Objective

- The microstructural effect will also be taken into account to predict the deformation mechanism in steels with multiphase matrix.
- The synchrotron x-ray diffraction methodology will be introduced for a detailed understanding of microstructural evolution during deformation and along heat treatment cycles.

Overview of the material design by the upgraded deformation mechanism maps

Input

A1 Gibbs free energy state for a quaternary (FeMnAlC) system
A2 CalPhaD stacking fault energy
A3 Thermodynamic data for kappa phase equilibrium
C1 EBSD, HRTEM
C3 Combinatoric alloy design in Fe-Mn-Al-C system

Example in WP1: What is the formation mechanism of kappa phase and how does it influence the strain hardening behavior of MBIP steels?

- The long-range ordered kappa phase already starts precipitating from the austenitic matrix as early as 15 min during aging at 600 °C in Fe-30Mn-8Al-1.2C steel.
- Up to 9 hours aging, the lattice misfit between the kappa phase and the austenite matrix still maintains being very small (less than 2 %) which may lead to an effective coherent precipitation hardening.

Output

A7/A10/B1/B4/B6 SFE and mechanism maps
A8 Phase field simulation
C6 Multiaxial/cyclic properties of HMnS
C8 Diffraction data for coherence stress assessment
C10 Tensile properties (under high strain rate) of MMnS

Goal/Impact

- Extension of mechanism maps (precipitation, microstructure evolution, κ-phase)
- Simulation of microstructure evolution using phase field models
- Validation of mechanism maps in the design of multiphase steels (MMnS)

Work package

- WP1: Synchrotron X-ray diffraction of kappa phase precipitation.
- WP2: Experimental validation of modeling results by atom probe tomography, EBSD and metallography.
- WP3: Phase field modeling of microstructure evolution during phase transformations in MMnS steels.
- WP4: Integration of the microstructural and partitioning features into Microstructure- and mechanism maps.