pH-controlled assembly of nanoparticle-polyelectrolyte complexes and their application to modern art restoration

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Adsorption of polyelectrolytes on oppositely charged particles usually leads to flocculation due to bridging or charge neutralization [1]. Since the main driving force for adsorption is of electrostatic nature, the interactions between particles and polymer can be tuned by changes in ionic strength or pH. Under certain conditions, it is possible to adsorb a polyelectrolyte on the surface of oppositely charged particles and form stable complexes [2]. We here present a study regarding preparation and colloidal stability of particle-polyelectrolyte complexes using concentrated silica sols and different polyelectrolytes, using pH as a means for controlling the build-up process. By carefully controlling the pH, the charge density and the structure of the polyelectrolytes, we have been able to weaken, stop or even reverse flocculation, leading to the construction of several layers on silica particles at concentrations above 5 wt%. The complexes were characterized by particles charge density, zeta potential and dynamic light scattering measurements. Investigation of the colloidal stability of the systems allowed us to understand the balance of the forces involved in the formation of the complexes, as well as to find the optimum composition of the complexes. Furthermore, we applied the formulations 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.

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