ESRF	**Experiment title:** High resolution tomography study of short fatigue cracks in the new 2050-T8 aluminium alloy compared to 7050-T7451 alloys	**Experiment number:** MA-2184
Beamline: ID19	**Date of experiment:** from: 07/05/2014 to: 09/05/2014	**Date of report:** 10 Sep. 2014
Shifts: 6	**Local contact(s):** E. Boller	*Received at ESRF:*

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Report:

1 Goals of the experiment

The MA2184 experiment took place in May 2014 at the ESRF, Grenoble. The main goal of that experiment was to study the effect of local microstructure (particles, grain size and orientation) on short fatigue crack initiation and growth in two aluminium alloys (2050-T8 and 7050-T7451). As set in the proposal, there is still a lack of data about 3D propagation of short cracks. This is an issue since fatigue crack propagation cannot be understood, as demonstrated in the literature, by 2D observations alone. This experiment solved two problems separately:

- recording statistical relevant 3D images of short cracks initiated ex situ,
- performing high-sampling rate in situ observations of short cracks.

2 Results of this experiment

For this experiment, a pink beam of energy 19 keV was used, and images were acquired with a frelon camera device. During imaging, all specimens were submitted to tensile loading in order to open cracks. This could be achieved with the in situ fatigue machine developed at INSA Lyon (Figures 1 and 2).

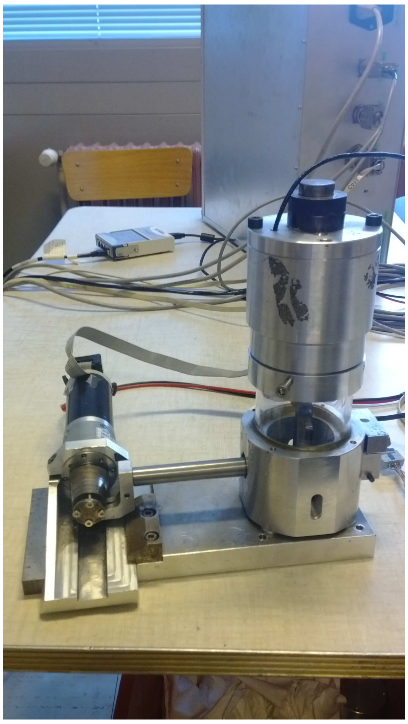

Fig. 1: In situ fatigue machine used during experiment MA2184.

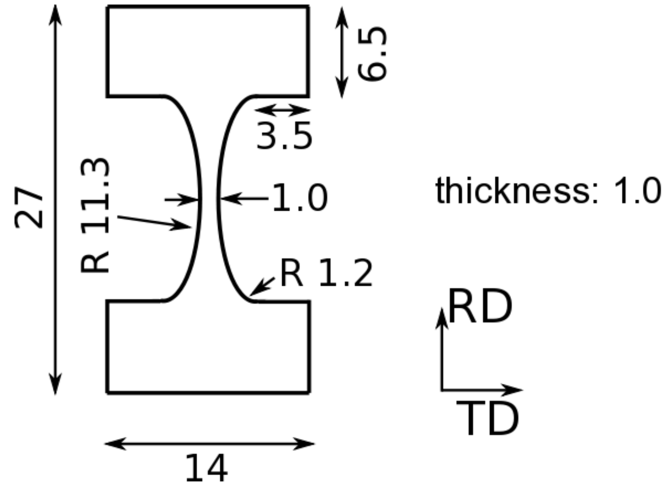

Fig. 2: Geometry of specimens used - cracks initiate in the central part.

During the *first part* of the experiment, 94 cracks were imaged in 11 specimens in 2050 and 8 specimens in 7050. For each crack, the shape of the crack front could be detected on images, and will provide statistical data about 3D crack shapes in aluminium alloys 2050 and 7050. In addition, the depth of some particles leading to crack initiation could be obtained, and are part of a paper in preparation (Figure 3).

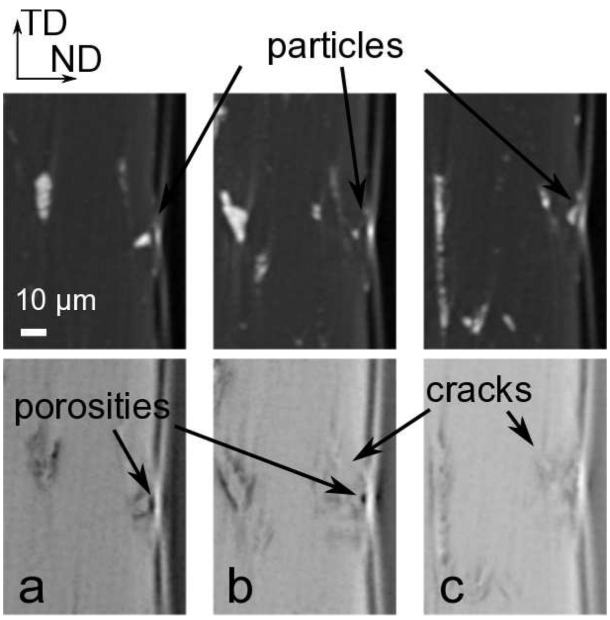

Fig. 3: The three smallest cracks detectable are shown to initiate near particles of comparable depths.

For the *second part* of the experiment, 3 specimens of 2050 and 4 specimens of 7050 were cycled in situ with the fatigue machine. A high sampling rate of one 3D image every 200 to 500 cycles could be obtained (for a lifetime of about 40 000 cycles). Thanks to these images, the evolution of the crack front shape can be precisely analyzed (Figure 4), and compared to surface data previously obtained.

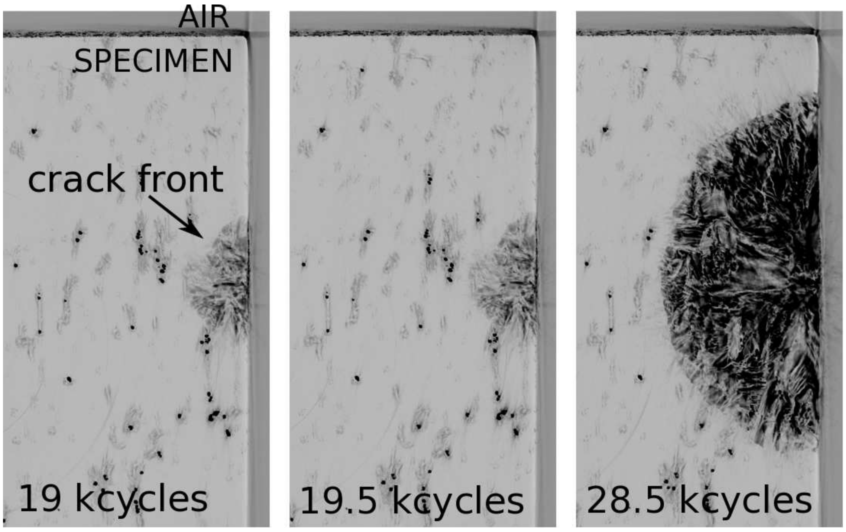

Fig. 4: Projection of a crack normal to the tensile direction after different timesteps. The sampling rate provides an unprecedented precision in the 3D observation of short cracks propagation.

3 Future work

This study shows the feasability on beamline ID19 to follow with a high sampling rate short fatigue cracks in aluminium alloys, which results are planed to be published. The few number of specimens followed could highlight the valuability of data provided by such an experiment. For the next step, it will be necessary to pursue the development of image analysis scripts adapted for such cracks. In parallel, it is needed to proceed to in situ fatigue testing at beamline ID19 to obtain statistical data on propagating small cracks - and not only ex situ cracks as was also done in this study.