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A particle-based model for yield-stress fluids JAMES J. FENG, S. MAJID HOSSEINI, Department of Chemical and Biological Engineering and Department of Mathematics, University of British Columbia, Vancouver, Canada — For soft materials that exhibit yielding, by far the most popular constitutive model is the Bingham model. Deceptively simple, such yield-stress models introduce a mathematical singularity into the problem, which creates great difficulties for flow simulations. The actual physics of yielding is specific to the microstructure of the material, and differs for gels and colloids, say. But it certainly contains no singularity. Inspired by this observation, we propose a mesoscopic model that represents the microstructures by particles. They interact via a potential force as well as a frictional force. We model the former by simple elastic springs that fail at a maximum forcing, and the latter using ideas from granular materials. The motions of the particles are computed using a procedure similar to smoothed particle hydrodynamics. This model predicts yielding in simple flows that agree with the picture based on a macroscopic yield stress. When applied to complex flows, the yield surface is captured naturally without having to deal with the artificial singularity in Bingham-like models.

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