ESRF	**Experiment title:** Pores closure during hot rolling	**Experiment number:** MA3482
Beamline: ID19	**Date of experiment:** from: 2017/07/12 to: 2017/07/15	**Date of report:** 2017/07/28
Shifts: 9	**Local contact(s):** Elodie BOLLER	*Received at ESRF:*

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Report:
Aims: In order to understand the thermomechanical phenomena involved in pore closure during hot rolling, tomography have been carried on aluminum alloy under hot compression. Practical aims were:

- to follow pore closure during compression (volume, shape, orientation)
- to evaluate the effect of various parameters (temperature, strain rate, ductility, number of passes) on pore closure

Experiments: In situ hot compression tests were performed on cylinders of 2 mm diameter and 2 mm height. These samples were compressed at high temperature (430 to 520C) using a dedicated homemade mechanical device and a resistive furnace. The compression of each sample was performed in several passes.
Different alloys were used to vary ductility. Other parameters were investigated : temperature, compression velocity and number of passes.
Temperature and force were simultaneously recorded during the experiment. Scans with a pixel size of 2.44 μm were acquired. Each sample was scanned at room temperature before compression, and then at high temperature before compression, between each pass and after compression. About 30 samples were imaged during the experiment.
Preliminary tests were also performed on other sample geometries. Double-collar compression and compression-tension on an embeded cylinder were tested. In a future experiment, these new geometries should allow to change the loading path during compression in order to be closer to rolling conditions.

Results: The experiment is currently under analysis. The following results come from preliminary analyses on few samples.
First observations show that some pores are closed and other are still present after compression. Pore closure strongly depend on the pore position in the sample, and thus on the loading path. Pores located close to the edge of the sample are re-opened during compression due to the tensile state caused by the rounded shape induced by friction.

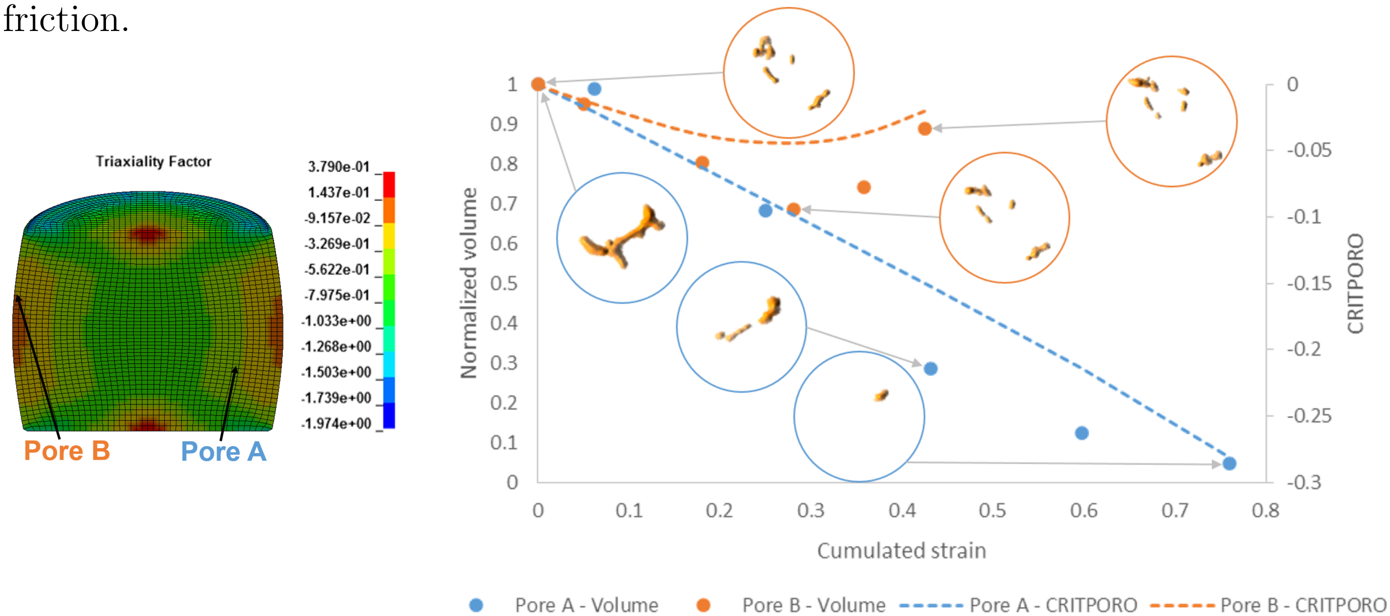

Figure 1: Example of pore closure for two diferent pores in the same sample during a 5 pass compression:
a) Triaxiality factor and localisation of the pores after the second pass
b) Pores volume and CRITPORO (closure criterion) as a function of cumulated strain

Pore A is located closer to the center of the sample leading to a compressive state which results in the quasi-total closure of the pore. Pore B is close to the surface resulting in a low variation of volume, whith first a phase of closure and then a phase of opening. CRITPORO is a numerical criterion used to describe pore closure, it is the integral of triaxiality along cumulated strain. CRITPORO and volume follow the same trend. Further analyses will be conducted to first determine the validity of CRITPORO and then quantify the influence of the tested parameters to take them into account in the criterion. The final aim is to validate a numerical criterion able to describe pore closure or opening during hot rolling.
Digital volume correlation will be use to track pores and determine the local deformation field. With this local deformation, the material law and numerical simulation, the local stress field around pores will be computed.

Valorisation: This experiment is a substantial part of the PhD of Pauline GRAVIER. Materials and methods, results and conclusions will be compiled in her PhD report (2019). Communication and publication of the most relevant results are planed in both industrial and academic contexts.