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Rheological properties of suspensions of bubbles in a yield stress fluid LUCIE DUCLOUE, GUILLAUME OVARLEZ, XAVIER CHATEAU, OLIVIER PITOIS, JULIE GOYON, Universite Paris-Est, Laboratoire Navier —
We study the macroscopic response under shear of suspensions of bubbles in yield stress fluids. Model suspensions are prepared by mixing a monodisperse foam with a concentrated oil in water emulsion, both having the same continuous phase of a surfactant solution. The interstitial concentrated emulsion behaves as a solid viscoelastic material below a critical stress, and as a shear-thinning fluid above this yield stress. We measure the change in the macroscopic response (elastic modulus, yield stress, non-linear viscosity) due to the addition of bubbles to the fluid. We find that for a given emulsion, the elastic modulus is a decreasing function of the gas volume fraction ϕ, this decrease being all the sharper as the bubbles are big. We also observe that the yield stress of most studied materials is not modified by the presence of bubbles, whereas the non-linear viscosity during flow increases with ϕ. We show that those apparently contradictory changes in the behaviour are ruled by the deformability of the bubbles in the fluid. To quantify this effect, we introduce capillary numbers which compare the stresses exerted on a bubble during a measurement to the stresses due to surface tension. We thus compute an elastic capillary number in the solid regime, a plastic capillary number at the yield stress and a viscous capillary number during flow. Those numbers are very different in the solid and in the liquid regimes, explaining why the elastic, plastic and viscous properties do not follow the same evolution. Our results are quantitatively well predicted by a micromechanical approach.

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