Influence of organic molecules on the aggregation of TiO_2 nanoparticles

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Nanotechnology is a rapidly growing industry, which leads to an increased amount of engineered nanoparticles (ENPs) released into the environment. Titanium dioxide (TiO_2) is one of the most used metal oxide nanoparticles due to its special properties. However, the fate and behavior of ENPs 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, Suwannee River Fulvic Acid (SRFA) was used in order to further mimic natural conditions. Aggregation and surface charging of the TiO_2 nanoparticles were studied by simultaneously monitoring the changes in particle size and zeta potential during the reactions using dynamic light scattering (DLS), and high-resolution transmission electron microscopy (HRTEM). Results show that the aggregation rates and zeta potential were dependent on concentration and molecular structure of the organic molecule, as well as pH in the solution.