Rheology of confined foams

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ABSTRACT

Liquid foams exhibit remarkable elastic properties arising from the surface energy stored in the interfaces as they are subjected to an applied strain. Their rheological behaviour has been extensively studied [1]. It is exploited in many applications such as EOR, drilling or soil remediation processes, or micro/milli-fluidic labs on a chip. In these situations, foams are placed in a confined environment and their structure must accommodate the shape of a narrow channel or pore of characteristic size of the order of a few bubbles. The foam deformation is then neither that of a single soap film confined in a pore nor that of a bulk 3D foam. Here we study the elastic response of ordered 3D soap froth, in which *N* layers of cells are confined between two rigid walls with a gap h (fig. 1). Surface Evolver [2] simulations are used to compute the equilibrium structure as the confinement is varied by changing *N* or *h* and as the foam is subjected to quasistatic shear. We show that confined foams are stiffer than bulk ones. The dependence of their shear moduli on *N* is well described by a three-layer model consisting of Fejes-Toth cells and a core of Kelvin cells that deform like bulk foam. The influence of foam confinement on the elastic limit is studied. The topological transitions are compared to those in bulk Kelvin foam [3].

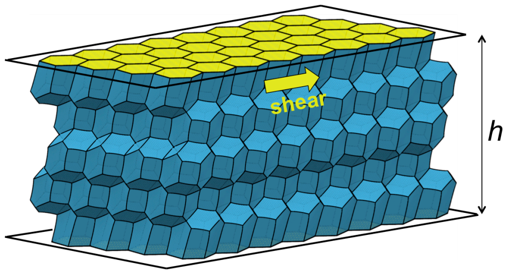

Figure 1: Soap froth (N=5) confined and sheared between two rigid walls.

[1] S. Cohen-Addad and R. Höhler, Curr. Opin. Colloid Interface Sci. 19:536–548, 2014.

[3] K. Brakke. http:// www.susqu.edu/facstaff/b/brakke/evolver/.

[4] P. Guyot, A. M. Kraynik, D. Reinelt and S. Cohen-Addad, Soft Matter, 15 :8227-8237, 2019.