High surface area bijels for biphasic catalysis

Mohd Azeem Khan, Van't Hoff Laboratory of Physical and Colloid Chemistry

Bicontinuous interfacially jammed emulsions (bijels) are particle stabilized bicontinuous emulsions formed by spinodal decomposition. Due to their biphasic composition and internal porosity, bijels have potential applications in catalysis [1] membrane separations [2], and energy storage [3]. Bijels are traditionally formed by phase separation of partially miscible binary liquids upon heating or cooling [[4]]. However, this method typically generates bijels with relatively small internal surface areas.

Recently, solvent transfer induced phase separation (STrIPS) has been introduced to continuously generate bijel fibers, films and microparticles [5] (see Figure 1). STrIPS can generate bijels with much higher surface areas, potentially enhancing their performance in applications. I am investigating the formation of nanostructured STrIPS-bijels formed by the rapid stabilization of the liquid-liquid phase separation with nanoparticles.

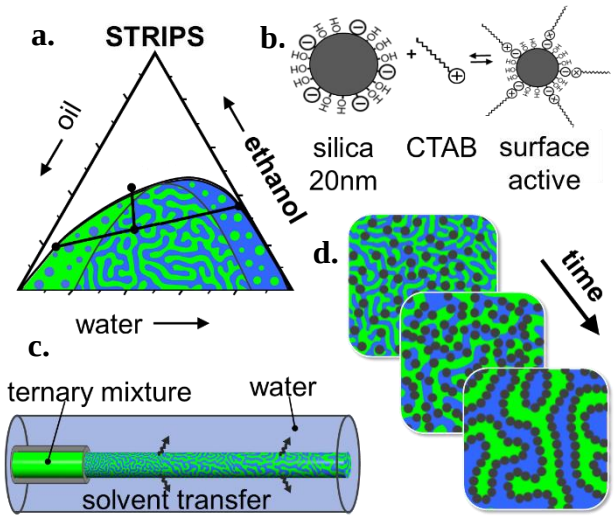

Figure 1: **a)** Ternary liquid-liquid phase diagram depicting regions of nucleation and spinodal decomposition. **b)** Surface functionalization of silica nanoparticles. **c)** Schematic of microfluidic bijel fiber formation. **d)** Schematic of interfacial jamming for bijel stabilization.

My research analyzes the dependency of bijel formation on the ternary liquid-liquid phase equilibrium and the nanoparticle surface chemistry. To this end, I employ a combination of techniques including confocal laser scanning microscopy, scanning electron microscopy, pendant drop tensiometry, and microfluidic in-situ mechanical testing [6].

My ultimate goal is to generate nanostructured bijels for applications in biphasic catalysis. The idea is to catalytically functionalize the nanoparticles within a bijel. The catalytic nanoparticles can then promote the chemical reaction of immiscible reagents within the bijel. In this system, reaction and separation happen simultaneously since products partition either into the oil or water phase of the bijel based on their preferential solubility.

For more information, check out: https://www.martinhaase.com/research-catalysis.html

1. Di Vitantonio, G., et al., ACS Nano, 2018. **13**(1): p. 26-31.
2. Haase, M.F., et al., Nature Communications, 2017. **8**(1): p. 1234-1234.
3. Witt, J.A., et al., Journal of Materials Chemistry A, 2016. **4**(3): p. 1000-1007.
4. Herzig, E.M., et al. Nature materials, 2007. **6**(12): p. 966-971.
5. Haase, M.F., et al, 2015. **27**(44): p. 7065-7071.
6. Haase, M.F., et al. ACS Nano, 2016. **10**(6): p. 6338-6344.