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# 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

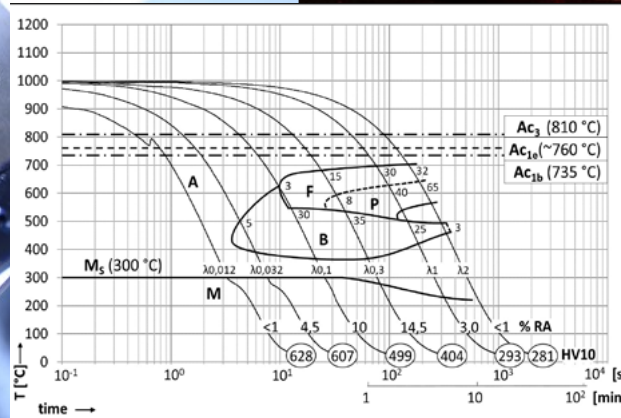
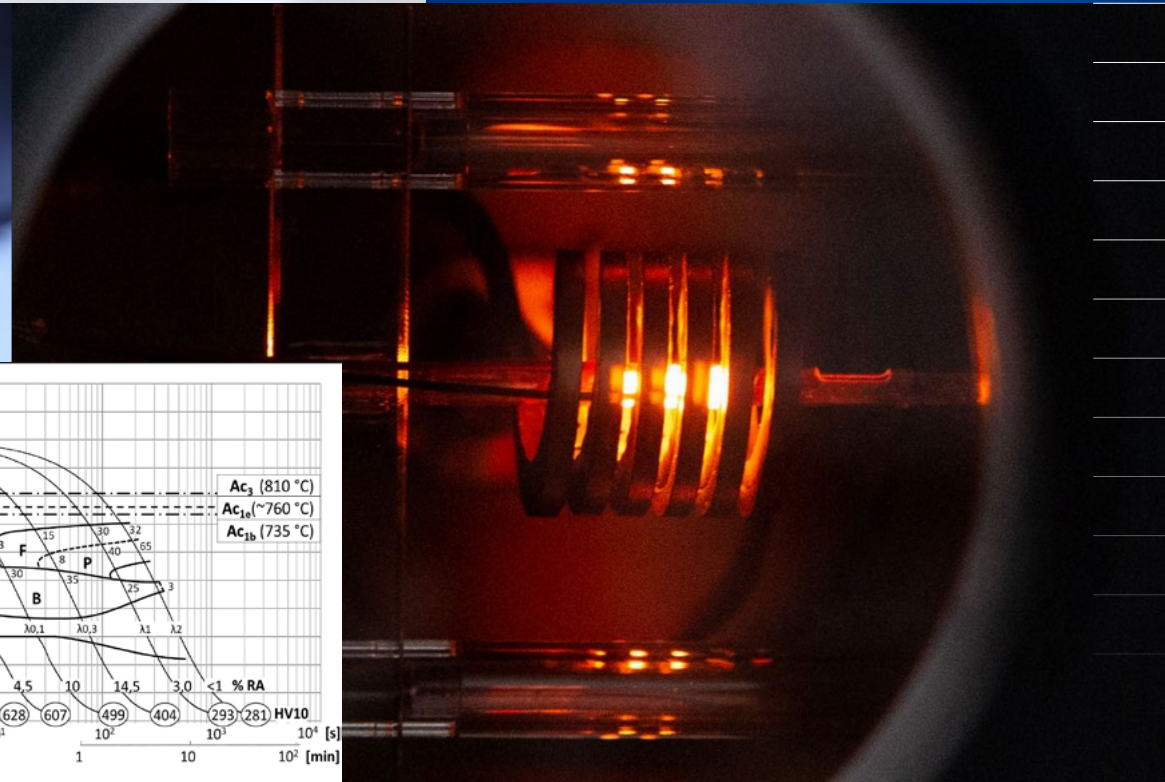
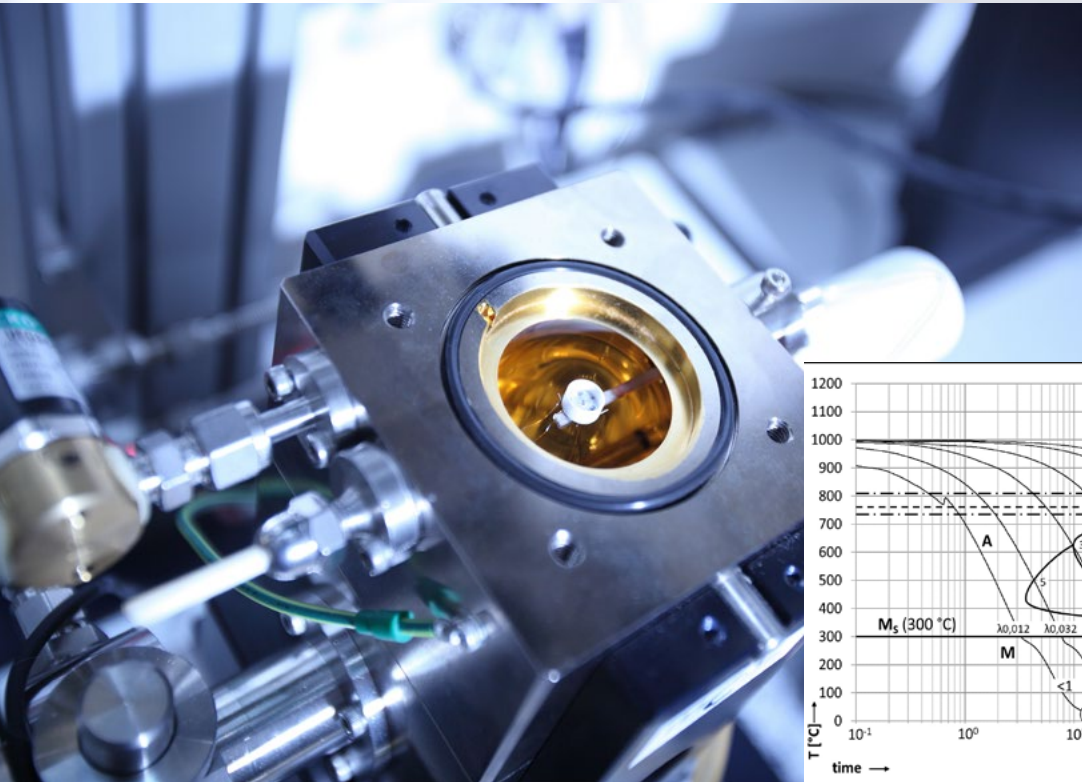
FE Simulation of Heat Treatment Processes

Consulting and Process Development



COMPETENCE & RELIABILITY

# Recording ZTU / ZTA Charts



Customized recording of transformation diagrams of steels

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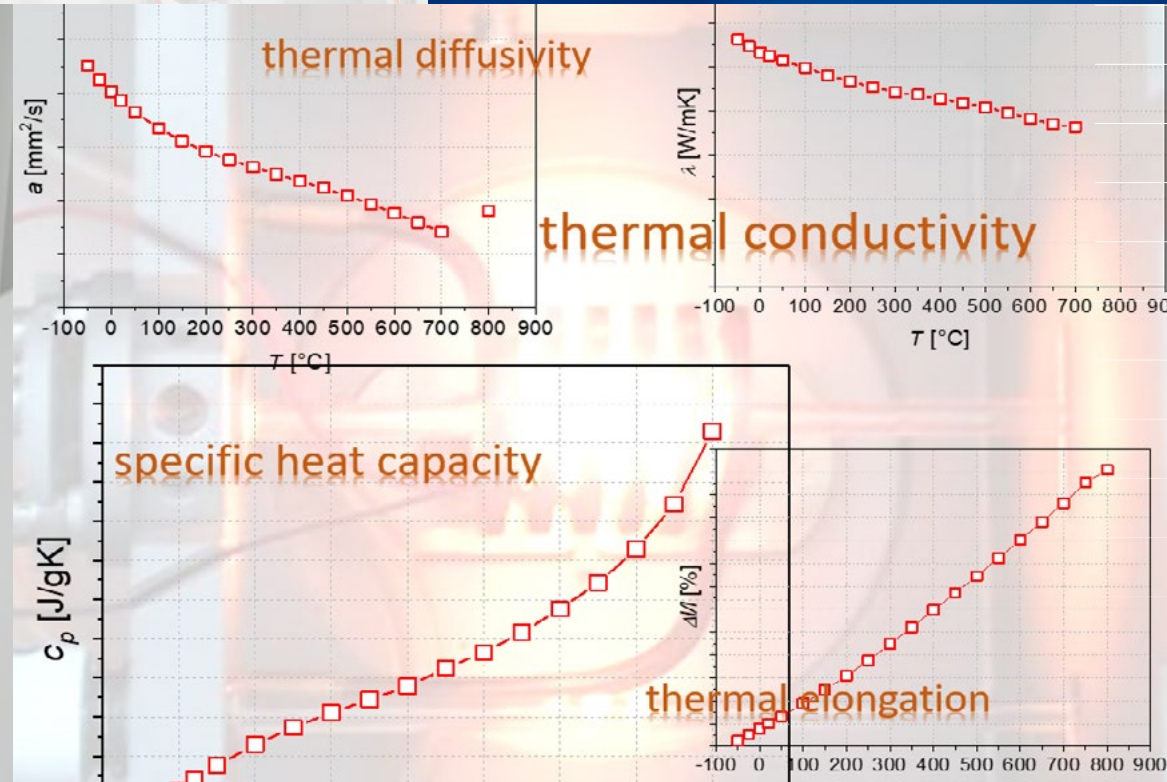
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Our Focus / Competences:

- investigation of steels, in particular high-alloy, multiphase stainless steels
- physical simulation of heat treatment processes by means of quench dilatometer
- determination of time-temperature transformation diagrams as well as time-temperature austenitization diagrams



# Determination of Thermophysical Properties



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

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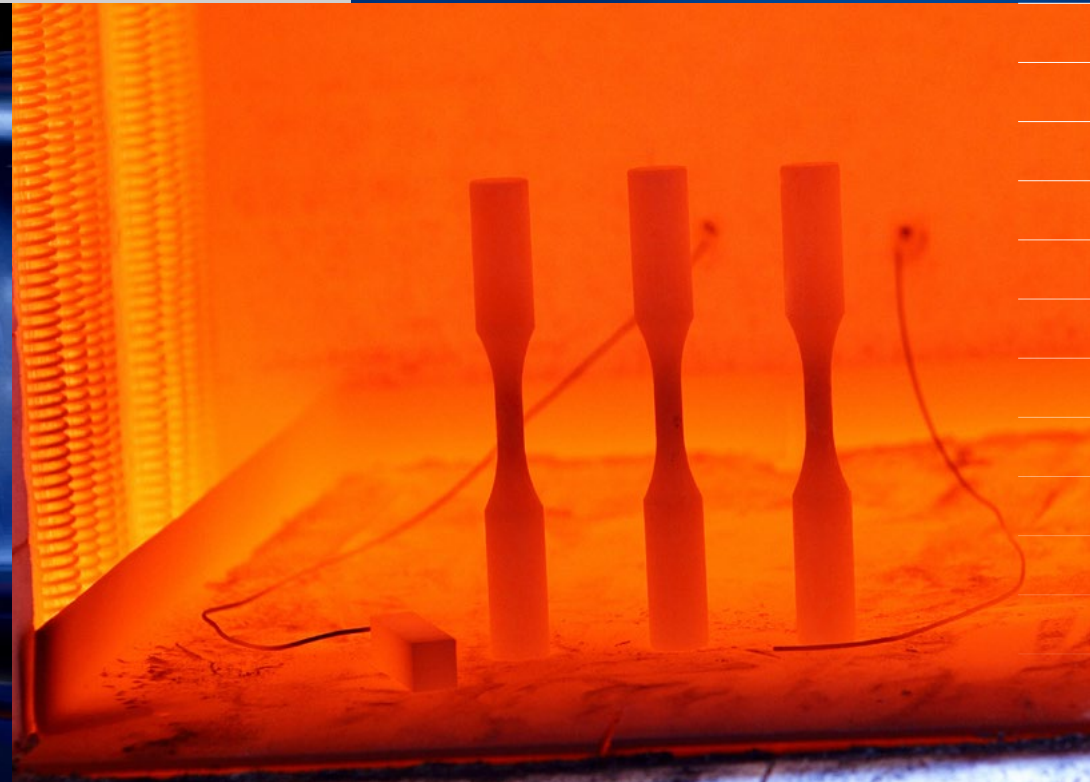
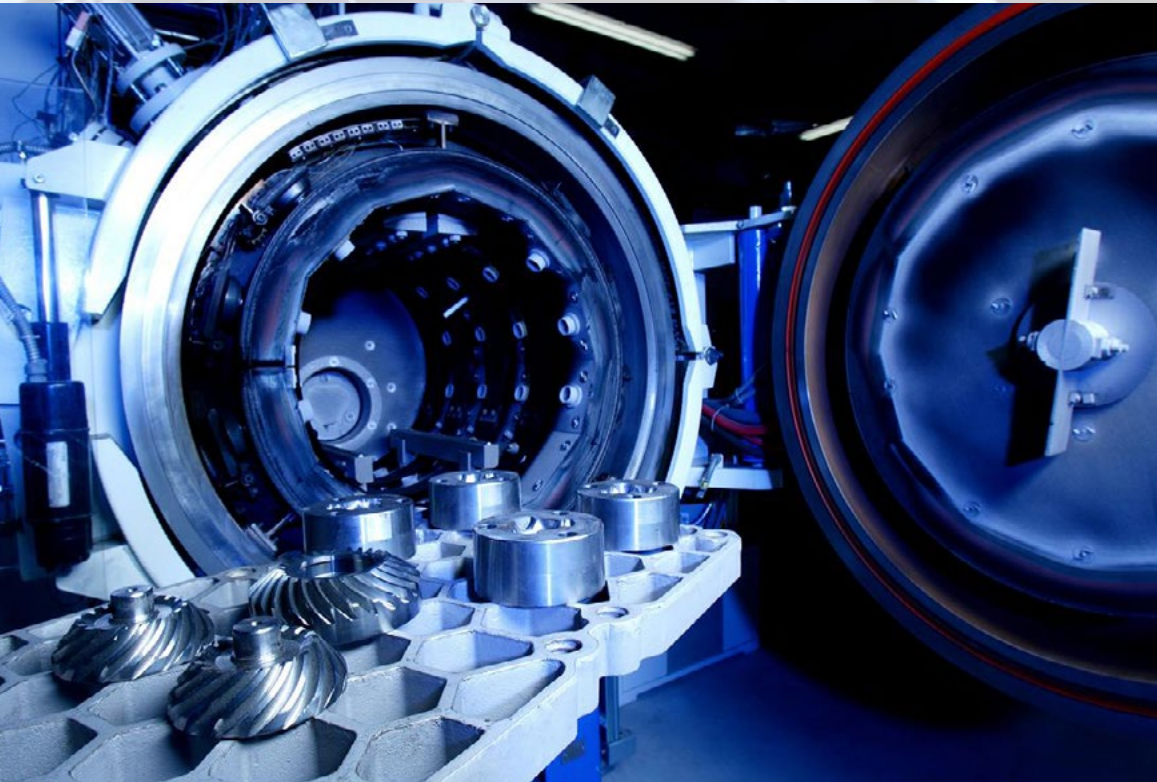
## Our Focus / Competences:

- determination of thermal diffusivity ( $-60^{\circ}\text{C}$  to  $1200^{\circ}\text{C}$ ) acc. to EN 821-2
- measurement of the thermal length change of solid bodies ( $-150^{\circ}\text{C}$  to  $1200^{\circ}\text{C}$ ) acc. to DIN 51 045-1
- measurement of the specific heat capacity ( $-150^{\circ}\text{C}$  to  $1100^{\circ}\text{C}$ ) acc. to EN 821-3 (\*)
- measurement of the dynamic modulus of elasticity ( $20^{\circ}\text{C}$  to  $900^{\circ}\text{C}$ ) acc. to EN 820-5 (\*)
- calculation of the temperature-dependent thermal conductivity
- measurement of electrical resistance/conductivity ( $20^{\circ}\text{C}$  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

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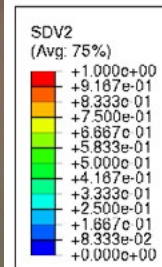
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## Our Focus / Competences:

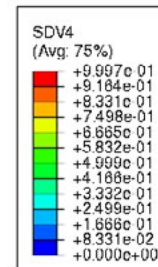
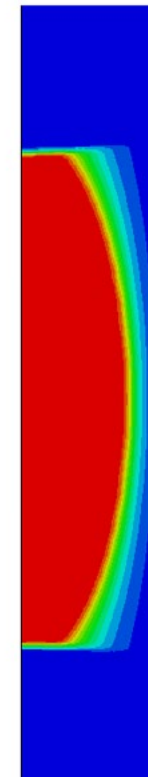
- individual, instrumented heat treatment processes under (convective) vacuum
- temperature-controlled heat treatment of samples and components incl. controlled quenching ( $l_{min} = 0.2$ )
- tempering or annealing under (convective) vacuum, inert gas (Ar, N<sub>2</sub>) or atmospheric conditions



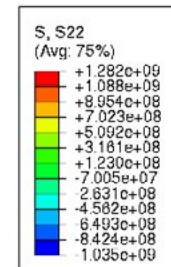
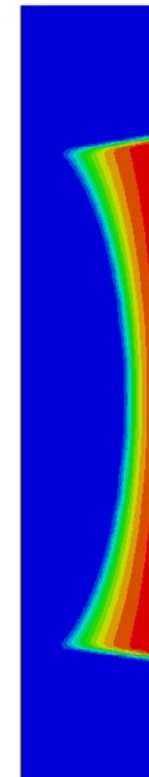
# Inductive Heat Treatment



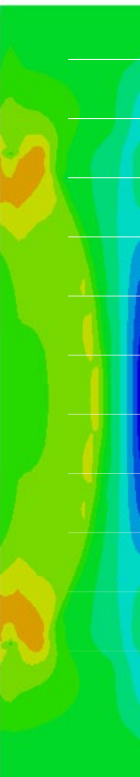
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Development of inductive heat treatment processes on bar material

Contact:



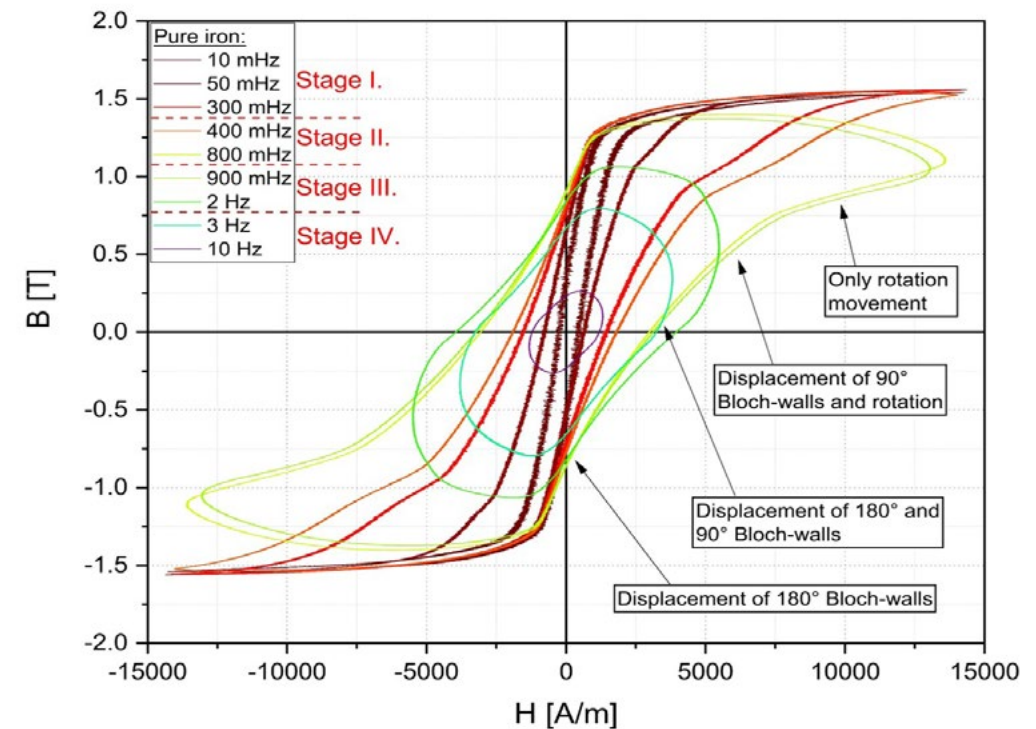
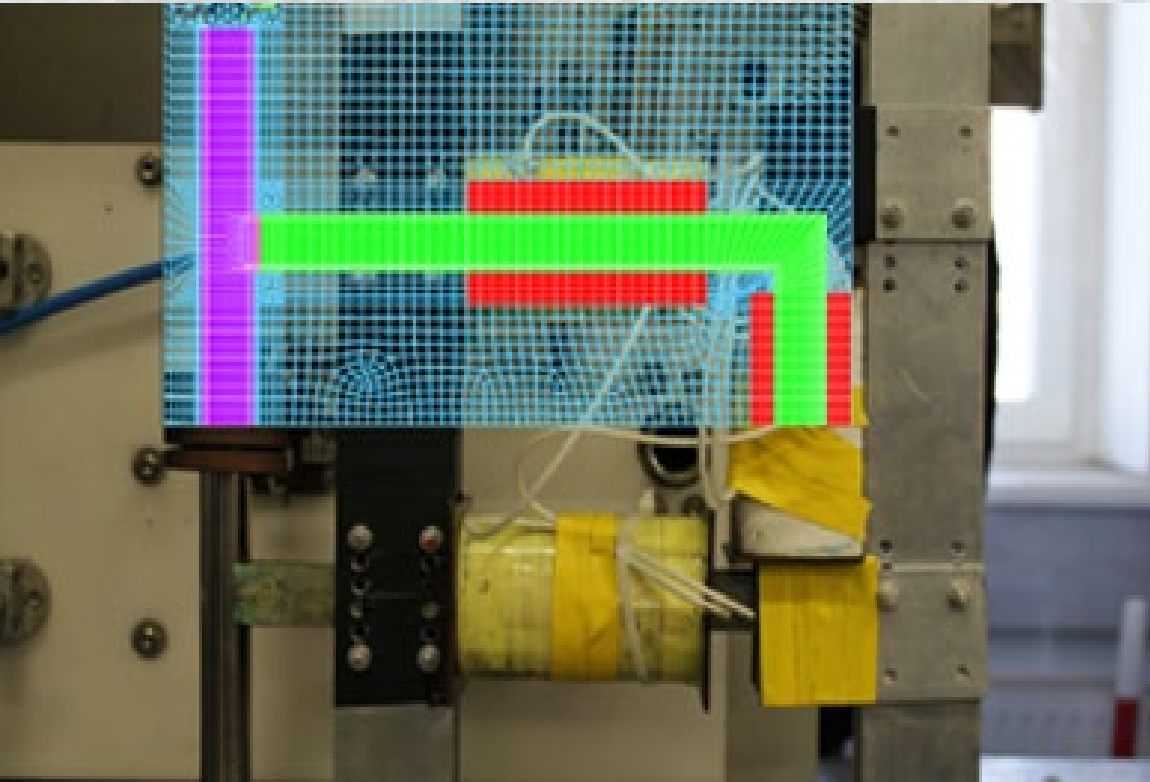
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## Our Focus / Competences:

- 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 temperature-dependent B-H curves as input parameters for finite element simulation

# Recording of BxH Curves



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

Contact:



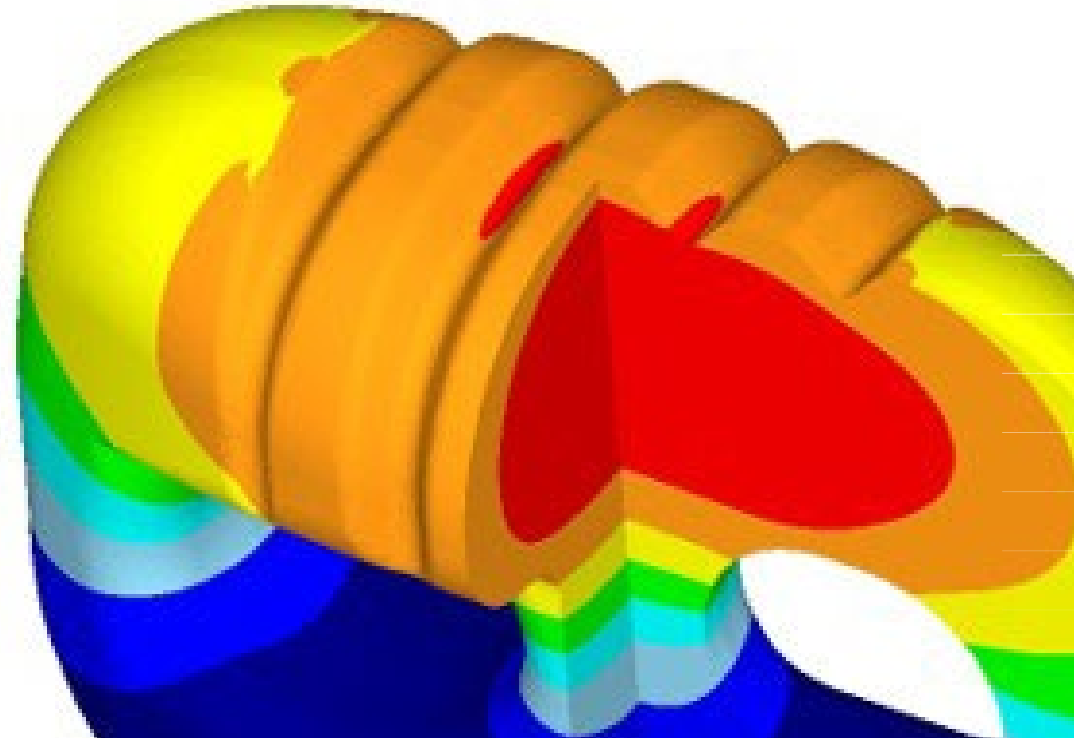
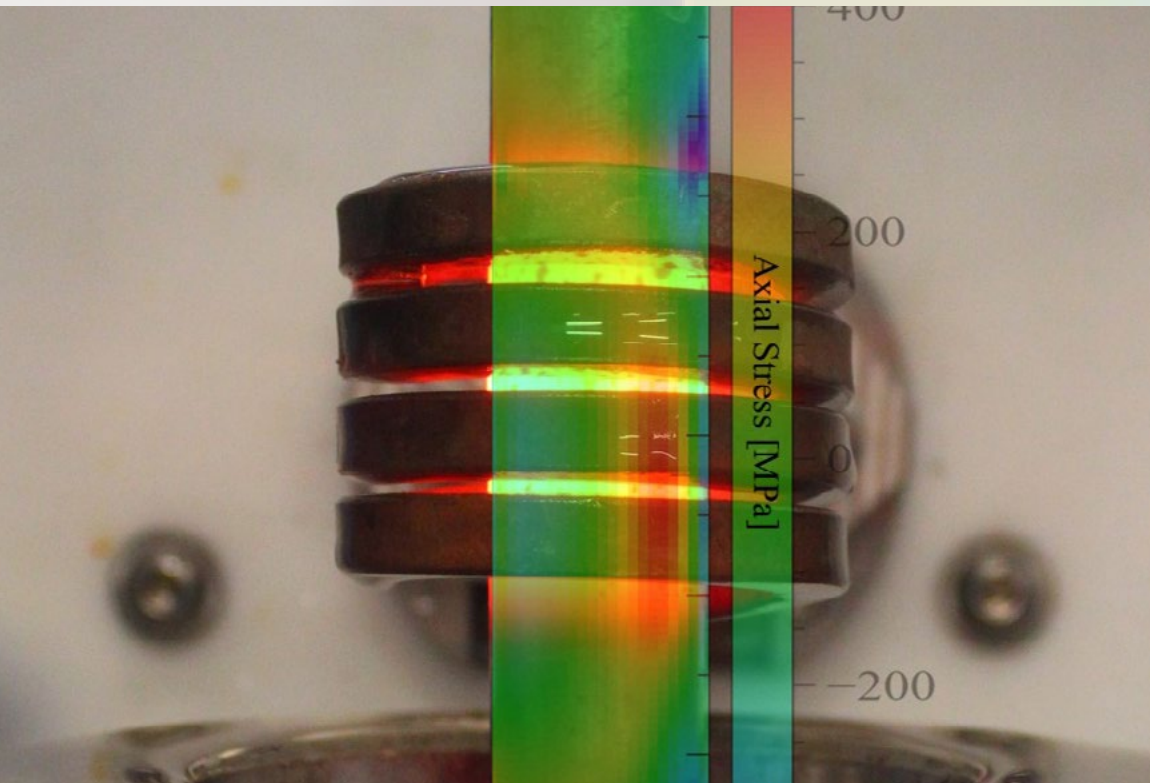
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## Our Focus / Competences:

- 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

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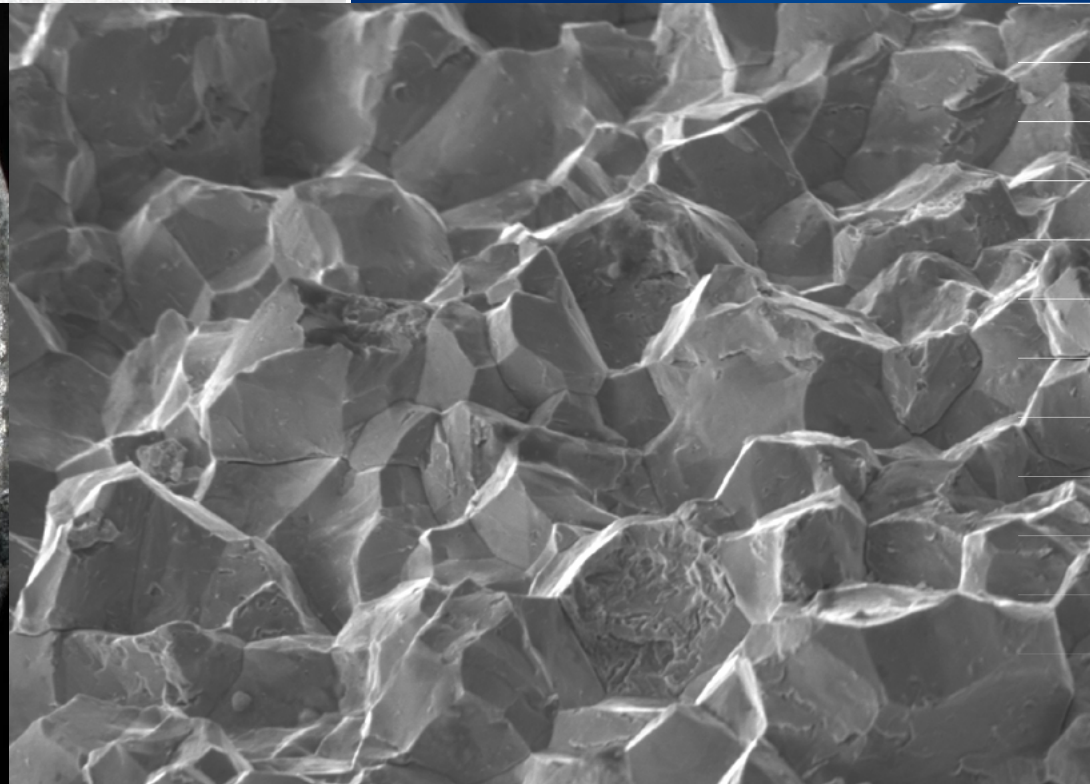
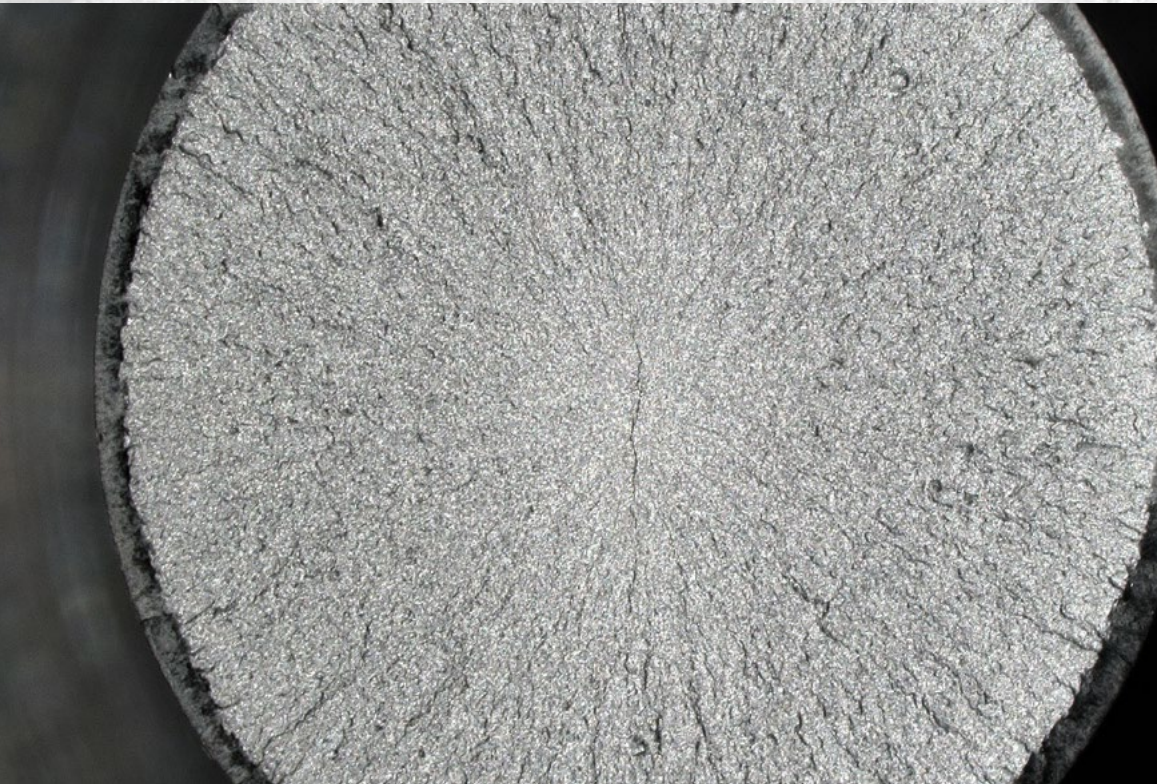
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## Our Focus / Competences:

- 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

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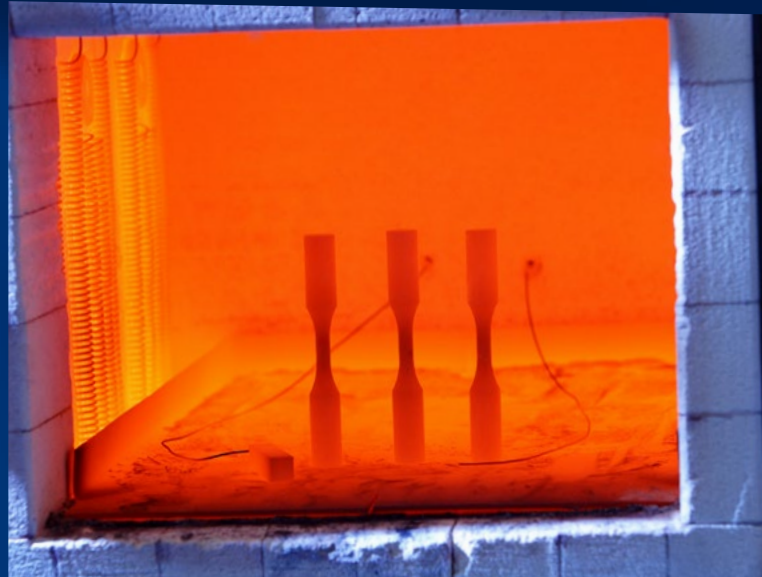
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## Our Focus / Competences:

- 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 (N<sub>2</sub> 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 (N<sub>2</sub> 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)

