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Evaluation of titanium dioxide nanoparticle fate and heteroaggregation in natural surface waters

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As development of engineered nanoparticles (ENPs) continues to progress, determination of ENP fate and impact on the natural environment remains challenging, and new strategies utilizing environmentally relevant system compositions and ENP concentrations (i.e., µg/L range) are warranted. Herein, we evaluated the fate of titanium dioxide (TiO2) ENPs in surface waters from a river (Rhône river, France) rich in mineral suspended particulate matter (SPM) and a lake (Cholet, France) containing high levels of natural organic matter (NOM). The TiO2 ENPs were spiked into these waters and the ENP/natural suspended matter heteroaggregation kinetics and sticking efficiencies were determined. To elucidate the physico-chemical factors driving heteroaggregation, studies were also conducted in synthetic waters of comparable composition. Furthermore, pH, ionic strength, elemental composition, and SPM and NOM contents and compositions were assessed to identify the key contributors to ENP fate. The TiO2 nanoparticles demonstrated a significant affinity for the mineral SPM, with rapid heteroaggregation and subsequent sedimentation of the resulting aggregates. However, heteroaggregation was less evident in the NOM-rich lake water. Together, these holistic data will serve in ranking potential ENP fate scenarios and assessing ENP risk within natural aqueous environments. Funded by the French ANR and the Swiss FOPH under ERA-NET SIINN NANOHETER.

Primary author: SLOMBERG, Danielle (CEREGE)

Co-author: LABILLE, Jérôme (CEREGE)

Presenter: SLOMBERG, Danielle (CEREGE)

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