The influence of complex rheology on the spreading of drops

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Understanding the drop spreading behaviour of rheologically complex liquids, like dense granular suspensions or concentrated polymer solutions, is of crucial importance for applications such as inkjet printing, spraying paints or coating. In this presentation, we focus in the correlation between complex rheological behavior, like shear thickening or shear thinning, and the dynamics of drop spreading on hard substrates.

As shear thickening systems, we study the spreading behaviour of suspensions on clean hydrophilic glass surfaces, with increasing particle mass fractions (Φ = 0.3 to 0.65) and varying particle diameter (d = 10 to 20 µm), chemistry and morphology. Depending on the particle mass fraction, being close or not to the jamming transition of the suspension, two outcomes were observed: the spreading curve either exhibited a spreading behaviour qualitatively similar to the one of the Newtonian carrier liquid, with two spreading regimes or a spreading behaviour diverging from the reference, with three spreading regimes and an increase in spreading rate in-between two, see Fig. 1. The different spreading behavior strongly correlates with an increasing shear thickening of the suspensions. The correlation between rheological behavior and spreading dynamics is general for all investigates particle types.

The study is complemented by spreading experiments of shear thinning concentrated polymer solutions. These polymer solutions exhibit also strong correlation of the spreading dynamics with the rheological properties of the solutions, like the shear rate at the end of the Newtonian plateau or the exponent in an assumed power law model.

In both cases, we relate the observed correlations between rheological behaviour and spreading dynamics of drops to the dissipative mechanisms close to the moving contact line of the drop.

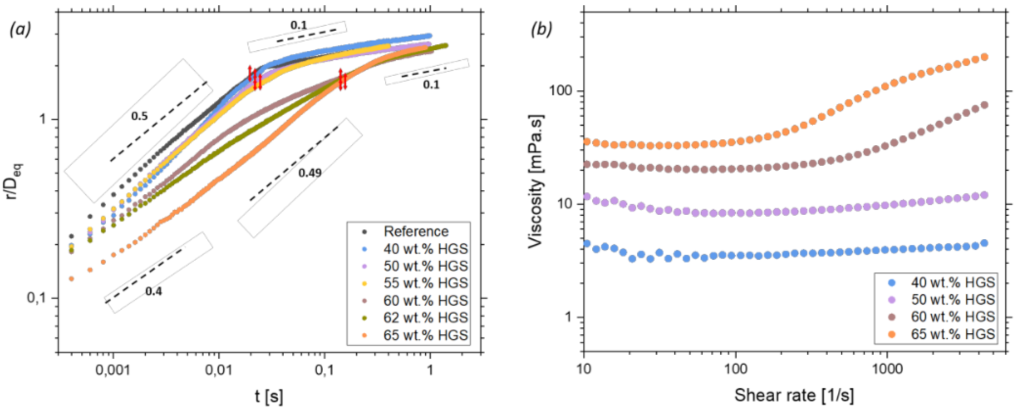

Figure 1: (a) Time evolution of the spreading radius for drops of aqueous suspensions with increasing particle mass fractions, (b) Flow curves of selected wt.% same suspensions.