Janus STrIPs Bijels

Physical and Colloid Chemistry (FCC)

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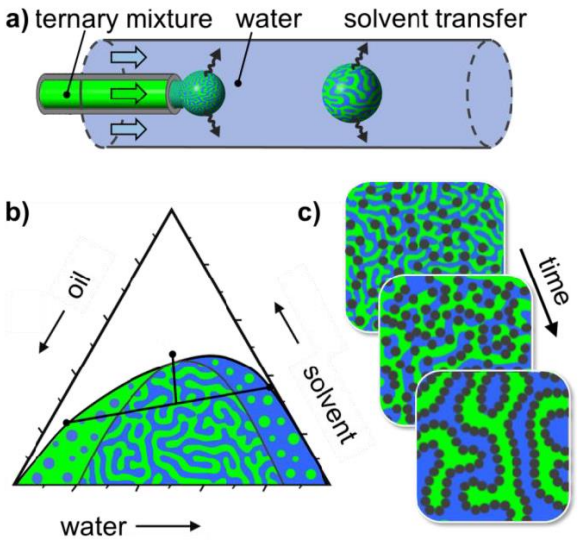
Project description:

Bicontinuous interfacially jammed emulsion gels (bijels) have found numerous uses as batteries,[1] filters,[2] tissue engineering scaffolds,[3] ultralight materials,[4] and catalytic microreactors.[5] Bijels consist of two continuous liquid phases arranged within an intertwined channel network. This out-of-equilibrium structure is stabilized by a rigid film of colloidal particles at the liquid-liquid interface.[6]



We have recently introduced Solvent Transfer Induced Phase Separation (STrIPS) to continuously generate bijel fibers, films and microparticles.[7] STrIPS requires the injection of a homogeneous mixture of three liquids into a continuous phase (Figure 1a). One of the liquids is a solvent that allows homogenous mixing of the other two liquids, (e.g. an oil and an aqueous phase), which are immiscible on their own. In the course of injection, this solvent is extracted into the continuous phase, leading to phase separation (Figure 1a). The ternary phase diagram qualitatively depicts this process (Figure 1b). During phase separation, surface-active particles within the ternary mixture attach to the interface between the oil- and water-rich phases to arrest phase separation and stabilize the bicontinuous structure (Figure 1c).

Electrochemical membrane fuel cells (EMFC) directly convert the chemical energy from reactant gases into electrical energy. Engineered microstructures with specific or patterned wettability have emerged as a powerful technique to avoid the water flooding in the EMFC caused by oxygen reaction at cathode.[8] Bicontinuous microporous structure of bijel with tunable hydrophobicity makes it a potential candidate for EMFC. Moreover, STrIPS provides a continuous fabrication route with scalable and easy chemical modification of these bijel structures. In this project we plan to impart selective wettability to water and oil phases to facilitate the diffusion of gas and removal of water through separate channels. This approach aims to enhance the operational efficiency of the electrochemical fuel cell and provide a high specific area for catalysis and energy storage applications.

Experimentally in this project, we will employ microfluidics for the fabrication of bijel structures. The confocal and electron scanning imaging will be used for chemical and structural characterization of generated bijels before and after the chemical modifications.

References

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