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Session: Ingredients

Drying of waterborne colloidal particles: relevance to food

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There are numerous examples of natural colloids in foods. For instance, in dairy products, casein micelles (<200 nm diameter), beta-lactoglobulin nanofibres, and butterfat droplets are suspended in water. During soluble coffee processing, insoluble nanoparticles are suspended in coffee extracts and cause fouling in industrial evaporators, increasing operating costs.

Although progress has been made in understanding the *equilibrium* state of colloidal foodstuffs, far less is understood about *non-equilibrium* processes, such as evaporation. Both the creaming of milk fat and the fouling of surfaces by coffee particulates are affected by water evaporation.

In this presentation, insights from studies of the drying of coatings of waterborne colloidal polymer particles will be shared. The distribution of nanoparticles in a wet colloidal film in the direction perpendicular to a substrate is determined by the relative rates of evaporation, Brownian diffusion, and sedimentation (or creaming). As the top surface drops downward during the evaporation of the continuous phase, slow-diffusing larger particles accumulate near that interface. Using a combination of experiments and Langevin dynamics simulations, we have discovered when drying blends of colloidal particles with two different sizes, that a layer of small particles assembles near the top. Small particles create an osmotic pressure that pushes the large particles away from the descending interface. When the sizes of the particles are increased by adjusting the pH to extend hydrophilic stabilising molecules, the higher viscosity and particle jamming suppress the stratification phenomenon. This mechanism of self-stratification provides opportunities to address problems of creaming, fouling and food coatings.