Advances in the semiconductor-mediated electron transfer mechanism at microbe-mineral interface

YING WANG, KUAN CHENG, TONXU LIU*, FANGBAI LI*

Guangdong Institute of Eco-Environmental Sciences & Technology, Guangzhou, P. R. China 510650.
txliu@soil.gd.cn; cefbli@soil.gd.cn

The interaction between minerals and microbes is an important biogeochemical process in the earth surface, which affects a series of important earth surface processes, including the formation and evolution of secondary minerals, nutrient cycling and environmental behaviors of pollutants. The previous studies on microbe-mineral interaction mainly focused on the extracellular electron transfer, and the dissolution and mineralization of minerals mediated by microbe. The unique energy level structures and redox properties of semiconducting mineral lead to a great difference in the mechanism of microbe-mineral interaction. The latest research progresses in the mechanism of microbe-mineral interaction mediated by semiconducting mineral are reviewed from two aspects: driven by thermodynamics and light energy. Under the thermodynamic driving force, the electron transfer was mediated by semiconducting minerals from microbes (a) to the mineral surface through the bulk phase of mineral, resulting in reductive dissolution of the surface; (b) to the electrode and consequently generated the microbial electricity in microbial fuel cell system; (c) to some pollutants adsorbed on mineral surface and was concomitantly reduced; and (d) to another kind of microorganism for promoting microbial interspecies electron transfer process. Under the light driving force, there are two types of electron transfer pathways: (a) photosynthetic microbes utlized the Fe(II) electron through the bulk phase of minerals to grow itself under light; (b) photoelectron generated by semiconducting minerals under light can be utlized by non-photosynthetic microbes. Finally, the future development trends of the interaction between microbes and semiconductor minerals are prospected.

This work was funded by the National Natural Science Foundations of China (41601240).