Effects of swelling on the mechanical properties of alginate gels

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Alginate-based hydrogels represent a promising biomaterial for industrial and medical applications, such as the delivery of bioactive agents or macromolecular drugs [1]. However, during industrial processing the gels are exposed to mechanical stresses that may lead to deformation or fracture. These issues may become exacerbated by the swelling response of alginate gels in ionic solutions, common in biological contexts. Understanding the mechanical behavior of the gels is therefore essential to ensure process efficiency and to guarantee their integrity in real application environments.
In this study, we employ capillary micromechanics [2] to characterize the mechanical properties of alginate-based beads and capsules. The deformation of gels driven into a tapered capillary under constant pressure allow to measure their elastic moduli. We compare their response in ultrapure water with their properties along the swelling-deswelling curve by increasing the concentration of NaCl at fixed concentrations of CaCl2. Performing serial dilution experiments, we then find different degrees of irreversibility, which we correlate with a loss of anisotropy present in the gels. By measuring the gelation dynamics, we explore the role of the manufacturing process in generating this structural anisotropy.

Keywords:
Alginate gels, mechanics, swelling, gelation

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