Aggregation, Transport, and Surface Transformation of Nano-TiO_2 in the Aqueous Environment

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Fate and transport of nanosized titanium dioxide ($nTiO_2$) are not well understood [1,2]. We evaluated: 1) the effect of material properties on the sedimentation and aggregation kinetics of $nTiO_2$[3]; 2) impurity dissolution kinetics and surface transformation of $nTiO_2$[4,5]; and 3) key factors controlling the stability and mobility of $nTiO_2$ in the natural aquatic environment [1, 6]. We used five types of commercially available $nTiO_2$ (5, 10, and 50 nm anatase and 10 × 40 and 30 × 40 nm rutile). Tests were run in dilute salt solutions at varying pHs with or without humic substances.

Results show that crystallinity and morphology are not influential factors in determining the stability of $nTiO_2$ suspensions; however, the differences in their chemical compositions, notably, the varying concentrations of impurities (i.e., silicon and phosphorus) in the pristine materials, determined the surface charge and therefore the sedimentation and aggregation of $nTiO_2$ [3].

In the impurity release study, both acidic and basic conditions accelerated the release of Si, while the basic conditions enhanced the P release greatly [4]. The amount of dissolved P from the 50 nm anatase reached 5000 to 7100 mg/Kg at neutral to alkaline pH, which indicated a potential pollutant source of P [5]. The impurity dissolution did not change the stability of $nTiO_2$ greatly at ionic strength of 20 – 50 mM at neutral pH.

Results from saturated sand column tests suggest that natural organic matter and solution pH are likely key factors that govern the stability and mobility of $nTiO_2$ in the natural aquatic environment [6].

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