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Understanding Mechanical Response Mechanisms of Modern Engineering Alloys

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Shape memory alloys (SMA) are stimuli-responsive materials which have the ability to return to their original shape and size after induced deformation. Ni-Ti (nitinol) is a SMA which presents several interesting properties for engineering applications, such as shape memory effect (SME) and superelasticity (SE). In both effects, the Ni-Ti deformation occurs by a diffusionless martensitic phase transformation. The name originates from the steel (Fe-C) system, where the transition occurs from austenite (face-centered cubic) phase to martensite (body-centered tetragonal). In the case of nitinol the martensitic transition occurs from a high symmetry, high temperature cubic structure (austenite, B2 type cubic) to a low symmetry, low temperature monoclinic structure (martensite, B19'type).

Superelasticity also called pseudoelasticity is an isothermal property where the deformation or transformation, respectively, is carried out just with applied stress, whereas the shape memory effect can be done in a one-way and/or a two-way mechanism. In one-way SME the alloy has the ability to return to its original shape via a heat treatment. Two-way SME is the ability of the Ni-Ti to "remember"its shape at high and low temperature which can be achieved by the application of thermo-mechanical processing treatment.

For this work in-situ neutron diffraction data from a Ni-Ti alloy as function of temperature was collected at the Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II) in Garching, Germany with the high resolution powder diffractometer SPODI. The aim of this research is to analyze the thermal structural changes in the alloy taking processing-induced texture (crystallographic preferred orientation) properly into account by refinement of the data by a new Rietveld software called MAUD.

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