ESRF	**Experiment title:** Small-angle x-ray scattering from omegaTi precipitates an in-situ kinetics study	**Experiment number:** MA-1931
Beamline: ID15A	**Date of experiment:** from: February 6, 2014 to: February 11, 2014	**Date of report:** July 28, 2014
Shifts: 15	**Local contact(s):** Simon Arthur John Kimber	*Received at ESRF:*

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Report:

Objectives of the study

Metastable β titanium alloys contain a sufficient amount of β-stabilizing elements to retain the high-temperature body-centered cubic phase in a metastable state after quenching to room temperature. In other words, the martensitic transformation $\beta \to \alpha$ is suppressed upon cooling. Furthermore, these titanium alloys exhibit formation of an additional metastable phase – ω phase. ω phase occurs as small particles (a few tens of nanometers in diameter) of either ellipsoidal or cuboidal shape, which are homogeneously dispersed throughout the β matrix. The presence of ω particles in the material has a significant impact on the mechanical properties as well as on further phase transformations occurring in the material during subsequent ageing.
The objective of this study was to examine the evolution of the ω particles in the β matrix by the means of small-angle x-ray scattering (SAXS) during in-situ ageing. For the purpose of this research, two metastable β titanium alloys were selected – Ti – 15 Mo and Ti – 6.8 Mo – 4.5 Fe – 1.5 Al (LCB). The evolution of the ω particles was studied during isothermal runs carried out at temperatures in the range of 335 ℃ – 450 ℃. The analysis of the results allowed us to determine the evolution of sizes and distances of ω particles in dependence on temperature and time of the ageing. Moreover, activation energies of ω particles growth were evaluated from Arrhenius plot.

Results

All measured samples were single crystals with the $\langle 001 \rangle$ direction (of the body-centered cubic β phase) oriented parallel to the beam direction. Obtained 2D SAXS patterns exhibited four side maxima centered around the beamstop. An independent Laue diffraction analysis showed that the side maxima are positioned along $[100]_\beta$ directions (see Fig. 1). The profiles of the side maxima were fitted using a short-range order model (SRO). In order to simplify the fitting procedure, only radial cuts through two of the side maxima were evaluated and therefore, one dimensional SRO model could be used. Fitting of the 1D SRO model yielded average sizes of the ω particles (R), mean inter-particle distances (L) and their root mean square deviations (σ_R and σ_L, respectively). Mean radii of the ω particles calculated from individual isothermal runs are plotted in Fig. 2 for LCB titanium alloy and in Fig. 3 for Ti – 15 Mo.

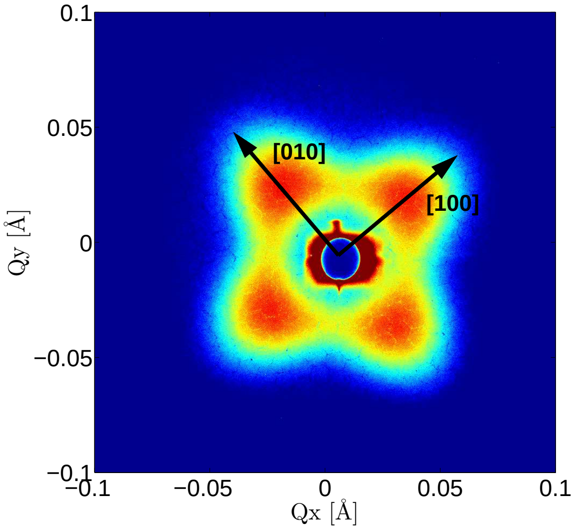

Fig. 1. An example of measured 2D SAXS pattern; directions in the β matrix are indicated by arrows.

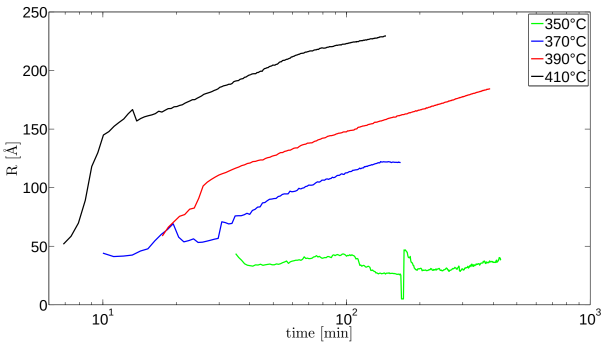

Fig. 2. LCB: Dependence of the radius R of the ω particles on ageing time and temperature.

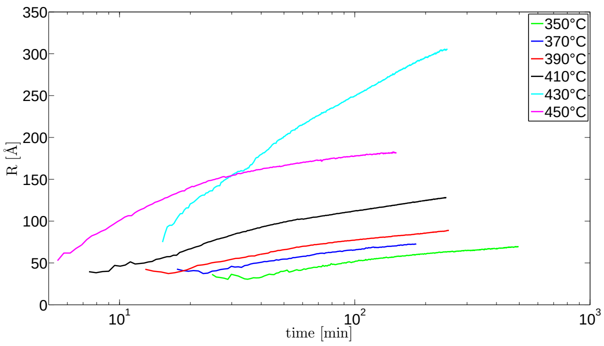

Fig. 3. Ti – 15 Mo: Dependence of the radius R of the ω particles on ageing time and temperature.