The impact of γ´ nanoprecipitates on the tensile deformation of superelastic $Co_{49}Ni_{21}Ga_{30}$

A. Reul[1], C. Lauhoff[2], P. Krooß[2], C. Somsen[3], D. Langenkämper[3], M.J. Gutmann[4], B. Pedersen[5], M. Hofmann[5], W.M. Gan[6], I. Kireeva[7], Y. I. Chumlyakov[7], G. Eggeler[3], T. Niendorf[2], W.W. Schmahl[1]

[1]Applied Crystallography, Department of Earth and Environmental Sciences, Ludwig Maximilian University of Munich, alexander.reul@lrz.uni-muenchen.de, Germany, [2]Institute of Materials Engineering, University of Kassel, Germany, [3]Institute for Materials, Ruhr-University Bochum, Germany, [4]Rutherford Appleton Laboratory, ISIS Facility, UK, [5]Heinz Maier-Leibnitz Zentrum (MLZ), Technical University of Munich, Germany, [6]German Engineering Materials Science Center (GEM) at MLZ, Helmholtz-Zentrum Hereon, Germany, [7]Tomsk State University, Siberian Physical Technical Institute, Russia

This study reports the morphology and domain variant selection of stress-induced martensite in [001]-oriented superelastic $Co_{49}Ni_{21}Ga_{30}$ shape memory alloy (SMA) single crystals under tensile load. In situ neutron diffraction, and in situ optical- and confocal laser scanning microscopy were conducted on three differently processed Co-Ni-Ga single crystals, i.e as-grown, solution-annealed and aged. Aging treatments performed at 350°C introduce γ´ nanoprecipitates which increase the number of habit plane interfaces while reducing lamellar martensite plate thickness compared to the as-grown and solution-annealed (precipitate free) specimens (Fig 1). In contrast to previous findings, γ´ nanoprecipitates in the aged tensile specimen do not induce multi variant microstructures with multiple orientations of habit planes and multiple domain variants. Instead, the aged specimen revealed a dominant martensite plate and a shear band with lamellar martensite plates between one set of parallel habit planes (hp) interfaces. During tensile loading, all specimens show stress-induced formation of martensite, characterized by one single domain variant (V_3) and one set of parallel habit planes in a shear band. The results show that γ´ nanoprecipitates do not necessarily promote multi-variant interaction during tensile loading. Thus, reduced recoverability in Co-Ni-Ga SMAs upon aging cannot be solely attributed to this kind of interaction as has been proposed before. Instead, γ´ nanoprecipitates in the aged specimen act as obstacles for austenite-martensite phase boundary movement which significantly increase the stress hysteresis compared to the as-grown and precipitate-free condition (Fig. 1).

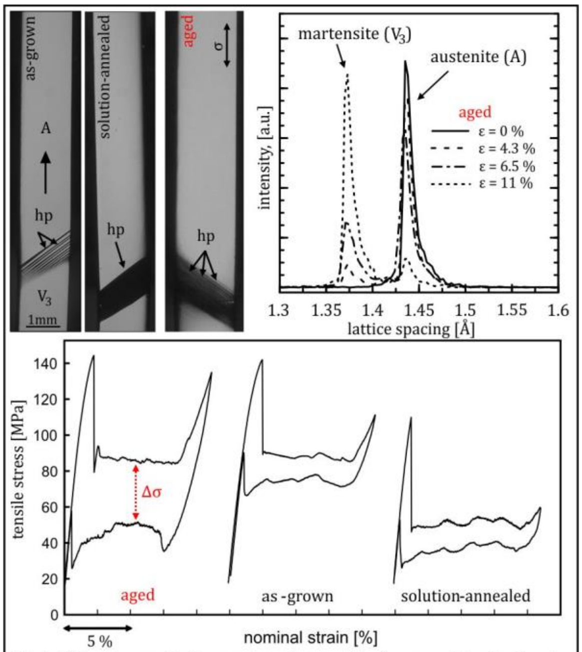

Fig.1: Diffractogram for the aged specimen with γ´nanoparticles (~ 5 nm). Optical images of strained specimens with habit planes (hp) between austenite and stress-induced martensite. Stress-strain curves for the different states of the alloy.

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