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3D Numerical Study of the Shear Rheology of a Semi-dilute Viscoelastic Suspension MENGFEI YANG, SREENATH KRISHNAN, ERIC SHAQFEH, Stanford University — The stress in suspensions of rigid particles in polymer solutions is of considerable interest in applications such as manufacturing processes and fracturing technologies. Deriving an analytic expression for the material functions of a viscoelastic suspension under shear is difficult due to the nonlinear particle-fluid and particle-particle interactions, and theoretical studies have been limited to dilute suspensions at low shear Weissenberg number (Wi) or low polymer concentrations. Previously, we performed 3D single-particle simulations and showed that the results agreed well with the existing theories in the appropriate parameter regimes. We found that suspensions in constant-viscosity elastic fluids shear-thicken over a range of Wi and their material properties plateau at higher Wi. However, discrepancies between simulation and existing experimental measurements for volume fractions as low as 2.5% suggested that interparticle hydrodynamic interactions could not be neglected. We now present 3D high fidelity numerical simulations of multiple spheres freely suspended in a sheared viscoelastic fluid using an immersed boundary framework to study the relationship between hydrodynamic interactions, particle structure formation, and the bulk rheology of viscoelastic suspensions. We observe that in a non-shear thinning elastic fluid, particles do not "chain", but their interactions induce additional polymer stresses in the fluid which contribute to a stronger particle effect than predicted in the dilute limit.

Mengfei Yang
Stanford University

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