Size effect on the reduction of hematite nanoparticles with outer membrane cytochromes OmcA of Shewanella oneidensis MR-1

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In natural environment, dissimilatory metal-reducing bacteria (DMRB) are involved in a prevalent redox process with sparingly soluble minerals and influence the fate and transport of redox-active metals, as well as organic and inorganic contaminants. To overcome the physical limitations associated with electron transfer (ET) across the outer membrane (OM) to solid extracellular terminal electron acceptors under natural conditions, c-type cytochromes (c-Cyts) in DMRBs compose an electron transport network across the entire microbial cell envelope. As the important terminal reductase, OmcA plays a key role in transferring electrons across the outer membrane to solid surface. This study investigated size effect on the reduction kinetics of hematite with OmcA. Reduction kinetics of hematite particles with mean primary particle sizes of 15, 30, 55, and 173 nm were systematically studied in reactions with OmcA and ascorbic acid, respectively. The changes of hematite particles before and after reaction with OmcA were investigated using a variety of methods. The different size effect in reactions with OmcA and ascorbic acid was discussed in terms of potential factors, such as primary particle size, size of reductase, and aggregation. This study is the first effort to investigate the effect of particle size on direct ET kinetics between hematite and important multi-heme c-type cytochrome.