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Oscillatory shear of suspensions of noncolloidal particles

JONATHAN BRICKER, JASON BUTLER, University of Florida — Noncolloidal suspensions undergoing unsteady shear flow present unique behavior not observed under steady shear conditions. To understand the dynamics of suspensions in unsteady shear flow, the rheological behavior under oscillatory flow conditions was studied using experiments and simulations. Experiments were performed to evaluate the stress as a function of the total strain. The rheology has a strong dependence on the applied strain amplitude. The complex viscosity decreased with total strain for high strain amplitudes and increased for low strain amplitudes. The transition point at which the qualitative behavior changed occurred at an amplitude-to-gap ratio between 0.1 and 0.5. The observed results were independent of the shear cell geometry, suggesting that shear-induced particle migration was unimportant and that the observed behavior was instead due to changes in the suspension microstructure. To investigate the microstructure at various strain amplitudes, Stokesian dynamics simulations of bounded suspensions undergoing oscillatory shear flow were performed. A similar dependence of the shear stress on the applied strain amplitude is observed. To identify the relevant mechanism for the observed behavior, the strain evolution of the pair distribution function was calculated. Although particles remain in close contact for all strain amplitudes, there is a strong dependence of the angular pair distribution function which results in the observed changes in shear stress with applied strain amplitude.

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