Rheology of a particle laden soap film

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Particle laden interfaces are ubiquitous in industry (e.g. oil recovery, filtration processes, armored drops used as microreactors, or concrete foams) for which interface stabilization effect have to be controlled. Recent studies [1,2], have shown that mechanical properties of particle-laden films differ from those of single particle laden interface, though the origin of the differences remains unclear. We study experimentally the rheology of a macroscopic particle-laden soap film constituted of slightly polydisperse polystyrene spheres trapped in a single film made of a tetradecyl trimethyl ammonium bromide (TTAB) and glycerol aqueous mixture of the same density as the particles. The particles are larger than the typical film thickness, they cross both interfaces and capillarity gives rise to attractive interactions between the particles. To study the strain-stress relation of such particle laden film, it is stretched in an annular rheometer cell and sheared at imposed velocity, measuring the stress. The strain-stress results are compared with local shear rate measured through image correlation. We show that, at dense particle volume fraction, the granular film exhibits a complex visco-plastic behavior which is largely influenced by interfacial parameters such as surface tension and surface viscosity of the carrying fluid. To account for the non-local rheology of the particle laden soap film, we confront the particle velocity fields to kinetic theory extended to dense granular media [3].

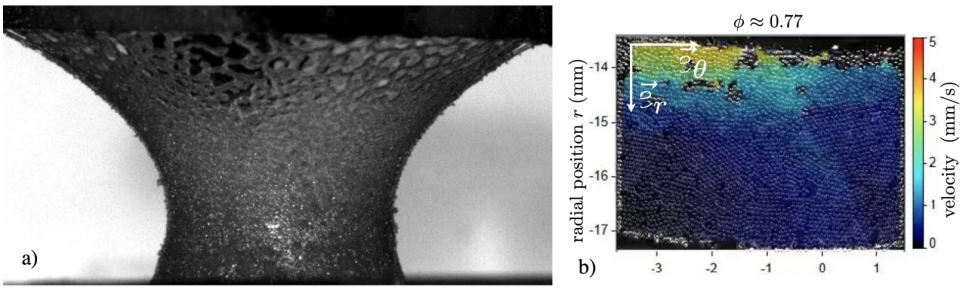

Figure 1. a) Pinch-off of a granular film. b) Velocity field of a granular film stretched in the rheometer cell for an imposed velocity Ω0. Hz using DIC software.

Références

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