FABRICATION OF HIGH-ENTROPY NITRIDES AND CARBONITRIDES

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In high-entropy alloys, the use of multiple principle alloying elements is known to entropically stabilize the material. Refractory nitrides and carbides of transition metals are widely known for their ultra high-temperature stability and their high hardness, properties that make them valuable materials for extreme environments, such as coating the exterior of hypersonic flight vehicles and the interior of nuclear reactors. By creating entropy-stabilized complex solid solutions of nitrides and carbides, one can take advantage of the inherent favorable properties of these materials, as well as increased thermal stability and solid solution strengthening. Five-metal systems are chosen using first-principles calculations to describe the energetic distribution of possible atomic configurations, in order to identify systems that are likely to form an entropy-stabilized solid solution. Bulk samples of equiatomic, hexanery (5-metal), high-entropy refractory nitrides and carbonitrides were then fabricated to demonstrate this concept, by using a combination of high-energy ball milling, spark plasma sintering, and hot pressing. The uniformity of the microstructures is characterized, and single-phase solid solutions are achieved, thus demonstrating the ability to entropically stabilize multi-component random mixtures of refractory carbides and nitrides.

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