DFG Schwerpunktprogramm / Priority Programme Compositionally Complex Alloys – High Entropy Alloys (CCA-HEA)

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Entropy Effects on Mechanical Properties of Single-Phase High Entropy Alloys

The key objective of the project is to investigate single-phase high entropy alloys (HEA) with fcc, bcc and hcp crystal structures with focus on fundamental properties. As a base composition for fcc solid solutions equiatomic CrMnFeCoNi, for bcc equiatomic TiZrNbHfTa and for hcp equiatomic YgdTbDyHo are to be investigated. Entropy measurements will be carried out by determination of the specific heat capacity and subsequent integration over temperature. These measurements will indicate if thermal entropy in connection with configurational entropy have different influences for pure metals in comparison to fcc, bcc and hcp HEA. Of particular interest here is hcp YgdTbDyHo because the lanthanide elements are very similar to each other. The project will investigate whether dislocations consider these atoms identical hence resulting in no net solid solution strengthening or whether a so-called Gibbs paradox also exists for mechanical properties. The critical resolved shear stresses as basic measures of mechanical strength will be determined and compared to each other for all three mentioned HEAs. The impact of further elemental additions to these HEA base alloys onto the CRSS as well as the phenomenon of deformation localization will be addressed. Within the project, the HEA alloy samples will be produced at the University Bayreuth (UBT) and the Forschungszentrum Jülich (FZJ). If possible, samples will be prepared as single crystals by zone melting or Bridgman casting. Mechanical testing will be carried out with proprietary equipment on miniature specimens from cryogenic temperatures up to high temperatures. Elastic properties will be measured as a function of temperature on small (4x5x6 mm^3), single crystal fcc, bcc and hcp HEA samples by ultrasonic resonance spectroscopy. Microstructure analysis and investigation of deformation mechanisms are performed by scanning and transmission electron microscopy.