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The Effect of Different Particle Contacts on Suspension Rheology

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Experiments involving a sphere travelling down an inclined plane in a viscous fluid at low Reynolds numbers have shown that the sphere and plane have irreversible interactions at an apparent contact height that depends on the inclination angle of the plane. In this paper we consider several models of contact roughness, some previously studied, others new in this work, which are capable of reproducing these experimental results. In particular, we consider particles with microscopic asperities causing contact at a fixed nominal separation, particles with microcopic asperities of two different heights, and particles having a thin, soft asperity layer that deforms under compression. We use the Stokesian Dynamics method to simulate the flow of large populations of particles with microscopic surface roughness, and hence investigate numerically the effect of contact on the rheology of a suspension of identical rough spheres in shear. The irreversible contact interactions lead to normal stress differences and also generally lower the suspension viscosity, due to the roughness elements preventing very close approach and lowering viscous lubrication effects.

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