BIJELS FORMED BY MIXING: ESCAPING FROM PHASE SEPARATING LIQUIDS

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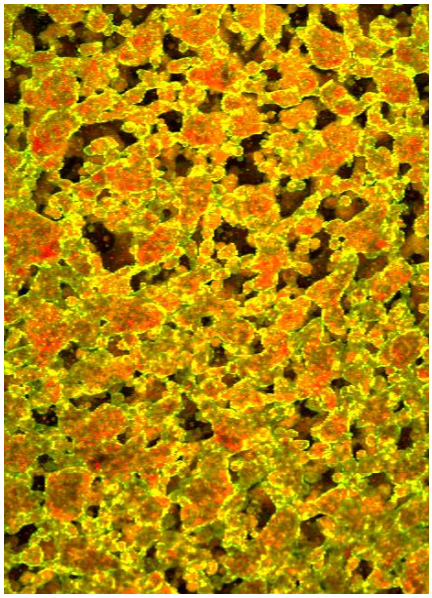
The liquid-liquid phase separation of binary fluids, induced by a temperature quench, can be arrested by colloidal particles trapped at the interface. The arrested structure, a novel soft solid known as a bicontinuous interfacially-jammed emulsion gel (bijel), is a variant of a Pickering emulsion [1]. The mechanical properties are controlled by the interfacial tension between the two fluid domains (e.g. a deeper quench yields a stronger bijel) and the volume fraction of particles. Similar structures have also been created using the biopolymer phase separation (e.g. of gelatin and starch) and also using phase separation driven by the transfer of a solvent out of a pre-mix [2].



In spite of this success, the use of the phase-separation behavior of partially miscible liquids greatly constrains the choice of starting ingredients. We have recently found that, by combining interfacial nanoparticles and molecular surfactants together with immiscible liquids of high viscosity, we can avoid the need for a phase separation transition. Others have achieved the same result using closer control of the molecular surfactant together with low viscosity liquids [3]. In both cases the tortuous structure is created via the mixing protocol. We will present these approaches and show how they open the way to creating bijels using a wider spectrum of ingredients.

Figure 1 – Glycerol / silicone oil composite stabilized with silica and CTAB

[1] Stratford et al. Science 309, 2198 (2005); Herzig et al. Nat. Mater. 6, 966 (2007).
[2] Firoozmand et al. Langmuir 25, 1300 (2009); Haase et al. Adv. Mater. 27, 7065 (2015).
[3] Cai et al. Soft Matter, 13, 4824 (2017); Huang et al Nat. Nano. 12, 1060 (2017).