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Particles-mediated photochemical redox transformation of mercury in water

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Mercury (Hg) is among the most notorious pollutants posing serious health risk to millions of people worldwide. In the environment, Hg cycles between major environmental compartments (air, soil, water, and sediment) and undergoes various transformation processes, forming a complex global biogeochemical cycle of Hg. Photochemical transformation between divalent Hg (Hg(II)) and elemental Hg (Hg(0)) in water is a crucial part of Hg cycle as it controls the inorganic Hg pool available for methylmercury production in aquatic environments and the air-water Hg exchange. While previous studies on photochemical redox transformation of Hg have been primarily focused on dissolved phase, the potential involvement of particulate mercury (pHg) species in photochemical transformation of Hg remains unresolved, hindering a more accurate understanding of aquatic Hg cycling and estimation of air-water Hg exchange fluxes. Recently, particles-mediated photochemical redox transformation of Hg has started garnering increasing attention. Both ubiquitously present natural aquatic particles and increasingly occurring engineered (especially metal-containing) nanoparticles in waters can have high affinity to adsorb Hg forming pHg species, resulting in the prevalence of pHg species in natural waters. These particles are often photosensitive and/or semiconducting in nature, involving in generating a variety of photoreactants such as free radicals, reactive oxygen species, and photoholes and photoelectrons that are capable of mediating Hg redox reactions. We synthesized previous information on potential roles of aquatic particles in Hg photochemical redox transformation, and discussed possible pathways and/or mechanisms of particles-mediated Hg redox reactions. We provided sample studies to demonstrate the involvement of aquatic particles and the particle characteristics-dependent effects in photoreduction of Hg(II) in natural waters and to illustrate the pathways of engineered nanoparticles mediating Hg photochemical redox reactions.