In-situ evaluation of elasticity during stress-induced phase transformation of NiTi using acoustic waves

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ABSTRACT

Shape-memory alloys exhibit a number of unique properties due to the martensitic transition between austenitic and martensitic phases. In the superelastic regime, i.e., above the transformation temperature, these alloys are capable of enduring compression of several percent as a reversible, elastic-like strain.

In the present contribution, a polycrystalline sample of the NiTi alloy is studied under compression up to 5 % by means of laser-ultrasonic methods. These offer a method for non-contact, non-destructive evaluation of elastic properties of the sample. More precisely, the change of propagation velocity of surface acoustic waves in several directions with respect to loading direction is measured in-situ during the mechanical loading. An inverse method based on the Ritz-Rayleigh numerical approach [1] is then used to obtain the development of elastic properties of the sample.

This measurement enables analysis of the stress-induced transformation from austenitic to martensitic phase. Before the loading, the sample is in an elastically isotropic state of a mixture of austenite and twinned R-phase. In the initial loading phase, a reorientation of the R-phase occurs, resulting in a surprisingly large anisotropy. Afterward, the martensitic transition occurs, showing a continuous stiffening of all shear constants. The fully-transformed martensite retains the anisotropic character, and the following loading shows considerable stress-dependency of the elastic coefficients of the martensitic phase.

REFERENCES

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