IFPRI Project Abstract

Simplified Industrial Systems – part 2

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Project Objective:

Investigating how particle characteristics, which lead to non-central forces, impact the rheological and gravitational properties of colloidal gels. Then to study on model systems, what controls the yielding transition. This requires us to use some more advanced rheological methods which we will be using on simplified industrial systems. Additionally we pursue imaging and micromechanical studies on model gels using AFM and optical tweezers

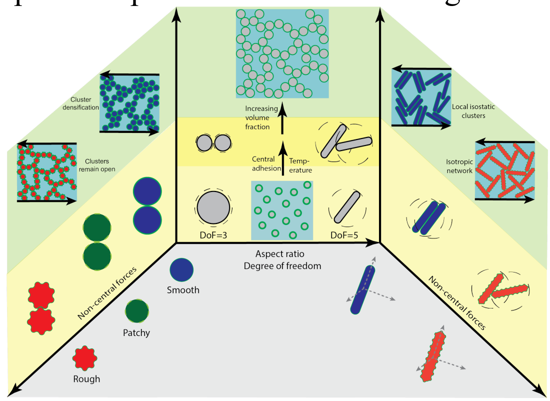
Approach:

- Experimental approaches : bottom up – novel systems (shape, roughness, patchiness). Rheological methods (creep/recovery, superposition rheology, high frequency and compression rheology).
- Conceptual : the yielding in colloidal suspensions as a stress activated flow.
- Microscale measurements of the local forces : colloidal probe AFM and optical tweezers.

Recent Results:

1. he experiments exploring the "conceptual toolbox"—how the properties of building blocks influence gel rheology—have been completed. Several manuscripts have already been published or are in preparation, including:;
    a. Langmuir : https://pubs.acs.org/doi/full/10.1021/acs.langmuir.4c03602 on the measurements of non central forces
    b. JCIShttps://www.sciencedirect.com/science/article/pii/S0021979725006587 on the synergistec effects of shape and roughness of particles
    c. Publication on the miodelling of the adhesion (preprint available)
    d. Publication on the instable flow in colloidal gels (preprint available)

A graphical depiction of the toolbox is given below.



2. A simple model for yielding—the elastoplastic transition—has been developed based on the concept of stress-activated flow. This framework has been extended to a tensorial form to capture compression, shear, and sedimentation. The model has been tested using large amplitude oscillatory shear (LAOS) experiments, and further modeling work on sedimentation is currently underway.
3. To understand the link with local scale dynamics we performed high speed confocal rheometry of systems near the yielding transition. A first paper, more showing the potential of the technique has been published https://pubs.acs.org/doi/10.1021/acs.iecr.4c03873. Further work has been focused on getting a stress activation function from the optical observations. Optical tweezer measurements are underway.

Next Steps:

Ongoing work focuses on completing the modeling framework and applying it to more complex, industrially relevant dispersions. This includes quantifying local-scale rearrangements to elucidate the pronounced impact of non-central forces on rheology.
