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Unique deformation mechanisms of an ultra-high strength NiTiHf alloy

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ABSTRACT

Ultra-high strength and energy storage has been observed of a nickel-rich (54-at. %), hafnium-lean (1-at. %), balance titanium alloy. Specifically, full recovery of 4.5% strain upon release of 2.3 GPa uniaxial stress is realized during compressive loading. Furthermore, in cyclic loading, accumulation of permanent set is not observed after the first cycle. Robustness to permanent set is attributed to precipitation of a relatively high volume fraction of fine Ni_4Ti_3 precipitates, which is the expected result. It was also anticipated that the ability to recover large strains would arise from superelasticity via martensitic transformation. However, in-situ diffraction experimentation revealed a different result. Martensitic (or any other) phase transformation was not observed. Instead, line profile analysis of the diffraction patterns shows the formation of ~25 nm subdomains of B2 structure within the ~5 μm parent grains, accompanied by heterogeneous deformation among similarly orientated diffracting domains. The subdomains fully revert upon unload. In this presentation, the in-situ diffraction characterization of this phenomenal deformation mechanism will be reviewed and conclusions will be supported with in-situ electron microscopy and macroscopic characterization data.