Controlling the Aggregation of Particles
to Tune Materials Properties

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Colloids and polymeric systems constitute building blocks of choice for designing and controlling material properties. One major parameter is therefore the aggregation state of the polymer/particles complexes and its control to achieve desired properties. In this presentation, two examples will be given to illustrate this principle.

The first example relates to paper surface hydrophobation, often referred to as surface sizing, where typically a combination of stabilized hydrophobic nanoparticles and an excess of starch is applied on the paper web in the paper making process. This study focused on the combination of the surface sizing particles of different charges (cationic, anionic and amphoteric) and anionic starch. The mixtures were investigated by turbidity, light scattering and SAXS measurements. While amphoteric and anionic particles were not affected by the starch addition, cationic particles aggregated strongly at low starch concentration. At higher starch concentration the stability was restored. We could correlate this behavior with the higher efficiency of the cationic particles in the hydrophobation of the paper surface compared to the amphoteric and the anionic particles. The effect of the size of the aggregate in the hydrophobation efficiency will also be discussed.

The second example deals with a strategy developed to prepare polyelectrolyte multilayers/silica complexes at high concentration to use them as reinforcing agent for degraded cotton fibers. It is well known that adsorption of polyelectrolytes on oppositely charged particles usually leads to uncontrolled flocculation. The strategy capitalizes on the tuning of the charge density by the pH which allows a controlled the build-up process, reaching final particle concentration higher than 5wt%. The complexes were characterized by particles charge density titration, zeta potential and dynamic light scattering measurements. The formulations were then applied on model surfaces of degraded cotton canvas by spraying. We believe that the formulations based on spherical silica nanoparticles in combination with a polyelectrolyte are ideally suited for restoration of degraded painting canvas. While polyelectrolytes provide compatibility improvement and mechanical strengthening, the alkaline silica nanoparticles can be used both as a filler and as a deacidification agent. The cotton samples were characterized by scanning electron microscopy and by assessment of tensile strength, before and after treatment. The best formulations resulted in excellent strengthening of model cotton material.