



High-throughput experimental and Calphad screening of CCAs (HiTeCC) - towards new alloys with exceptional mechanical properties

The classical concept for tailoring properties of metallic materials compromises alloying of a single, metallic principle element with typically minor alloying elements. In contrast, high entropy alloys contain at least five elements in significant amounts - in many cases an almost equimolar composition is used. Here, CoCrFeMnNi or HfNbTaTiZr should be mentioned since these alloys exhibit rather simple disordered, face centered cubic or body centered cubic crystal structures which contradicts the metallurgical expectations. Since the expected, usually brittle intermetallic phases do not form, a rather high ductility even at low temperature is observed. The aim of the proposed project is to reveal the underlying mechanisms of deformation in these systems at low temperature or at high strain rates. For this purpose, the alloys have to be prepared in according microstructural conditions in a reproducible manner as well as disorder has to be verified bridging several length scales. Subsequently, the contributions of dislocation slip and mechanical twinning will be quantitatively evaluated at low temperatures and high strain rates based on microstructural investigations. This will especially lead to a better understanding of the not intensively investigated deformation mechanisms in HfNbTaTiZr with its rather unexpected high ductility at room temperature. The gained knowledge will be later on used to investigate the interaction of dislocations with lattice distortion and local disorder induced by the mixed elements by suppression of thermal activation at even lower temperatures (temperature of liquid helium, 4.2 K). In order to reveal these interactions, the fundamentally different physical properties - low thermal conductivity and very low specific heat - have to be quantitatively taken into account since these may result in lack of coupling to the cooling medium and in retarded heat dissipation from zones of localized deformation. In the end, a holistic understanding of the interaction of dislocations and lattice distortion is aimed by further analyzing its most important macroscopic manifestation: solid solution hardening. For this purpose, a recently proposed theory for describing solid solution hardening in concentrated alloys will be verified within the CoCrFeMnNi system and tested for possible transfer to HfNbTaTiZr.