Adaption and recovery of Nitrosomonas europaea to chronic TiO2 nanoparticle exposure - DTU Orbit (03/08/2019)

Adaption and recovery of Nitrosomonas europaea to chronic TiO2 nanoparticle exposure

Although the adverse impacts of emerging nanoparticles (NPs) on the biological nitrogen removal (BNR) process have been broadly reported, the adaptive responses of NP-impaired nitrifiers and the related mechanisms have seldom been addressed to date. Here, we systematically explored the adaption and recovery capacities of the ammonia oxidizer Nitrosomonas europaea under chronic TiO2 NP exposure and different dissolved oxygen (DO) conditions at the physiological and transcriptional levels in a chemostat reactor. N. europaea cells adapted to 50mg/L TiO2 NP exposure after 40-d incubation and the inhibited cell growth, membrane integrity, nitritation rate, and ammonia monooxygenase activity all recovered regardless of the DO concentrations. Transmission electron microscope imaging indicated the remission of the membrane distortion after the cells’ 40-d adaption to the NP exposure. The microarray results further suggested that the metabolic processes associated with the membrane repair were pivotal for cellular adaption/recovery, such as the membrane efflux for toxicant exclusion, the structural preservation or stabilization, and the osmotic equilibrium adjustment. In addition, diverse metabolic and stress-defense pathways, including aminoacyl-IRNA biosynthesis, respiratory chain, ATP production, toxin-antitoxin ‘stress-fighting’, and DNA repair were activated for the cellular adaption coupled with the metabolic activity recovery, probably via recovering the energy production/conversion efficiency and mediating the non-photooxidative stress. Finally, low DO (0.5mg/L) incubated cells were more susceptible to TiO2 NP exposure and required more time to adapt to and recover from the stress, which was probably due to the stimulation limitation of the oxygen-dependent energy metabolism with a lower oxygen supply. The findings of this study provide new insights into NP contamination control and management adjustments during the BNR process.

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