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Mechanical properties and thermal stability of reactively sputtered multicomponent Hf-Ta-Ti-V-Zr nitrides

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High-entropy alloys (HEAs) and high-entropy ceramics (HECs) have recently gained particular attraction in the field of materials research due to their promising properties, such as high hardness, high strength, and thermal stability. Within this work, we report on the thermal stability of high entropy nitrides to provide a further insight to a more extensive understanding of the high-entropy effect, according to which, based on the Gibbs-free energy, such materials should be stabilised in the high-temperature regime. Therefore, (Hf,Ta,Ti,V,Zr)N coatings were reactively sputtered from a single powder-metallurgically produced composite target and vacuum annealed between 600 and 1500 °C. The structure and morphology, the chemical composition, the mechanical properties, and the thermal stability of the coatings were investigated by scanning electron microscopy, X-ray diffraction, nanoindentation, transmission electron microscopy, thermogravimetric analysis, and atom probe tomography.
We observe a promising thermal stability of the single-phase face-centred cubic (fcc) coatings up to 1400 °C, whereas coatings annealed at 1500 °C indicate a slight decomposition into a nitrogen-depleted hexagonal phase next to the fcc matrix. As the XRD peak width remains relatively constant, we assume that the expected thermally-induced grain growth and/or decomposition takes place at significantly higher temperatures than compared to coatings like TiN and TiAlN. Our here presented results represent a promising basis for a further improvement in order to establish (HfTaTiVZr)N coatings as a candidate for (novel) high temperature applications.

Keywords
high-entropy alloys (HEAs)
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