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Developing High Entropy Alloys for High Temperature Applications

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High Entropy Alloys (HEAs) are defined as alloys consisting of five or more elements with concentration between 5 to 35 at%. Contrary to conventional alloys in which the main component provides a primary property and the alloying elements allocate secondary ones, HEAs involve usually 5 elements forming simple solid solutions rather than complex microstructures because of significant role of high configurational entropy: therefore, the number of phases in them is much less than that of phases allowed by the Gibbs phase rule.Interest in HEAs has been sparked by their high potential of improving mechanical properties due to four core effects: high-entropy, sluggish diffusion, severe lattice distortion and local anisotropy affecting thermodynamics, kinetics, structure and properties, respectively. Their phase and microstructural stability make HEAs convenient for both high temperature (HT) and cryogenic applications. HT performances of HEAs depend on facturing method, alloy composition, heat treatment, increasing contribution of mixing entropy at the elevated temperatures and unusual deformation mechanisms under HT conditions. Methods have been developed for prediction of phase formation in HEAs based on properties of the elements as well as computational techniques. This thesis project is based on the selection of metals according to a modern use of Hume-Rothery rules and to free energy calculation for solid solutions. Groups of transition elements have been chosen for alloy synthesis, e. g. CrCoFrNiW and CrTaTiVZr in equimolar ratio, structural (diffraction techniques) and microstructural (microscopies) characterization and mechanical property (hardness, scratch test) studies. Materials are envisaged for HT application.

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