

Effects of a non-ionic surfactant admixture on the rheology of dense silica suspensions

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Chemical additives are widely used to tune the behavior of dense colloidal suspensions encountered in various industrial fields such as civil engineering, ceramics or cosmetics. Nevertheless, the mechanism by which admixtures modify inter-particle interactions, and thus the overall rheology, remains obscure. As a result, optimization processes rely essentially on a trial and error strategy.

Understanding the link between inter-particle contacts and the overall rheology requires to work with model systems, especially when chemicals are added. We therefore prepared dense suspensions with well-controlled properties by dispersing silica beads into an aqueous salt solution mixed with a non-ionic surfactant. We experimentally investigated suspension properties from the contact scale to the overall rheology by combining rheometry, total organic carbon, zeta potential, confocal microscopy and optical tweezers experiments.

Our results highlight that the adsorption of surfactant onto silica beads strongly modifies both the contact properties and the microstructure of the suspension, leading to non-monotonic variations in yield stress and elastic shear modulus as a function of the amount of added surfactant.

We propose micro-macro scaling relationships to predict the yield stress and elastic shear modulus of the suspension from the contact properties probed with optical tweezers, as depicted in Fig. 1.

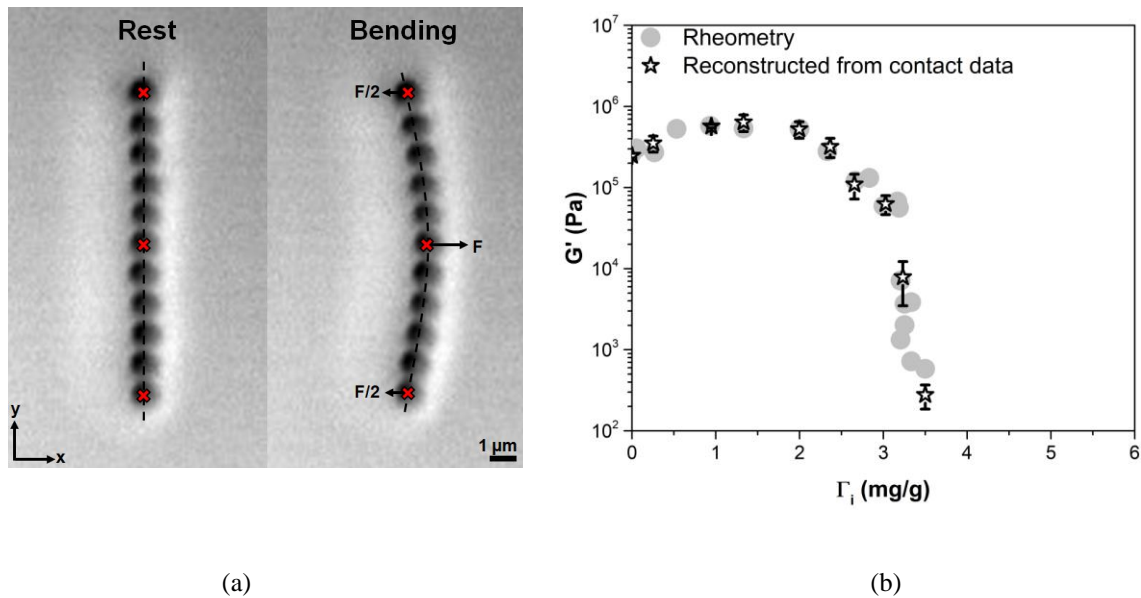


Figure 1: (a) A 3-point bending test on a silica bead rod loaded with optical traps (red crosses) to probe the inter-particle contact properties. (b) Comparison of the elastic shear modulus (G') of dense silica suspensions measured by rheometry (gray symbols) with values calculated from contact data probed with laser tweezers (empty stars) as a function of the surfactant added mass per unit of bead mass (Γ_i) (suspension packing fraction: 45%_v, ionic strength: 0.15 M).