

We Innovate Materials

# Modeling and Simulation



Modeling of Complex Material Behavior

Material Modeling at the Atomic Level

Experiments Combined with Simulations

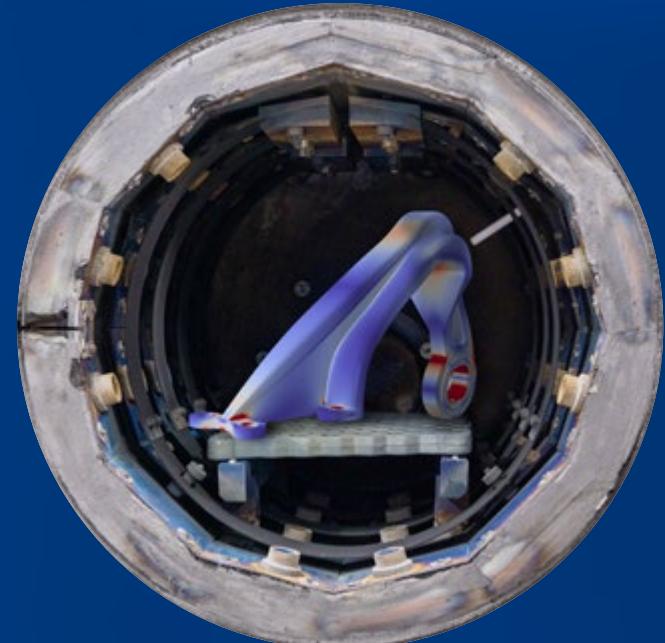
Modeling of Manufacturing Processes

Optimization of Products and Processes

Damage Analysis

Multiphysical Systems

Computational Fluid Dynamics (CFD)



COMPETENCE & RELIABILITY

# Our Services

We provide services that go beyond standard solutions and seek the challenge of complex tasks.

Our service group (Simulation Services) adopts methods from research, giving us direct access to the latest state-of-the-art technology. As a result, our portfolio includes both research-oriented services and specialized expertise in the development and optimization of technologically advanced products.

The necessary simulation data is generated in-house, enabling us to offer a comprehensive package from one single provider.

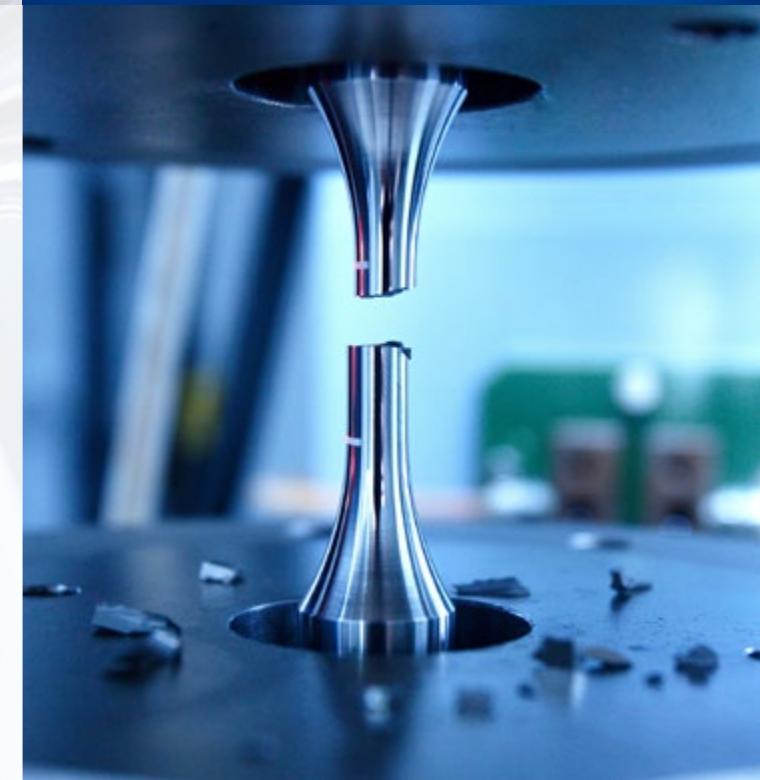
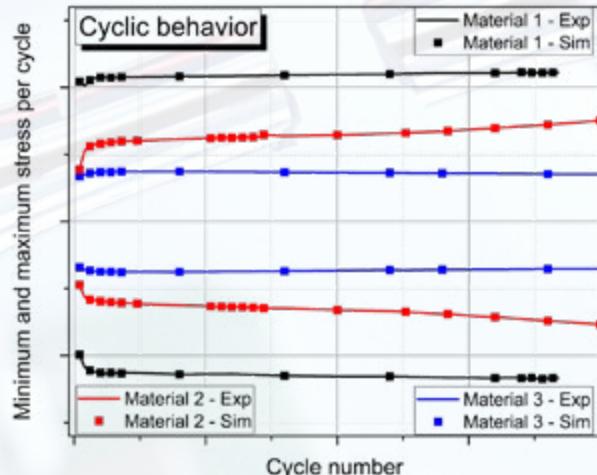
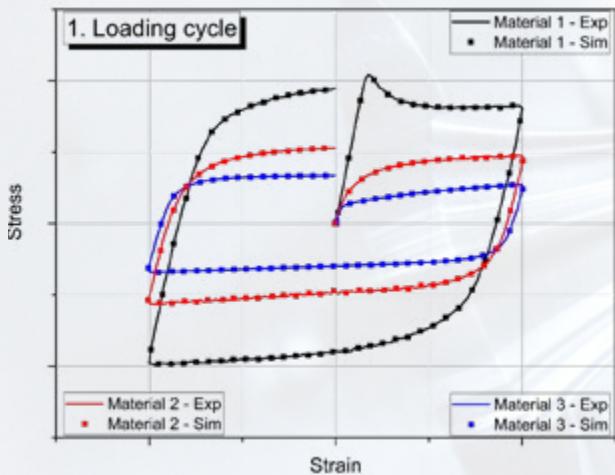
One of our particular strengths lies in the detailed consideration of material behavior under complex loading conditions, in line with our motto: "simulation meets materials."



## Our Focus/Competences

- Modeling of complex material behavior at micro-, meso-, and macro scales
- Modeling of manufacturing processes
- Damage analysis
- Structural integrity assessment according to FKM, IIW, ASME, BS
- Optimization of components and processes
- Integration of experiments into simulation
- Multiphysical systems
- Computational Fluid Dynamics

# Modeling of Complex Material Behavior



Reliable material models for more precise prediction of material behavior, developed for the use in simulations and process optimization.

## Contact:



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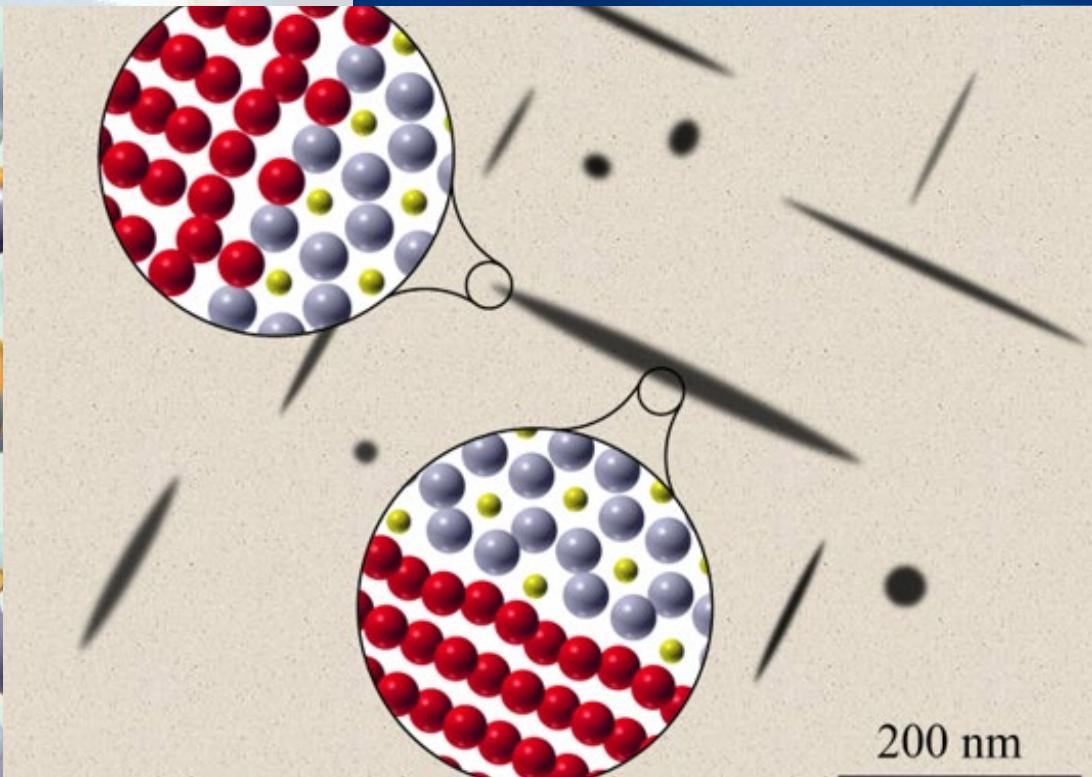
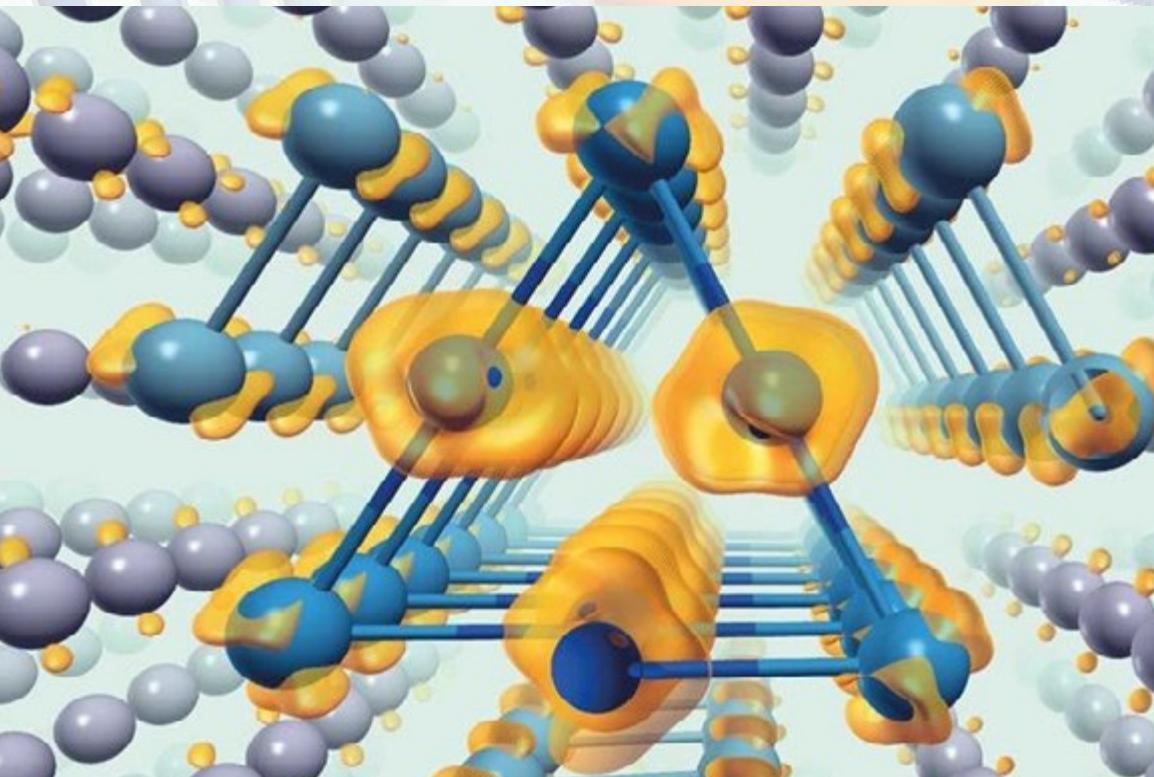
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## Our Focus/Competences

- Development of material models based on experimental data - for complex testing scenarios, we apply inverse optimization to identify model parameter
- Temperature-dependent cyclic elasto-(visco)plastic material behavior: phase transformation models, latent heat, grain growth, transformation-induced plasticity
- Development of customized material models tailored to various specific applications
- Fatigue, damage, and fracture
- Metall alloys (steel, iron, copper, aluminum, titanium, nickel,...), ceramics, composite materials

# Material Modeling at the Atomic Level



Prediction of thermodynamic and mechanical properties of materials at the atomic level.

## Contact:



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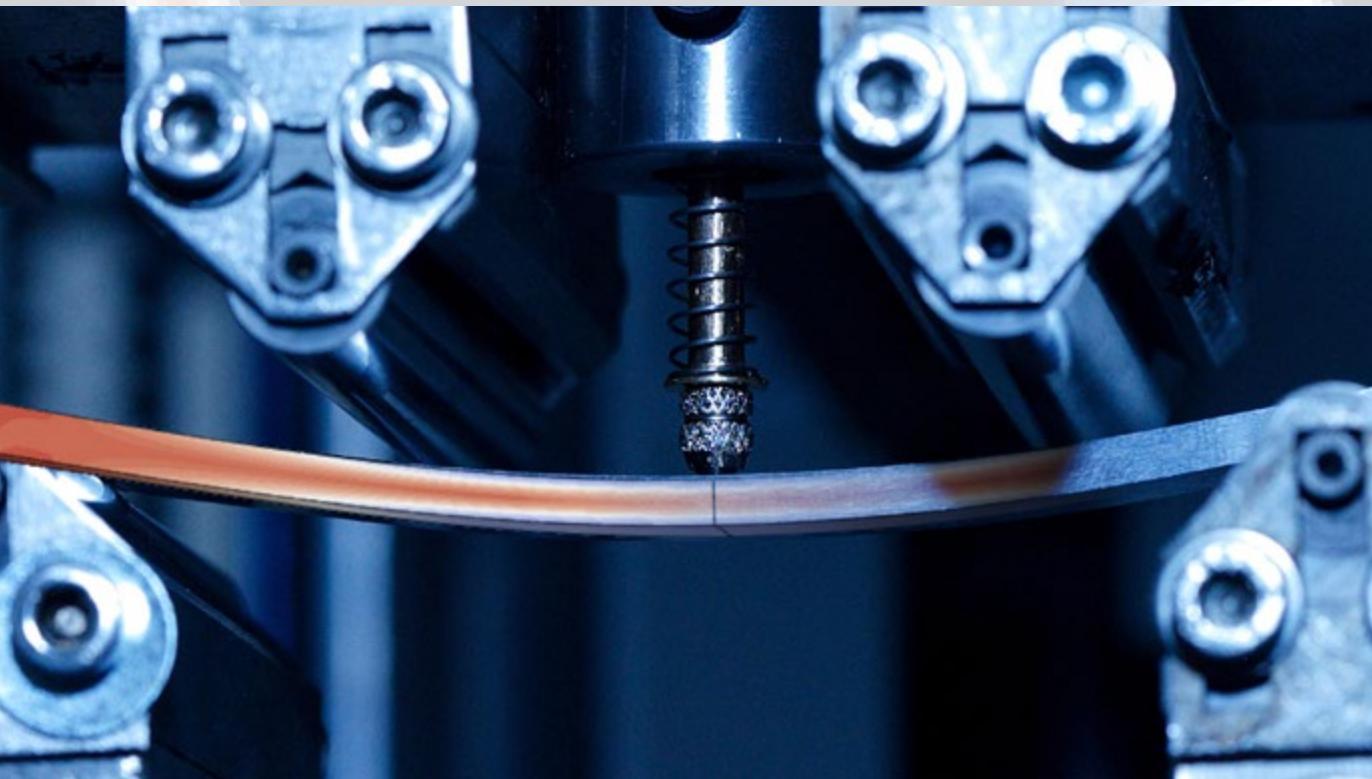
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## Our Focus/Competences

- Density Functional Theory (DFT method)
- Calculation of thermal expansion coefficients, elastic properties, grain boundary segregation, grain boundary strength, and stacking fault energy
- Evaluation of interface cohesion between different phases in materials
- Vacancies, dislocations, grain boundaries, precipitates
- Materials for energy transport and storage (hydrogen, perovskites)

# Experiments Combined with Simulations



Simulation-supported evaluation of complex experiments and derivation of material properties that cannot be accessed through direct measurement.

## Contact:

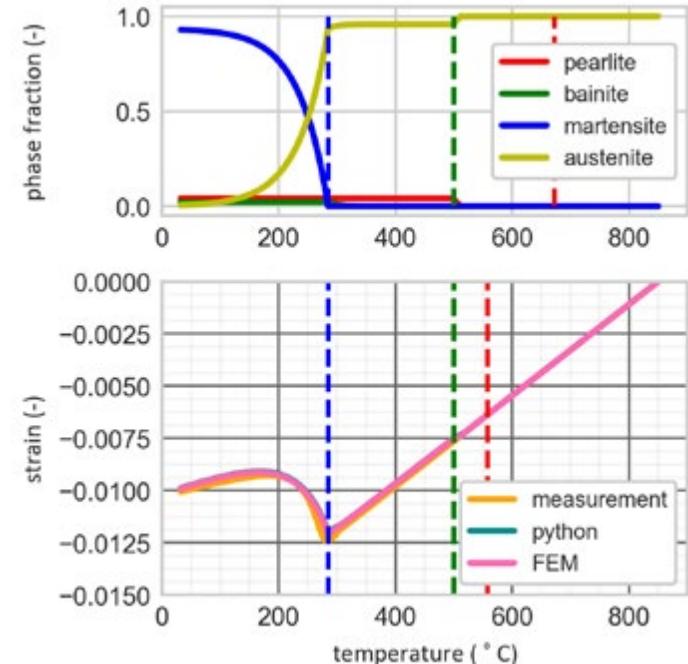


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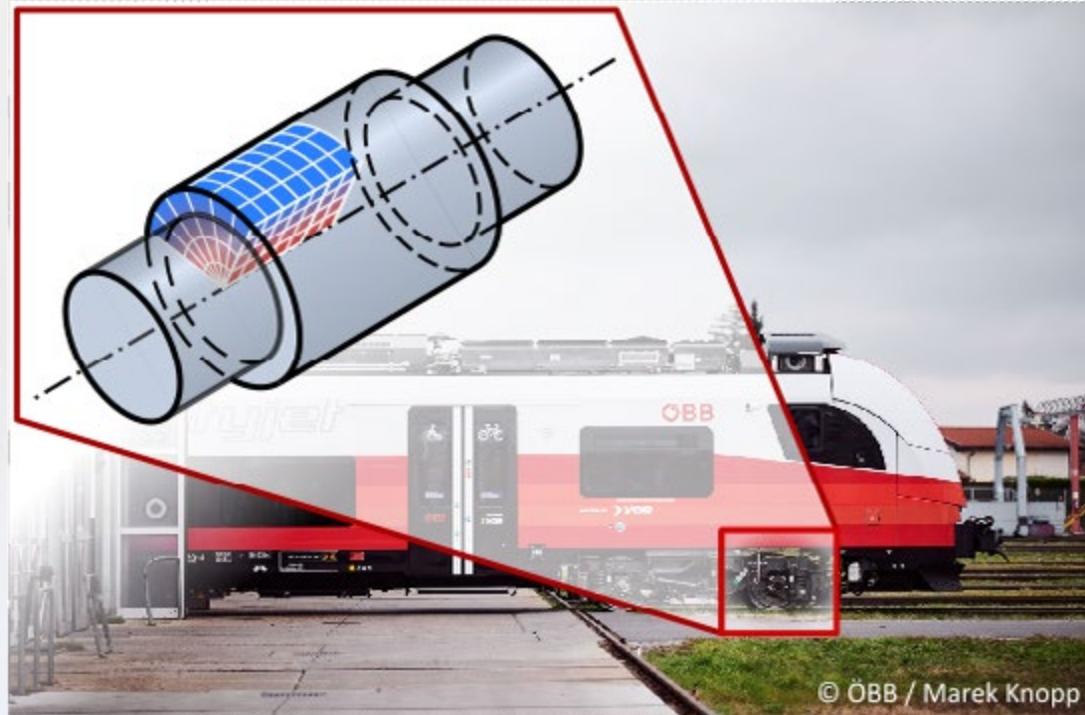
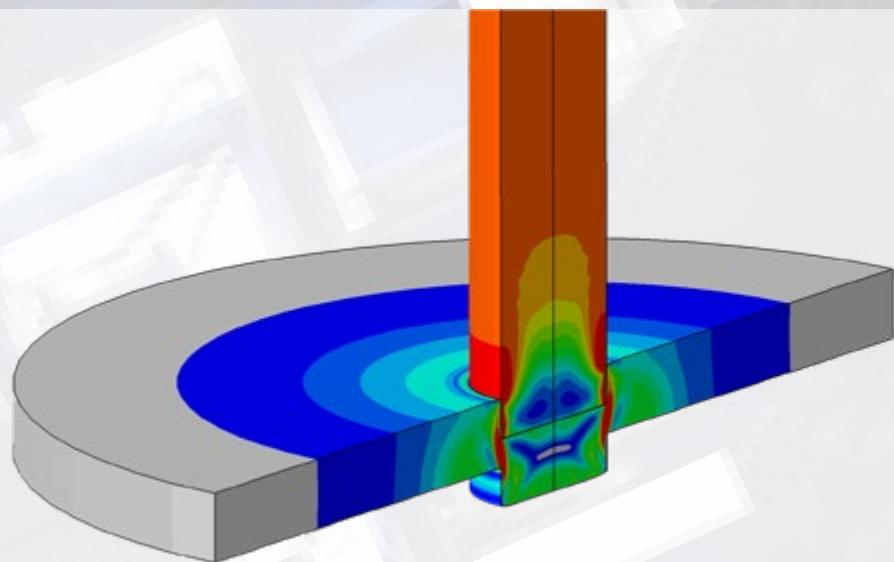
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## Our Focus/Competences

- Determining challenging material properties – from elastic behavior in foils and thin films to cyclic plasticity in micro-components.
- Determining residual stresses introduced during manufacturing using cut compliance methods.
- Stress analysis of complex experiments: digital twins, digital shadows
- Statistical experimental design and evaluation

# Modeling of Manufacturing Processes



Efficient manufacturing processes through simulation-based analysis across all scales.

## Contact:



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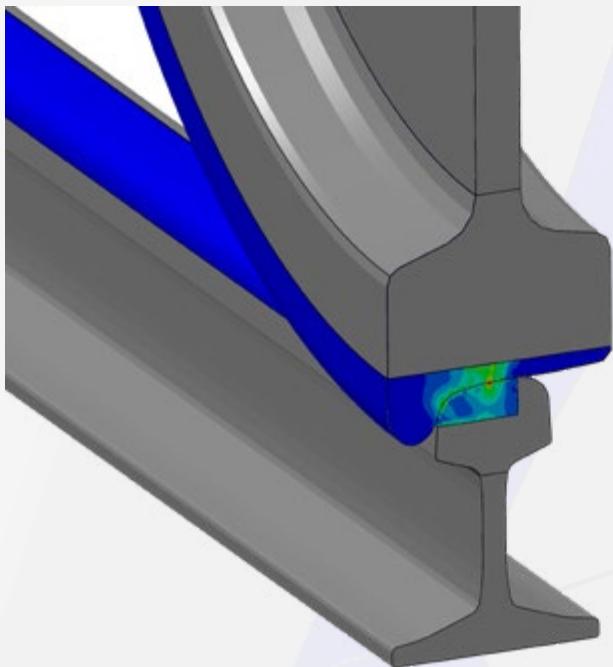
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## Our Focus/Competences

- Development of efficient processes and process chains
- Improvement of material and component properties by optimizing the manufacturing process
- Modification of material properties through targeted heat treatment
- Improving dimensional accuracy to meet tight tolerances in high-performance components.

# Optimization of Products and Processes



Shorter development times and better products through simulation-based optimization.

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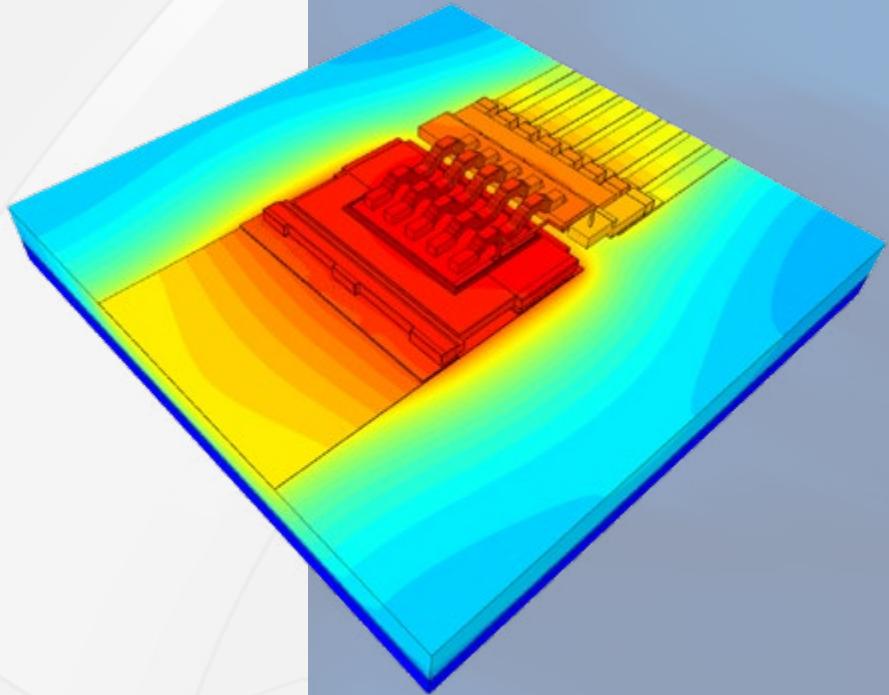


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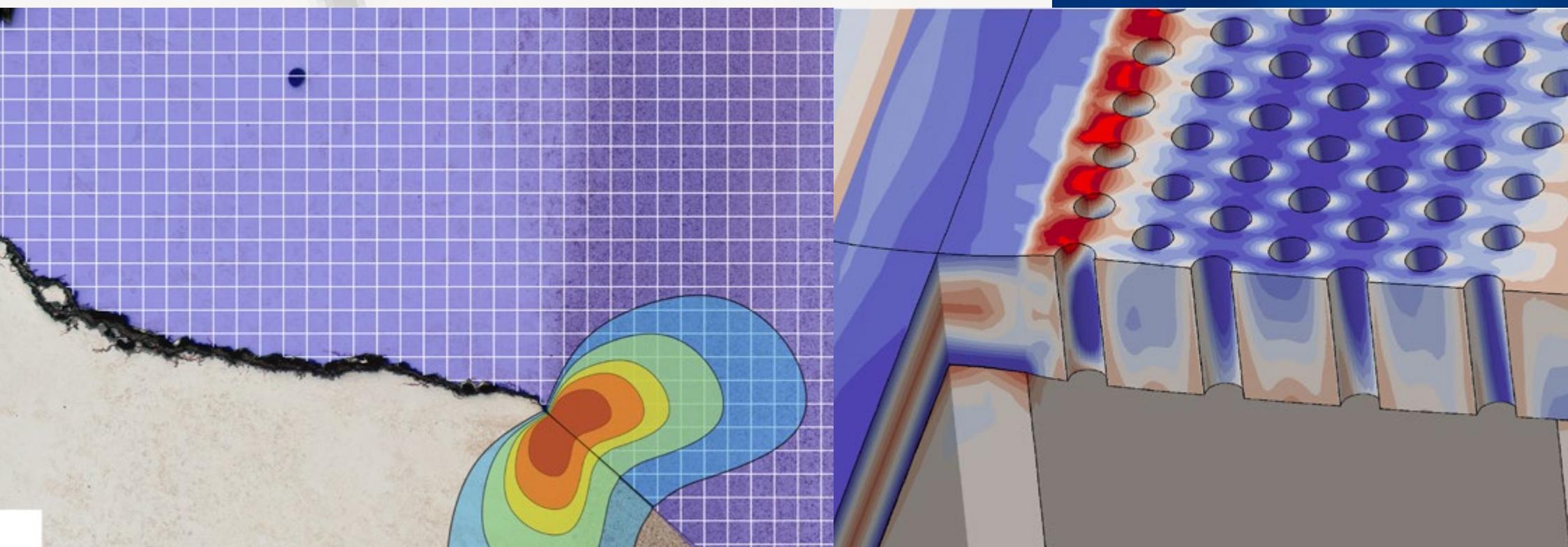
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## Our Focus/Competences

- Optimization of manufacturing parameters
- Component optimization under complex contact scenarios, including friction, wear, and contact fatigue.
- Optimization of products through virtual sensing techniques and alignment with real-world measurement data.
- Gaining insight into the interior of products during manufacturing and operation
- Lifetime optimization of products and reduction of inspection intervals through increased knowledge of material and loading
- Time-efficient product optimization and

# Damage Analysis



Holistic damage analysis with practical solutions to prevent future failures.

## Contact:



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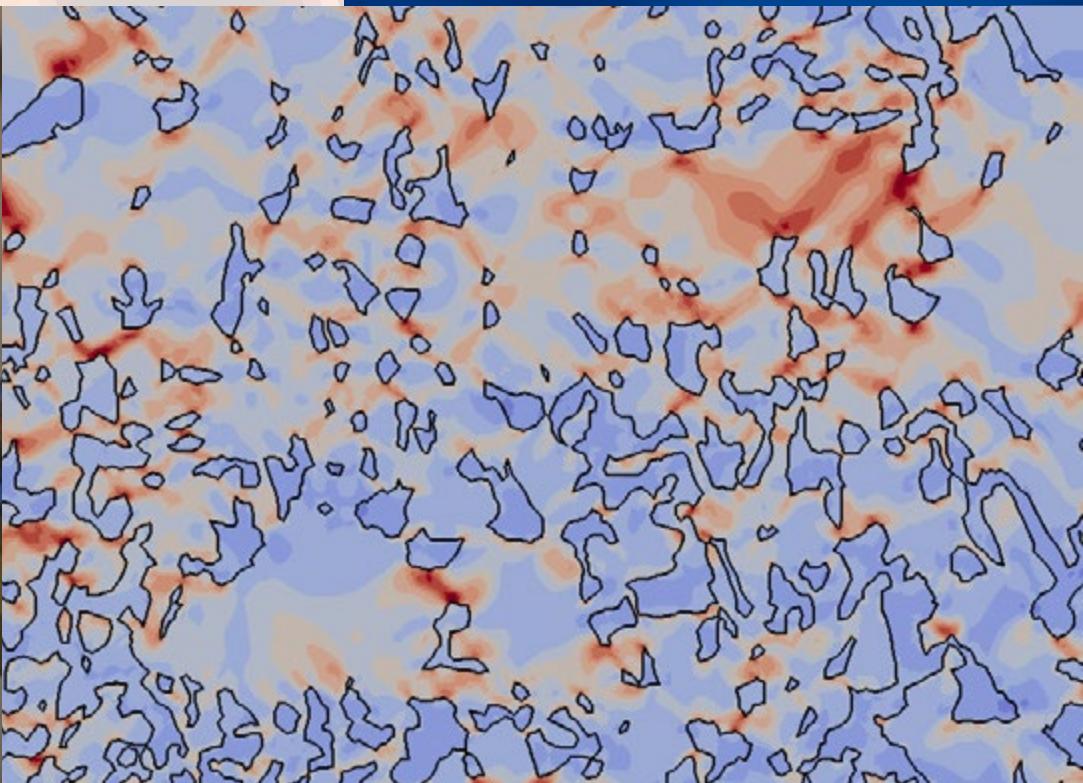
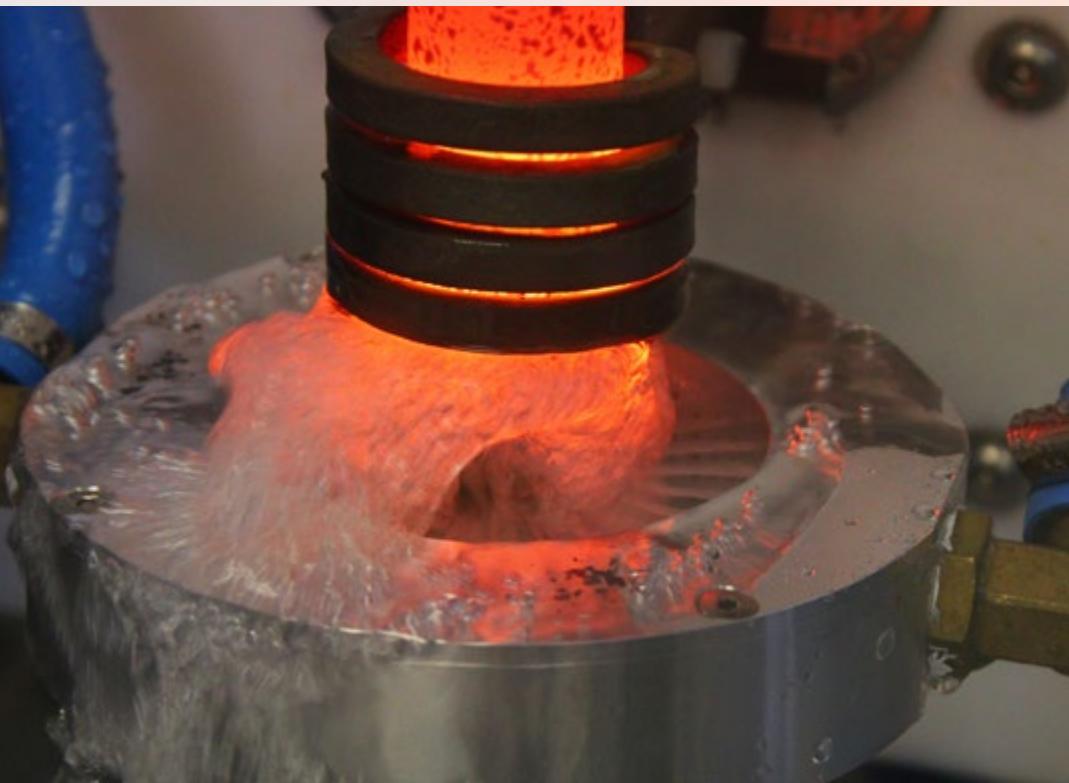
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## Our Focus/Competences

- On-site damage assessment at the customer or in the laboratory
- Identification of damage causes through laboratory analysis supported by simulation
- Identification of damage mechanisms through process and product simulation
- Determination of material properties and their changes during operation
- Testing of hypotheses for damage prevention

# Multiphysical Systems



Precise simulation and optimization of multiphysical systems, taking into account interactions between mechanics, thermodynamics, electromagnetism, and other physical effects

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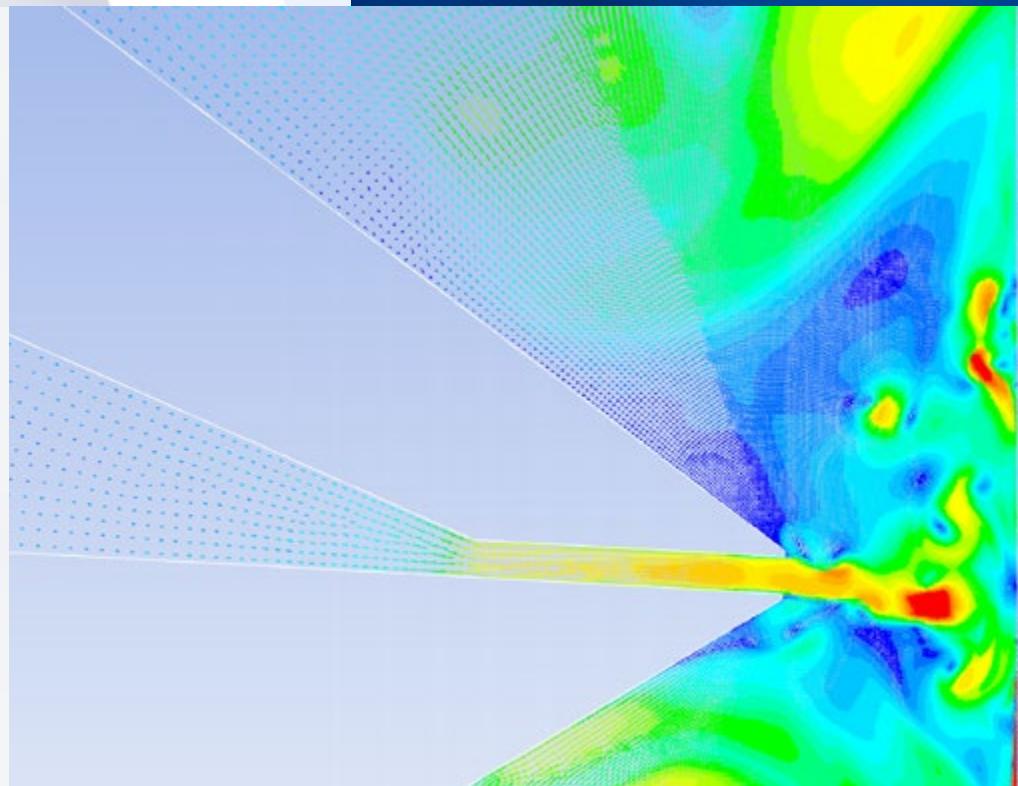
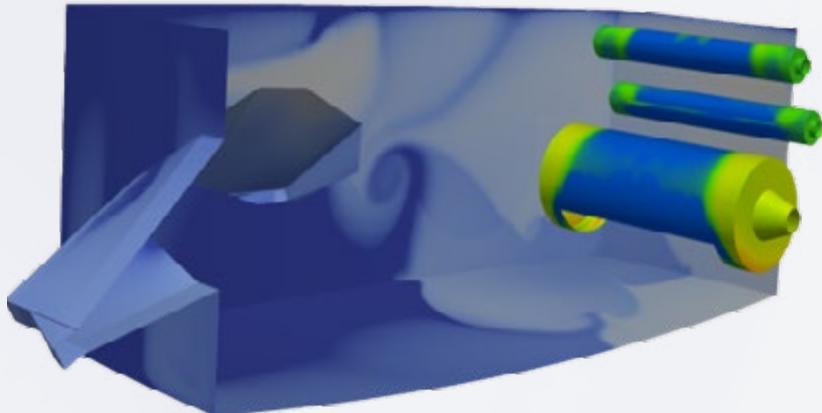
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## Our Focus/Competences

- Combination of thermal and mechanical loading
- Nonlinear electromagnetic material behavior in thermo-mechanical processes (e.g., spot welding, induction)
- Hydrogen diffusion and hydrogen embrittlement
- Phase transformation, TRIP effect
- Crystal plasticity

# Computational Fluid Dynamics (CFD)



Modeling of flows and complex fluid behavior for the determination and optimization of process parameters and components

## Contact:



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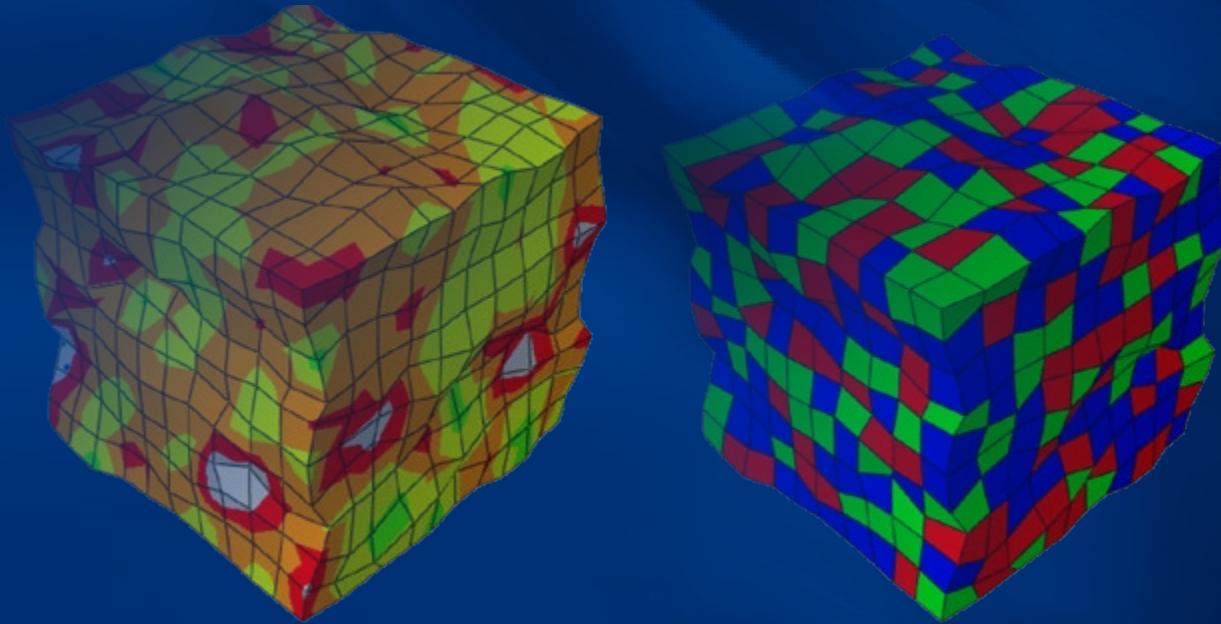


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## Our Focus/Competences

- Turbulent flows
- Coupled heat transfer between solids and fluids (e.g., cooling of components)
- Multiphase simulation, particle transport
- Reaction kinetics including surface reactions
- Coating simulations



## COMPETENCE & RELIABILITY

### Our Offers

- Process modeling
- Material modeling
- Damage analysis
- Determination of material properties not directly measurable
- Multiscale material and microstructure modeling
- Multiphysical problems
- Material models and subroutines for FE simulations

### Methods

- Finite Element Method (FEM)
- Computational Fluid Dynamics (CFD)
- Density Functional Theory (DFT)
- Standards-compliant design and dimensioning (FKM, IIW, ASME, BS,...)

### Software

- Abaqus
- Ansys
- Deform
- Comsol
- various in-house developments

### Hardware

- 20 Linux workstations with Intel Xeon or AMD Epyc processors
- up to 512 GB RAM
- nVidia Quadro RTX 5000 accelerator cards
- 3 Windows workstations



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