Segregation of Suspensions in Microscale In-Line Mixers

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Abstract

We investigate the mixing and segregation of mono- and bi-dispersed microsphere suspensions in microchannel flows. Suspension transport in pressure driven flows is significantly hindered by shear-induced migration, where particles migrate away from the walls and are focused in the center due to multibody hydrodynamic interactions. The microchannels used in this study have geometries that induce chaotic advection in Newtonian fluids. Due to this complex interplay of advection and shear-induced migration, chaotic mixing introduced by staggered herringbone channel is not always effective for dispersing particles. We directly image the suspension using dynamic confocal laser scanning microscopy (CLSM) to resolve the local concentration of the suspension across the microchannel. Our results show that mixing in herringbone (HB) and staggered herringbone (SHB) channels (Stroock et al., Science, 2002) depends strongly on volume fraction. Chaotic advection in SHB channels enhance mixing at low bulk volume fraction while HB channels enhance dispersion at higher bulk volume fraction. It is shown that at moderate volume fractions the addition of smaller particles strengthens the shear-induced migration of larger particles in these geometries. In addition, we will describe recently developed techniques using CLSM to identify the local structure of the suspension and characterize the structural anisotropy of sheared suspensions that leads to migration in these flows.

keywords: suspensions, flow, chaos, chaotic mixing, non-Newtonian, shear migration, normal stresses, microscale, MEMS

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