ESRF	**Experiment title:** In situ solidification microtomography of AlMgSi alloys	**Experiment number:** IN662
Beamline: ID19	**Date of experiment:** from: 07.07.2008 to: 08.07.2008	**Date of report:** 27 Aug 2009
Shifts: 3	**Local contact(s):** Elodie Boller	*Received at ESRF:* **27 Aug 2009**

Names and affiliations of applicants (* indicates experimentalists):

Prof. Dr. Hans-Peter Degischer*[1]
Dr. Guillermo Requena*[1]
Michael Schöbel *[1]
Domonkos Tolnai*[1]
Dr. Luc Salvo*[2]

[1] Institute of Materials Science and Technology, Vienna University of Technology, 1040 Karlsplatz 13. Vienna, Austria
[2] Laboratory E.N.S.P.G. Saint Martin D Heres G.P.M.2 B.P. 46 F-38402 Saint Martin d Heres France

Report:

Synchrotron tomography was performed on AlMg5Si8 specimens. The aim of the experiments was to investigate the solidification of this alloy by high-speed in-situ tomography. The mesurements were carried out at the ID19 beamline using an energy of 15 keV with a sample-detector distance of 20 mm. The acquisition of the X-ray radiographies was done using the ESRF FreLoN camera. During the experiment the furnace was mounted on an external frame as shown in Figure 1.

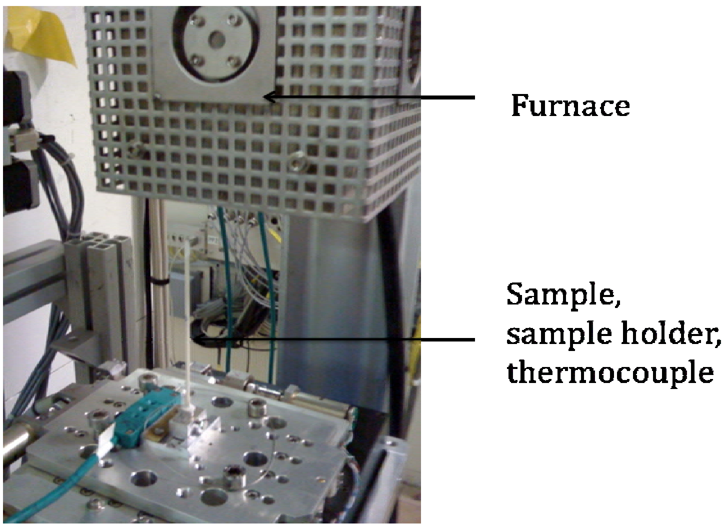

Figure 1. The experimental setup of the measurement.

In comparison with other metals the in-situ investigation of Al alloys is feasible because the oxide skin of the aluminium keeps the shape of the sample even when the internal part of the specimen, the metal, is molten. Therefore there is no need for any special x-ray transparent holder around the sample.

Five samples were measured with a diameter of 1.4 mm and a voxel resolution of (1.4 μm)^3. The experiments were carried out using different cooling rates from different temperatures (Figure 2) according to the solidification point of the different internal phases, in order to clarify the effect on the microstructure and to compare the solidification sequence with differential scanning calorimetry measurements and thermodynamic calculations [1,2].

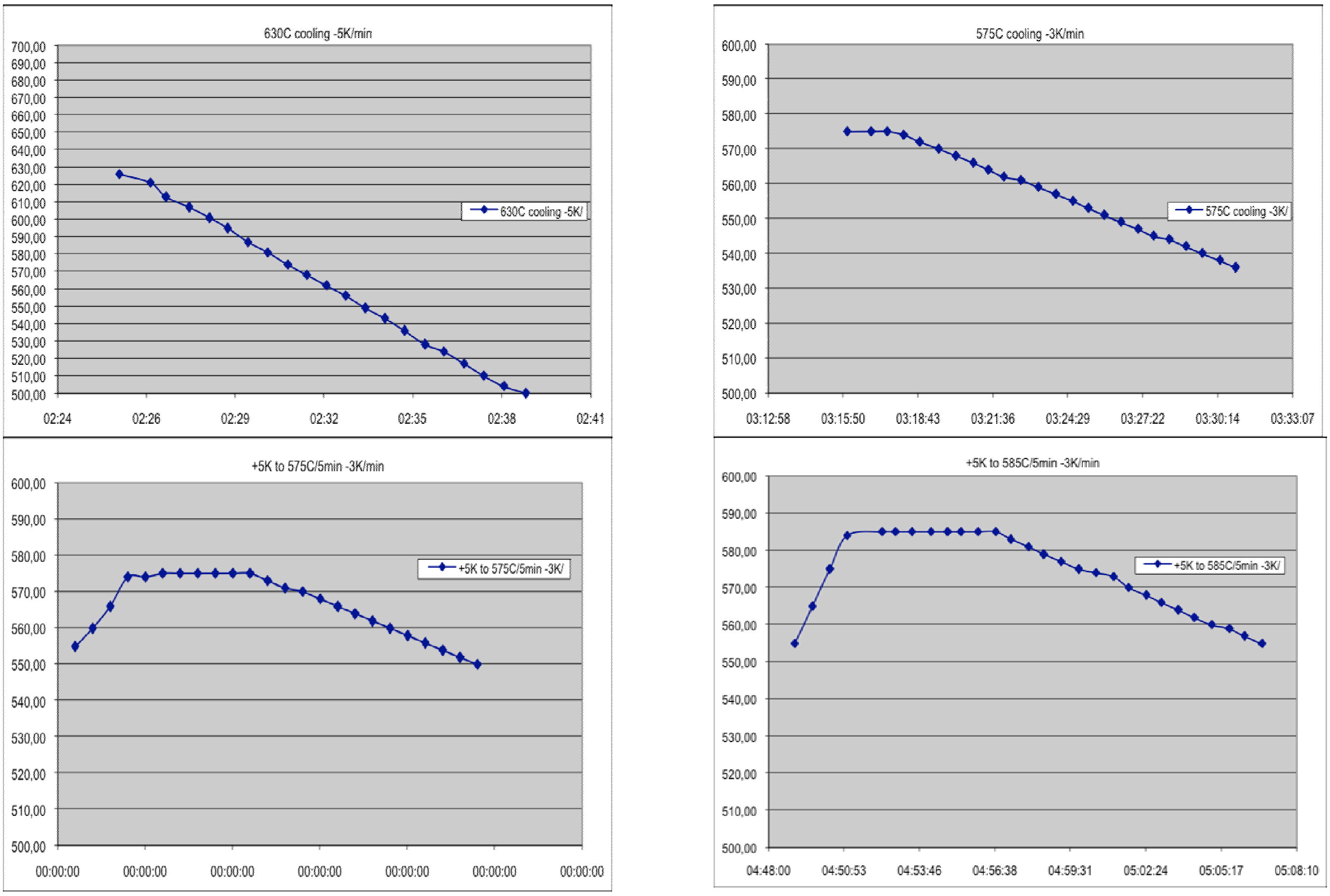

Figure 2. Experimental time-temperature profiles used for the different samples.

In the investigated alloy, α-aluminium dendrites solidify first, then Al/Mg_2Si eutectic from the remaining Mg and Si rich molten phase, and in the final step the liquid freezes in $Al/Mg_2Si/Si$ triple eutectic. In the meantime Fe and Mn rich intermetallic platelets will seggregate [3], which is not visible on the DSC curves.

Results:

In the majority of the measurements hydrogen bubbles appeared in the molten samples. Since they were moving during the rotation of the sample while taking the radiographies, the proper reconstruction was extremely difficult in some cases (Figure 3). In those samples where the reconstructions were possible, we could clarify the solidification sequence [3], which is in good correspondance with the thermodynamic simulations. From the experimental approach it could be also determined that the intermetallics solidify at the same time as the eutectic (Figure 4), therefore the peaks are overlapped in the calorimetric measurements. Further investigations on the solidification of Al alloys are being carried out within the Long Term Project Ma560.

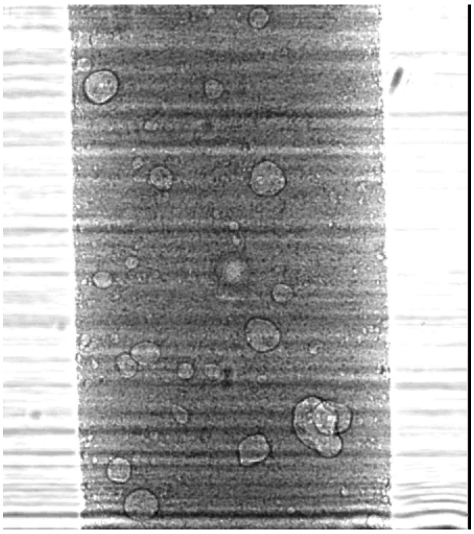

Figure 3. Radiography of the investigated alloy with the hydrogen bubbles

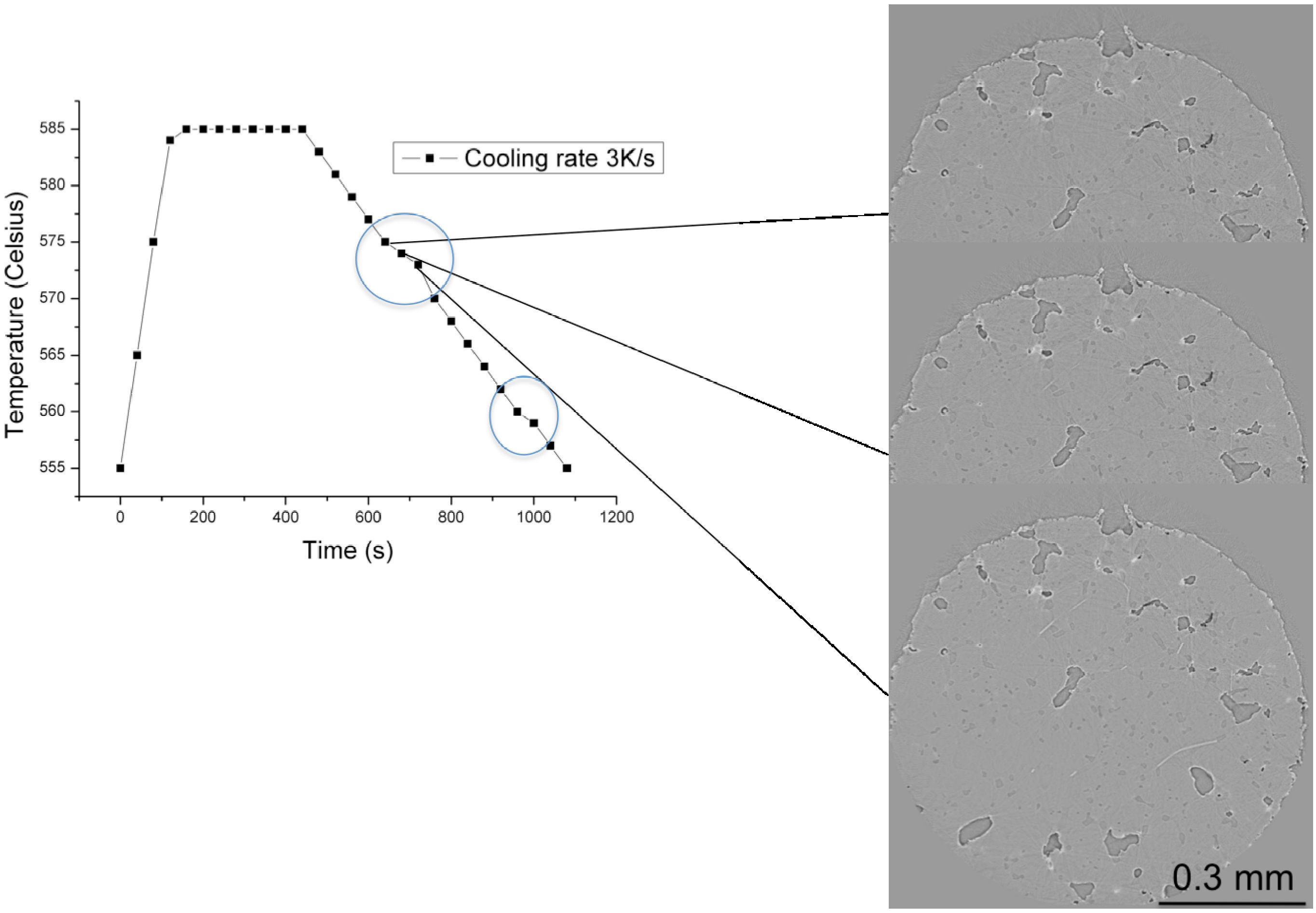

Figure 4. Reconstructed slices of the solidification measurement. The slices show that the iron rich intermetallics start to solidify after the eutectic, but roughly at the same time. The marked regions on the curve are the temperatures of solidification of the eutectic and triple eutectic phases.

References:

[1] L. F. Mondolfo, Al Alloys: Structures and Properties (Butterworth, London/Boston, 1976).
[2]Thermocalc © Version 3.
[3] D. Tolnai, H. P. Degischer, J. Lendvai. Characterization of phases in an Al casting alloy by synchrotron tomography, *Phys. Status Solidi A.* 206, No.8 (2009), 1850-1854.