ESRF	**Experiment title:** **Evolution of omega phase nanoparticles in metastable beta-Ti alloys under external uniaxial stress**	**Experiment number:** **MA-3612**
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Report:

Objectives of the study

This study was performed on a metastable β titanium alloy, Ti-15 wt % Mo. Metastable β titanium alloys contain a sufficient amount of so-called β-stabilizing elements (i.e. those which stabilize the high-temperature bcc β phase to lower temperatures, effectively lowering the stability range of the low-temperature hcp α phase) to supress during rapid cooling the martensitic transformation β→α below room temperature. In some of these metastable β titanium alloys, including Ti-15Mo, particles of metastable ω phase form in the material during quenching and grow upon subsequent ageing. The ω phase is an important nucleation site for precipitates of α phase; furthermore, it has a significant impact on mechanical properties of the alloy. The interface between the parent β phase and ω particles is coherent and due to a small β/ω misfit, the β lattice is elastically deformed around ω particles. It can be therefore expected that the formation and growth of ω phase particles will be strongly dependent on external stresses.

The main objective of this research was to investigate the influence of external uniaxial stress (both in compression and tension) on the formation and evolution of ω phase particles. Different levels of external stress were combined with ageing treatment at selected temperatures and the evolution of ω particles was studied *in situ* using Laue (white beam) diffraction at BM32 with the energy range of approximately 5 – 19 keV.

Results

For the purpose of this study, single crystals of Ti-15Mo were grown in an optical floating zone furnace with the $\langle 111 \rangle_\beta$ direction parallel to the length of the ingot. Subsequently, tensile (flat dog-bone with the active part of approx. 1.0 x 3.0 x 5.5 mm^3) and compression (rectangular cuboids, approx. 2.5 x 2.5 x 4.5 mm^3) were cut from the ingot, so that the tensile/compression axis was along the $\langle 111 \rangle_\beta$ crystallographic direction. The samples were deformed and aged in situ during collection of x-ray diffraction patterns using a compact deformation stage MTII/Fullam SEMtester 1000 equipped with a small heating element.

Fig. 1 shows an example of a measured Laue diffraction pattern with indexed β diffractions (Fig. 1a) and four variants of ω peaks (Fig. 1b).

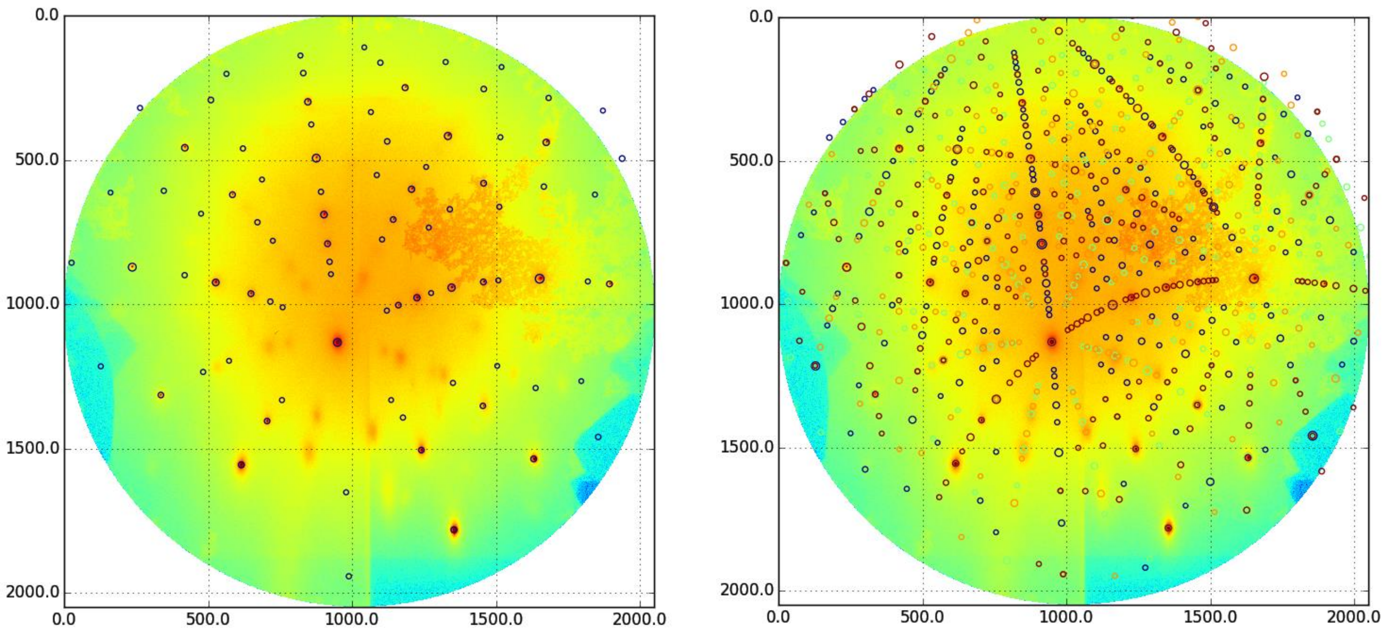

Fig. 1: Selected Laue diffraction pattern and simulated a) β and b) ω diffraction spots. In b) each colour represents one variant of ω phase particles. β peaks almost always coincide with one or more ω variants.

Evaluation of the obtained data showed that in the case of compressive uniaxial stress, no measurable differences between samples aged with and without an applied stress could be detected. This surprising result may arise from different factors: either the compressive stress does not play a role in ω particles formation or the effective stress during ageing was too low. The employed stress levels were determined as percentages (e.g. 50%, 75% and 85%) of the yield stress of the solution treated material, which is relatively soft and ductile. However, as the ω phase starts to form during ageing, the yield strength of the alloy increases significantly. Therefore, the initial load value might be too low to affect ω phase formation in later stages of ageing treatment. However, it was shown that tensile stress affects slightly the distribution of ω phase particles within the four crystallographic families.