Oxidative dissolution of silver nanoparticles by chlorine: Implications to silver nanoparticle fate and toxicity

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The kinetics of oxidative dissolution of silver nanoparticles (AgNPs) by chlorine are investigated in this work with results showing that AgNPs are oxidized in the presence of chlorine at a much faster rate than observed in the presence of dioxygen and/or hydrogen peroxide. The oxidation of AgNPs by chlorine occurs in air-saturated solution in stoichiometric amounts with two moles of AgNPs oxidized for each mole of chlorine added. It is clear however that dioxygen plays an important role in OCl^--mediated AgNP oxidation, especially at lower OCl^- concentrations, with the mechanism shifting from stoichiometric oxidation of AgNP by OCl^- in the presence of oxygen to catalytic removal of OCl^- by AgNP in the absence of dioxygen. These results suggest that the presence of chlorine will mitigate AgNP toxicity by forming less-reactive AgCl(s) following AgNP oxidation though the disinfection efficiency of OCl^- may not be significantly impacted by the presence of AgNPs since a chlorine-containing species is formed on OCl^- decay that has significant oxidizing capacity. Our results further suggest that the antibacterial efficacy of nanosilver particles embedded on fabrics may be negated when treated with detergents containing strong oxidants such as chlorine.