LadHyX Seminar – May 22nd, 10:45

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Self-assembly of architected polymeric foams from liquid templates

From the assembly of objects at interfaces to the arrangement of bubbles into foams, capillarity has proven to be an efficient pathway for mechanical self-assembly. In that context, the interest for architected materials is raising a fundamental interesting question: can we convince bubbles to arrange themselves in unusual structures by guiding their assembly, thereby providing an alternative route to additive manufacturing? Despite their wide industrial use and the recent progress on "liquid foam templating" techniques, we still lack methods to explicitly control and customize the geometry and topology of liquid and solid foams.

To access novel architectures with interesting associated properties, we are studying how bubbles modify their organization by (i) exploring the mechanical self-assembly of bubbles and flexible intruders, (ii) analyzing the arrangement of bubbles in arrays of rigid fibers, and (ii) extending the range of accessible formulations for model foams able to solidify in a controlled manner to reach architected solid foams.

In terms of elastocapillary self-assembly of bubbles and intruders, we will focus on a two-dimensional model system, showing how the introduction of an elastic ribbon in a column of bubbles "bends" Plateau's laws. We will then focus on the ordering of foams inside rigid fiber arrays, showing that different crystalline structures can be obtained depending on the fiber pattern. Such structures are characterized through X-ray tomography, and an in-depth statistical analysis of the orientational order is performed by adapting Steinhardt's bond orientational order parameters to those systems. Finally, we will discuss physical chemistry aspects in terms of solidifying foams, highlighting strategies to extend the range of " liquid foam templating " to different formulations, including polyurethane, hydrogels and silicones.