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Foams and soft intruders: exploiting elastocapillarity towards novel foam structures

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Systems involving a competition between elasticity and capillarity have raised growing interest in the past twenty years, including fundamental physics questions but also engineering perspectives in emerging fields such as micro-fabrication and soft robotics. Taking advantage of capillarity has proven to be an efficient way to assemble, orient, or spontaneously bend elastic slender structures. However, the application of such approach to complex cellular systems is limited so far. We will focus here on the question of tuning foam structures using systems involving capillarity and elasticity.

Foams consist of gas bubbles trapped in a continuous liquid or solid material, whose structure is strictly guided by capillarity. Despite recent progress in "liquid foam templating" to produce solid foams in a controlled and self-assembled way from liquid precursors, we still lack methods to tune the geometry and topology of foams. To reach a better control of foam structures and of their resulting properties, we propose to investigate how integrating deformable objects in foams can modify their structure in the liquid state, before the solidification step. Using a combination of model experiments and theoretical energy minimisation approaches, we first quantified the competition between elasticity and capillarity in a simplified liquid foam structure (deformation of a thin ribbon introduced in a 2D bubble column [1,2]). We will present this first set of results and discuss the extension of this approach to 3D complex materials.

[1] Jouanlanne, M., Egelé, A., Favier, D., Drenckhan, W., Farago, J., & Hourlier-Fargette, A. (2022). Elastocapillary deformation of thin elastic ribbons in 2D foam columns. Soft Matter, 18(12), 2325-2331. https://doi.org/10.1039/D1SM01687C

[2] Physical Review E, Editorial: First Annual APS DSOFT Gallery of Soft Matter. https://doi.org/10.1103/PhysRevE.106.050001

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