1. Experimental setup

The experimental setup is the same than the one described in Divoux et al. [2009]. For sake of clarity, we report it in Figure 1 (Auxiliary Material). The experimental cell has an inner diameter of 74 mm, and a total height of 270 mm. Air is injected at constant flow-rate Q at the bottom of a non-Newtonian fluid column, via a chamber of volume V, through a nozzle of 2 mm diameter. We measure the overpressure variations δP in the chamber through time.

We note h_0 the initial fluid height, at the beginning of the experiment. After some time, the bubble column fills up with small bubbles trapped due to the fluid yield stress. This vertical bubble gradient is well visible on the picture above. As the void fraction increases, the fluid column height h increases. For a certain range of air flow rate Q, we observe the formation of a dome of height $\Delta h = h_d - h$.

2. Fluid rheology

In the experiment presented in this article, we used, as a non-Newtonian fluid, a diluted solution (15% in mass of distilled water) of a commercial hair-dressing gel (*Gel coiffant, fixation extra forte* Auchan). If preserved from drying, this gel has stable characteristics through time.

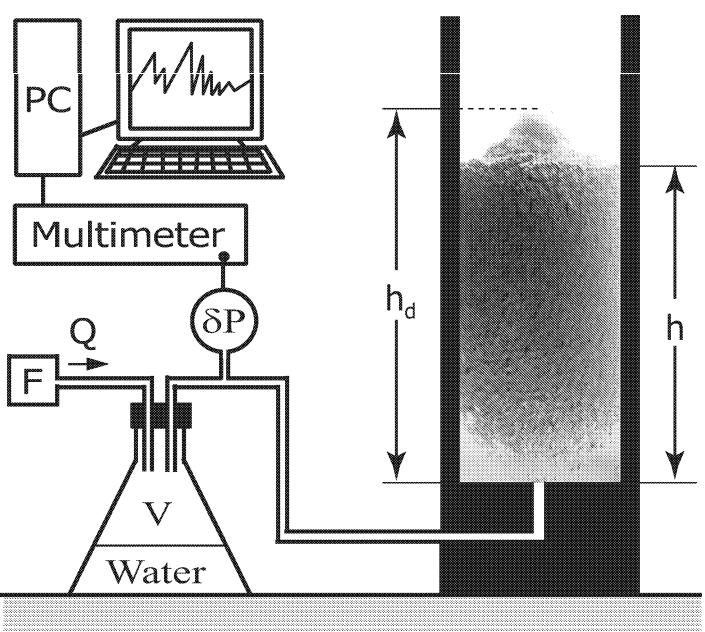
The rheological measurements presented here are performed with a rheometer Bohlin Instruments, C-VOR 150, equipped with parallel plates (PP-60, gap 1000 μm). In order to prevent any sliding of the fluid at the walls, sand paper was glued to the plates. All the measurements are performed at constant temperature T = 25°C.

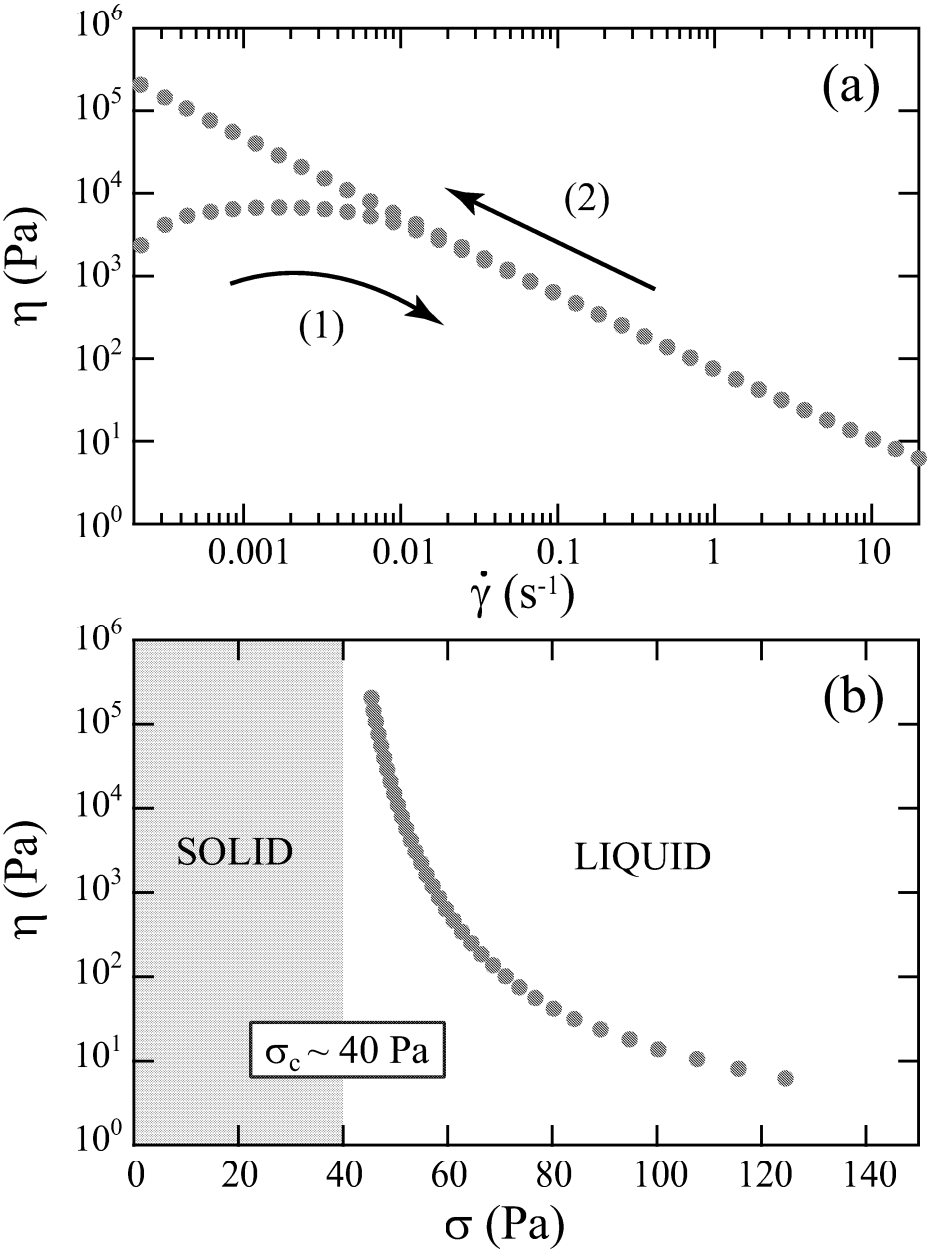
In Figure 2 (Auxiliary Material) are displayed the rheology measurements for the fluid used in this work. The fluid is strongly shear-thinning for shear rates higher than 10^{-2} s^{-1} (Fig. 2a) and presents a yield strength $\sigma_c \sim 40$ Pa (Fig. 2b). In a previous work [Divoux et al., 2009], we mainly used a 10% gel mixture. The graph below presents the change in rheology when varying the gel concentration.

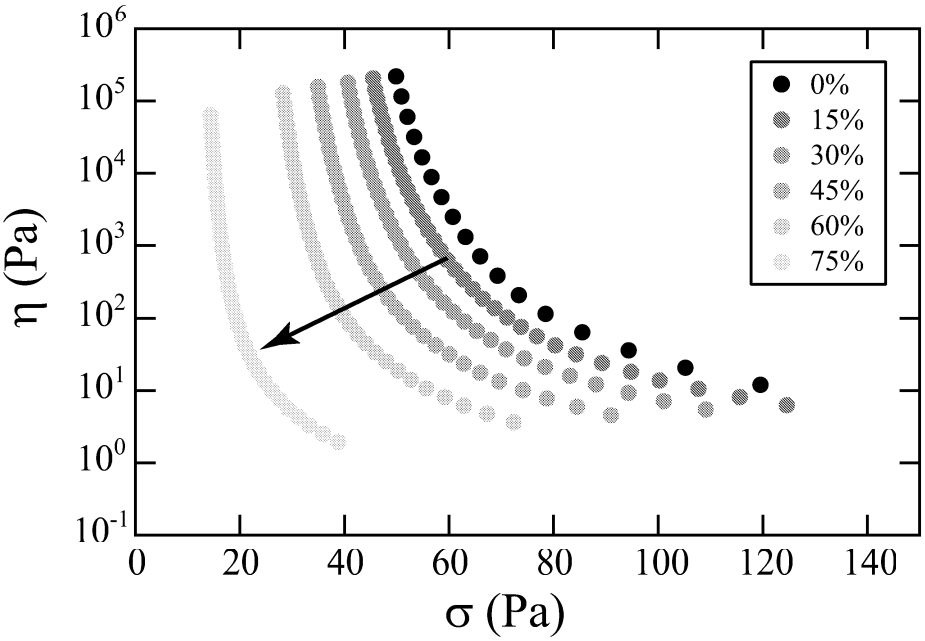
In Figure 3 (Auxiliary Material), we present the evolution of the fluid viscosity as a function of shear stress, for different gel-water mixtures. Note the continuous evolution of the rheological curves. In a previous study, we presented the evolution of such curves for the 10% gel, when the void fraction (number of small bubbles trapped in the fluid) increases (see Divoux et al. [2009], Fig.11). The evolution is similar, indicating that the presence of bubbles strongly influences the fluid rheology.

References

T. Divoux, E. Bertin, V. Vidal & J.-C. Géminard (2009), Intermittent outgassing through a non-Newtonian fluid, *Phys. Rev. E* **79**, 056204.


PC
Multimeter
δP
Q
F
V
Water
h_d
h


(a)
(1)
(2)
η (Pa)
γ̇ (s⁻¹)
10⁰
10¹
10²
10³
10⁴
10⁵
10⁶
0.001
0.01
0.1
1
10
(b)
SOLID
LIQUID
σc ~ 40 Pa
η (Pa)
σ (Pa)
0
20
40
60
80
100
120
140


10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
η (Pa)
0
20
40
60
80
100
120
140
σ (Pa)
0%
15%
30%
45%
60%
75%