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Order phenomena and mechanical properties in refractory high entropy alloys

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Refractory high entropy alloys, especially those from the Ta-Mo-Cr-Ti-Al system, exhibit a promising combination of strength and oxidation resistance at elevated temperatures [1]. However, the equiatomic alloys possess a B2-ordered crystal structure as well as significant amount of brittle C15 Laves phase and, therefore, lack ductility [2]. Based on thermodynamic calculation, the order-disorder transformation was altered by alloy modification to appear below room temperature, e.g. single-phase disordered A2 alloys were obtained for certain Al concentrations in the Laves phase-free subsystem MoCrTi-xAl. Consequently, compression tests at temperatures ranging from room temperature up to 800°C reveal a significant improvement of plastic deformability as compared to the formerly investigated equiatomic MoCrTiAl. The appearance of pronounced yield strength plateaus and serrated plastic flow at elevated temperatures is stressed depending on the ordering state. In order to further tailor the alloys for an optimal balance of room temperature ductility and high temperature mechanical properties, different multi-phase A2-B2 microstructures were designed based on thermodynamic calculations and experimentally verified. Some of these alloys exhibit proper transformation paths to obtain precipitation strengthened microstructures of A2 matrix and B2 precipitates.

Keywords: Refractory compositionally complex alloys, Refractory high entropy alloy, Phase transition, crystal structure, Differential scanning calorimetry

References:

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