EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

	Experiment title: **High resolution 3D imaging of foam flows in porous media**	**Experiment number**: SC4591
Beamline:	**Date of experiment**: from: 24Novembre 2017 to: 28Novembre 2017	**Date of report**: 01/03/2018
Shifts:	**Local contact(s)**: Elodie Boller	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

SC 4591	-Main proposer **Elisabeth Rosenberg** High resolution 3D imaging of foam flows in porou s media

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Report:

This study aimed at characterizing the texture of a foam flowing in a porous medium and more particularly the bubble size and the gas trapping mechanisms in the 3D pore network.

This first experiment was done to optimize and validate the microcell and its environnment for flow monitoring, to validate the spatial and temporal resolution necessary to observe the foam flowing and to initiate the description of the trapping phenomenon in the pore network.

The first results are very promising and are worth it to be completed by the study of the foam texture for different controlled conditions (pore size, flow rate and gas fraction) . A more precise acquisition workflow should be defined in order to capture the relevant characteristic times for foam trapping.

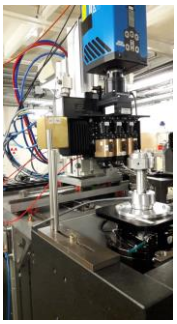
Experimental setup

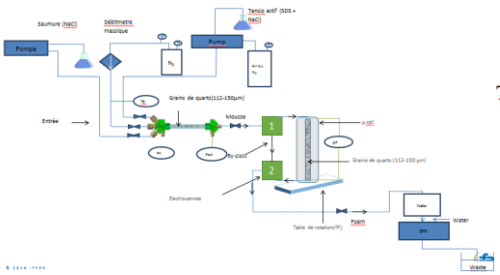
In this experiment the SDS + NaCl foam was preformed and injected in a unconsolidated medium SiO2 112-150 microns in a PEEK cell 2mm in diameter.

The experimental setup (Figure 1) consists in a foamer and an injection cell and its environment, including pressure sensors, a Backpressure and an intermediary buffering bottle at the outlet of the cell.

The pressure sensors are used to measure the differential pressure between the inlet and the outlet of each cell (absolute and differential pressure). The sensor are linked to a computer and controlled with a Labview software.

We use a backpressure to maintain the pore pressure (baseline pressure) of the porous medium at 5 bar. When the surfactant and the gas are co-injected the pressure along the porous medium increases. A safety relief valve is set to 32bar.The environment is certified and secured to work at 30 bars.





The characteristics of the porous media are the following :

- foamer: 6.5 cm * 4mm
- µCell: 10 cm * 2mm
- Porosity:
  - foamer = 39.8%
  - µCell =46%
- Permeability: - foamer = 9.3 darcy
  - µcell= 17.6 darcy

Figure 2 : Injection setup for foam injection

A cell with slipping rings has been specially designed for enabling a continuous rotation of the sample while the foam is flowing in the porous medium. p We encoutered some issues. In particular, the immobilization of the body of the cell during the rotation was not optimized initially. This has been corrected since.
For this run we chose a rotation of 180° per tomo. Two consecutive tomos were acquired in opposite side and a registering of the images was necessary. This was finally corrected for a rotation of 360° (2sec instead of 1 sec) which is still compatible with the observation of gas bubbles.

Results

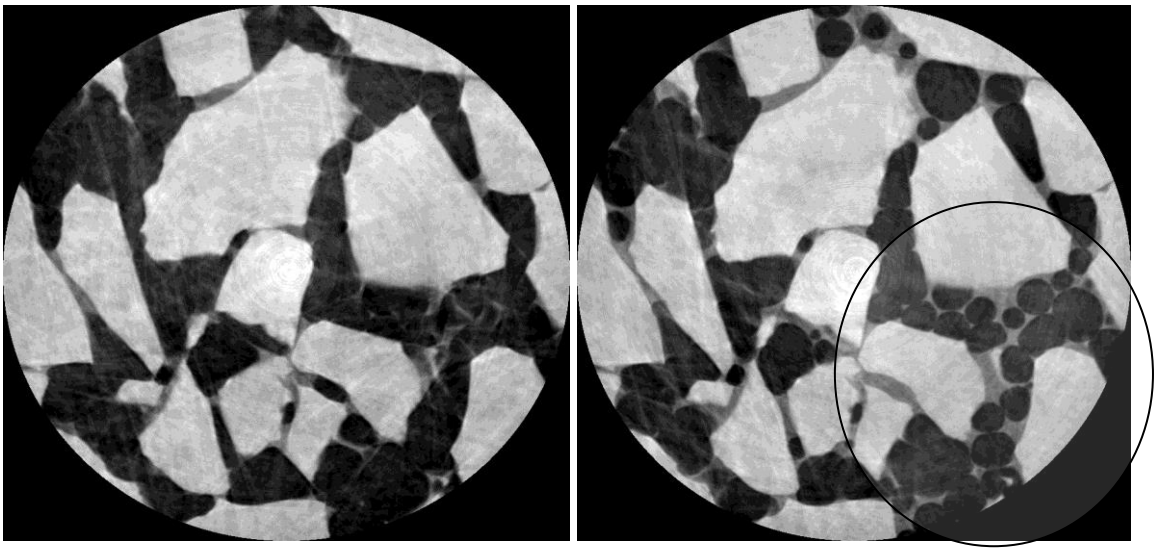


*Figure 4 : Reconstructed slices 1008x1008x1.1 micron of the foam flowing in the porous medium at two minutes interval. The flow rate is equivalent to 10 pores/sec**ond** . The well defined bubbles are **trapped** bubbles.*

From the first reconstructed cross sections we can assess that micro-tomography on the synchrotron line ID19 is well adapted to the description of a flowing foam in a porous media. Phase contrast gives clearly the best contrast without any need of marking the water. Fast tomography coupled with a high resolution (0.5 to 1 micron) provides images of the gas bubbles. We observed very interesting intermittent phenomenon of trapping-mobilization of gas bubbles and we need now to extract the characteristic times for this phenomenon.

The treatment of the images is still ongoing.