CONCENTRATED SILICONE EMULSIONS: HOW TO PREDICT THEIR SHELF LIFE?

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Silicones represent a class of organic-inorganic polymers based on silicon that exist in a variety of forms[1]. For more than 70 years, they have been applied in many industries and have expanded in a diverse assortment of product types and applications. Due to their unusual surface properties, their resistance to the effects of weather and their ability to perform over a wide temperature range, silicones find many uses in the 21st century.
In addition to their unique features as pure materials, silicones often need to be formulated and delivered in an aqueous emulsion format[2]. It provides a convenient means for handling highly viscous substances, solvent free while being easy to clean. This product form is present in a range of key markets including: Personal care, Coatings, Textiles, Paper coating, Antifoam, Construction, etc

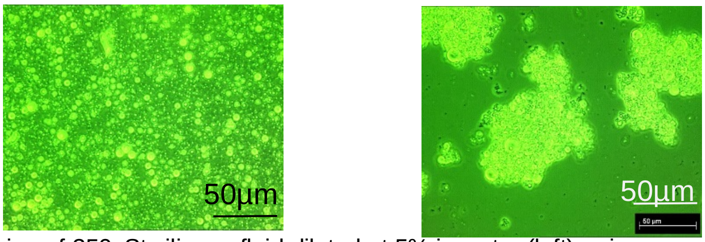

Figure: Coarse emulsion of 350cSt silicone fluid diluted at 5% in water (left) or in an excess of surfactant (right). An excess of surfactant induces the emulsion to flocculate through depletion.

While designing a silicone emulsion to perform in a final product application is challenging, its stability[3] over time is critical too. Creaming, freeze thaw, stability at high temperature, shear stability and electrolyte stability are some examples of hurdles that can be encountered by the product during its shelf life.
In this work, we will show that detection and prediction of the stability of concentrated emulsions are challenging and sometimes misleading. Indeed, these systems tend to gel in the presence of an excess of surfactant and depending on the sample volume, phase separation can occur. Multiple light scattering technique (Turbiscan) may not be able detect this gelation process besides, the phase separation being volume dependent, may not occur in 20mL measurement cells. However, Diffusion Wave Spectroscopy (DWS) based microrheology (Rheolaser Master), is a powerful tool to study weak gelation phenomena in concentrated emulsions, which is a precursor of phase separation. Thus, the combination of multiple light scattering and microrheology can overcome some of the issues faced to when working with concentrated systems.

References

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2. “Silicone Dispersion” Edited by Yihan Liu; Surfactant Science Series.
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