Influence of Supramolecular Structure on Hydrogel Strength

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Biological materials lend some of their material properties on their supramolecular structure. As a result, a small amount of molecular building blocks are responsible for a large variety of macroscopic behaviors [1]. Inspired by biology, hydrogel designs have started to include hierarchical structures [2,3]. However, adapting the supramolecular structure of hydrogels without impacting their molecular structure remains a challenge. One method to achieve this aim is by templating the hydrogel in another material, but this can limit the accessible suprastructures [4].
Here, we vary the supramolecular structure by templating the hydrogel in a bicontinuous interfacially jammed emulsion gel (bijel). Bijels self-assemble via interfacial jamming of nanoparticles during spinodal phase separation of two immiscible liquids [5-7]. By varying the wettability of the nanoparticles, we vary the bijel template structure without impacting the chemical composition of the hydrogel. In particular, we using this technique we can achieve a variety of structures; from non-porous with nanoparticle intrusions, to encapsulated pores, to bicontinuously porous.
We correlate structural information gathered from confocal laser scanning microscopy and scanning electron microscopy with the stress-strain relationship of the hydrogels. Because the manner in which we create the supramolecular structure of the hydrogels keeps the chemical composition constant, we can directly map the changes in hydrogel strength to its supramolecular structure. Thus, showing the importance of controlling not only molecular structure but also the supramolecular structure of materials.

Keywords:
Hydrogel, Bijel, Supramolecular structure, Particle stabilized emulsions

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