

2.075 Photocatalytic degradation of single, levitated organic aerosol particles containing iron nanoparticles or Arizona test dust..

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Abstract:

Iron (Fe(III)) carboxylate complexes in an organic aerosol particle absorb visible light below about 500 nm, with an inner complex electron transfer leading to the reduction of Fe(III) to Fe(II) and an escape of an organic radical from the complex followed by a fast decarboxylation reaction. When oxygen is present, ensuing radical chemistry will likely lead to further decarboxylation as well as peroxides and oxygenated volatile organic compounds production. The radicals (e.g., OH•, HO₂•, RO₂) in turn allow re-oxidation of Fe(II) to Fe(III), closing a photocatalytic cycle, in which the iron carboxylate complex acts as a photocatalyst.

Atmospheric aerosol particles may contain both, carboxylic acids and iron oxides, the latter being a component of mineral dust. Iron carboxylate complexes formed in these particles will promote photochemical degradation of the carboxylate ligands with an accompanying repartitioning of condensed phase mass to the gas phase.

We track mass and size changes of a single surrogate organic aerosol droplet levitated in an electrodynamic balance during photochemical processing under visible (473 nm) light irradiation. The surrogate droplets (radius ca. 5 - 10 μm) contain either Fe₂O₃ nanoparticles (< 50 nm) or Arizona Test Dust (ATD) particles (< 3 μm) in aqueous citric acid. As reference, we studied different concentrations of iron-citrate dissolved in aqueous citric acid droplets.

We observe substantial mass loss up to 80 % of the initial mass over 24 hours of irradiation for the reference droplets containing dissolved iron citrate, a similar loss for the droplets containing Fe_2O_3 nanoparticles and a smaller loss for the droplets containing ATD. Comparing the time needed for a 10% mass loss we conclude that Fe_2O_3 particles in the droplet lead to the same photocatalytic degradation as dissolved iron citrate whereas only 10% of the nominal iron in ATD becomes photochemically active.