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Formation of Heterogeneous Toroidal-Spiral Particles – by Drop Sedimentation and Interaction[1] YING LIU, LUDWIG NITSCHE, RICHARD GEMEINHART, VISHAL SHARMA, MAGDALENA SZYMUSIAK, HAO SHEN, University of Illinois at Chicago — We describe self-assembly of polymeric particles, whereby competitive kinetics of viscous sedimentation, diffusion, and cross-linking yield a controllable toroidal-spiral (TS) structure. Precursor polymeric droplets are splashed through the surface of a less dense, miscible solution, after which viscous forces entrain the surrounding bulk solution into the sedimenting polymer drop to form TS channels. The intricate structure forms because low interfacial tension between the two miscible solutions is dominated by viscous forces. The biocompatible polymer, poly(ethylene glycol) diacrylate (PEG-DA), is used to demonstrate the solidification of the TS shapes at various configurational stages by UV-triggered cross-linking. The dimensions of the channels are controlled by Weber number during impact on the surface, and Reynolds number and viscosity ratio during subsequent sedimentation. Within the critical separation distance, interaction of multiple drops generates similar structure with more flexibility. Furthermore, the understanding of multiple drop interaction is essential for mass production of TS particles by using parallel and sequential arrays of drops.

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