Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Extensional rheology of a dilute suspension of spheres in a dilute polymer solution[1] ARJUN SHARMA, Graduate Student, Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY, 14853, USA, DONALD KOCH, Professor, Robert Frederick Smith School of Chemical and Biomolecular Engineering, Cornell University, Ithaca, NY 14853, USA — We investigate the steady-state rheology of a dilute suspension of spherical particles in a dilute polymer solution modeled by the FENE-P constitutive relation. This work uses a semi-analytical method based on ensemble averaged equations, a perturbation for small polymer concentration and the generalized reciprocal to determine the polymers' influence on the particle stresslet and the particles' influence on the polymer stress. In the undisturbed flow, polymers undergo a rapid transition from a coiled to almost fully stretched state at a critical Deborah number (ratio of polymer relaxation to flow time scale) of De_c=0.5. The particle-polymer contribution enhances the averaged stress below De_c due to a strong local stretch enhancement in specific regions of the flow. Above De_c, polymers passing around the particle tend to collapse in response to a time history of strain rates which on average are smaller near the particle. These insights are elucidated through a variant of the Finite-time Lyapunov exponent for the Stokes velocity around the sphere. Similar to the undisturbed stress, below De_c we find the particle- polymer contribution to the average stress to be independent of the maximum stretching length (L) and for higher De to scale as L^2 for $L \gg 1$.

[1]NSF grant 1803156

Arjun Sharma
Graduate Student, Sibley School of Mech and Aerospace Eng, Cornell Univ

Date submitted: 05 Aug 2019 Electronic form version 1.4