BoKoMaT

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Vortragssprache: EN

Using Advanced Electron Microscopy to Provide Insights into Microstructure-Property Correlations in Shape Memory Alloys

Advanced characterization methods are providing new insights into the functional properties of shape memory alloys (SMAs). One application to be discussed is the pronounced and beneficial effect of nanoscale precipitates on the constant force thermal cycling response of high temperature SMAs Ni(Ti,Hf) alloys. The structure of the ordered H phase precipitates has been determined using scanning transmission electron microscopy (STEM) based techniques. The technique of "4D STEM" has been used to quantify these strain fields associated with these coherent precipitates, which strongly influence the local martensite orientations that form around the particles. Based on these results, finite element models have been developed to help explain how the microstructural scale of the martensite plates, and consequently the transformation strains, can be modified by the aging process. In a second example, microstructure development in cold-rolled TiNi SMAs at various amounts of cold-rolling deformation is investigated. After 15% cold-rolling, sub-grain B2-phase austenite domain formation is observed forming a remarkable herringbone structure. The majority of the B2 domains boundaries are special Σ boundaries based EBSD analysis. High-resolution STEM observations show directly the atomic structure of B19′ nanodomains crossing a $\{1\bar{1}4\}$B2 twin boundary following an associated $\{20\bar{1}\}$B19′ twin relation. We hypothesize that such pre-existing B19′ nanodomains can immediately grow upon loading/cooling, which will lead to tend to smear-out the thermal and stress-strain hysteresis of the first-order B2- B19′ martensitic transformation, leading to quasi-linear superelasticity behavior. As will be discussed, this herringbone-like B2 austenite configuration can be understood through the symmetry-dictated non-transformation pathway theory.

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