High-entropy alloys: growth, microstructure and defects

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High-entropy alloys (HEAs) are substitutional solid solutions formed in multicomponent metallic systems. The number of components is high, usually five or more, and all are present in major, frequently equiatomic proportion, which leads to a high entropy contribution to the free energy. Ideal HEAs solidify as single phase of simple average crystal structure with an fcc, bcc or hexagonal lattice. The constituting atoms are randomly distributed on the simple crystal lattice, and therefore HEAs display chemical disorder on a topologically ordered lattice. Thus, these novel materials take a unique position between simple and amorphous metals.

In this contribution, after a brief introduction to HEAs we will address the development of HEA materials by crystal-growth methods such as the Czochralski technique and zone melting. HEAs with different basic structures will be discussed.

In the literature, HEAs are commonly promoted as high-strength materials. We will present investigations on macroscopic plastic deformation properties of HEAs, including thermodynamic activation analysis. We discuss the microstructure after deformation and present defect analyses for different phases. Our results cast doubt on the prevalently discussed hardening mechanisms in these materials.