Drainage and Stability of Solidifying Hydrogel Films

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ABSTRACT

Polymer foams can be open-cell, closed-cell, or a combination thereof. Controlling the connectivity of polymer foams is of utmost importance for controlling foam properties, such as absorption, mechanical or acoustic properties. Despite its importance, our fundamental understanding of the mechanisms which control the pore opening process remains very limited.

Here, we investigate the pore-opening mechanism in hydrogel foams, which are a widely used class of materials in the biomedical field. Several studies reported hydrogel foams produced via foam templating, i.e. the gelation of a liquid foam containing a polymer in solution, in which some pores were open, and others were closed (see Figure 1) [1-3]. However, none dwelt on the possible reasons for the film rupture upon gelation. We propose to tackle this yet unanswered question using a model system consisting of an alginate hydrogel, cross-linked with calcium ions. To design reproducible experiments, we study free-standing vertical and horizontal films undergoing in-situ cross-linking. The horizontal films are investigated within a home-designed microfluidic thin film pressure balance which allows for a precise observation of the apparition of holes in the gelling films. We tweak both the capillary pressure within the film as well as the hydrogel elasticity to find the regimes in which (1) the films break too early, yielding an unstable foam, (2) the films open during or after gelation, yielding an open-cell foam, and (3) the films do not open or rupture, yielding a closed-cell foam.

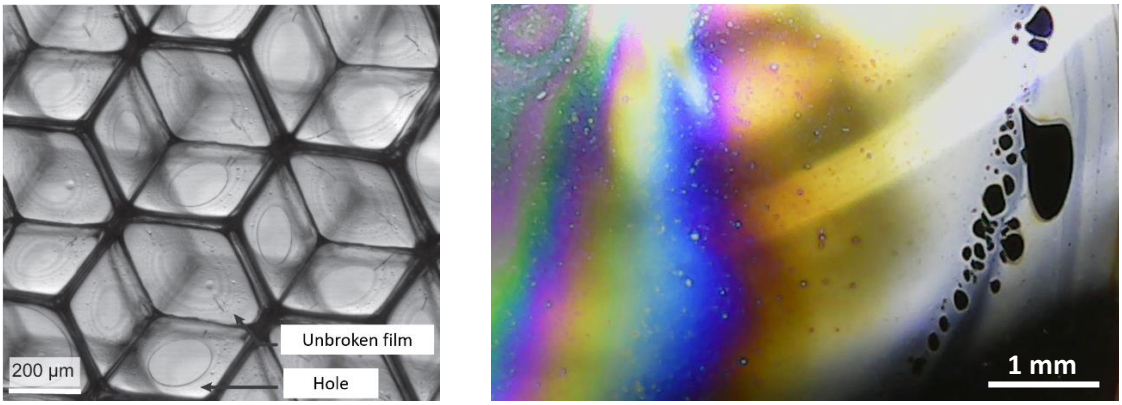

Figure 1: (left) Alginate hydrogel foam showing unbroken films and holes in the films. [1] (right) Model experiment showing an alginate hydrogel film withstanding the formation of holes.

[1] Y.Y. Chung Sang. Vers des micromousses stimulables, PhD Thesis, Université Paris Diderot – Paris 7, Université Paris Est Marne-la-Vallée, 2009.

[2] S. Andrieux et al., *Composites Part A* 2019, *125*, 105516.

[3] F. Dehli et al., *Biomacromolecules* 2019, *20*(7), 2666-2674.