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Experiment title: In situ observation of the formation of the β-Al5FeSi intermetallic phase during slow cooling solidification of Al-Si casting alloys by synchrotron X-ray tomography.

Experiment number: MA-2405

Beamline: ID19 **Date of experiment: 22nd October 2014 to: 25th October 2014**

Shifts: 12 **Local contact(s): Dr. A. Rack**

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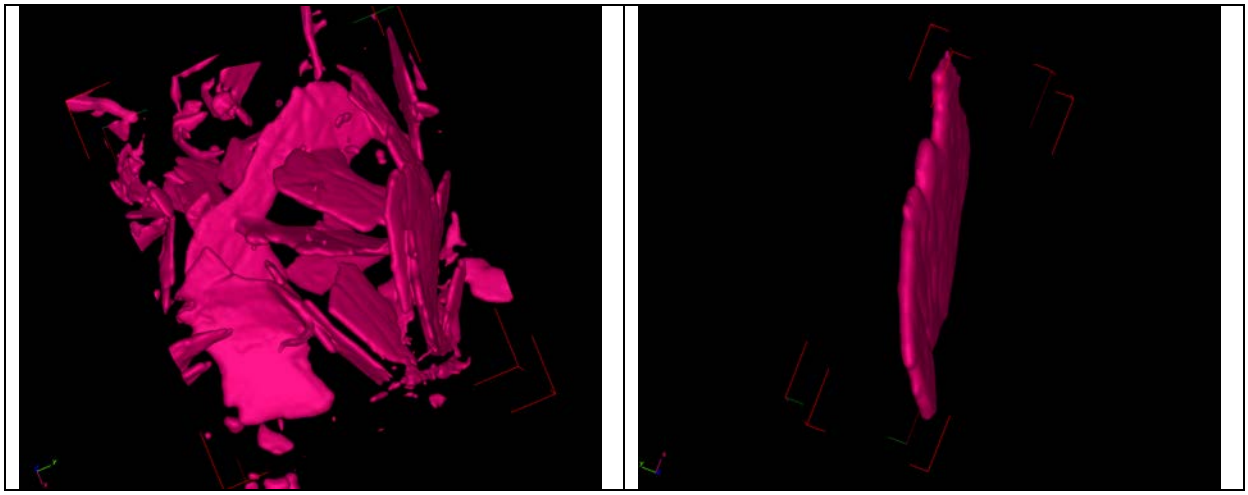
Experimental report:

Four alloys of different compositions (Al-10Si-0.3Fe and Al-10Si-0.3Fe-200 ppm Sr, two of them based on pure elements and the other two are commercial alloys) have been analysed at the ID19 beam line. In the synchrotron X-ray beam line the sample were heated with 20°C/min to a temperature of 660°C (measured by thermocouple located close to the sample), held for 5 min to ensure complete melting and cooled down to a temperature of 450°C with a varied cooling rates: 1°C/min, 9°C/ min and 30°C/min. The microtomography image data were continuously gathered during the complete cooling process. Thousand six hundred thirty two projections (exposures) were taken during the each 180° rotation.

Classical image corrections and a ring-artefact corrections algorithm were applied before the final 3- D reconstruction. To obtain 3-D volumes from the 2-D projections we used VG Studio. To obtain phases the volume of the images were reduced or cropped from the full resolution images to analyse particular regions of interest. Some 3-D images have been made with advanced rendering in order to accurately reveal details on the surfaces of selected b-phases. During solidification, the primary Al dendrites form first appearing slightly darker than the liquid melt. The second observed phase is β-phase which appearing dark in contrast. The third solidified phases are eutectic Si and Al, at which eutectic Si appearing bright. In order to focus on the b-phase, all other features were removed from the investigated 2-D tomography images. We have carefully extract images with β-phases. The β-phases were reconstructed in 3-D as plates, one of the examples is shown below in the Figure. The β-phase is very large, the edge of the plates reaches up to 120 µm.



a) b)

Fig. 3D synchrotron tomography of β-phases in casting Al-10Si-0.3Fe commercial alloy: a) several β-phases reconstructed in an investigated volume 297 x 225 x 195 μm³ and b) β-phase reconstructed in an investigated volume 147 x 48 x 141 μm³.

However, in order to compare the evolution of the microstructure and the formation of β-phase during casting of alloy produced in the industry we need very rapid quenching experiments of samples (~ 20°C/sec). Therefore we applied for 1 day (3 shifts) time for the additional experiments.