	Experiment title: Towards the dry foam limit and its scale invariant growth regime	**Experiment number**: SC1759
Beamline: ID19	**Date of experiment**: from: 12/09/2005 to: 17/09/2005	**Date of report**: 01/09/2006
Shifts: 12	**Local contact(s)**: Peter Cloetens and Rajmund Mokso	*Received at ESRF:*

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Report:

This set of experiments was dedicated to the study of the coarsening of 3D "dry" liquid foams, i.e. foams containing a small volumic fraction of liquid. These experiments were very successful and enabled us to answer to the two questions that had been formulated in the proposal :

1- Is it possible to demonstrate the existence of a scaling regime in coarsening foams ?

2- What are the good parameters that determine the dynamics of individual bubbles inside a coarsening 3D foam ?

These questions had previously attracted considerable attention but were still unanswered. Our experiments, performed at the ID19 beamline of ESRF from the 12th to the 17th of september 2005, lead to clear answers. Two letters are being finalized to describe our results. A third, detailed, article describing the whole set of results is currently in preparation. Hereafter we describe some of the important results obtained exploiting the datas recorded in september 2005.

Let us notice that a new proposal (standard) will be submitted along with this report to study the forced dynamics of liquid foams under external stress, since our experiments clearly showed that X-Ray tomography at ESRF now yields sharp enough images in a short enough time to study the slow dynamics of liquid foams.

Experimental improvements

Two experimental improvements were brought with regard to SC1111, to enable us to carry on the study of the coarsening of dry liquid foams.

First, a major improvement of the speed of image acquisition, together with an excellent contrast of the images enabled us to acquire images of foams less than a minute after their fabrication, and thus to visualize well defined Plateau borders inside young foams. This was necessary in order to derive statistically relevant growth laws for the bubbles. This work was realized in the frame of the PhD thesis of Rajmund Mokso under the supervision of Peter Cloetens at ESRF.

Secondly, an image analysis tool was devised in Rennes to analyse and correlate successive 3D images containing tens of thousands of bubbles in order to grab the dynamics of individual bubbles.

Experimental results

1- Experimental demonstration of the existence of G(F)

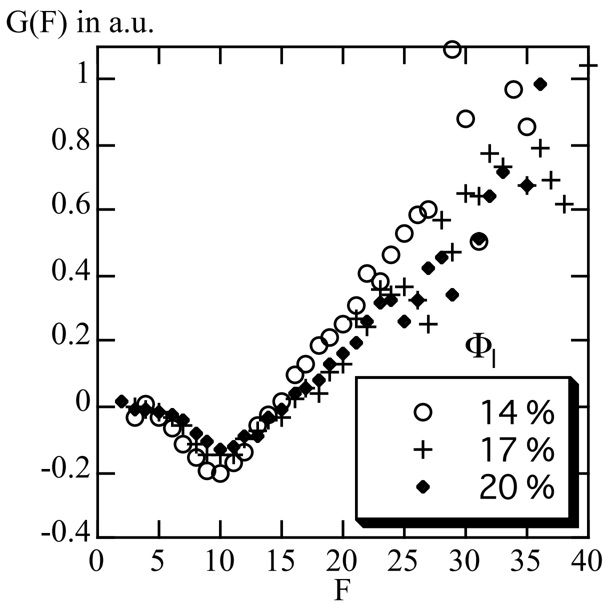
The mechanism of coarsening inside a liquid foam is well understood at the scale of a bubble : neighbouring bubbles exchange gas through the liquid film they share because of their pressure difference. Inside a « dry » two dimensional foam, von Neumann demonstrated theoretically that the growth rate of the surface of a bubble only depends on its number of sides. This result has been transposed theoretically to 3D by Mullins who showed (via some approximations) that the growth rate of F-faced bubbles depends more on F than on their volume. Simulations and theory based on ideal bubbles tended to agree with this statement although no experimental proof had been brought yet.

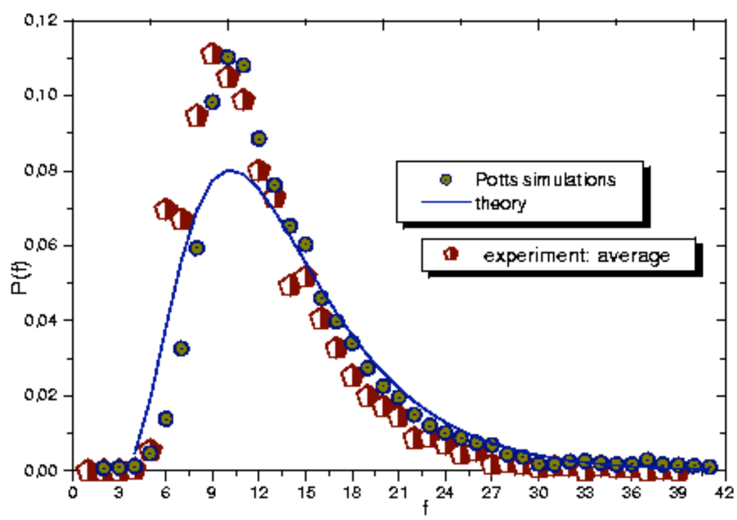
Left figure shows that indeed G(F), the *average growth rate* of F-faced bubbles, is a function of F for 3D foams, even if these latter are « wet » (liquid fraction ~15%). This result unveils new questions since our data should enable us to analyse the shape of G(F) with respect to the liquid fraction and with the disorder inside the foam. A first analysis of G(F) is performed in Lambert *et al.* (in preparation).

2- Existence of a dynamical scaling regime at latter stages of the foam evolution.

Conditions for the existence of a scaling regime inside a coarsening foam have been studied numerically and theoritecally for long, although the existence of this regime had only been partly demonstrated by numerical simulations. By analysing the distributions of volume and number of faces of bubbles inside dry foam, we found that, after re-scaling, these distributions were stable, thus demonstrating the existence of the scaling regime.

These results have been presented by R. Mokso in his PhD (Univ. Grenoble I, June 2006).





Left : Experimental G(F) in a coarsening foam measurements for 3 different liquid fractions.

Right : Faces distribution in a coarsening dry foam compared with theoretical and numerical (Potts) results.