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The tensile strength of hexagonal closest-packed rare earth high-, medium- and low-entropy alloys

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The equiatomic hexagonal closest-packed (HCP) high-entropy alloy (HEA) Ho- Dy- Y- Gd- Tb consists of rare earth elements with very similar chemical properties. Due to the similarity, this alloying system is a well-suited candidate for the investigation of a configurational entropy effect on mechanical behavior of alloys. To vary the configurational entropy, equiatomic medium- and low-entropy alloys were derived from the HEA and tested together with the pure constituent elements. All samples were prepared in an electric arc furnace and tensile tests were conducted. The microstructure and chemical composition of all materials were analyzed via scanning electron microscopy, electron backscatter diffraction, and micro-X-ray fluorescence analysis. We found that there is no direct correlation between tensile strength and configurational entropy of the tested materials. The investigated alloys show little solid-solution strengthening compared to the pure elements. Consequently, we can disprove a configurational entropy effect on the tensile strength in this alloy system. This work contributes to understanding the influence of configurational entropy on an HCP HEA and enhances our knowledge of how this microstructure evolves during deformation.

Keywords: High-entropy alloy, configurational entropy, tensile strength, Gibbs paradox, rare-earth elements

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