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SOFTMAT

Simplifying industrial dispersions

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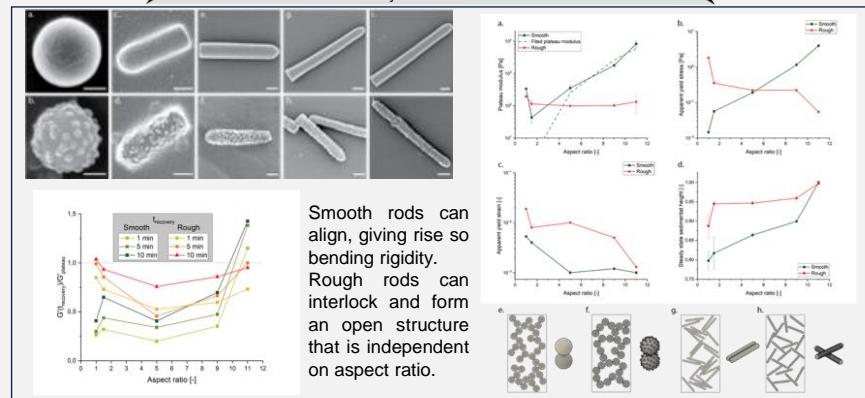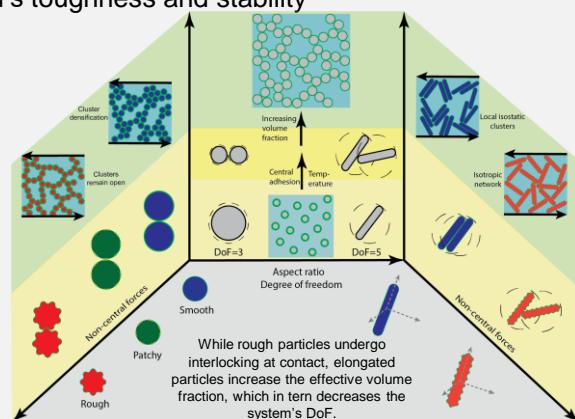## 1. Introduction

|		
Design and characterize model system with new design handles, tailoring the shape and surface roughness	Develop advanced characterization methods encompassing both macroscale and microscale analyses	Benchmark model systems against simplified representations of relevant industrial formulations

2. Particle interaction as design parameters

- Decreasing the system's degrees of freedom (DoF) enhances material's toughness and stability

While rough particles undergo interlocking at contact, elongated particles increase the effective volume fraction, which in tern decreases the system's DoF.

Smooth rods can align, giving rise so bending rigidity. Rough rods can interlock and form an open structure that is independent on aspect ratio.

- Microscopic methods to indagate interaction between particles: both single particle and local multiparticle interactions

Investigating multiparticle interactions with optical tweezers: Silica particles are assembled into linear aggregates. Bending tests on these structures reveal the **backbone stiffness** of cluster-cluster connections in the gel

Central forces   Sliding   Rolling   Twisting

Polymer brushes mediated interaction
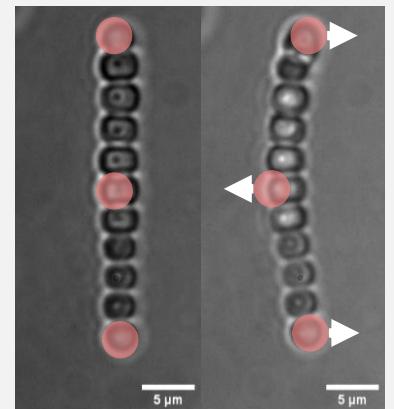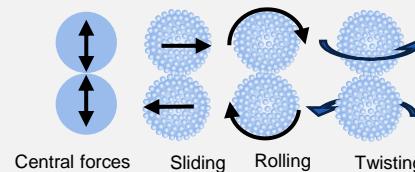
Deformation of linear chain of 2 μm silica via optical trapping
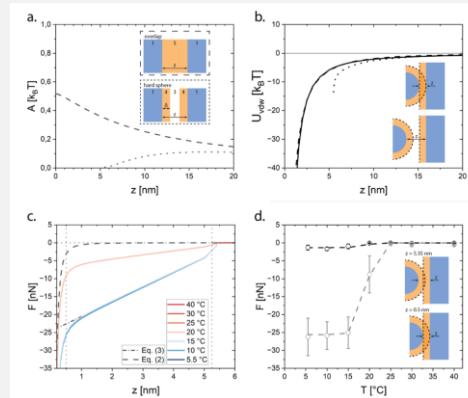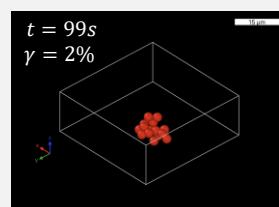
Measuring interparticle forces with AFM: Investigating central (adhesive) and non-central (frictional) forces

a. Hamaker functions
b. VDw forces between sphere and wall
c. Force curves
d. Model versus calculations (approach/sep)

4. Microstructural evolution and plastic event detection

$t = 99s$
$\gamma = 2\%$

Our **ultrafast rheo-confocal setup** allows us to capture the live evolution of the colloidal gel microstructure under shear while measuring its effects on rheological properties.
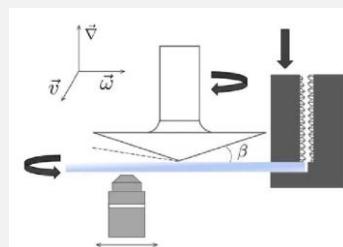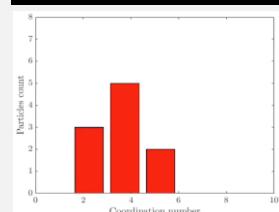
A compaction into a **more stable structure** can be seen by tracking the particles in the rearrangement during flow reversal.
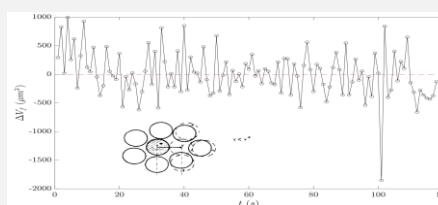
5. Simple model for yield-stress materials
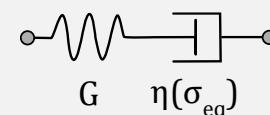
$$\sigma_{12} = G\gamma_e$$
$$\dot{\gamma}_e = \dot{\gamma} - \dot{\gamma}_p$$
$$\sigma_{eq} = |\sigma_{12}|$$
$$\dot{\gamma}_p = \frac{\sigma_{12}}{\eta(\sigma_{eq})}$$
$$\eta(\sigma_{eq}) = \eta_0 a_\sigma(\sigma_{eq})$$

Stress-activated Maxwell model

$$G \quad \eta(\sigma_{eq})$$

Simplest material model for elasto-visco-plastic materials. The elastic stress is dissipated by an as-hoc plastic viscosity, retrieved by the description of non-linear behaviour. It can predict complex dynamic, as LAOS, for yield-stress material in a smoother way that classic model , e.g. three-component-model (TCC).
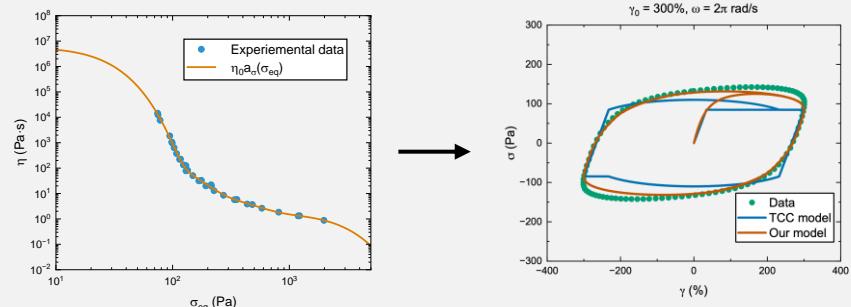
Conclusions and further work:

- Detailed microstructural studies on rough systems
- Opto-mechanical characterization of sheared structures

- Simple constitutive model that is able to predict complex deformation
- Micro-scale probing of single particles or clusters and targeted deformation modes