A finite restructuring-time mesoscopic model for the rheology of soft glasses

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In spite of the extreme diversity of their physical and chemical natures, soft glasses (foams, emulsions, etc.) exhibit striking similarities in their rheology: an elastic response at low stresses, and local rearrangements of particles at larger imposed stresses, followed by stress redistribution in the medium. These key elements have been incorporated into a variety of mesoscopic models. Our minimalistic, but mechanically consistent, model mainly differs from its counterparts in that blocks that have yielded need a finite time to 'restructure'. A mean-field analysis of the model showed that the restructuring time is determinant for the existence of a non-monotonic constitutive curve, a hallmark of shear-banding. Beyond mean-field, the macroscopic heterogeneity of the sample is rendered possible by stress fluctuations. The flow behaviour thus results from a competition between the macroscopically-imposed constraint and the mechanical noise arising from stress redistribution. The latter is associated with flow cooperativity and prevails at low shear rates. We perform numerical simulations of the two-dimensional model in its tensorial version and compare the results to available experimental data for flows in microchannels.