Report on: "Tomography on polymer and metal matrix composites" (IN540)

Synchrotron tomography of the following polymers and metal matrix composites was carried out at ID19 using a voxel size of $(0.7\ \mu m)^3$ - picture resolution 2048x2048 - using the acquisition modes indicated below:

1- Polypropylene reinforced with 33 vol% of Ethylene particles: Phase contrast
2- Polypropylene reinforced with 20 vol% of glass fibres: Absorption Contrast
3- AlSi12CuMgNi/Al_2O_3/15s in T6S condition (overaged before creep test): Phase contrast
4- AlSi12CuMgNi/Al_2O_3/15s after heat treatment at 300°C during 6400 h: Phase contrast
5- AlSi12CuMgNi/Al_2O_3/15s after creep exposure at 300°C during 6400 h: Phase contrast

Samples 3 to 5 are from a thermomechanical exposure project on Saffil® short fibre reinforced metals (SFRM) [1-2]. The aims of these investigations were:

a) The identification of the three dimensional reinforcing network formed by the Si and the short fibres (SF) which are interconnected if the Si content is higher than 7% [3]. The stability and strength of this network depends on the size and amount of Si bridges joining the SF. The morphology of the eutectic Si changes during temperature exposures due to the diffusion [1-3]. It is expected that the creep load will orient the coarsening of the Si particles. The phase contrast mode was preferred instead of the absorption mode since the contrast between Si, Al_2O_3 and Al given by absorption contrast is very low.

b) The identification of the Fe- and Ni-rich intermetallic particles, the determination of their volume fraction and shape evolution during heat treatment and creep exposure.

The phase contrast images do not allow the quantification of the evolution of porosity in the SFRM samples provoked by creep. The presence of Fresnel fringes [4] around the SF which can lead to an overestimation of the pore volume fraction. However, a relative estimation between the samples is possible. Thus, about 60% higher pore volume fraction was obtained for the crept sample in comparison to the untested sample.

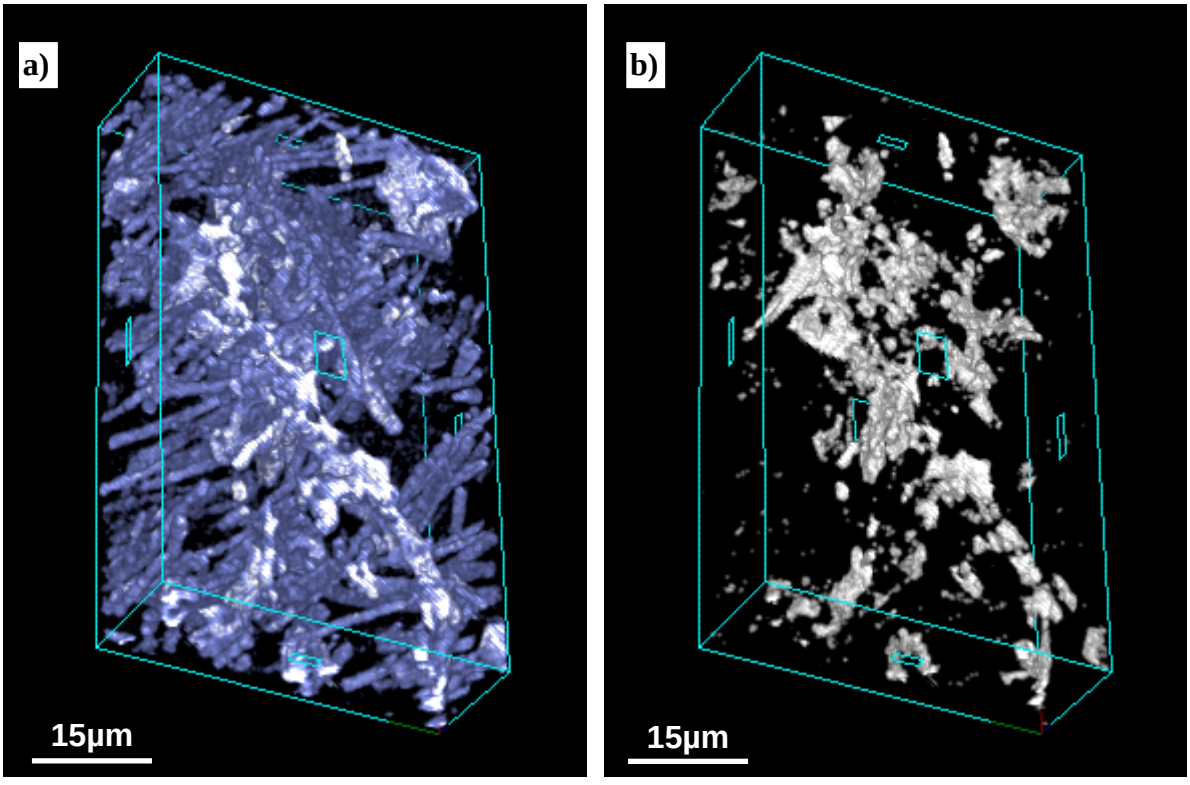

Figure 1. 3D reconstruction of the long term creep exposed SFRM showing: a) the interaction between SF and intermetallics and b) the same volume with only the intermetallics

The resolution of the phase contrast mode was not enough to depict the morphology of the Si in the hybrid Si-SF network. Holotomography measurements may be necessary to achieve this objective [4].
Figure 1 a) shows 3D reconstructions of the crept SFRM sample, where the interaction between the reinforcing SF (blue) and the intermetallic phases (white) can be observed. The same volume is depicted in Figure 1 b) but showing only the intermetallic phases (white). The contrast obtained for these two phases will allow to determine quantitatively the change in shape, in orientation, in volume fraction and in interconnectivity of the intermetallics as well as the possible change in orientation of the reinforcing SF due to matrix diffusion during long term creep exposure.

References

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[3] F. Lasagni, A. Lasagni, C. Holzapfel, F. Mücklich, H.P. Degischer.: *Three Dimensional Characterization of unmodified and Sr-modified Al-Si eutectics by FIB and FIB EDX Tomography*, Advanced Engineering Materials, 8, 2006.

[4] L. Salvo, P. Cloetens, E. Maire, S. Zabler, J. Blandin, J. Buffiere, W. Ludwig, E. Boller, D. Bellet, C. Josserond, *X-ray micro-tomography an attractive characterisation technique in materials science*, Nuclear Instruments and Methods in Physics Research, 200, 2003, 273-286.