Steady-state droplet size in Pickering emulsions

Jeroen S. van Duijneveldt[1*], William J. Ganley[1]

[1]*School of Chemistry, Cantock's Close, Bristol BS8 1TS, UK*

**J.S. van-Duijneveldt@bristol.ac.uk*

Clay platelets have the potential to be very effective Pickering emulsion stabilisers due to their large surface area. By optimising the surface chemistry using surfactants, well-stabilised emulsions were indeed obtained, but the final droplet sizes were an order of magnitude larger than theoretically possible [1]. We seek to understand this observation here.

Emulsions were prepared of hexadecane in water, stabilised by montmorillonite platelets and using high shear mixing, as a function of both clay and oil concentrations [2]. Droplet size distributions were obtained using optical microscopy and image analysis.

Emulsions were made with oil volume fractions ranging from 0.1 to 0.5, and clay platelet volume fractions from 0.001 to 0.01. The droplet sizes were found to reach a steady, minimum value after up to 10 min of mixing, with the final size decreasing with increasing clay concentration, and a lowest droplet diameter around 10 μm.

Whilst the stability of such particle stabilised emulsions arises from the large adsorption energy of the particles at the oil-water interface (of order 10^5 kT), we argue that the results indicate platelets reach a steady-state between adsorption and desorption during the mixing process. A kinetic model is constructed that reproduces experimental observations well, and allows us to make predictions of optimal conditions for Pickering emulsion formulation.

Figure Differential interference contrast micrograph of oil-in-water emulsion

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[2] W.J. Ganley and J.S. van Duijneveldt, *submitted.*