Experimental report

23/08/2022

Proposal: **9-10-1730** **Council:** 4/2021

Title: Mechanisms of (de)stabilization ofan electrostatic foam

Research area: Soft condensed matter

This proposal is a new proposal

Main proposer: **Julien LAMOLINAIRIE**

Experimental team: Leonardo CHIAPPISI
Julien LAMOLINAIRIE
Rodolfo ESPOSITO
Coralie PASQUIER
Alban JONCHERE

Local contacts: Leonardo CHIAPPISI

Samples: Sodium Dodecyl Sulfate
BrijO10

Instrument	Requested days	Allocated days	From	To
D33	1	1	11/10/2021	12/10/2021

Abstract:

Aqueous solutions don¿t all foam in the same way. When you try to produce a foam, you may observe different behavior: a few short-lived bubbles, a fragile foam which rapidly disappears, or a more stable one lasting several hours. The fact that a foam forms at all is the result of several different mechanisms which tend either to produce and stabilize it or to destroy it.

In order to obtain a stable foam, it is evidently necessary to add to the liquid surfactants. During foaming, surfactants adsorb to the gas/liquid interfaces of each bubble. The electrostatic interaction, which is often significant because the interfaces are generally electrically charged, stabilizes the film by repulsive forces between its surfaces. These charged surfaces repel each other. However, for some foams, stability decreases by increasing the charge on the interface. The goal is therefore to study an electrostatic foam to understand the mechanisms of (de)stabilization of the foam.

/Experimental report

01/08/22

Proposal: 9-10-1730 **Council:** 2021-10

Title: **Mechanisms of (de)stabilization of an electrostatic foam**

Research area: Soft condensed matter

Main proposer: **Olivier DIAT**

Experimental team:

Pierre Bauduin
Luc Girard
Alban Jonchère

Local contacts: L. Chiappisi

Samples: BrijO10, D2O, SiW, SDS

Instrument	Requested days	Allocated days	From	To
D33	3	2	2021 June 23 at 9h to 25 at 9h00	

Abstract: **When you try to produce a liquid foam, you may observe different behavior: a few shortlived bubbles, a fragile foam which rapidly disappears, or a more stable one lasting several hours. The fact that a foam forms at all is the result of several different mechanisms which tend either to produce and stabilize it or to destroy it.**
In order to obtain a stable foam, it is evidently necessary to add to the liquid surfactants. During foaming, surfactants adsorb to the gas/liquid interfaces of each bubble. The electrostatic interaction, which is often significant because the interfaces are generally electrically charged, stabilizes the film by repulsive forces between its surfaces. These charged surfaces repel each other. However, for some foams, stability decreases by increasing the charge on the interface. The goal is therefore to study an electrostatic foam to understand the mechanisms of (de)stabilization of the foam.

Experimental Report

For this series of experiments on foam free drainage control, using a non-ionic surfactant BRIJ010, we add a small amount of ionic species: a ionic surfactant (SDS) known to bring some surface charges that will slow down the drainage process and especially add some electrostatic repulsion between inter-bubbles films and also nano-ions known now to play a role of ionic surfactants (see DOI 10.1002/anie.201916193 and 10.1002/ange.201916193) – two nano-ions, a polyoxometallate $SiW_{12}O_{40}^{4-}$ (acid form) and a boron ionic cluster $B_{12}I_{12}^{2-}$(sodium form). Some differences are expected because foam lifetimes in free drainage are different and the objective is to determine at which scale the differences are predominant.

Using our precedent development to analyze foam at different scales simultaneously recording foam images, ion conductivity and SANS spectra as a function of time, figures presented below show the time evolution for 3 molar ratios of non-ionic surfactant over ionic charge (BRIJ concentration being equal to 0.5mM) for the number density, average foam bubble radius and polydispersity, liquid volume fraction extracted from image analysis and from SANS spectra, interbubble thickness and specific surface areas (from plateau border – full lines and from thin films - dotted lines).

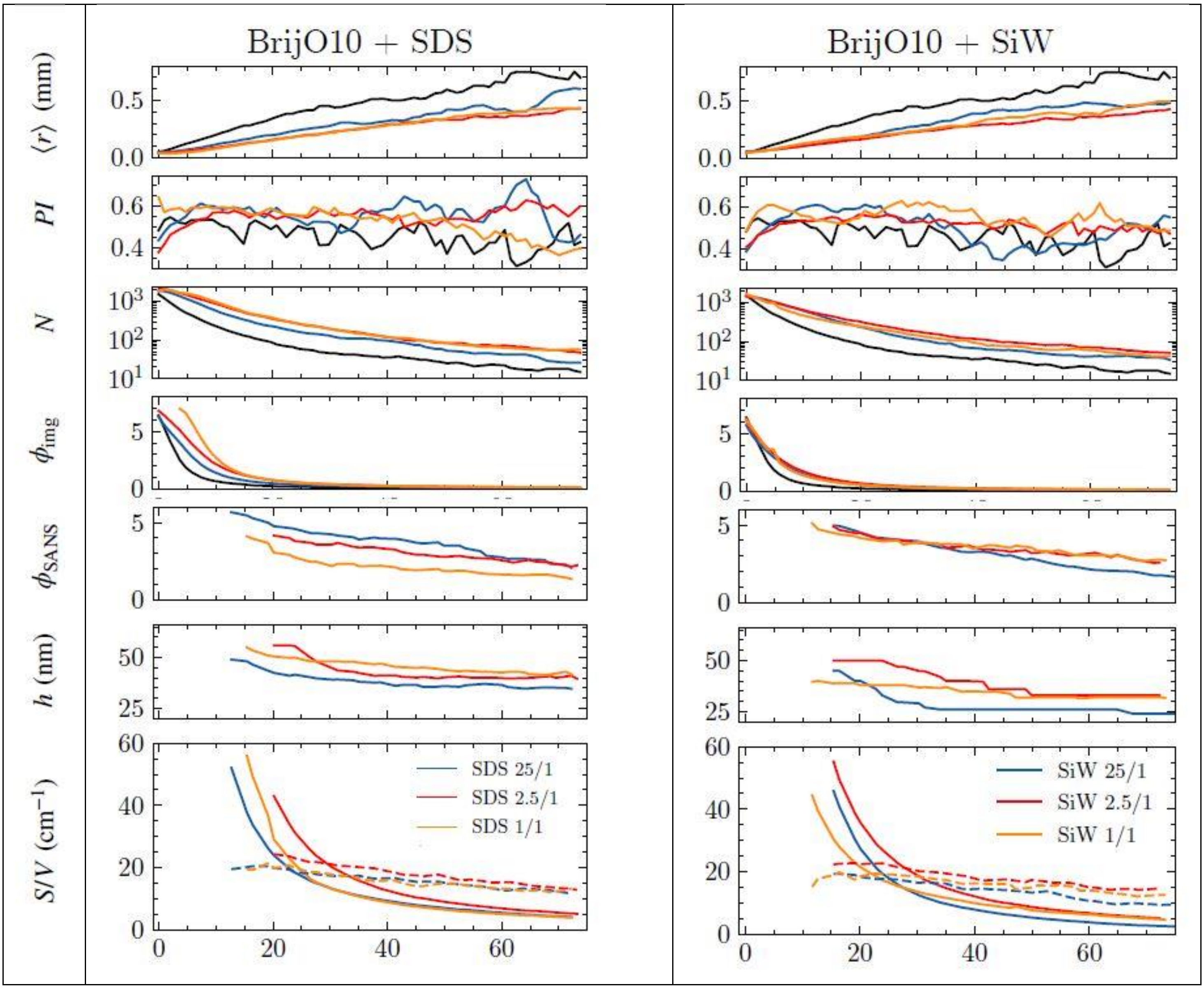

Fig. 1: time-resolved Data obtained using a specific foam column within the J. Lamolinairie (ILL-funded) PhD work and coupling foam image acquisition, ion conductivity, neutron transmission and normalized SANS 2D-records analysed using a new model (publication submitted in Scientific Report this summer). X-axis is the time in minutes., black curves are the BRIJ alone as references

Fig 2. Shows the macroscopic foam volume time evolution within the column in which it is generated.

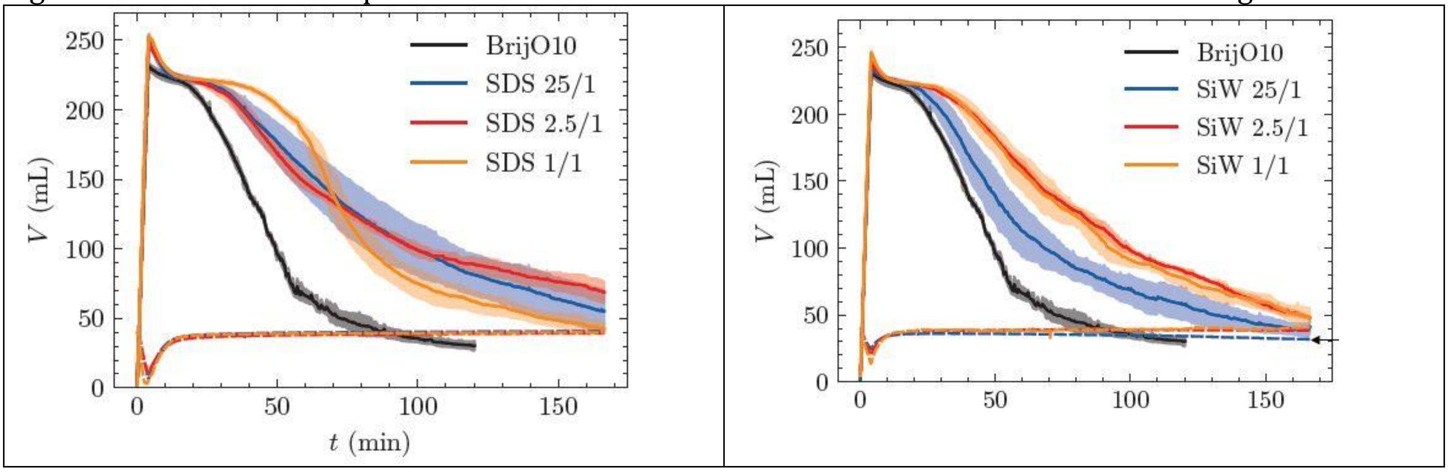

Fig. 2: foam volume variation obtained using a foamscan from Teclis Instrument

All the correlations in the first 70 min, before the foam starts really to collapse are still in progress and kinetic model are in development. However, if we already focus on the BRIJ/SDS system in comparison with this BRIJ/SiW system for 1:1 molar ratio, we can already claim that the SDS addition allows to hold water more efficiently within the foam structure and more specifically within the interbubble film. Their thicknesses are always larger whatever the time whereas the solution within the Plateau border network run down much faster.

At lower BRIJ/SDS ratio compare to BRIJ/SiW, the former system is also much more efficient.
We observe also some differences, changing the charge density of the NI, with an efficiency in term of foam stabilization that appears more efficient are low ratio down to 25/1.
A publication gathering all these results are in progress. 2 or 3 SANS spectra are still necessary to confirm some observation and because also some NOMAD connection error prevent us to performed all the required scans expected in the two-days run.