Wissenszuwachs aus 20 Jahren Forschung über Hochentropielegierungen (HEA)

U. Glatzel

Metallische Werkstoffe, Universität Bayreuth, 95445 Bayreuth, Deutschland
uwe.glatzel@uni-bayreuth.de

The denomination high entropy alloys (HEA) was published first in 2004 by Prof. J.-W. Yeh and in parallel by Prof. B. Cantor. Research picked up exponentially since then, leading to more than 2,200 (!) papers listed in Web of Science containing "high entropy alloy" within the title in the year 2023.

Due to this number, it is impossible to discuss all research results in detail. The focus of this presentation is on mechanical strength. Four core effects, resulting from an increased configurational entropy, have been proposed: decrease in Gibb's free energy at higher temperatures, lattice distortion, sluggish (slower) diffusion and cocktail effect.

Within this presentation, there will be a clear distinction between single-phase HEA (at the designated application temperature) and two- or more-phase alloys. Due to this distinction, it will be possible to clearly separate into well-known strengthening effects. The probability of staying single-phase is decreasing with the number of elements since intermetallic phases can form, decreasing the Gibb's free energy more than the configurational entropy does. Therefore, only a handful of single-phase, equi-atomic, 5-component HEA are known by now. They can be distinguished by crystallographic structure and located in groups within the periodic table. To name some of them: fcc or Cantor alloy, fcc of precious metals, bcc or Senkov alloy, hcp or Feuerbach alloy. With respect to mechanical strengthening the only classical strengthening mechanism is solid solution strengthening.

On the other hand, the number of two- or more-phase compositionally complex alloys (CCA) is countless, and all options of precipitate hardening are available (e.g., internal stresses, Orowan bowing, locally strong increase of dislocation density, cutting of precipitates) additionally to solid solution strengthening.

Selected examples from literature and our own research will be presented and discussed.