Simulation of coupled transformation and plasticity in NiTi at elevated temperatures and stresses

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ABSTRACT

Description of mechanisms of plastic deformation in high-quality NiTi superelastic wires is far from trivial, as basic understanding of these mechanisms is still missing. Mechanisms of deformation qualitatively change with temperature in these wires – from functional behaviours stemming from the reversible martensitic transformation at low temperatures (<50 °C) through large plastic deformation generated alongside the martensitic transformation at the medium temperature range (100–250 °C) and, finally, to conventional plastic deformation of austenite at high temperatures (>300 °C).

In this contribution, we present a macroscopic thermodynamical model of the coupled transformation and plasticity in NiTi SMA. The model focuses mainly to mutual interconnection of reversible transformation/reorientation processes and irreversible plastic deformation mechanisms. We formulated a unique energetical and dissipation functions which describe properly plastic deformation of both austenite and martensite phases, but in the same time also coupled phenomena as martensite stabilization by plastic deformation, change of thermo-mechanical coupling at elevated temperatures/stresses and the reverse transformation of martensite into twinned austenite [1,2] which plays a crucial role in plastic strain generation and functional fatigue of NiTi.

A comparison of experimental and simulated data will be presented, and it will be also discussed how the understanding and description of these phenomena can allow tailoring of strain heterogeneity inside NiTi components, which would open new opportunities in NiTi components design.

REFERENCES

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