Self-Organized Electrically Conductive Bacterial Networks

Ryuhei Nakamura[1]; Kazuhito Hashimoto[2]

[1] the University of Tokyo; [2] the University of Tokyo
JST/ERATO

Microbial attachment to mineral surfaces is a fundamental process for initiating a broad range of biochemical and geological events in a natural environment. The genus Shewanella, which consists of dissimilatory metal-reducing bacteria often found in subsurface sediments, has been shown to have the ability to recognize the surface of Fe(III) oxides and initiate extracellular electron transfer (ET) to the attached iron oxides as a terminal process in its metabolism. This is an important process for its influence on the biogeochemical cycling of iron, and also has gained attention not only for a new aspect of the metabolic strategy of microorganisms, but also for its biotechnological applicability in microbial fuel cells.

The outer-membrane (OM) c-type decaheme cytochromes (c-Cyt) have been identified to play a critical role in mediating ET from the cell to Fe(III) oxides. A great deal of research has been focused on the electrochemical and spectroscopic investigation of the purified OM proteins. However, few studies have been performed by directly monitoring the ET process of intact cells, and therefore the mechanism of this process has largely remained unsolved. Here we report the first experimental verification for the ability of S. loihica PV-4 (and also S. oneidensis MR-1) to self-assemble into an electrically conductive network in the presence of Fe(III) oxides, and demonstrate the role of semiconductive nanocolloids in promoting a long-distance ET process using direct photo- and electrochemical monitoring of the extracellular ET in the bacterial network.