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NANOSTRUCTURES AND STRESS-INDUCED TRANSFORMATION IN THERMOMECHANICALLY TREATED TITANIUM NICKELIDE

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The thermomechanical treatment of Ti-Ni shape memory alloys (SMAs) comprising cold rolling (CR) and post-deformation annealing (PDA) forms nanocrystalline structures (NCS) which provide much higher functional properties than their coarse-grained counterparts. In its turn, the NCS is graded to a "nanograined structure" (NGS) consisting of grains surrounded by high-angle (>15^{o}) boundaries, and a "nanosubgrained" structure (NSS) consisting of subgrains separated by low-angle (<15^{o}) boundaries (subboundaries). The strain dependence of the substructure formation in cold-rolled Ti-Ni SMA is as follows: a moderate CR up to a true strain of e=0.3 triggers the process of dynamic recovery and results in the formation of highly-dislocated, but not yet polygonized, dislocation substructures in austenite and martensite. An increase in CR strain up to an intermediate range of 0.5 to 1 triggers the process of dynamic polygonization and results in the formation of nano-sized subgrains, i.e. NSS, and also small quantities of the NG and amorphous structures. A further increase in CR strain up to 1.7 (severe deformation) triggers the processes of dynamic recrystallization and amorphization and results in the gradual replacement of the NSS by the NG and amorphous structures. The low-temperature PDA results in formation of predominant NSS after the moderate CR, mixed NSS+NGS after intermediate CR, and predominant NGS after severe CR. The NS structures observed in Ti-Ni after PDA preceded by either intermediate or severe CR do not significantly differ from each other because of the development of the dynamic polygonization (formation of subgrains) process during cold rolling which is followed by static polygonization (perfection of subgrains and their subboundaries) during post-deformation annealing. Conversely, substructure of a moderately cold-rolled alloy is highly dislocated but not polygonized, and this highly dislocated structure transforms to a statically polygonized substructure upon PDA. The stress-induced transformation of NG and NS B2-austenite in titanium nickelide keeps its "discrete" (martensitic B2→B19') mechanism down to ultimately low average austenite grain size: *in situ* tracing the evolution of X-ray lines during stress-induced transformation unambiguously evidences a jump-like (not continuous) transformation of B2 into B19' lattice parameters in the austenite with average grain size down to 2.3 ±0.2 nm. The stress-induced transformation in such ultimately fine-grained Ti-Ni does not go to its end, and the critical austenite grain size for the stress-induced B2→B19' transformation in Ti-Ni shape memory alloys is about 4.5 nm which is an order of magnitude less than that for the cooling-induced transformation.