Macroscopic Martensitic Transformation Front in NiTi Shape Memory Alloys: Experimental Observations and Numerical Reconstruction

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ABSTRACT

In particular geometries and loading modes, martensitic phase transformation develops inhomogenously, in a highly localized manner. In this work, we analyze morphology and mechanics of a macroscopic transformation front separating regions of austenite and martensite phases in a particular case of NiTi superelastic wire under tension.

Three-dimensional X-ray diffraction method (3D-XRD) was employed to determine complete strain and stress states of the polycrystalline grains close to the transformation front [1]. Taking into account the experimental findings, we have adapted our macroscopic constitutive model of NiTi SMA [2] by modifying the free energy term (allowing for strain-softening response) and including non-local (gradient-like) effects [3]. The finite element implementation of the model into Abaqus FEA software allowed successful reconstruction of the transformation front as a 3D object in a loaded wire as well as its stable propagation at a constant external force. The simulation also confirms significantly inhomogeneous stress state within the parent phase and predicts non-uniform stress distribution within the product phase even far from the front. Further modifications which would allow the model to reconstruct transformation patterns (homogeneous/localized) in other geometries and/or more general loading modes will be also discussed.

REFERENCES

