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HETEROAGGREGATION OF TITANIUM DIOXIDE NANOPARTICLES WITH SUSPENDED PARTICULATE AND NATURAL ORGANIC MATTER ANALOGUES

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The fate of engineered nanoparticles (ENPs) in natural aqueous environments is influenced by ENP dispersion/transport and aggregation/deposition related to environmental factors as well as those intrinsic to the nanoparticles themselves. For example, at environmentally relevant concentrations ($\mu\text{g/L}$), TiO_2 ENPs likely have a higher probability of interacting with suspended particulate matter (SPM) and natural organic matter (NOM) present at mg/L to g/L concentrations in natural surface waters, rather than with themselves. With both high specific surface area and reactivity, the SPM and NOM may act as TiO_2 ENP carriers in the water column, strongly affecting their fate and transport via the heteroaggregation process. Herein, previously identified and characterized SPM and NOM compositions of the Rhone River, a major European river, were used to guide the selection of relevant analogues for mechanistic evaluation of TiO_2 ENP fate in surface waters. The TiO_2 ENPs ($\mu\text{g/L}$) were first spiked into synthetic riverine waters containing one of the main SPM analogues (e.g., quartz, calcite, chlorite, feldspar, muscovite). With rapid heteroaggregation and subsequent sedimentation, the TiO_2 ENPs demonstrated a significant affinity for several of the SPM analogues, especially quartz and calcite. In addition to determining the ENP/SPM heteroaggregation kinetics and attachment efficiencies, the influence of NOM on the TiO_2 ENP fate and behaviour was also assessed. Four common families of NOM analogues (i.e., proteins, polyhydroxy aromatics, polysaccharides, and amino sugars) were added to the SPM-containing synthetic waters to evaluate the role of NOM on the TiO_2 ENP compartmentalization. The protein (bovine serum albumin) and polyhydroxy aromatic (Suwannee River humic acid) analogues, followed by the amino sugar (*N*-acetyl-D-glucosamine) had the strongest stabilising effects on the system, while enhanced aggregation was observed in the presence of the polysaccharide (YAS 34). Together, these mechanistic data, coupled to a river-scale fate model, will aid in ranking potential TiO_2 ENP fate scenarios and assessing their risk within natural aqueous environments. This work was funded by the French National Research Agency and the Swiss FOEN as NANOHETER under the frame of SIINN. <http://nanoheter.cerege.fr>

Heteroaggregation of titanium dioxide nanoparticles with suspended particulate matter analogues

