Kwinking as the plastic forming mechanism of B19' NiTi martensite

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Abstract

Recent experimental findings from thermomechanical testing and microstructural analysis of NiTi polycrystalline shape memory alloy have brought a qualitatively new picture of plastic deformation mechanisms of this most common shape memory material (1). In particular, they challenge the widely accepted paradigm that austenite is a phase more susceptible to dislocation slip and plastic deformation in NiTi than B19' martensite, despite the fact that only a single (100)(001)M dislocation slip system is observed in martensite.
In this contribution, we show that if the plastic slip of (100)(001)M and reorientation of martensite between two variants sharing the (010)M plane are active simultaneously, a new deformation mechanism arises that combines kink banding and twinning forming the so-called "kwink bands" (2). A model describing the formation of kwink bands developed based on the tools of nonlinear elasticity theory of martensite and crystal plasticity will be presented and it will be shown how the monoclinic martensite lattice can accommodate large prescribed macroscopic plastic deformations despite the activation of a single dislocation slip system.

(1) Šittner P., Sedlák P., Seiner H., Sedmák P., Pilch J., Delville R., Heller L., Kadeřávek L., On the coupling between martensitic transformation and plasticity in NiTi: Experiments and continuum based modelling (2018) Progress in Materials Science, 98, pp. 249 – 298.

(2) Seiner H., Sedlák P., Frost M., Šittner P., Kwinking as the plastic forming mechanism of B19 NiTi martensite (2023) International Journal of Plasticity, 168, art. no. 103697.

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