Nanoparticles in thin films

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Structural forces are a well known phenomenon in surface science. They arise due to the layering of particles in the vicinity of a confining wall. The layered structure has an oscillatory density profile in normal direction. Overlap with a second interfacial region results in an attractive or repulsive force acting on the surfaces, depending on the separation of the walls. These forces can be fitted via following formula: $f(x)=-A*e^{(-x/\xi)}*\cos(2\pi(x-\Delta x)/\lambda)$, where f is the force, x is the separation between the walls, A is the amplitude of the oscillations, ξ is the decay length, λ signifies the wavelength of the oscillation and Δx is the phase shift. This common fit formula can be extended by introducing an additional term of exponential decaying nature. The additional term is able to describe deviations between the common fit and data measured for aqueous suspensions of silica nanoparticles, especially at small wall to wall separations and larger concentrations. Furthermore, it is shown that neglecting this term leads to an oscillatory behaviour depending on the starting point of the fit region of the three important fit parameters: amplitude, wavelength and decay-length. The extension enables a large increase of the data range accessible for accurate fitting, especially towards small separation and leads to the removal of the oscillatory behaviour of the fit parameters. Therefore, resulting in a strong increase of accuracy for all fit parameter in the system studied here.

Silica nanoparticles can become effective foam stabilizers when they are partially hydrophobized. Foams were prepared from dispersions of silica nanoparticles with different degrees of hydrophobic modification by a short chain amine. The samples show strong synergistic effects in terms of foamability and foam stability compared to solutions that contain the hydrophobic amine or unmodified silica particles only. The systems were characterized at various length scales from the nanometer to the centimeter scale. We determine the contact angle of the nanoparticles at the air water interface via x-ray reflectivity. With increasing hydrophobicity, the nanoparticles form a colloidal network around the air bubbles, whereby the apparent fractal dimension of the network shows a strong effect on foamability and foam structure.