EXTREME EMULSIFICATION: HIGH-THROUGHPUT PRODUCTION OF NANOSCALE DROPLETS

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We have systematically investigated the high-throughput production of “nanoemulsions”, droplets of one liquid phase in another immiscible liquid phase that have diameters less than 100 nm [1]. By systematically controlling the emulsion’s composition and the history of extreme shear, we explore the limits of emulsification by rupturing droplets toward the molecular scale. We obtain bulk quantities of nanoscale droplets by repeatedly shearing a silicone oil-in-water emulsion stabilized by sodium dodecylsulfate (SDS) in an inhomogeneous extensional shear flow that is created by a high-pressure microfluidic device. Using dynamic light scattering, we study the changes in the droplet size distribution as a function of the number of passes through the microfluidic device, N, the driving injection pressure, the droplet volume fraction, surfactant concentration, and droplet oil viscosity. At large surfactant concentrations, small droplet viscosities, low droplet volume fractions, and high shear rates, we obtain nanoemulsions having $\langle a \rangle = 10$ nm. For large droplet volume fractions corresponding to jamming, droplets interact with their neighbors strongly in the extreme shear, and we observe phase inversion, rather than a reduction in the droplet size. This provides evidence that droplet coalescence can occur during extreme shear even when a significant excess of a strongly stabilizing surfactant is present.

References

[1] K. Meleson, S. Graves, T.G. Mason, “Formation of Concentrated Nanoemulsions by Extreme Shear”, *Soft Materials* **2**, 109, 2004.

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