The experiment “MA3379” was performed on the ID11 beamline from april 4^{th} to april 9^{th} 2017.

The aim is to study the relationship between the 3D microstructure of a copper based shape memory alloy (CuAlBe) and its mechanical behavior (pseudo-elasticity) when exposed to external axial loads. For that, several DCT [1] and 3DXRD [2] measurements were carried on upon different CuAlBe samples with different grain sizes (see table1).

Table 1. Main measurements in the experiment "ma3379"

Sample	Properties	3DXRD *in-situ*	DCT (unstrained)	DCT *in-situ*
R117-680	Ms = -100°C ; Ø0.86mm Grain size = 100 µm	✓	✓	
R117-700	Ms =-100°C ; Ø0.86mm Grain size = 120 µm	✓	✓	
AH-35	Ms = -65°C ; 0.9mm x 0.8mm Grain size = 80 µm	✓	✓	
AH-35	Ms = -65°C ; 0.9mm x 0.8mm Grain size = 80 µm			✓

The Diffraction Contrast Tomography (DCT) technique was used to reconstruct the initial microstructures at an unstrained state. After data reduction, it gives the 3D shape of each austenitic grain, its orientation and its localization inside the probed volume. However, a full 360 degree rotation of the sample is required and the reconstruction code gives better results for undeformed lattices; which make difficult any “*in-situ* DCT”. Thus, most of the DCT measurements were performed before mounting the sample in the tensile rig (figure 1-a).

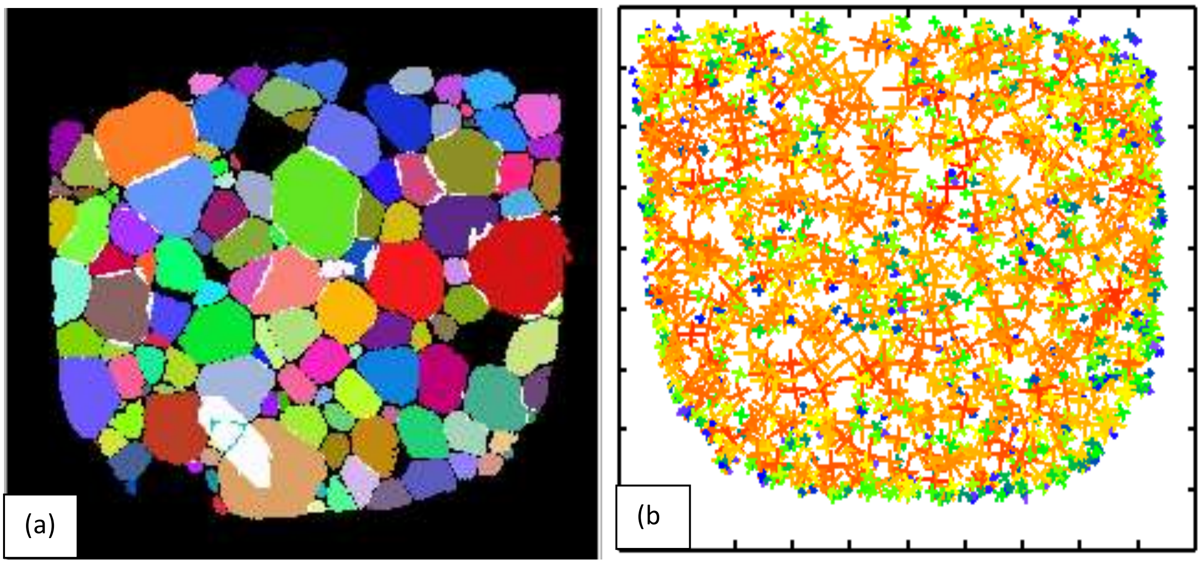

Figure 1. Unstrained AH35 sample containing more than 1400 grains in the probed volume: (a) DCT reconstruction, (b) 3DXRD result.

On the other hand, the far field 3D X-Ray Diffraction (3DXRD) does not require a full rotation and also allow a relatively wide sample – detector distance (≈242 mm in our setup); therefore, an *in-situ* setup become feasible. Unlike DCT, 3DXRD setup does not give access to the grain shape (figure1-b). However, it gives a good measurement of the mean strain state for each austenitic grain at each load. Hence DCT and 3DXRD together allow us to follow the evolution of the 3D microstructure (orientations, grain shape, grain boundaries and strain/stress tensors) at a grain scale.

While the data reduction and analysis for this experiment is still in progress, the first results show a large heterogeneous behavior at the grain scale (figure 2). Therefore, the effect of each microstructural aspect (orientations, surface, grain size, neighbor grains) on the local mechanical behavior must be clearly highlighted.

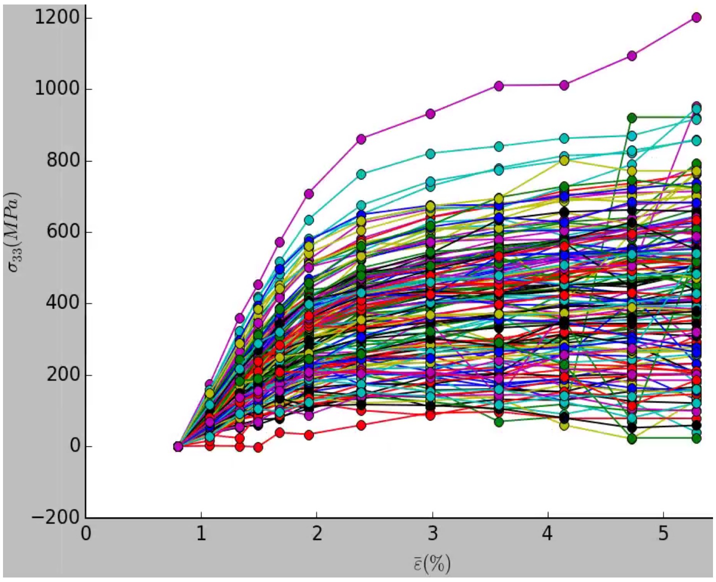

Figure 2. Stress state of individual R117-680 grains, following the loading direction, as function of the macroscopic strain.

For now, a big difference in stress state between the surface and the internal volume of the samples has been pointed out as shown in figure 3.

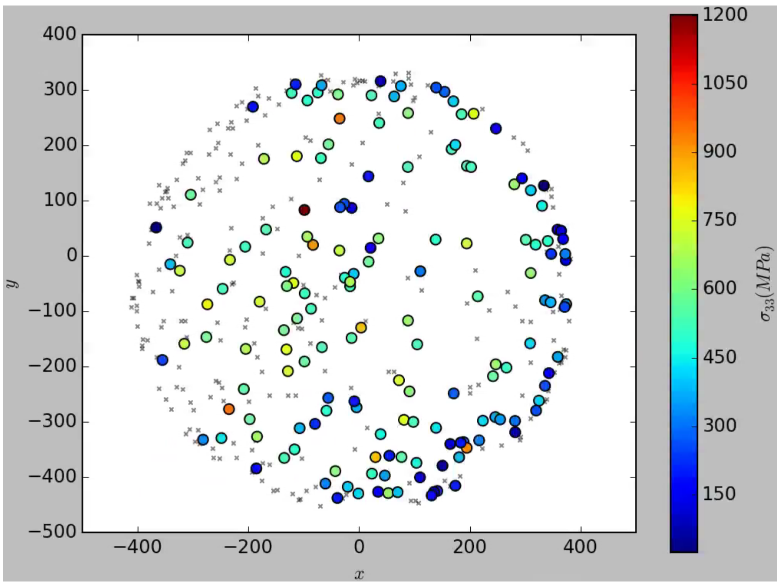

Figure 3. Radial positions and stress state of individual grains in the sample "R117-680".

The experimental 3D microstructures given by "MA3379" experiment, along with the results from the ongoing analysis of the *in-situ* tensile test, will be meshed and input into finite element code.

References:

[1]: W. Ludwig, A. King, P. Reischig, M. Herbig, E.M. Lauridsen, S. Schmidt, H. Proudhon, S. Forest, P. Cloetens, S. Rolland du Roscoat, J.Y. Buffière, T.J. Marrow, H.F. Poulsen, Mater. Sci. Eng. A, 524 (2009).

[2]: H. F. Poulsen, J. Appl. Cryst., 45 (2012).