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Bulk aggregation versus surface adsorption of silica

Surface coatings are used in many applications. Examples are coating walls with paint, coating rain coats for water resistance, adding a layer to prevent corrosion or making a surface electrically conductive. For most coatings a smooth, homogeneous, tight packed layer is desirable. Adding particles for a coating from a dispersion gives the ability to control the rate of adsorption by changing for example the temperature. This could give control of the compactness of the surface coverage. This research focusses on bulk aggregation versus surface adsorption of silica particles on a glass surface.

The system used contained industrial Ludox silica particles and flat silica surfaces. The attractive force between the particles and between a particle and the surface was induced by adding a polyelectrolyte to induce a depletion flocculation. The main systems studied were mixtures of LudoxTM particles with sodium poly acrylate.

Bulk aggregation

Aggregation in the bulk was followed by determining phase behavior by visual inspection and by measuring dynamic light scattering (DLS). For LudoxTM and sodium poly-acrylate mixtures, above a certain polymer concentration the mixtures showed a liquid-liquid phase separation. Below this 'phase boundary' the mixtures were transparent which indicates that there was no phase separation. DLS measurements confirmed that below the phase boundary no aggregates were formed.

Surface adsorption

Adsorption of the LudoxTM particles onto a glass surface was followed by ellipsometry. A certain polymer concentration was necessary to get the particles to adsorb at the surface. This polymer concentration was lower than the concentration needed for bulk aggregation. For different polymer concentrations where surface adsorption took place but no bulk aggregation occurred, the thickness and adsorbed amount were measured using ellipsometry. The results at 6000 seconds after starting the measurement are shown in figure 1.

What this results show is the more polymer added, the more surface adsorption. Besides, there is a certain polymer concentration needed before adsorption occurs, because the depletion attraction has to dominate over the electrostatic repulsion. In addition, an increase in the concentration of silica particles also caused an increase in surface adsorption.

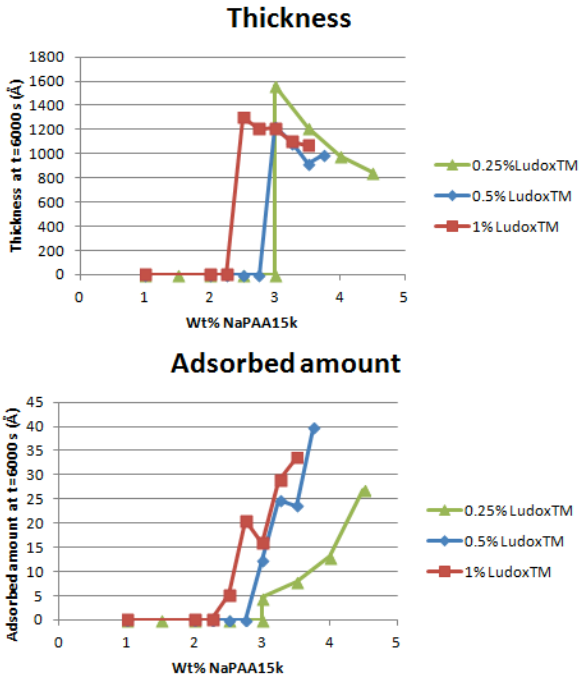

Figure 1: thickness and adsorbed amount of a layer of LudoxTM particles as function of polymer concentration (wt% NaPAA15k) at t = 6000 s.

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