

Understanding the Structure of Bicontinuous, Particle-Stabilised Emulsions

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The stabilisation of emulsions with solid particles has been a cornerstone of soft matter science in recent decades, with particle-decorated droplets (Pickering emulsions) receiving particular attention. Bicontinuous interfacially jammed emulsion gels (bijels) are a natural extension of this concept, yet the rules governing their structure remain not fully understood. This is especially true for bijels formed through solvent-transfer induced phase separation (STrIPS) [1], despite their relevance as template materials for membrane separation [2] and catalysis [3].

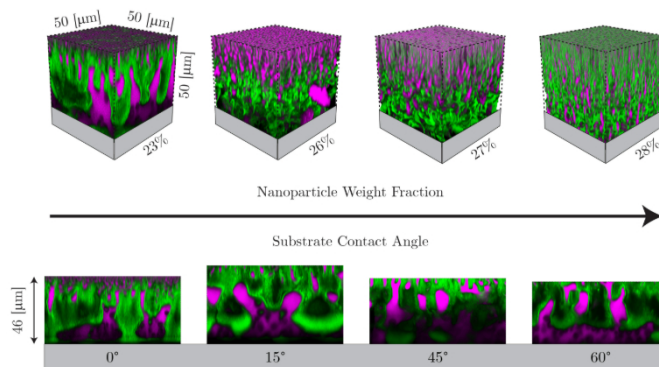
In this work, we determine two key factors that dictate the structure of STrIPS bijels. The first is the concentration of nanoparticles, which we investigate by mapping the 3D morphology of supported STrIPS bijel films through a combination of confocal microscopy and computer simulations. The resulting relationship between the size of the liquid domains and the particle concentration strongly deviates from that of a standard particle-stabilised emulsion, requiring a new model that better captures the specific formation conditions of STrIPS bijels.

Second, we cover the influence of substrate-directed phase separation on the morphology of supported STrIPS bijels. Computer simulations predict the formation of a distinct wetting layer during the STrIPS process, which is confirmed through confocal microscopy on experimental bijels. The composition of this wetting layer can be tuned by progressively increasing the hydrophobicity of the substrate material, ultimately driving a full inversion from water to oil.

Together, these findings provide a framework for the rational design of complex particle-stabilised emulsions with tailorable structures, such as STrIPS bijels.

Keywords:

Emulsions, Nanoparticles, Phase Separation



3D confocal reconstructions of supported STrIPS bijel films. Oil is indicated in magenta, water in black and nanoparticles in green. The top and bottom rows of images reflect the structural influence of the nanoparticle concentration and substrate wettability, respectively.

References:

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