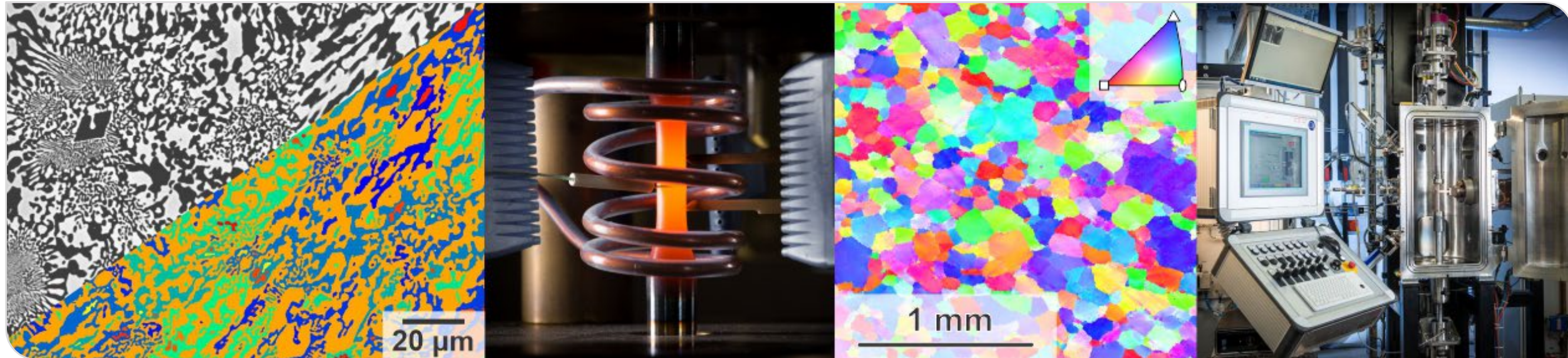


Phase Transformations in Materials

Lecture for “Mechanical Engineering” and “Materials Science and Engineering”
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Structure

■ Thermodynamic Fundamentals

- Component and Phase
- Position Dependence of Properties $P = P(\mathbf{x})$
- Direction Dependence of Properties $P_{klmn\dots}$
- Quantities $T, S; p, V; \mu_i, N_i; \sigma_{kl}, \varepsilon_{kl}; E_k, D_k; H_k, B_k$
- Composition, Concentration and Phase Fraction $x_i, w_i, c_i, x_i^j, w_i^j, x^j, w^j, v^j$
- Thermodynamic Potentials U, F, H, G and dU, dF, dH, dG
- Thermodynamic Equilibrium
- Stability: Stable, Metastable and Unstable
- Driving Force
- General Considerations on the Temperature Dependence of G

Structure

- Kinetic fundamentals
 - General Considerations
 - Diffusion
 - Phenomenological Description
 - Fick's Laws
 - Generalization
 - Simple Solutions of Fick's 2nd Law
 - Microscopic Considerations

Structure

- Overview about Phase Transformations
 - General Aspects and Considerations
 - Schemes

Structure

- Experimental techniques
 - General Terms
 - Structural Investigations
 - Physical Investigations
 - Chemical Investigations
 - Microstructural Investigations

Structure

- Single-Component Systems
 - Solidification and Allotropic Transformations (Discontinuous)
 - Temperature-Dependent Thermodynamic Potentials
 - Driving Force and Latent Heat
 - Nucleation
 - Temperature and Time Dependence
 - Homogeneous vs. Heterogeneous
 - Growth
 - Surface/Interface Energy
 - Growth Velocity
 - Temperature Distribution (Heat Dissipation)
 - Continuous Phase Transitions
 - Concept of Order Parameter
 - Landau Formalism: Taylor Series of Thermodynamic Potentials

Structure

■ Multi-Component Systems

■ Reconstructive Transformation

(changes are achieved by long-range diffusion)

- Spinodal Decomposition (change in composition, not in crystal structure)
- Precipitation (change in composition and crystal structure from one parent phase into a two-phase microstructure)
 - Continuous
 - Discontinuous
- Eutectic Reaction (invariant reaction with change in composition and crystal structure resulting in a two-phase microstructure)
- Peritectic Reaction (invariant reaction with change in composition and crystal structure from two parent phases to a single phase)

Structure

■ Multi-Component Systems

■ Displacive Transformation

(no long-range diffusion and changes in crystal structure are achieved by deformation)

- Shear transformation
- Dilation transformation
- Transformation by shuffling

■ Intermediate transitions

(no long-range diffusion)

- Order Transition (symmetry break in crystal structure by resembling site occupation, no change in total composition)
- Massive Transformation (change in crystal structure without change in total composition)