

Characterization of Water-in-Water Emulsions Stabilized by Slightly Hydrophobic Silica Particles

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Water-in-water (w/w) emulsions are colloidal dispersions made of two immiscible aqueous phases at thermodynamic equilibrium. [1] These emulsions form when two water-soluble molecules are incompatible in solution, such as polymer mixtures [2], and electrolyte/polymer mixtures (due to the salting-out effect). However, stabilizing w/w emulsions is particularly challenging due to their extremely low interfacial tension, especially near the critical point. As soon as stirring stops, and if no mechanism prevents flocculation and coalescence, the system quickly separates into two phases.

Unlike water/oil (w/o) emulsions, w/w emulsions have a poorly defined and generally thicker interface between the two aqueous solutions. [3] This prevents small hydrophilic molecules, such as surfactants, from adsorbing at the interface and stabilizing the system. To address this, one effective approach is the use of solid particles to block coalescence, leading to the formation of water-in-water Pickering emulsions, which we study in this work. Indeed, the formulation of stable water-in-water emulsions could open the way to new applications in green chemistry.

A preliminary study performed in our laboratory highlighted the interest of using slightly hydrophobic fumed silica to stabilize several types of w/w emulsions. Expanding on these findings, the present study focuses on the results obtained from the characterization of water-in-water emulsions formulated using a polymer system (polyethylene glycol, PEG) combined with an electrolyte (MgSO₄), with partially hydrophobic fumed silica (Aerosil R816) serving as the emulsifier. Key parameters, such as the compositions and the volume fractions of the two equilibrated phases, were investigated. The volume fractions were varied between 20% and 80%. Different methods for introducing the solid particles were also explored, either by directly adding them to the two separated phases or by pre-dispersing them in one phase before incorporating the second phase. The resulting emulsions were analyzed through optical microscopy, and the continuous and dispersed phases were identified using a trace amount of fluorescein isothiocyanate- functionalized mPEG. Moreover, some contact angles of a drop of salt-rich phase into the PEG-rich phase were also measured on a pellet of fumed silica particles. The final objective is to be able to formulate stable emulsions that could be used in catalytic applications.

Références : ¹Esquena J. Water-in-water (W/W) emulsions, *Current Opinion in Colloid & Interface Science*, 2016, **25**, 109-119.

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