DIFFRACTION MEASUREMENTS DURING MECHANICAL LOADING IN SUPERELASTIC AND SHAPE-MEMORY ALLOYS

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When NiTi is mechanically loaded, a stress-induced austenitic to martensitic phase transformation can result in macroscopic strains as high as 8%. On unloading, the martensite becomes unstable and transforms back to austenite, with a concomitant macroscopic strain recovery. This phenomenon is called the superelastic or pseudoelastic effect and finds application in, e.g., mobile phone antennae, vascular stents and guidewires. Associated with this behavior is the shape-memory effect wherein large strains are generated in the martensite phase (through deformation twinning) and then fully recovered by a temperature-induced transformation of martensite to austenite.

We summarize and synthesize here a systematic study of superelastic NiTi subjected to monotonic and cyclic loading and NiTi-TiC subjected to monotonic, quasi-static loading, while neutron diffraction spectra are simultaneously acquired. The spectra were recorded while interrupting the cycle (but continuing to apply a constant load) during loading and unloading portions of the stress-strain curve. A Rietveld refinement methodology was established to obtain phase-specific quantitative strain, texture and phase volume fraction information during the forward and reverse stress-induced martensitic transformation. The diffraction experiments allowed for a comparison between the micostructural texture, phase volume fraction and strain changes during the stress-induced austenite to martensite transformation and the macroscopic stress-strain response.

Results from recent *in situ* neutron diffraction measurements during tensile and compressive loading of shape-memory martensitic NiTi will also be presented. The objective of these measurements on shape-memory NiTi was to follow deformation twinning as a function of the applied external load and to relate the texture and internal strain evolution (from diffraction data) with macroscopic strain data (from an extensometer attached to the sample).