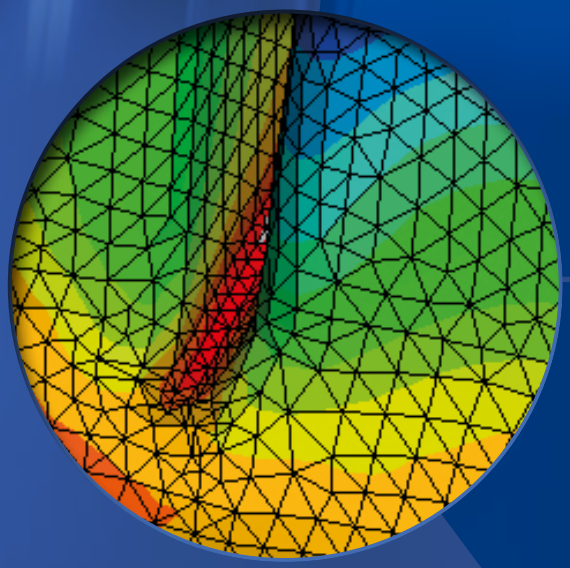
STEEL
TOOLS
MICROELECTRONICS
SERVICES

MATERIALS CENTER LEOBEN FORSCHUNG GMBH

We Innovate Materials




ZUKUNFTSDIALOG

Our Expertise: Exploring the Possible

Univ.-Prof. Dr. Reinhold Ebner
Managing Director

Mag. Alexandra Purkarthofer, MBA
Managing Director

No one should rest on their laurels. The success of a manufacturing company has nothing to do with its size or its past performance. Its future is determined by its power to innovate. However, many innovations require more input than a company can achieve on its own. The key ingredients for modern material-based developments in a wide range of industries are basic research and a breadth of experience which extends beyond any single company's own core expertise.

Materials Center Leoben Forschung GmbH (MCL) is an international research company working in the field of materials research and technology. We are specialised partners for industry, providing the foundations for the innovations which will secure the future of individual companies in the global marketplace.

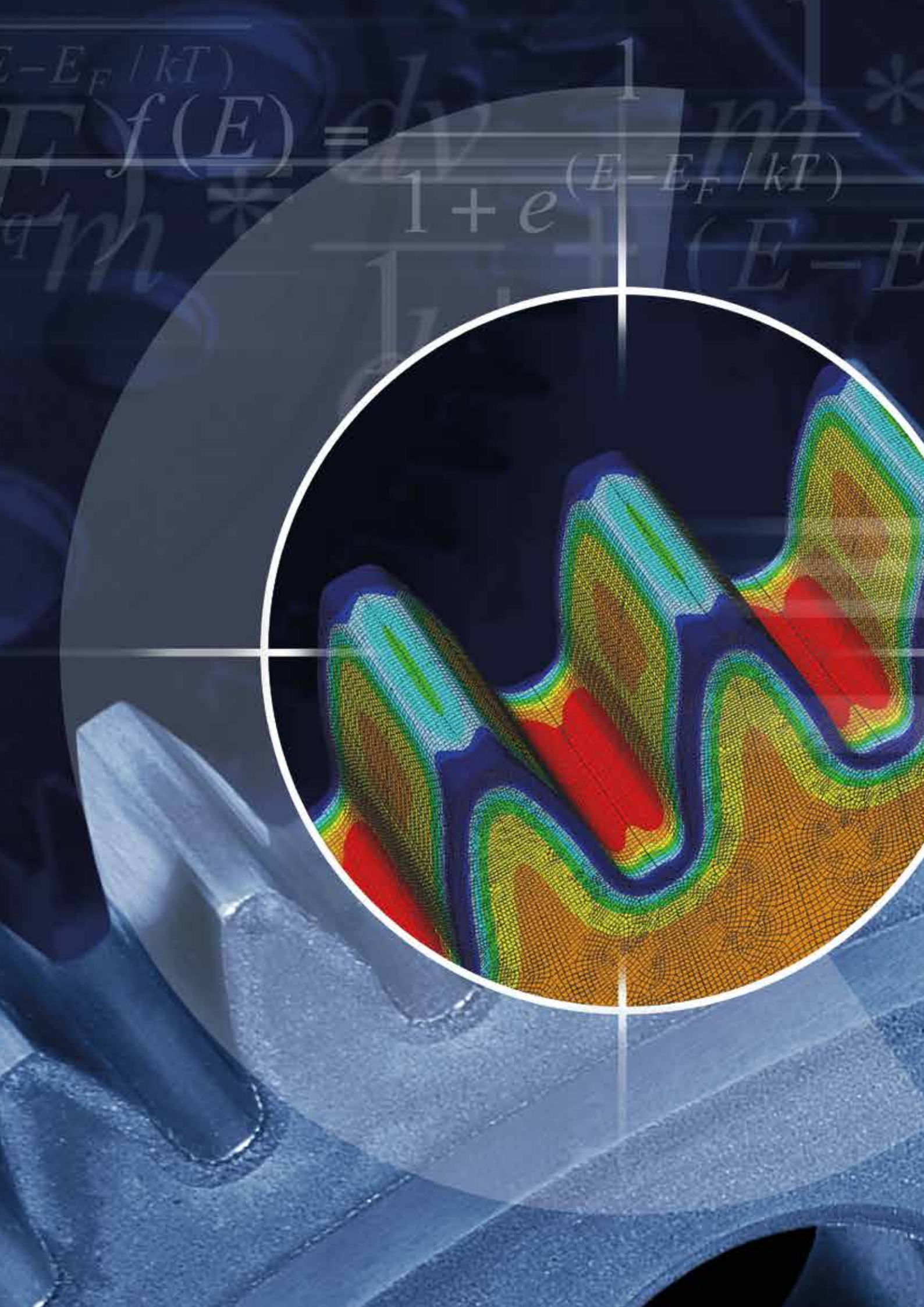
MCL specialises in materials, their manufacture and processing, as well as innovative material applications. MCL research focuses on the following areas:

- **STEEL – Extending diversity**
  Developing, processing, innovating and optimising the design, weight and safe use of steel and other metallic materials
- **TOOLS – Processing beyond limits**
  Developing tool materials, and researching tool design and service life
- **MICROELECTRONICS – Opening up new dimensions**
  Researching materials and composites to increase the reliability of electronic components, as well as new sensor materials and systems
- **SERVICES – Comprehensive solutions to urgent problems**
  Materials analysis at all length scales, as well as material mechanics and simulations of manufacturing processes, design and reliability

As the operating company of the COMET K2 Competence Center "MPPE – Integrated Research in Materials, Processing and Product Engineering", MCL is the ideal partner when it comes to demanding and complex, interdisciplinary research and development tasks. Within the framework of cooperative research and development projects, more than 140 highly qualified employees work together with over 140 industrial and scientific partners on fundamental and innovative developments along the entire value chain, from materials synthesis and processing through to in-service behaviour.

> MCL is Austria's leading cooperative materials research center for business and science, undertaking research and development of an international quality."

There's a reason that MCL is based in Leoben. With a long history as a steel and technology city and home to the world famous Montanuniversitaet Leoben, it is a global player when it comes to materials expertise. Through close cooperation with the Montanuniversitaet and regional companies who manufacture hightech materials or process them into new and innovative products, MCL is ideally placed to become a proactive competence center of global renown.



STEEL
INNOVATED BY MCL

Materials and manufacturing technologies for the benefit of our customers

Steel comes in thousands of forms and qualities, making them ideal for a huge variety of applications. Although steel is sometimes considered an 'old' material, thanks to its versatility its potential is by no means exhausted. MCL understands steel in all its forms, right down to its atomic structure, making it the ideal partner when it comes to lending this complex materials group new and innovative facets.

Steel

EXTENDING DIVERSITY.

Whether we're looking for something new or trying to improve what we have: only with a sound, theoretical and comprehensive understanding of steel in all its manifestations can we achieve our goals to develop new products for the benefit of our customers, optimising factors such as energy, material and time input in the manufacturing process, or improving service life and durability. Using state-of-the-art technical equipment, MCL is able to characterise the structure and properties of steel at all length scales, from microscopic samples through to complete components. MCL researches steels right down to their atomic level using high-performance computing infrastructure which enables state-of-the-art simulations to a standard previously undreamed of. MCL offers the highest levels of expertise in basic and applied research, focusing on the simulation of steels both in the manufacturing process and in service..

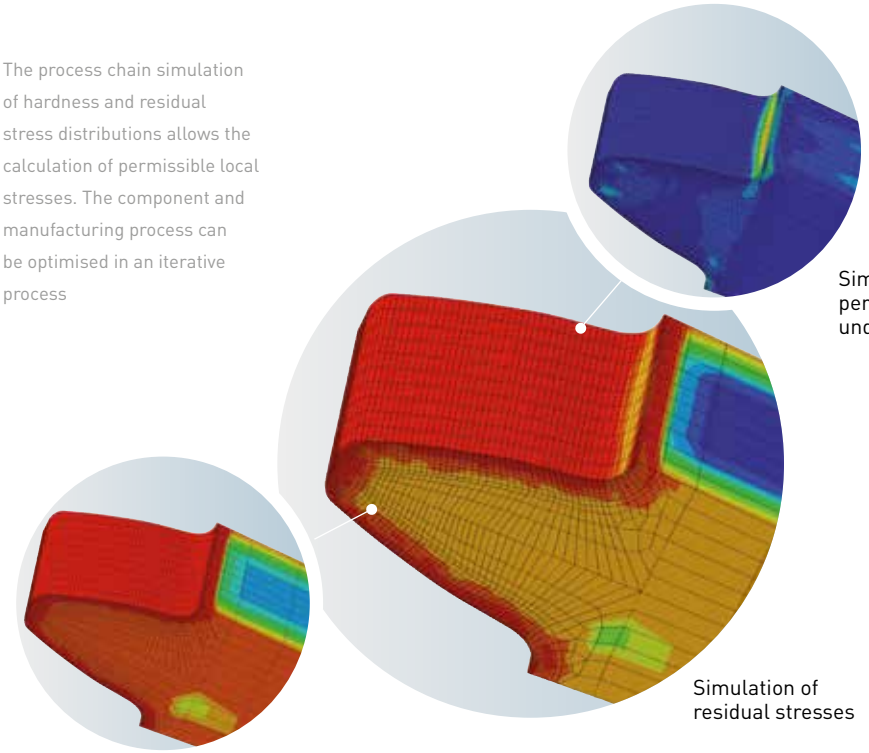
Development:

Reinventing steel every day.

The MCL laboratories provide the foundations for the development of innovative steels for specific applications. A wide range of optimisation processes are available depending on customer requirements:

- Improving material properties such as maximum strength or toughness and physical properties such as thermal conductivity and expansion
- Cost reduction through resource efficiency in the manufacturing process and shorter process chains, e.g. for novel age-hardening steelsf
- Design of steels that open up new fields of application

The process chain simulation of hardness and residual stress distributions allows the calculation of permissible local stresses. The component and manufacturing process can be optimised in an iterative process



Simulation of permissible stresses under fatigue load

Simulation of residual stresses

Simulation of hardness distribution

STEEL

Manufacturing and process chains:

We make steel manufacturing more efficient and environmentally-friendly.

The focus in the further development of processing chains for steels and steel composites is on:

- Modification of steels aimed at optimising their processing behaviour
- Simulation-based optimisation and shortening of process chains in terms of production efficiency, quality and resource use
- Support of intelligent production control concepts using physically-based process models

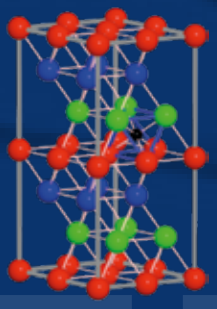
Selected applications:
① Transmission components,
② Tyre protection chains,
③ Rails / switch points,
④ Bearings, ...

Use of highly complex components:

We direct atoms to ensure their perfect interaction in service.

MCL has special expertise in the experimental analysis and simulation of the behaviour of highly complex components:

- Stress and fracture mechanics analysis for new design concepts
- Fitness-for-purpose and damage-tolerant-design-concepts
- Thermo-mechanical fatigue (TMF)
- Multiaxial loading
- Load bearing capacity and fatigue behaviour of inhomogeneously structured components (e.g. welded structures)
- Graded materials and material composites
- Modelling of complex material and damage behaviour



Simulation of atomic crystal structures, interface structures and properties

Examples:

Our customers and partners are changing the world.

MCL provides fundamentals, simulations and experimental results for

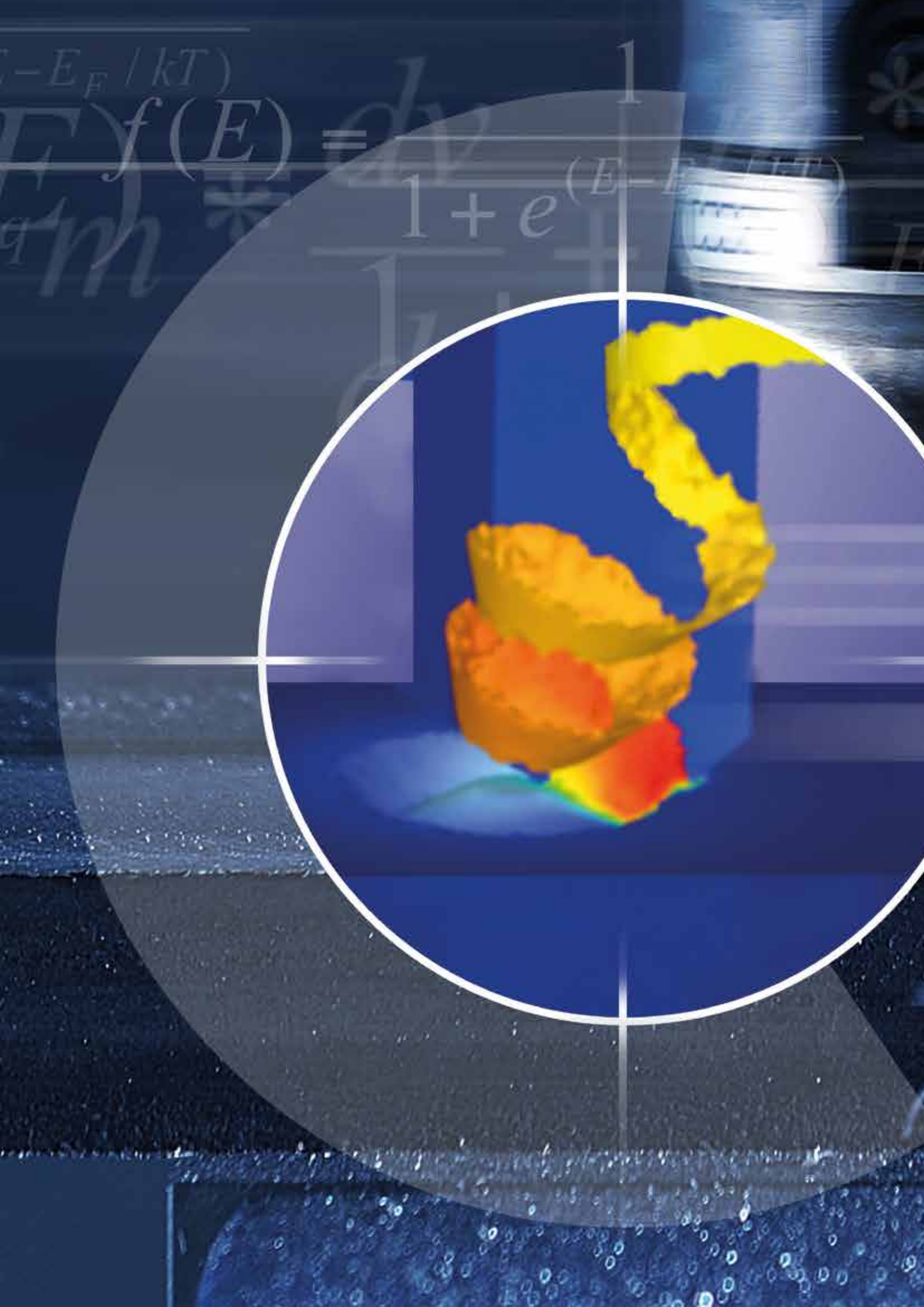
- Weight optimised components for extreme load conditions, e.g. for generator parts or rail vehicles
- Customised solutions for advanced inhomogeneously structured steel products, e.g. novel material concepts for rail switch points or tyre protection chains for utility vehicles in the steel industry
- Innovative design of high-strength steels, e.g. tool steels for stamping and fine blanking or high-performance steels for roller bearings
- New material and process concepts designed to reduce manufacturing steps, e.g. new precipitation hardening steels for high-performance automotive components

Expertise:

Why we simply know more.

MCL's expertise in the field of steel is based on the following pillars:

- Long years of steel research coupled with the traditional expertise of Montanuniversitaet Leoben
- Continuous collaboration with leading steel manufacturers, processors and users in different industrial sectors
- State-of-the-art laboratory equipment and analysis methods



TOOLS INNOVATED BY MCL

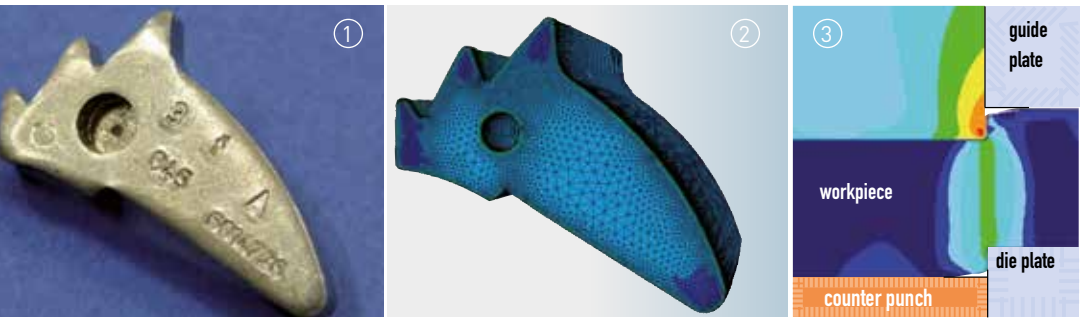
Analysing, developing and optimising tools

Tools are both a key innovator as well as cost factor in industrial production. The interaction between tool and workpiece always involves contact of different materials under extreme conditions. The goal of MCL's materials research is to extend tool life and efficiency, making manufacturing processes more cost-efficient, and opening up entirely new methods of production. This creates the basis for using innovative tool developments to process new materials and design new shapes – from small and smallest dimensions to the largest scale.

Tools

PROCESSING BEYOND LIMITS.

Any change in a material's form or internal structure also requires profound changes in the manufacturing process – whether a material is suitable for an application or not often depends on the tool used for shaping it. With its expertise in high-strength tool materials, MCL offers its development, simulation and testing services wherever two different materials come into contact in the manufacturing process. This places MCL on track to achieve its ambitious goal of becoming the world's leading center for tool technology and production.



① Part of belt tensioner produced by fine blanking

② FE model of a fine blanking punch

③ 2D view of stresses arising in the workpiece and in the tool during fine blanking

Materials for tools:

Ongoing innovation

MCL collaborates with partners to develop innovative tool materials and coatings based on the characterisation of material structure and properties:

- Material development
  - Tool steels
  - Steels with specific physical properties
  - Hard metals
  - Nickel and carbon-based tool materials
  - Hard and tribological coatings
- Characterisation of material structures and material properties

Tool dimensioning and tool behaviour:

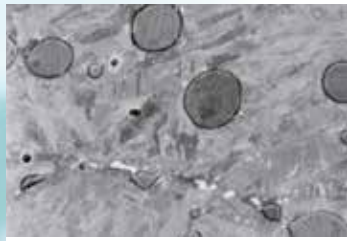
We understand tools inside out.

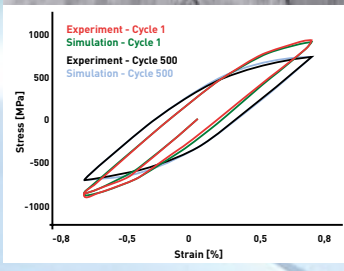
With our many years of experience, MCL can simulate the behaviour of all types of tools to their physical limits. This enables reliable load calculations and predictions of service life which in turn create the basis for the efficient planning of process chains and innovative methods of tool optimisation. MCL also has the methods and equipment needed to record the necessary simulation data:

- Knowledge based design of high-performance tools, including material selection
- Damage analysis and calculation of tool life
- Shortening of process chains and cycle times
- Simulation of in-service tool behaviour for
  - die casting tools
  - forging tools
  - cold working tools
  - turning, stamping and drilling tools, including inserts
  - fine blanking tools
  - tunnel drills

LCF testing of high-strength tool materials

High-resolution SEM microstructure image of a high-carbide high-speed steel





Modelling of cyclic material behaviour (comparison simulation / experiment)

Optimising tools through specific adaptation to local stresses:

Putting the right properties in the right place

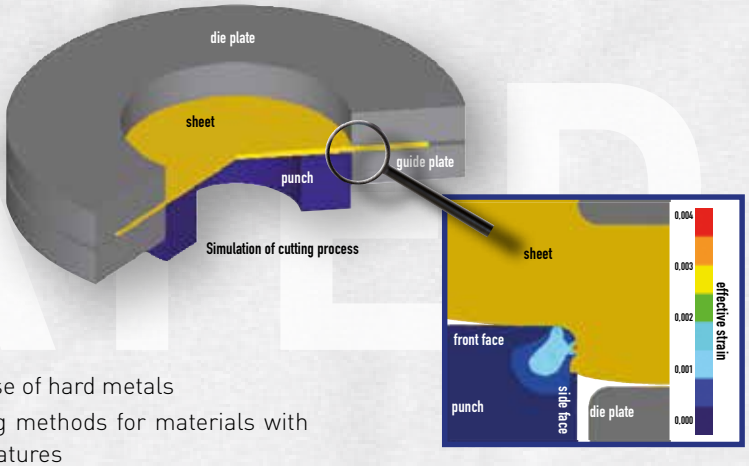
MCL calculates the tool loads occurring during manufacturing processes to develop concepts for tailoring tool properties to local loading conditions (targeted inhomogeneous tool structure). This includes:

- Technologies for adapting material properties to service conditions
  - heat treatment
  - surface technology – mechanical, chemical and thermochemical
- Prediction of local properties after manufacture
  - hardness, toughness and property distributions
- Simulation of in-service behaviour and properties of tools with an inhomogeneous structure
  - crack formation and growth in inhomogeneous tools
  - service life of inhomogeneous tools

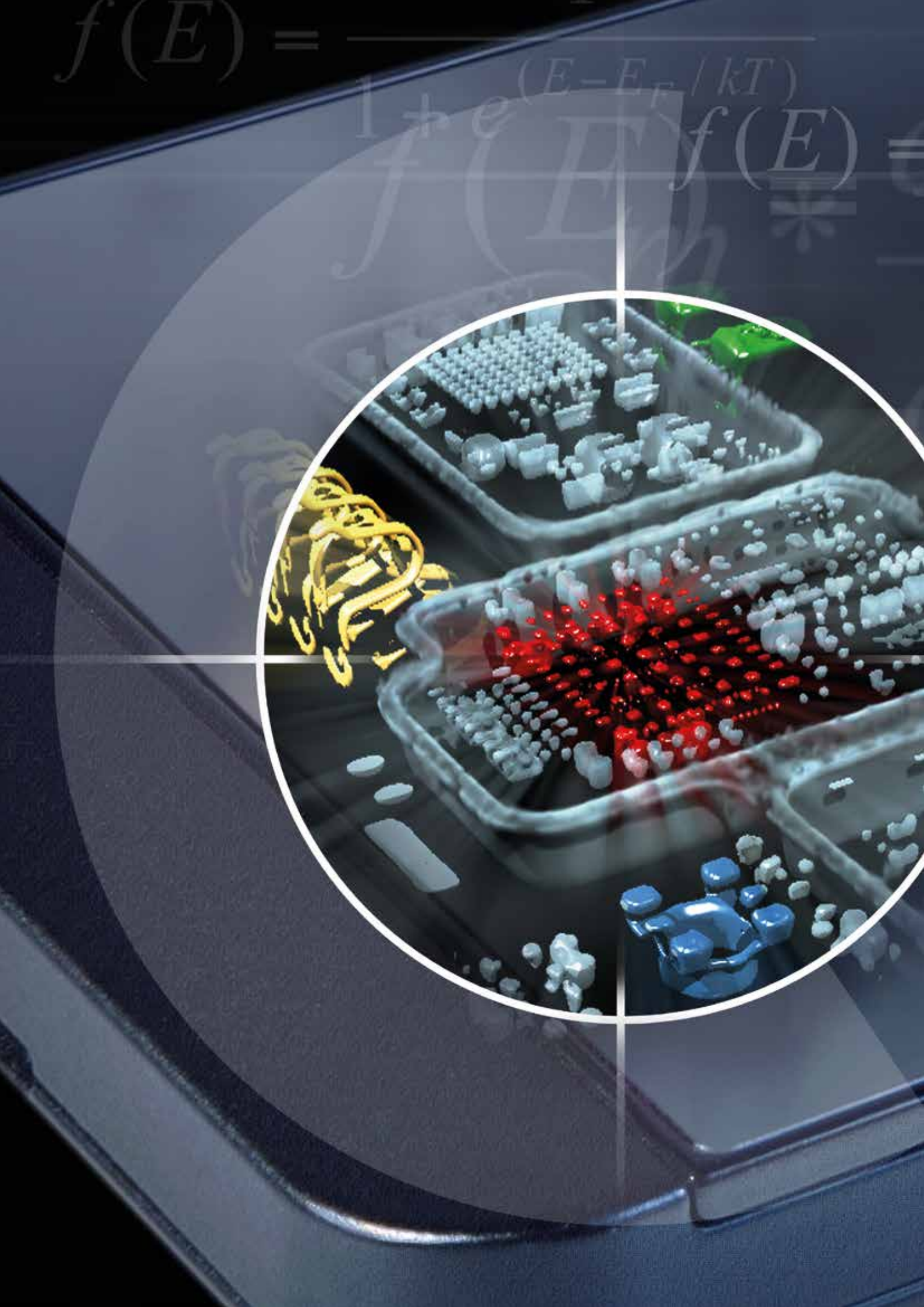
Examples:

The tools of our customers and partners are shaping the world.

MCL provides fundamental research, simulation and experimental results that enable our customers and partners to manufacture tools that redefine the possibilities of production processes.



- PCB micro drills through to tunnel drills of several meters in diameter
- Opening up new manufacturing possibilities through the use of hard metals
- Development of sophisticated characterisation and testing methods for materials with strengths of more than 8000 MPa, even at elevated temperatures



MICRO ELECTRONICS

INNOVATED BY MCL

From structures and properties in the nanometer range to the performance of electrical devices

Ever more functions and higher performance packed into ever smaller devices: that's where microelectronics is heading. This involves hugely varied classes of materials meeting in small spaces and ultra-thin layers, and under increasingly extreme conditions. Mechanical, electrical and thermal stresses on material composites have an increasing impact on the durability and security of microelectronic devices whose range of functions is also expanding through the integration of modern sensors. MCL combines materials knowledge, process technology, analysis and simulations to contribute to ongoing innovation.

Microelectronics

PERFECTION IN MINIATURE

Materials research at the nano and micrometer scale is becoming ever more important. It helps guarantee the performance and reliability of microelectronic components in order to manufacture new functional sensor systems. By miniaturising electronic components, whilst simultaneously increasing their functional range, the mechanical, thermal and electrical stresses on the materials involved continue to grow, and may eventually lead to the failure of the component. At the same time, nanomaterials are opening up new applications. Research at MCL ensures that innovative and highly reliable components can be implemented quickly, thus reducing the associated development costs.

Processes:

Step by step to perfection

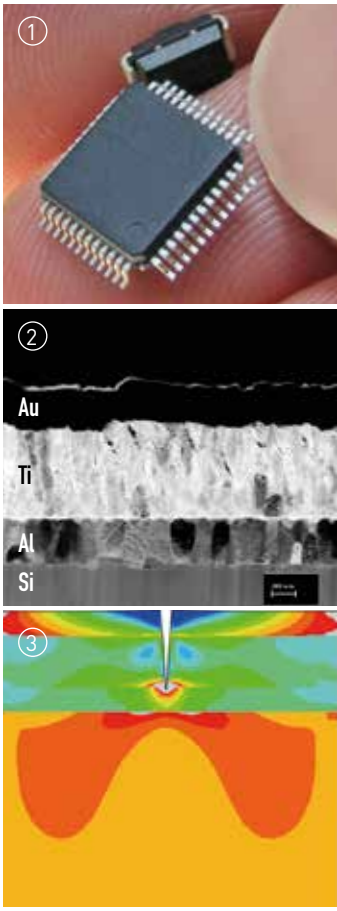
MCL has an extensive range of methods and wide-reaching knowledge of process technology in the manufacture of electronic components. We offer two different approaches to provide our partners and clients with the best possible assistance:
We support industrial processes by determining the stresses to which materials and components are exposed during manufacturing. This includes, for example, examining the development of internal stresses and how they are related to the design of the component using complex process simulations.
For joint process and material developments, MCL has access to a process chain for developing gas sensors on Si chips at its site in Leoben and at a cooperative site in Vienna. Here the focus is on innovative materials for sensor technology and their manufacture using CMOS-compatible technologies.

- **Supporting technologies:**
  Packaging and embedding | Bonding | Through-silicon vias | Process modelling of mechanical and thermal loads for design optimisation
- **Technologies on site:**
  Spray pyrolysis | Process chain for thin-film and nanowire gas sensors on 8 inch wafers | Structuring

Reliability and system performance in service:

Preconditions for reliability

MCL offers a variety of testing methods to determine the durability of electronic components. The focus lies on identifying the thermal, electrical and mechanical properties of components and their constituent materials. With the aid of advanced numerical analysis, we close the circle between function assessment, reliability assessment, and predictive reliability analysis. These findings form the basis for designing new and reliable productst.

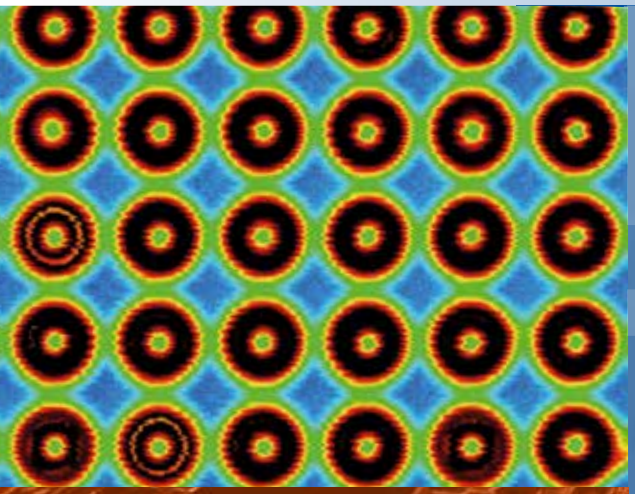


① Microchip

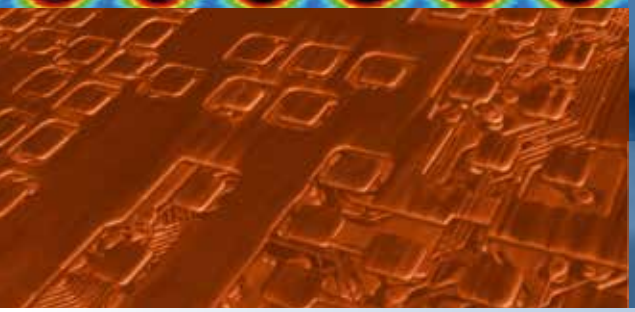
② Layer sequence of a back electrode

③ Simulation of crack growth in the layers of an electronic component

MICRO



Scanning acoustic microscope image of a silicon wafer. The ring-shaped structures show a top view of the metal interconnects through the silicon substrate.



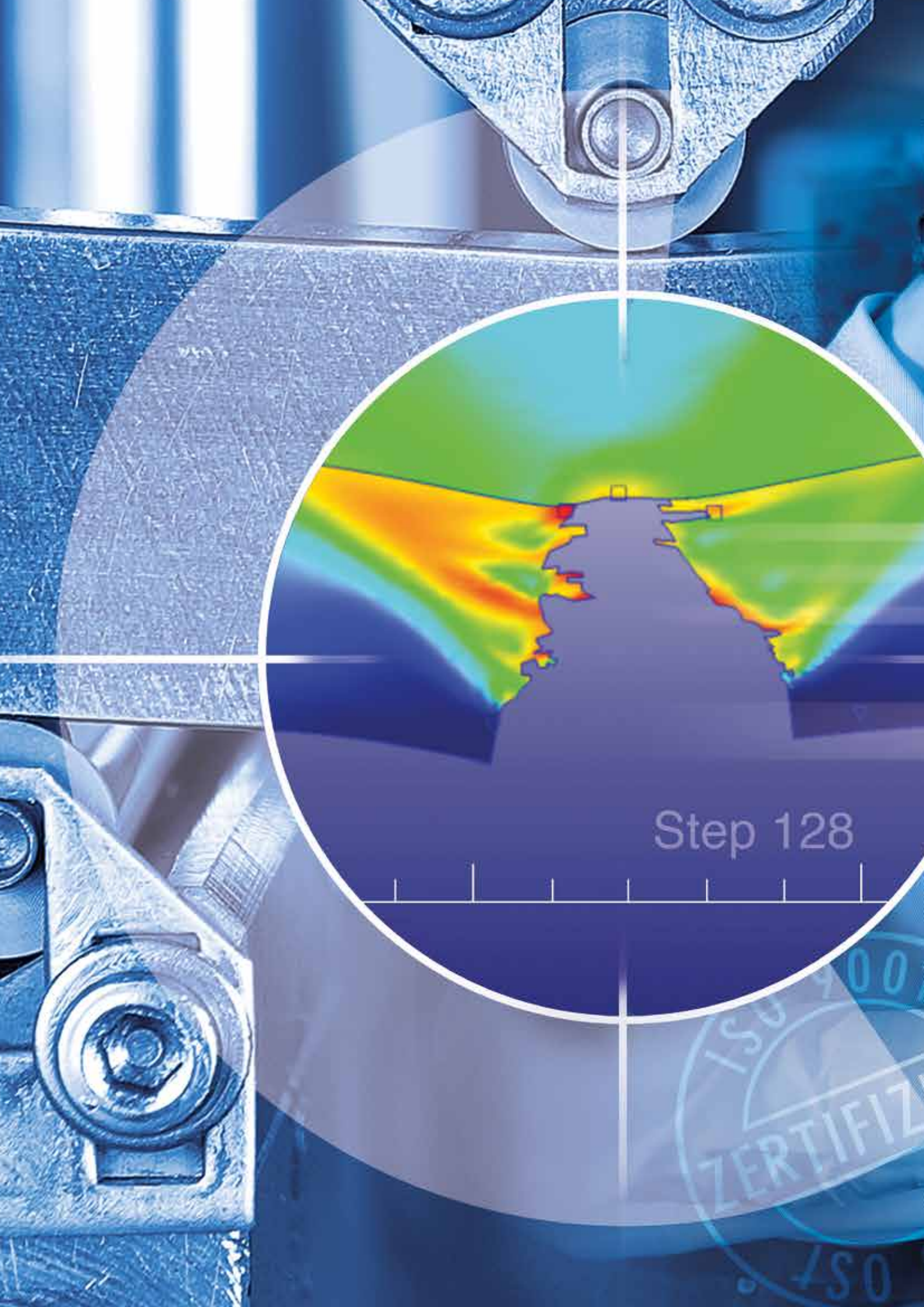
Computed tomography scan of a PCB. The image clearly shows the conducting paths on the various levels and the contact pads.

- **Key topics**
  3D-integrated components and systems | Thermal assessment of packages | Nanosensor development
- **Test methods**
  Thermomechanical tests | Electronic tests | Combined mechanical, thermal and electrical test methods | Determination of residual stress within the package using XRD
- **Analytical methods**
  Non-destructive characterisation using computed tomography and acoustic microscopy | Destructive characterisation using target preparation, optical microscopy, scanning electron microscopy with focused ion beam-technology, electron backscatter diffraction | Material characterisation using indentation methods and scanning force microscopy | Material characterisation using microdynamic-mechanical analysis | Sensor test bed
- **Simulation services**
  Material modelling – development of material models | Modelling of mechanical and thermomechanical loading | Interfaces | Modelling of crack formation and growth | Design optimisation in terms of thermal management and stress

Examples:

Nanosensors for microelectronic components

MCL is coordinating an EU project with 17 partners aimed at integrating nanosensors into microelectronic components. The primary objective is to develop extremely small sensors for integration into computer chips. Innovations such as these could be used in smartphones for example, to warn participants in outdoor sports of dangerously high ozone levels, city dwellers of high levels of particulate matter, farmers of gases in silos, or sunbathers on the beach of dangerous exposure to UV radiation. Nanosensors also open up new possibilities in building technology: networks of infrared sensors can locate the source of a fire and indicate the exact location of potential victims. Nanosensors also make it possible to control air conditioning systems based not only on room temperature but also on the CO2 concentration, helping to make them more energy-efficient.


Step 128

SERVICES

INNOVATED BY MCL

Analysis, simulation and support designed to find solutions for the development of materials and products, and remedying damage

MCL's core service offerings include characterising materials and components in terms of their structure and microstructure, determining the mechanical and physical properties of materials, developing material models for simulations as well as finite-element-simulations, damage analysis, and advice on the choice of materials. MCL's key advantage lies in its combination of experimental laboratory analysis with calculations and simulations, state-of-the-art technical facilities, and wide-ranging specialist knowledge of the most diverse range of materials. MCL has the expertise and experience required to provide scientifically sound results and targeted support in practical material and product development.

Services

EXPERTISE AND KNOW-HOW IN THE SERVICE OF RESEARCH AND DEVELOPMENT

The technical facilities, together with our theoretical and practical expertise, make MCL a flexible professional partner for research and development in the fields of materials engineering, process technology, quality assurance and component design. MCL offers a variety of laboratory analyses and complex services such as damage analysis or materials advice, in addition to materials, components and process simulations.

Metallography

The Metallography Laboratory offers the following fields of expertise:

- Microstructure characterisation of metallic/ceramic materials, composites and components
- Determination of cleanliness level or grain size according to standard methods
- Hardness testing from low to high loads
- Profilometry surface analysis, e.g. surface roughness
- Mobile metallography testing on site

Technical equipment of the Metallography Laboratory:

- Equipment for metallographic preparation of metallic materials and composites
- Optical and stereo microscopes including a quantitative image analysis system
- Confocal microscope for profilometry measurements
- Micro, small load and macro hardness testers (partially instrumented)
- Nano-indenter with integrated heating unit up to 500°C

Physical-chemical analysis

The Physical/Chemical Laboratory offers the following fields of expertise:

- X-ray phase and structure analysis, e.g. determination of retained austenite
- X-ray texture analysis
- X-ray analysis of process or service-induced residual stresses and residual stress depth profiles
- Determination of phase transformation temperatures
- Measurement of time-temperature transformation and precipitation diagrams
- Chemical materials analysis
- Measurement of carbon and nitrogen depth profiles and other chemical depth profiles
- 3D imaging using high-resolution computed tomography

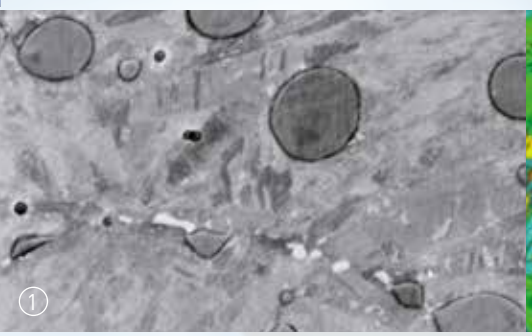
Technical equipment of the Physical/Chemical Laboratory:

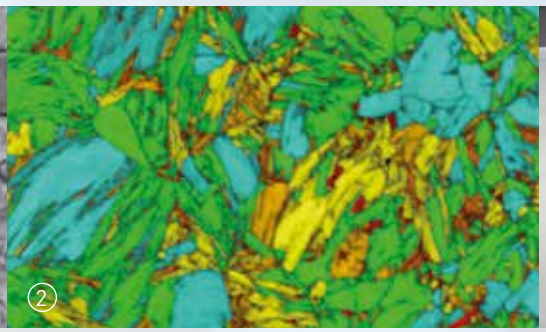
- Various X-ray diffractometers (laboratory and mobile goniometers)
- High-resolution glow discharge spectrometer
- Differential scanning calorimeter including mass spectrometer
- Quenching dilatometer including low-temperature unit
- High-resolution CT scanner
- Acoustic microscope

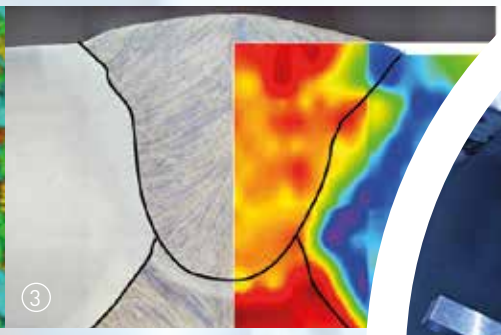
① High-resolution microstructure image of high-speed tool steel

② EBSD image of heat-treated steel

③ 2D hardness mapping of multi-layer weld







Electron microscopy

The Electron Microscopy Laboratory offers the following fields of expertise:

- Characterisation of surfaces, fracture surfaces and metallographic specimens using scanning electron microscopy
- Materials analysis including 3D microstructure tomography using SEM-FIB-technology
- Target preparation of TEM thin films or atom probe specimens for subsequent high-resolution analysis
- Characterisation of local electronic and magnetic properties and surface morphology using scanning probe microscopy
- Damage characterisation

Technical equipment of the Electron Microscopy Laboratory:

- High-resolution dual-beam scanning electron microscope (SEM-FIB)
- Scanning electron microscope with large specimen chamber for component analysis
- Scanning probe microscope (SPM), which can also be integrated into the SEM-FIB for in-situ-analysis

Mechanical tests

The Mechanical Testing Laboratory specialises in static and cyclic material tests:

Static materials testing:

- Uniaxial tensile tests from room temperature to 1000°C
- Various other static tensile, compression and bending tests
- Fracture toughness tests (KIC, J-integral and CTOD) from -150°C to 500°C
- Notch-bar impact tests

Cyclic materials testing:

- Uniaxial low cycle fatigue tests on metallic materials from -150°C to 1000°C
- Multiaxial cyclic tests on metallic materials from room temperature to 1000°C with integrated gas quenching
- S-N curves from -150°C to 900°C
- Fracture mechanical tests (crack growth behaviour, determination of threshold values)

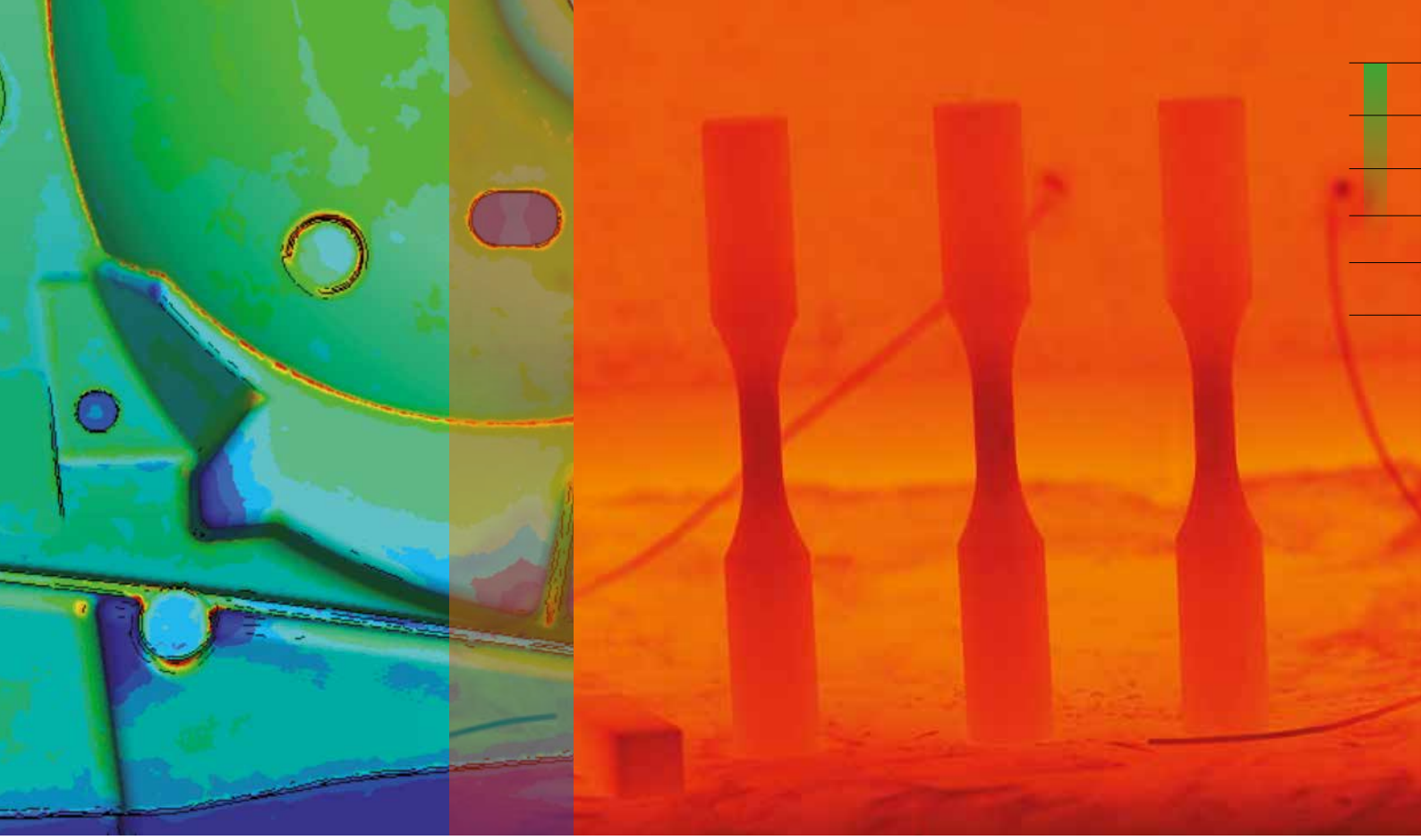
Technical equipment of the Mechanical Testing Laboratory:

- 2 universal testing machines with extensive accessories
- 3 servohydraulic testing machines with various heating and cooling units, including a vacuum chamber*)
- 3 electrodynamic (resonant) testing machines
- Various strain measurement sensors and crack measurement devices (potential probes)

*from 06/2015

Damage analysis and materials advice

MCL provides comprehensive expertise and an experienced team of specialists to assist customers in damage analysis.
Applications include structural components, tools and functional components with a focus on metallic materials and composites. We have special expertise in the detection and repair of material, process and service-induced damage. A key strength of MCL is its sound knowledge of physical damage mechanisms combined with a thorough understanding of industrial production processes and applications. Our experts not only determine the cause of damage, but also develop remedial measures and assist you in implementing improvement measures.
.



Heat treatment

The Heat Treatment Laboratory offers the following fields of expertise:

- Standard and special vacuum hardening with controlled high-pressure gas quenching
- Tempering and annealing under vacuum, inert gas or atmospheric conditions
- Deep freezing to -180°C with integrated heating up to 600°C
- Low-pressure carburising of components and specimens
- Plasma nitriding and plasma oxidation of steel materials

A special focus of the laboratory is on sampling, special treatment with strictly defined parameters (e.g. controlled gas quenching) and targeted specimen heat treatment.

Technical equipment of the Heat Treatment Laboratory:

- Industrial vacuum furnaces with integrated high-pressure gas quenching for hardening and annealing processes and for thermochemical processes
- Industrial plasma nitriding system
- Freezing unit
- Various lab furnaces for annealing processes

Modelling and Simulation

The Modelling and Simulation team offers the following fields of expertise:

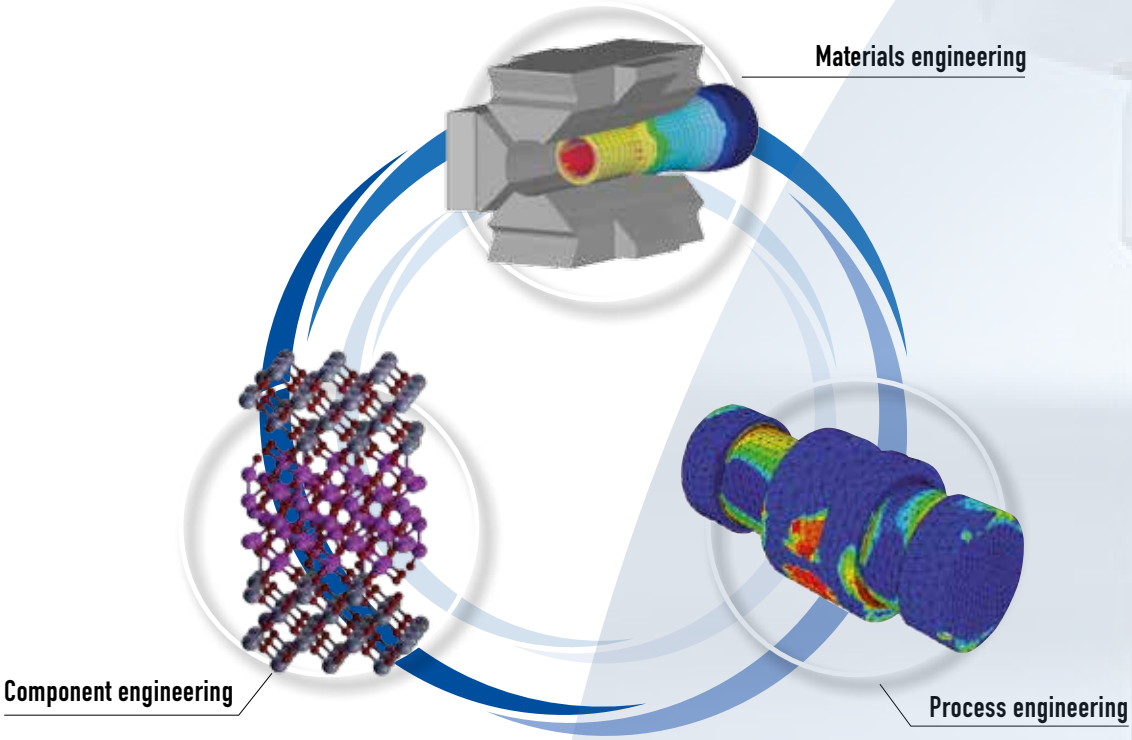
- Simulation services for development and design
- Damage tolerant design
- Thermomechanical loading
- Process chain simulation
- Modelling of complex material behaviour

Technical equipment of the Modelling and Simulation team:

- Various high-performance workstations and access to high-performance computer clusters
- Wide range of software tools for finite element, CFD, ab-initio, thermodynamic and kinetic simulations

COMET K2 Materials, Processing and Product Engineering (MPPE)

MATERIALS INNOVATED BY MCL



The Materials Center Leoben is one of five Austrian COMET K2 Competence Centers. Together with partners from industry and science, the COMET K2 Center for "Integrated Research in Materials, Processing and Product Engineering (MPPE)" focuses on key areas of the process chain, including:

1. **Development and characterisation of materials**
2. **Materials synthesis**
3. **Materials processing**
4. **Design and manufacture of parts and functional components**
5. **Behaviour of materials in service**

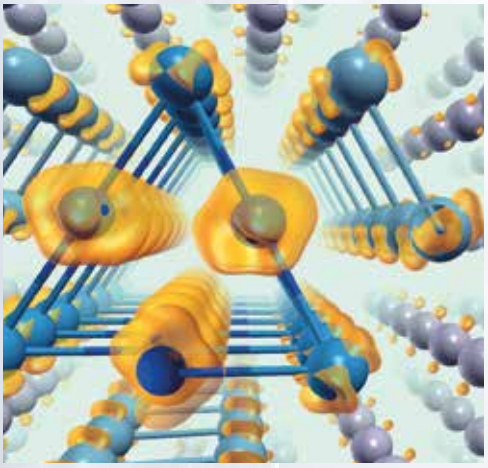
The strategic objectives of MCL as a Competence Center for Excellent Technologies (COMET) are:

- developing new expertise by initiating and supporting long-term research collaboration between science and industry in top-level research
- and establishing and securing the technological leadership of companies

MCL advances and concentrates existing strengths and integrates international research expertise in order to strengthen Austria's position as a research location for the long term. MCL receives funding from

- the Austrian Federal Government (especially the Federal Ministry of Transport, Innovation and Technology and the Federal Ministry of Science, Research and Economy) represented by the Austrian Research Promotion Agency (FFG)
- the Styrian Regional Government represented by the Styrian Business Promotion Agency (SFG)
- the Tyrolean Regional Government, represented by the Business Promotion Agency Tyrol
- scientific and industrial partners

Phase I of the research programme ran from 2008 to 2012 with a total project volume of approx. Euro Sans 50 million. After an evaluation in 2012, the COMET K2 Center was extended for another five years to the end of 2017. A project volume of some € 60 million will be available for Phase II.



Selected industrial partners:

- Andritz Hydro, Pulp & Paper
- AT&S AG, Leoben-Hinterberg, Styria
- Böhler Edelstahl GmbH, Kapfenberg, Styria
- Ceratizit Austria Gesellschaft mbH, Reutte, Tyrol
- Ceratizit Luxembourg S.a.r.l., Mamer, Luxembourg
- Epcos OHG, Deutschlandsberg, Styria
- Georg Fischer Automotive AG, Schaffhausen, Switzerland
- Plansee SE, Reutte, Tyrol
- RHI AG – Technology Center Leoben, Styria
- Robert Bosch GmbH, Stuttgart, Germany
- Siemens AG Österreich, Graz, Styria
- voestalpine VAE GmbH
- voestalpine Stahl GmbH, Linz, Upper Austria

Selected national scientific partners:

- Montanuniversitaet Leoben
- Austrian Academy of Sciences
- Graz University of Technology
- Vienna University of Technology
- Joanneum Research Forschungsgesellschaft mbH

Selected international scientific partners:

- Centre des Matériaux P.M. Fourt, École des Mines de Paris, France
- Academy of Sciences of the Czech Republic, Institute of Physics of Materials, Czech Republic
- Royal Institute of Technology, Department of Materials Physics, Sweden
- Max-Planck-Institute of Colloids and Interfaces, Germany

Certifications

ISO 9001:2008 CERTIFICATION FOR INTERNAL AND EXTERNAL SERVICES


ZERTIFIKAT

TÜV AUSTRIA

für das Managementsystem nach
EN ISO 9001:2008

Der Nachweis der regelwerkskonformen Anwendung wurde erbracht und wird gemäß TÜV AUSTRIA CERT-Verfahren bescheinigt für

Materials Center Leoben
Forschung GmbH
Roseggerstrasse 12
A-8700 Leoben

Geltungsbereich

Services im Bereich Werkstoff- und Bauteilcharakterisierung, Werkstoffauswahl, numerische Simulation und Schadensanalytik

Zertifikat-Registrier-Nr: 20 100 112007001 Gültig bis 2015-03-18

Zertifizierungsstelle der TÜV AUSTRIA CERT GMBH

Wien, 2012-03-19

Diese Zertifizierung wurde gemäß TÜV AUSTRIA CERT-Verfahren zur Auditierung und Zertifizierung durchgeführt und wird regelmäßig überwacht.
TÜV AUSTRIA CERT GMBH Krugerstraße 16 A-1015 Wien www.tuv.at

In addition to its research activities, MCL provides businesses and scientific partners with services in the fields of materials and component characterisation, materials selection and damage analysis. To be able to offer these services at a high quality level, MCL has obtained certification to ISO 9001:2008, which includes the following points:

Rapid order processing
When it comes to damage analysis, materials selection and materials analysis, rapid order processing is vital for keeping up production processes, averting damage and preventing delays in development. MCL promptly responds to customer enquiries, submits a tailored offer and processes incoming orders in a timely manner.

Reproducible and reliable results
MCL can draw on highly qualified and trained technical staff, detailed operating instructions and documented procedures for the standard tests offered, as well as serviced, calibrated and regularly checked facilities and measuring instruments. The test results, specimens and materials are documented and archived in accordance with strict confidentiality regulations, and submitted to the customer in the agreed format – anything from a protocol through to a comprehensive analysis report.

Customer satisfaction and on-going company development
Our focus is on satisfying our customers. However, we can only achieve this if our services, processes, personnel and the entire company continues to develop with the customer in mind in order to improve customer satisfaction on a continuous basis.

MCL CERTIFIED AS "AUSTRIAN LEADING COMPANY"

MCL received the 'Leitbetriebe Austria' certificate, which is awarded to leading companies which demonstrate outstanding performance in terms of corporate innovation, sustainability and social responsibility.

LEITBETRIEBE AUSTRIA

Materials Center Leoben Forschung GmbH
Responsible for content:
Univ.-Prof. Dr. Reinhold Ebner, Managing Director
Mag. Alexandra Purkarthofer, MBA, Managing Director
8700 Leoben, Roseggerstrasse 12
AUSTRIA
Tel: +43 3842/45 9 22-0
Fax: +43 3842/45 9 22-500
E-mail: mclburo@mcl.at
Internet: www.mcl.at

Printed by Druckerei Dorrong OG, Graz

Idea & Concept: www.innovation-marketing.at

Photo credits:

We would like to thank the following companies and partners for providing photos:

Fotolia
innovation marketing
MCL
MIBA AG
Montanuniverstitaet Leoben
Institute for Mechanics
Institute for Structural and Functional Ceramics
Chair of Materials Physics
Morgenstern Klaus
pewag Austria GmbH
Siemens AG
voestalpine VAE GmbH

MATERIALS CENTER LEOBEN
FORSCHUNG GMBH

Materials Center Leoben Forschung GmbH
Roseggerstrasse 12 | A-8700 Leoben | T +43-3842-45922 | F +43-3842-45922-500 | mclburo@mcl.at | **www.mcl.at**