Bioreduction of Au(III) in the presence of graphene oxide to Au/rGO complex for improved nitrobenzene biotransformation

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Many carbon nanomaterials such as carbon nanotube, graphene and fullerene etc. are released into natural environments during their production and application. The presence of these anthropogenic nanomaterials, which possess large surface area, multiple functional groups and high conductivity, could impact the biogeochemical cycling of different elements and the bioremediation of pollutants. It is well-known that *Shewanella* strains can effectively reduce a wide range of metals or metalloids including Fe(III), Mn(IV), Au(III), Ag(I), As(V), Se(IV), Cr(VI) and U(VI) etc. to their lower valences or even elementary states and thus play important roles in biogeochemical cycles of these elements. In addition, members from this genus also demonstrate great capacity for the biodegradation and bioremediation of organic pollutants in aqueous environments, sediments and soils.

We found that *Shewanella oneidensis* MR-1 could simultaneously transform graphene oxide and Au(III) to reduced graphene oxide (rGO) and Au(0) nanoparticles. The biogenic Au nanoparticles located evenly on the rGO sheets with a mean size of 7~8 nm. Both cellular components and extracellular polymeric substances were involved in the formation of Au/rGO complex. The biogenic Au nanoparticle, rGO, and Au/rGO complex could all stimulate the reduction of model organic pollutant nitrobenzene significantly. And the best improving effects were observed with Au/rGO complex. MR-1 cells attached themselves closely to the surfaces of Au/rGO complex. It was suggested that the biogenic and conductive nanomaterials might act as redox mediator and participate in the transferring of electrons from cells to extracellular pollutant. Cytochromes of the Mtr pathway were found to be essential for the electron transfer through biogenic Au/rGO by MR-1. Therefore, the release of artificially synthesized nanomaterials into natural environments could significantly impact biogeochemical and pollutant biotransformation processes.

The work was partly supported by National Natural Science Foundation of China (No. 51478076).