IFPRI Project Abstract

Accelerated acoustic prediction of aging and failure

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Project Objective:

This project will develop an acoustic platform to accelerate aging in wet systems. The method works by increasing the activity of particles through pulses of high frequency ultrasound, which increases the rate of collision and thus kinetic destabilization. The PI will test this method on different kinds of formulations that best represent the technological interests of the IFPRI member base.

Approach:

A few model systems will be developed for testing with the acoustic platform, including oil/water emulsions and solid dispersions in liquid. Changes in the system will be tracked over time using visual inspection, rheometry, and confocal microscopy. For heat sensitive materials, the microstructure and rheology will also be tracked as a function of temperature. The acoustic pressure will be optimized based on destabilization kinetics.

Recent Results:

A low-power acoustic platform that applies acoustic pressures in the range of 1-1000 Pa has been developed. Aging acceleration has been demonstrated using this platform on oil/water nanoemulsions and a commercial agrochemical dispersion. In the agrochemical system, the rheology and microstructure of samples subjected to low power acoustics showed similarities to that of ones that were naturally aged. However, high power acoustic led to some internal yielding which then led to a weaker structure at high stresses. In the nanoemulsion system, droplet sizes displayed a delayed two-step growth kinetics regardless of the aging methodology, but the growth seen in the second step was substantially higher and faster with heat or acoustic aging. Furthermore, there was an intermediate acoustic pressure where the droplet growth rate was the greatest. This could be due to a resonant perturbation stress on the order of the Brownian stress that led to the maximum number of interdroplet collisions.

Next Steps:

The team will continue development of the second academic model system, a colloidal depletion gel, due to its unique compatibility with single particle visualization techniques. This system will be subjected to acoustic aging to determine if certain particles are responsible for accelerated aging and failure. Acoustic setups for in situ confocal microscopy and rheometry will be constructed. Destabilization kinetics will be superimposed on one another to determine if there is a correlation between the accelerated kinetics with the real-time aging data. Finally, efforts will be directed at understanding how acoustic waves target specific destabilization mechanisms such as coalescence.
