

Dissolution behavior of Silver Nanoparticles and Formation of Secondary Silver Nanoparticles in Municipal Wastewater by Single Particle ICP-MS

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The anticipated increase in the use of engineered Ag nanoparticles (nAg) in consumer products and the release to the environment necessitates a better understanding of the environmental fate of nAg. Dissolution of nAg is an important environmental transformation process because it releases dissolved Ag into the aquatic environment and alters the size of nAg, both of which can influence the toxicity of NPs. A significant fraction of nAg are expected to be released with wastewater (WW). However, the factors controlling the dissolution of nAg and the fate of Ag⁺ ions released in a complex matrix such as WW are currently poorly understood. In this study, dissolution of 80 nm nAg in the municipal WW samples were studied, with two particle coatings (citrate and PVP) and at two particle concentrations, 10 and 1000 ppb. Single particle inductively coupled plasma mass spectrometry (spICP-MS) was used to determine the mean size and particle size distribution of the NPs and the dissolved silver concentrations to quantify the rate and extent of dissolution of nAg. Our investigations determined that nAg dissolved significantly less (~47%) in WW effluent as compared to DI water. Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) and X-ray photoelectron spectroscopy (XPS) analyses suggested close association of WW DOC as well as sulfides (organic and inorganic) on the surface of the nAg which influenced the rate and extent of nAg dissolution. Transmission electron microscopy (TEM) showed that the dissolved Ag reformed into small (~20 nm) NPs over time.