Dual jamming of bio-based CNC-stabilized bijel fibers via continuous solvent transfer induced phase separation

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Bicontinuous particle-stabilized emulsions are formed by mixing two immiscible liquids with a cosolvent, followed by inducing phase separation within the spinodal regime and kinetically arresting the evolving morphology with colloidal particles. Here, bio-based, rod-like cellulose nanocrystals (CNCs) are employed to stabilize bicontinuous emulsions through combined inter- and intra-phase jamming at a low particle loading of 3 wt.%, yielding characteristic domain sizes of approximately 10 μm. The use of 1-propanol as a cosolvent promotes CNC dispersion prior to and during solvent diffusion, enabling the continuous development of CNC-based bicontinuous emulsion gels in the form of segmented fibers (1–2 cm) and continuous filaments exceeding 25 cm in length. Crucially, surfactant-specific access to near-neutral wetting is identified as a practical control lever for CNC: stable bicontinuity is not achieved with CTAB, whereas robust filament formation is enabled by DDAB. The resulting porous, biphasic CNC network supports efficient crossflow mass transfer and provides a robust platform for interfacial chemical processes, opening an opportunity for sustainable material design.

Keywords:
Cellulose nanocrystals (CNCs), Pickering bicontinuous emulsions, interfacial jamming, solvent-transfer induced phase separation (STRIPS).

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