IFPRI Project Abstract

Syneresis of Colloidal Dispersions

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Project Objective:

The shelf-life of colloidal gel products is often limited by syneresis, where the gel structure remains largely intact but shrinks and contracts expelling a small volume fraction of a dilute particle phase. It is clear that the nature of the interparticle contacts and their evolution, or aging, under different environmental conditions, plays a central role in this phenomenon, however there is still limited understanding of the variables controlling the extent and the rate of the gel shrinkage. A key unknown is how changes in the particle contacts, and in the forces acting on them, translate into stress redistribution triggering changes in the gel structures at larger scales.

Approach:

We address these questions using computer simulations of particle based numerical model, to disentangle the dynamical processes at the particle-level (single bond-breaking or forming) and the large-scale reorganization at level of the network structure (gel shrinkage).

Recent Results:

We have identified a set of computational models for colloidal gels where gelation leads to different internal stresses. We have performed computer simulations to generate gel configurations in the different models and quantified the local stresses, obtained from the particle interactions in the gel structure, once mechanical equilibrium is attained. The monthly meetings with industry IFPRI members have helped clarify the model parameters that can be related to various systems of interest, the relevant volume fractions, and how the simplifying assumptions made in the models and in the computational approach can be transferred to real systems of interest. In addition to already studied models where the colloidal contacts are described in terms of strength and bending stiffness, we have focused on models that include particle cohesion, frictional effects due to surface roughness, and adhesion. We have discussed potential synergies and interactions with other IFPRI projects.

Next Steps:

We are developing new computational tests to characterize the tendency of the different model gels to shrink, depending on the internal stresses obtained through different preparation protocols. We will use these tests also to analyze, in space and time, the microscopic rearrangements associated to the gel shrinking. We are also designing new simulations where the gels are confined between walls and wall-gel interactions can be tuned, to explore their impact on the microscopic dynamics leading to shrinkage and the gel tendency to shrink. We will explore multi-component systems.