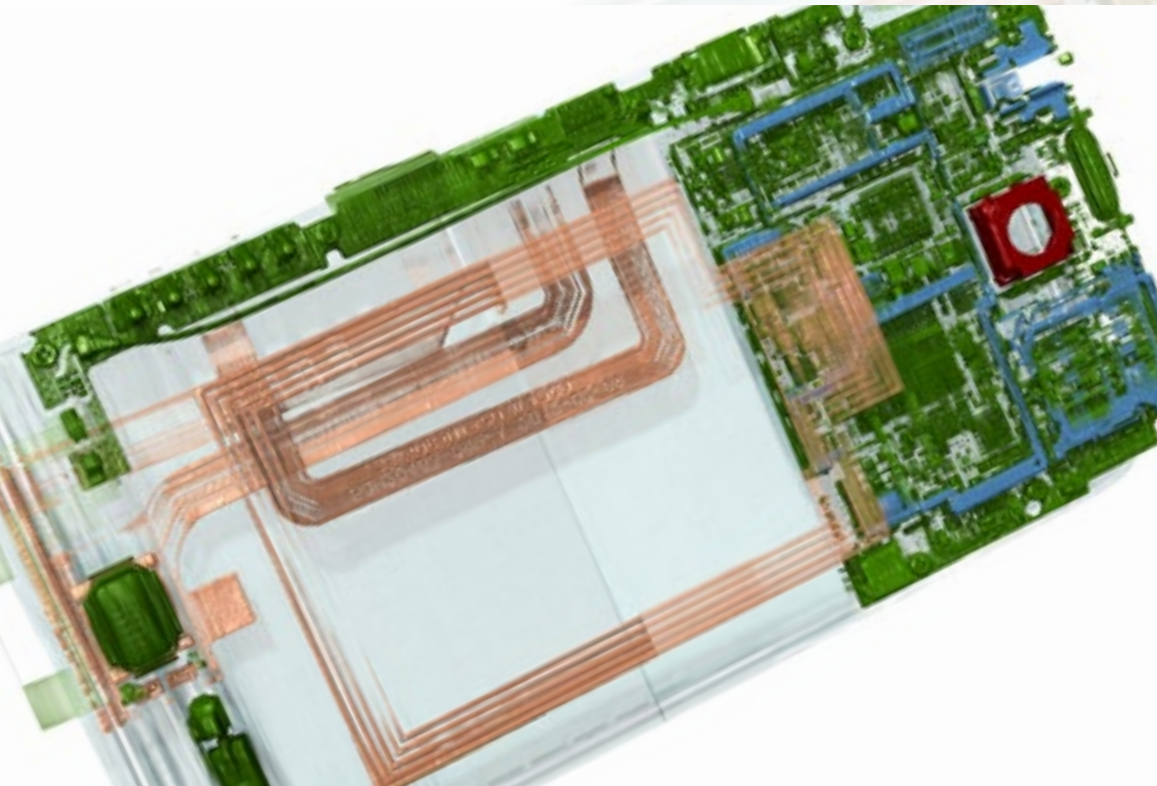


Non-Destructive Analytics
Destructive Physical Analysis
Thermal Management
Environmental Simulation Laboratory
Thin Film Analysis
Raman Characterization
Electronic Laboratory
Phase, Morphology and Residual Stress Analysis



COMPETENCE & RELIABILITY

Non-Destructive Analytics



Non-destructive quality assurance and failure analysis for microelectronic devices

We Innovate Materials

Contact:

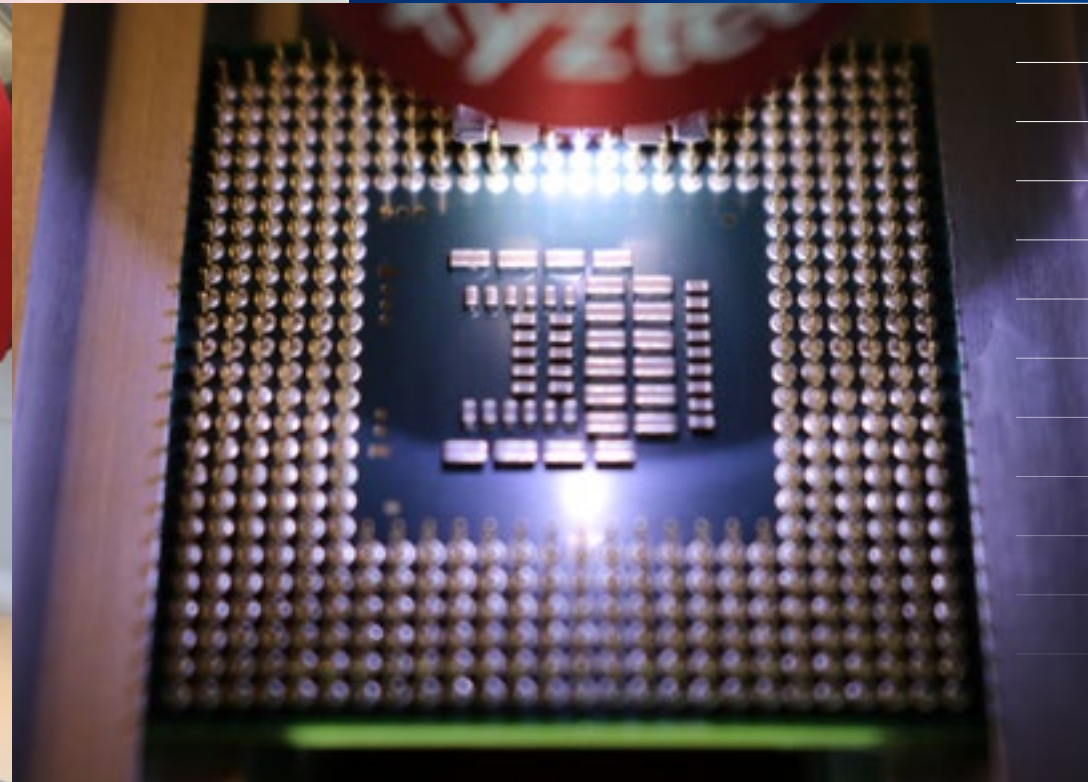


Mag. Jördis Rosc
T: +43-3842-45922-641

Our Focus / Competences:

- defect analysis - localization and evaluation of defects
- 2D and 3D porosity analysis
- acquisition of geometry data
- nominal/actual comparison
- texture analysis - phase segmentation
- in-situ testing with mechanical / thermal / electrical loading

Destructive Physical Analysis



Reliability of structure and integrated circuit packaging

Contact:



Dr. Barbara Kosednar-Legenstein
T: +43-676 848883 650



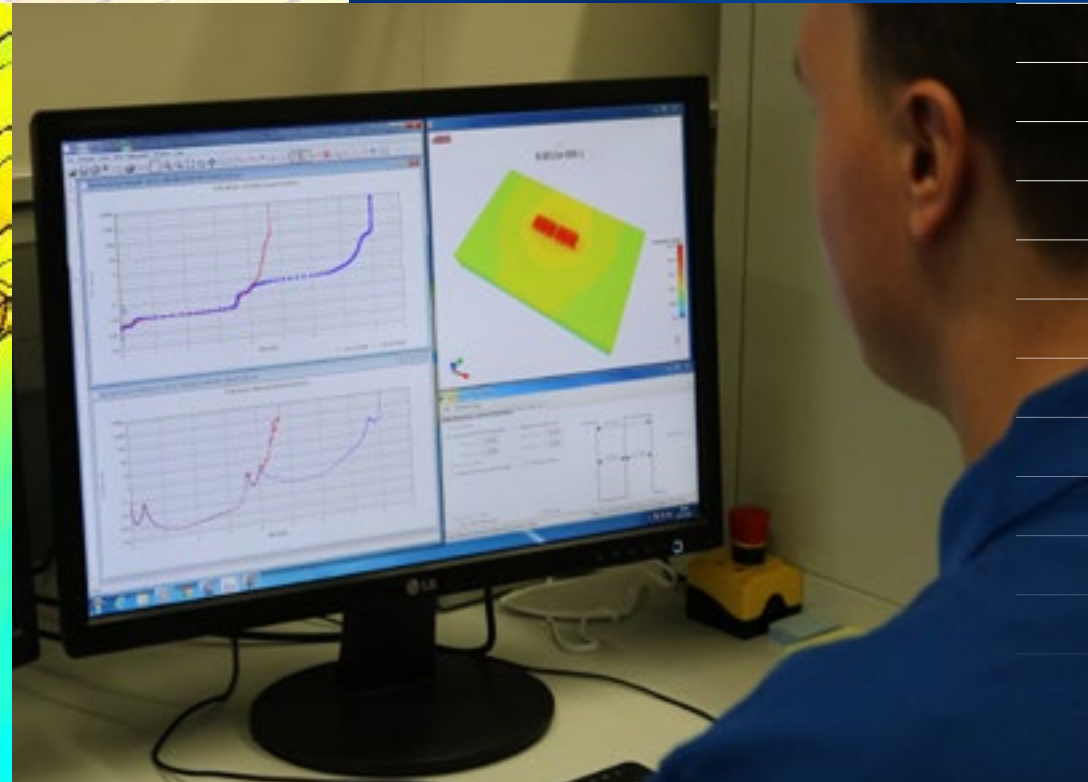
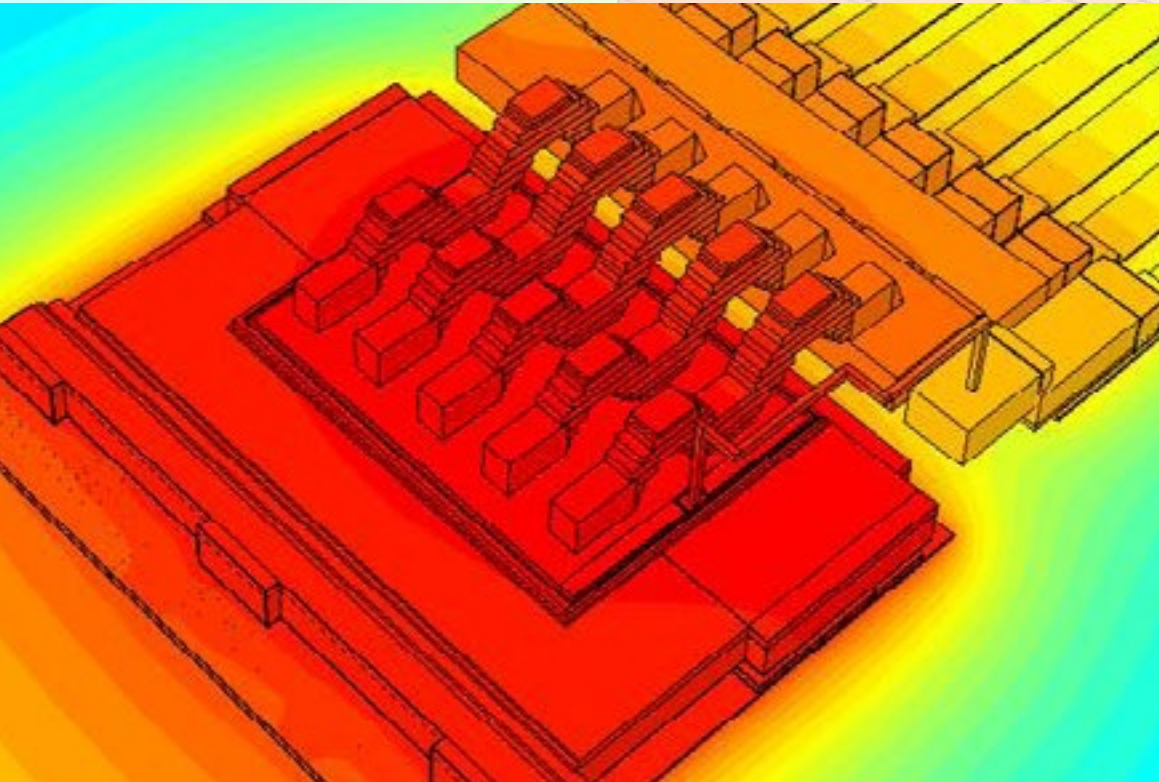
Dr. Julien Magnien
T: +43-676 848883 640

We Innovate Materials

Our Focus / Competences:

- visualization of surface structures
- detection of geometry and microstructure
- failure and root-cause analysis of electronic components (inclusions, cracks, aging processes)
- determination of deformation, damage and fracture behavior of different assembly and interconnection technologies
- evaluation of mechanical peel, shear and tensile stresses
- 3-point and 4-point bending test
- digital Image Correlation (DIC)

Thermal Management



Thermal analysis from material to electronic systems

Contact:



Dr. Julien Magnien
T +43-676 848883 640



Dr. Lisa Mitterhuber-Gressl
T +43-3842-45922-661

We Innovate Materials

Our focus / competences

- thermal resistance analysis of materials and systems (thermal impedance analysis)
- derating analysis up to $\leq 160^{\circ}\text{C}$
- heat path analysis of microelectronic packages and systems
- determination of thermal properties of thin films (temperature dependence) - temperature range: 20°C to 500°C
- determination of the thermal interface resistance
- validated thermal models for failure analysis and design guidelines

Environmental Simulation Laboratory



Active and passive thermal reliability testing

We Innovate Materials

Contact:

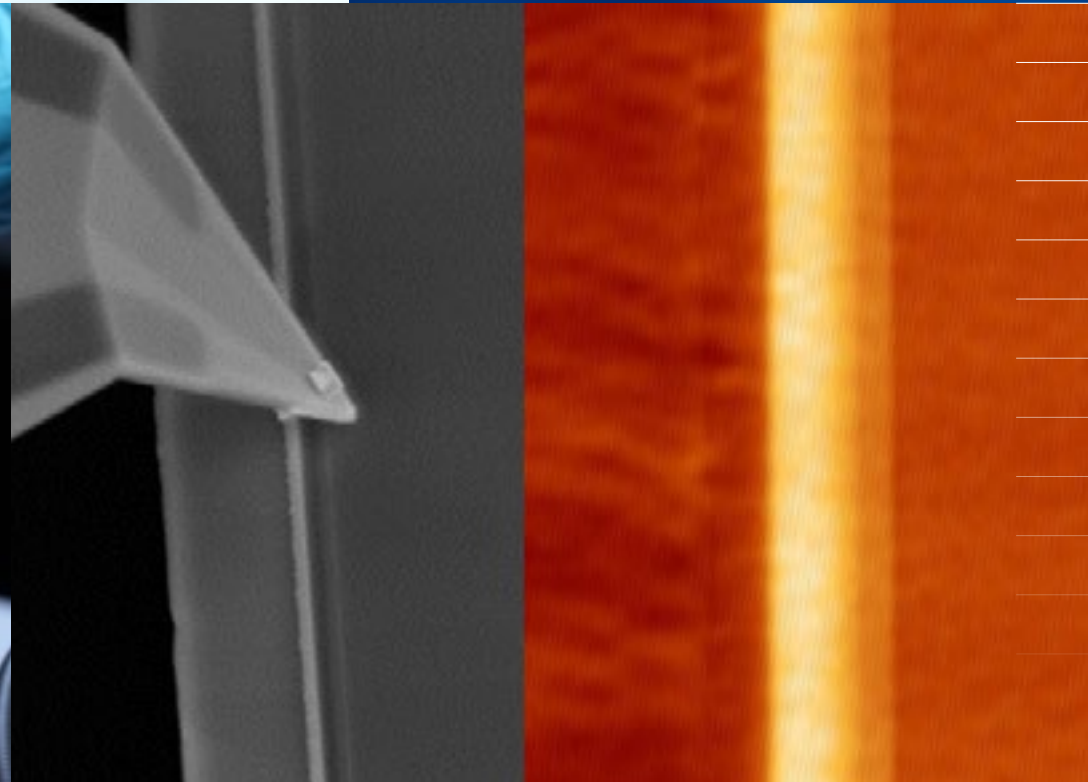
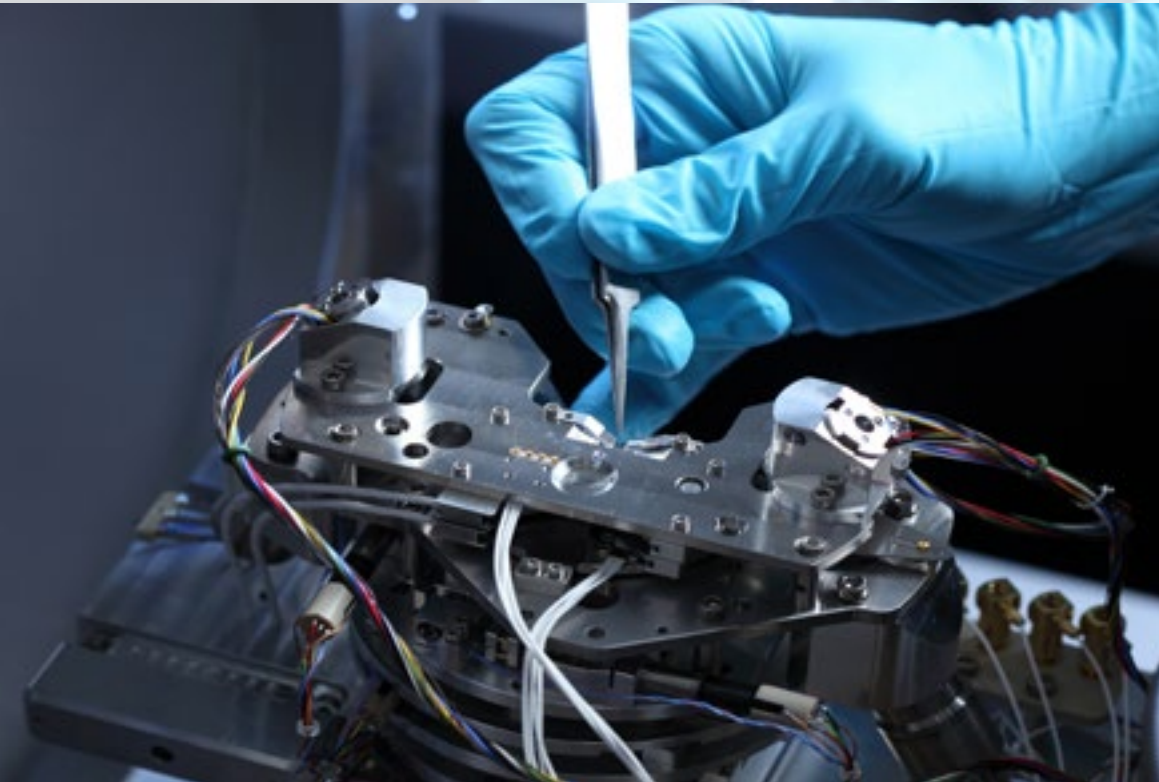


Dr. Julien Magnien
T: +43-676 848883 640

Our Focus / Competences:

- temperature shock test -80°C to 220°C
- drying and heating oven up to 300°C
- alternating climate chamber -40°C to 180°C
- power cycle test up to 80 A
- condition monitoring by means of Temperature Tensitive Electrical Parameters (TSEP)
- data exploration and processing for early failure detection and lifetime modeling

Thin Film Analysis



Single and multilayer systems in the nm to μm range

Contact:



Dr. Julien Magnien
T +43-676 848883 640



Dr. Lisa Mitterhuber-Gressl
T +43-3842-45922-661

We Innovate Materials

Our Focus / Competences:

- Scanning Probe Microscopy (SPM) analysis under different atmospheres (Ar, N, vacuum, air)
- topography and roughness analysis
- Kelvin Probe Force Microscopy (KPFM)
- Scanning Thermal Microscopy (SThM)
- EBAC (Electron Beam Absorbed Current) / EBIC (Electron Beam Induced Current)

Raman Characterization



Non-contact analysis method for material characterization

Contact:



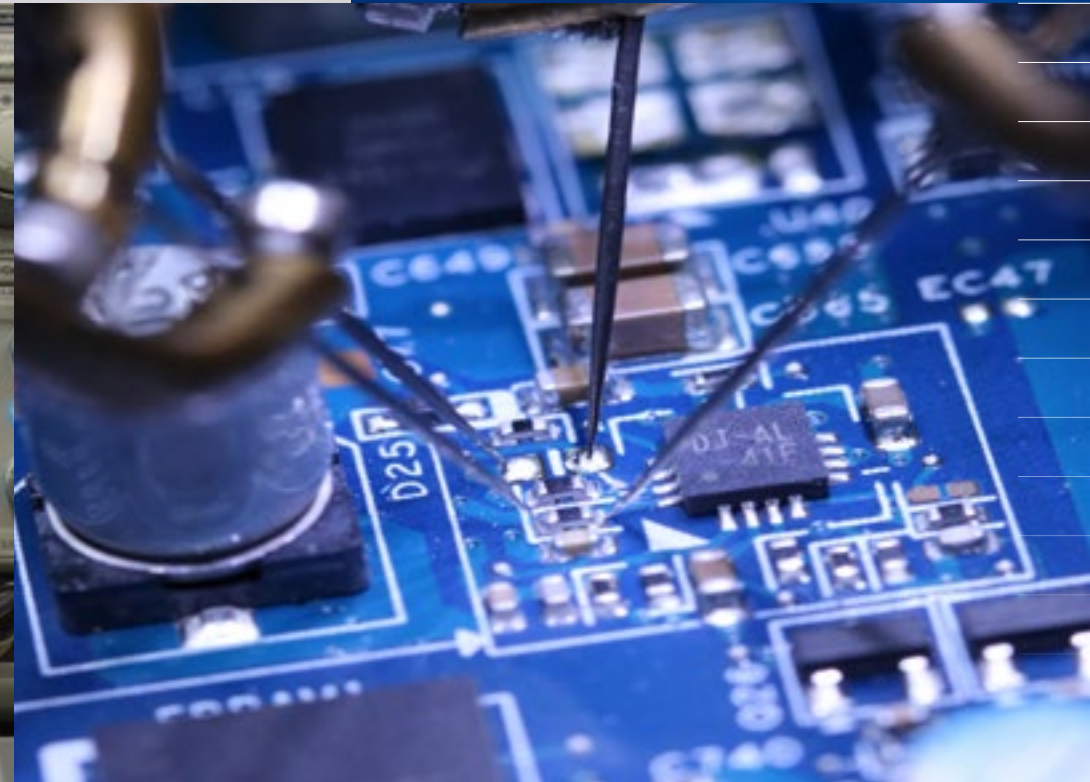
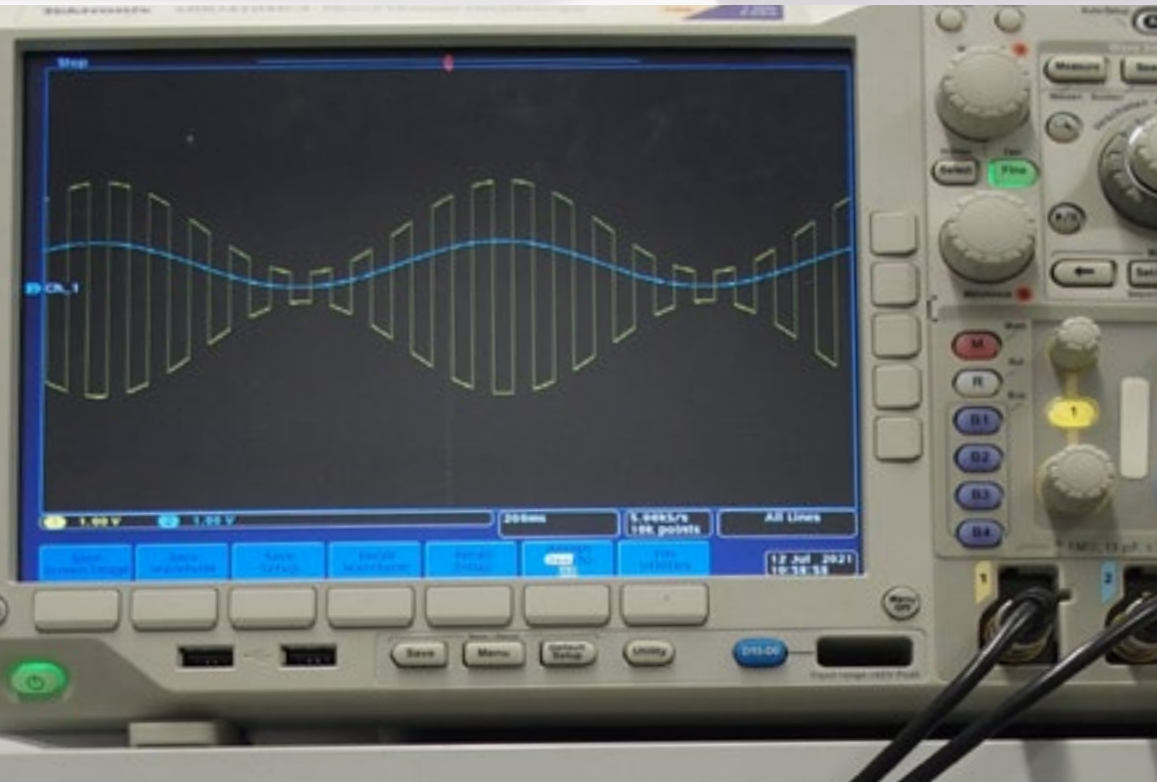
Dr. Barbara Kosednar-Legenstein
T: +43-676 848883 650

We Innovate Materials

Our Focus / Competences:

- chemical composition of materials
- crystallinity, phase transformations and phase compositions
- impurities and defects
- polarization analysis
- residual stress analysis
- texture analysis
- temperature range -196°C to 600°C

Electronic Laboratory



Analysis of functional materials up to electronic systems

We Innovate Materials

Contact:

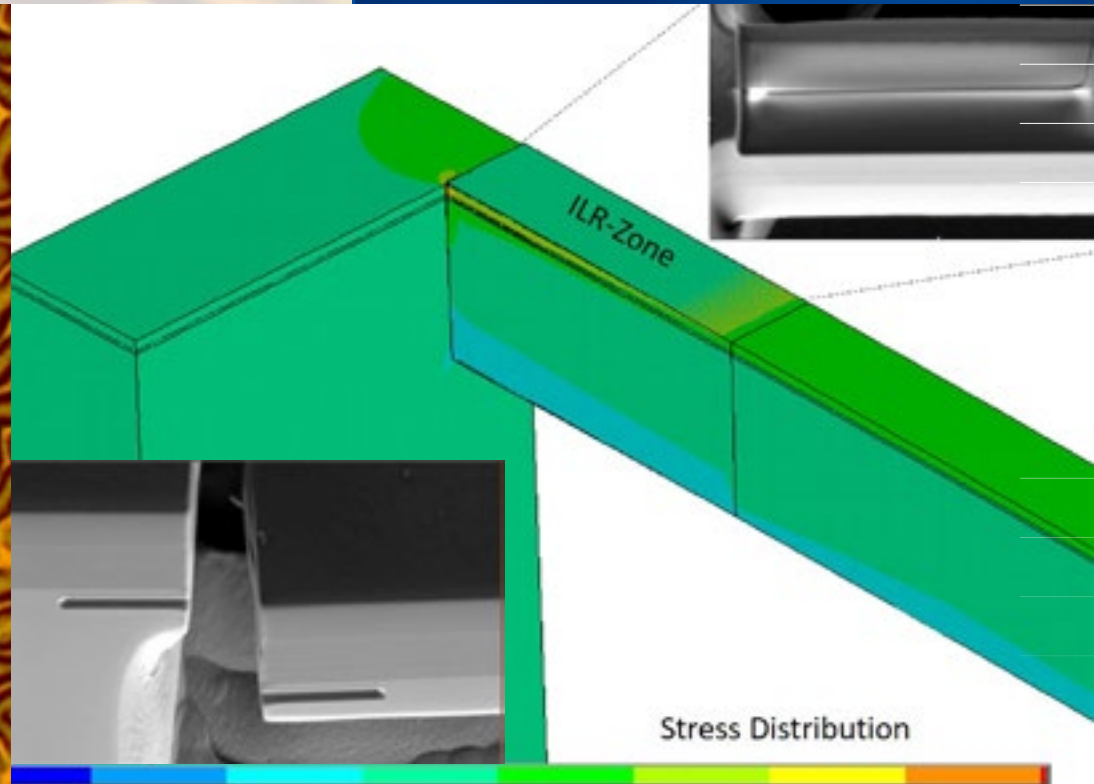
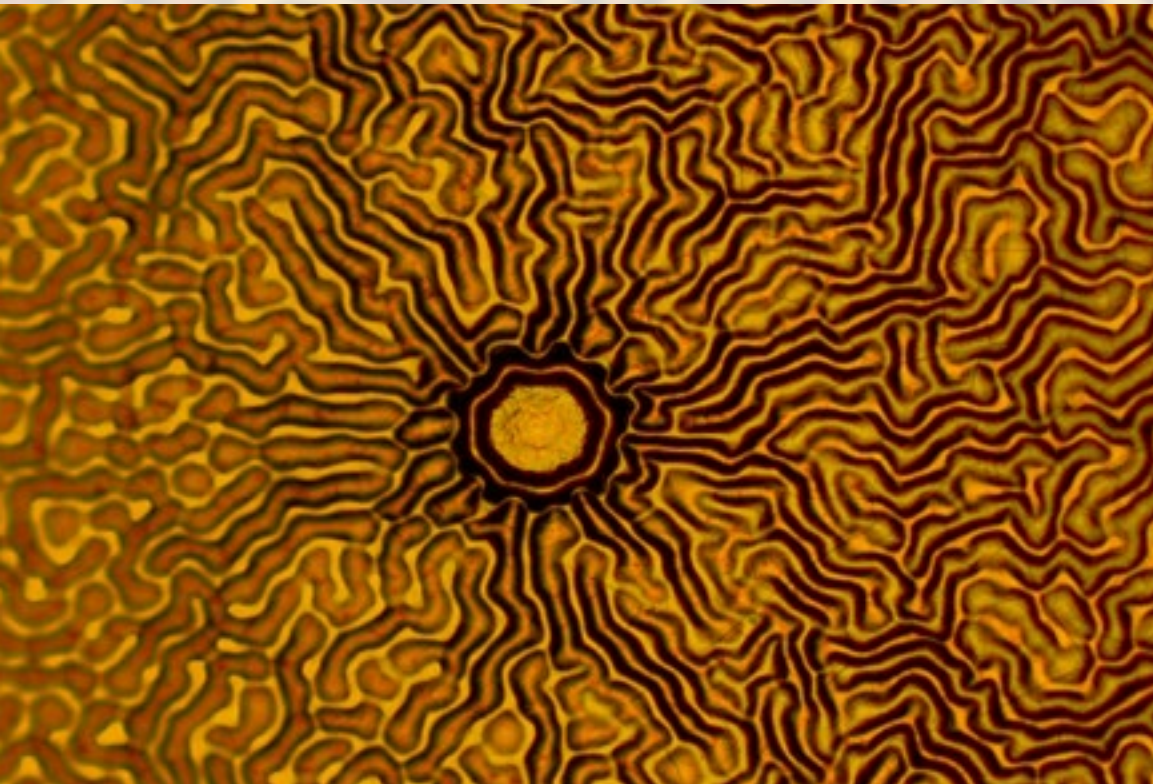


Dr. Julien Magnien
T: +43-676 848883 650

Our Focus / Competences:

- analysis of static and dynamic hysteresis
- piezoelectric analysis
- breakdown voltage analysis ± 1 A (± 500 V)
- current/voltage characteristics
- frequency range 0.01 Hz to 150 MHz (2 GSa/s)
- temperature range -50°C to 400°C
- electrical impedance analysis
- 4-wire/point measurements

Phase, Morphology and Residual Stress Analysis



Structure and morphology influence on residual stresses in single and multilayer systems

Contact:



Dr. Julien Magnien
T: +43-676 848883 650

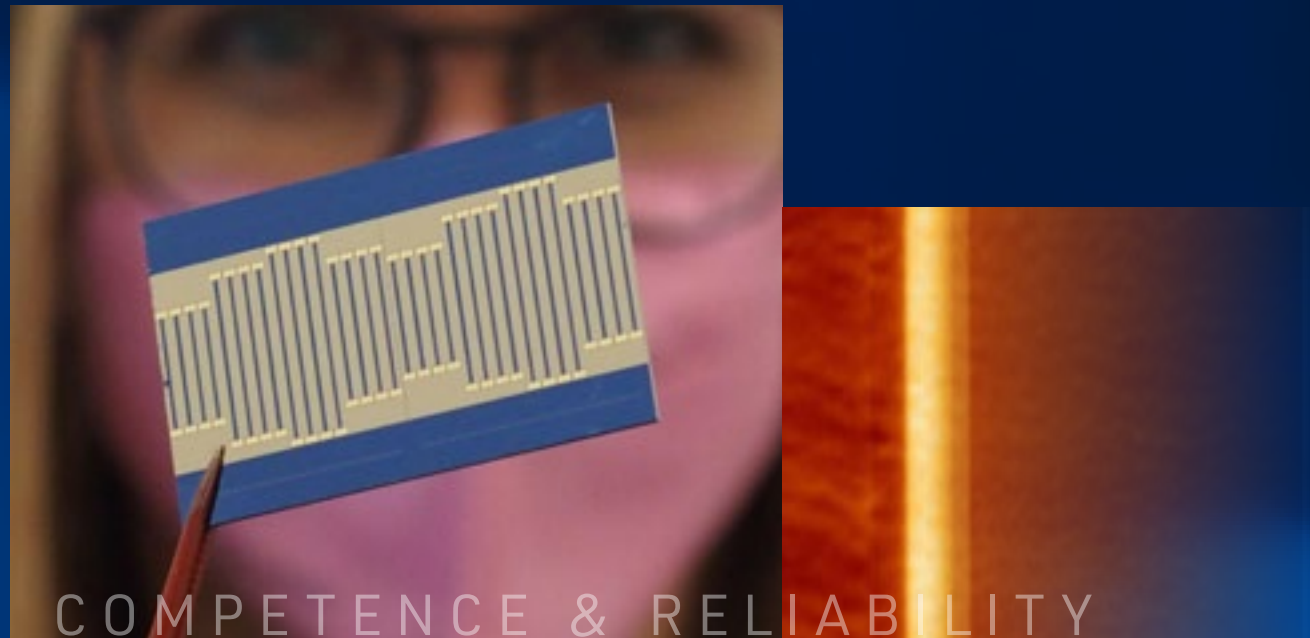


Priv.Do. Dr. Roland Brunner
T: +43-676 848883 620

We Innovate Materials

Our Focus / Competences:

- high resolution EDX & EBSD analysis in the nm range
- high resolution morphology characterization by FE-SEM
- interface & phase analysis
- local residual stress analysis by IL-R (Ion Layer Removal) method

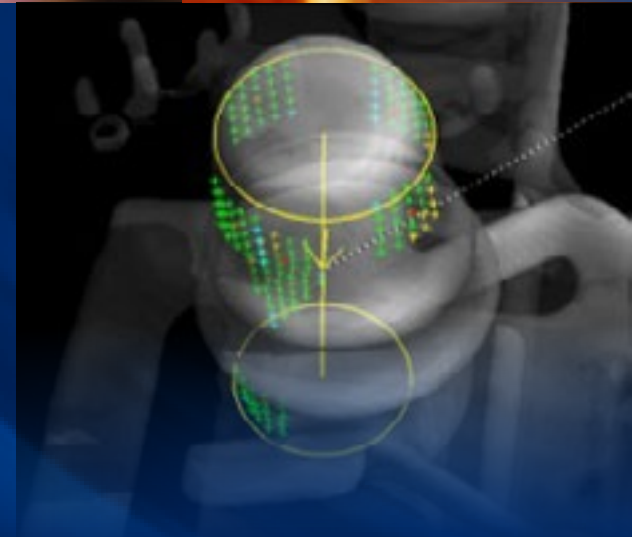


Service Offer

- analyses of materials, products, process defects, PCB defects and component failures
- thermal analysis on material and system level
- mechanical testing (tensile, shear test, nanoindentation, ...)
- determination of aging phenomena and processes
- localization and visualization of material and/or system failures
- environmental simulation (TS, TC, PTC, HTOL, ...)
- thin film analysis (material analysis and physical properties)
- phase, morphology and residual stress analysis
- system evaluation of new materials
- Physics of Failure (PoF)
- seminars and workshops

Equipment

- Computer tomograph - Nanotom
- Confocal UV Raman microscope - alpha300R (Witec)
- Bond tester - SigmaCondor (xyzTec)
- μ DMA - RSA-G2 (TA-Instruments)
- MK56 & 53 thermal cycling ovens (Binder)
- temperature shock - ShockEvent T/60/V2 (Weiss-technik)
- TF Analyzer 3000 (aixACCT Systems)
- TDTR - PicoTR (Netzsch)
- Scanning Probe Microscope (Semilab)
- PU / SMU / Frequency Generators
- Leica TXP EM





Materials Center Leoben Forschung GmbH
Department Services
Roseggerstraße 12 | A-8700 Leoben
T +43-3842-45922
services@mcl.at | www.mcl.at