Understanding Particle Adsorption at the Oil/Water Interface in Light-Responsive Pickering Emulsions and Real-Time Formation under In Situ Ultrasound

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Light-responsive Pickering emulsions offer a route to externally controlled destabilisation through light-induced changes in particle wettability [1]. However, their response is often highly sensitive to formulation, and the relationship between particle-scale interfacial behaviour and macroscopic emulsion stability remains unclear.
Here, we investigate adsorption and organisation of azobenzene-functionalised silica particles at the oil–water interface. By systematically varying particle loading, surface functionalisation, photoswitch structure, and oil phase, we identify key parameters governing interfacial packing and adsorption energy. Langmuir trough measurements combined with neutron reflectometry are used to resolve structural changes at planar interfaces under irradiation, distinguishing lateral rearrangement from out-of-plane redistribution. These results are correlated with bulk emulsion behaviour characterised by optical microscopy and droplet size analysis [2–4].
In parallel, we present a newly developed sample environment at the ISIS Neutron and Muon Source that enables real-time emulsion formation under in situ ultrasound and controlled light irradiation on small-angle neutron scattering beamlines. The system integrates a tip sonicator with a sealed neutron-compatible cell and multi-wavelength LED illumination, allowing emulsification and external perturbation directly within the neutron beam. Preliminary measurements demonstrate the capability to follow structural evolution during emulsification and provide direct comparison with conventional ex situ preparation.
This combined approach links interfacial structure to bulk emulsion response and establishes new opportunities for studying dynamic emulsion formation under external stimuli.

Keywords:
Pickering emulsions, light-responsive particles, particle adsorption, oil–water interface, neutron reflectometry, small-angle neutron scattering

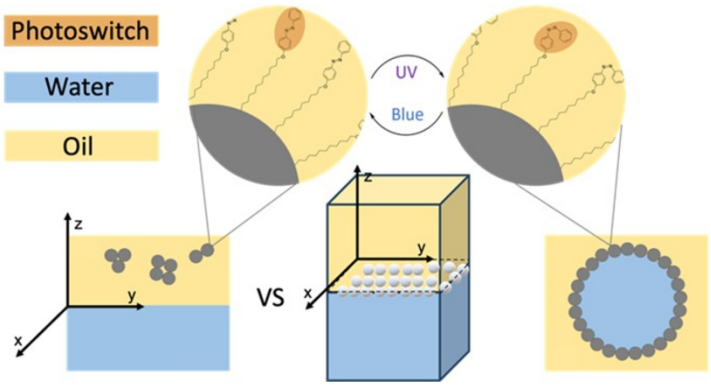

Figure 1: Light-induced changes in particle wettability at the oil/water interface.

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