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Amphiphilic nanoparticles suppress droplet break-up and increase serial droplet interrogation rate. MINKYU KIM, YA GAI, MING PAN, SINDY K. Y. TANG, Mechanical Engineering, Stanford University — We describe the break-up behavior of a concentrated emulsion comprising drops stabilized by amphiphilic silica nanoparticles ('NPs') flowing in a tapered microchannel. Such channel geometry is commonly used in droplet serial interrogation and assay. We focus on concentrated emulsions as they often form after the droplet incubation. Unlike solid wells in their multi-well plate counterpart, drops are prone to interfacial instability. Droplet break-up ruins assay accuracy. The rate at which break-up occurs sets the limit for assay throughput. Previously, we have studied the break-up of surfactant-stabilized drops in a concentrated emulsion. The key motivation for replacing surfactants with NPs is that NPs can mitigate inter-drop transport of small molecules. Our results show replacing surfactant with NPs as droplet stabilizers has an additional advantage of reducing droplet break-up, thereby increasing the droplet interrogation rate. Such result can be attributed to the increased interfacial viscoelasticity. We examine the effect of channel confinement, viscosity ratio, and size of NPs on the break-up behavior of drops. We find the break-up is dependent on confinement and size of NPs, while insensitive to viscosity ratio within the tested range. Our results have immediate practical use in increasing the throughput limit of droplet-based applications such as serial assay and interrogation.

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