ESRF	**Experiment title:** In-situ characterization by X-ray synchrotron diffraction of the reversible stress-induced martensitic transformation in superelastic titanium-based alloys	**Experiment number**: MA - 1688
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Report:

Metastable β titanium alloys are currently investigated as Ni-free biomedical alloys. These alloys can be subject to a reversible stress-induced martensitic (SIM) transformation from the β phase (austenite) to a α" martensitic phase. In order to characterize this reversible stress-induced martensitic transformation, in situ cyclic tensile tests were performed on several titanium-based superelastic alloys.

Cyclic tensile tests consisted of strain increments of 0.5% until 5% of applied strain, each step being followed by a total release of the stress (an example of such tensile curve is given in Fig. 1). Further cycles until 6%, 8% and 10% were then also done. X-ray diffractograms were acquired for each cycle under loading condition (the stress being still applied) and after unloading (without any stress) to investigate the reversibility of the SIM transformation. The duration of one in situ experiment was about 8 hours. An example of a set of diffractograms are given in Fig. 2 under loading condition (Fig. 2a) and after unloading (Fig. 2b) for each cycle. Diffractograms are cut in the 2θ angular range of 8-11.5° in order to highlight the observed phenomena.

From Fig. 2a, the peaks related to the stress-induced martensite, labelled as (020)α″, (111)α″ and (021)α″, start to be visible from 1.5% of strain and their intensities continue to increase as the applied strain increases. At the same time, the intensity of the (110)β peak, related to the austenite, decreases meaning that the SIM transformation has occurred on loading in this alloy. After unloading (Fig. 2b), it can be clearly observed that all the martensitic α″ phase is transformed back to the β phase as the (110)β peak intensity is recovered while the α″ peaks disappear. In addition, lattice parameters of both α″ and β phases will be calculated in order to follow their evolution as a function of the applied strain.

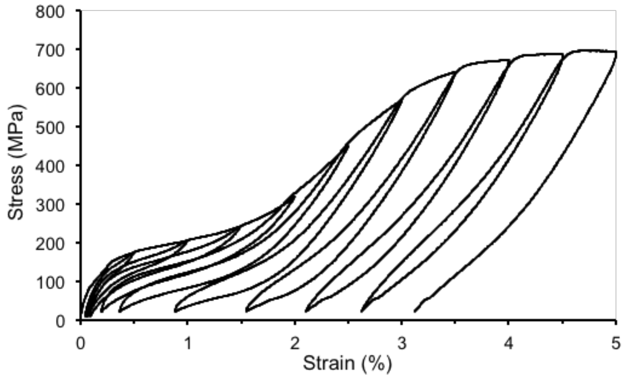

Fig. 1. Example of cyclic stress-strain curve corresponding to in situ experiments.

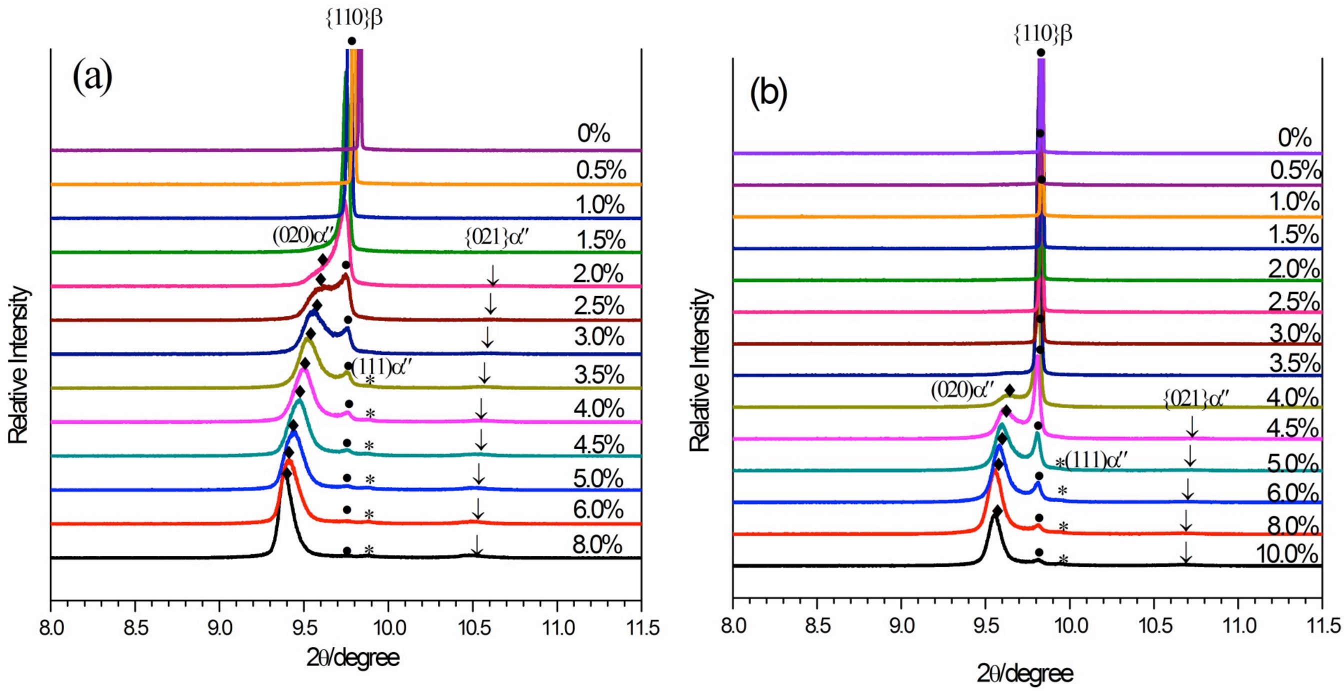

Fig. 2. Example of diffractograms obtained during an in situ experiment under loading condition (a) and after each unloading (b); the applied strain is indicated on each diffractogram.

Such experiments were performed on 10 titanium-based alloys exhibiting quite different mechanical behaviors and one NiTi alloy for comparison. The obtained results showed new unexpected features of the SIM transformation in superelastic β titanium alloys and will be published when all the data will be analyzed.