Time dependent aggregation behaviour of TiO_2 nanoparticles in the presence of organic molecules

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Titanium dioxide (TiO_2) is one of the most used metal oxide nanoparticles due to its special properties. Nanomaterials are used in a wide variety of applications and their use has increased over the recent years, which leads to an increased amount of synthetic nanoparticles released into the environment. However, the fate and behavior of synthetic nanoparticles in the environment are not well-known. Nanoparticles generally have higher reactivity than larger particles of the same material, and this might influence the surface charging and aggregation behavior. Further, nanoparticles can interact with natural organic matter (NOM), such as humic and fulvic acids. Adsorption of NOM affects the surface speciation and net charge of the nanoparticles and is therefore of great importance for their colloidal stability.

The objective of the present study was to investigate the aggregation behavior of synthetic TiO_2 nanoparticles in aqueous solution as a function of time in the presence of organic molecules. Synthesized and well-characterized TiO_2 (anatase) nanoparticles were used as test nanoparticles and selected phenolic carboxylic compounds were used as model substances to mimic the interactions of nanoparticles with NOM. In addition, a standardized fulvic acid was used in order to further mimic natural conditions. The aggregation and surface charging of the particles were studied by simultaneously monitoring the changes in particle size and zeta potential during the reactions using time-resolved DLS. Also, a time study was performed in order to observe potential changes in surface charge and size over a time period of several months. Result show that both the type and the position of functional groups on the organic molecules affect the aggregation behaviour of the particles. Since the environment is very dynamic, a study over a long period of time period is of great importance for understanding the fate and potential risk of nanoparticles in the natural environment.