Investigation of the indirect dissimilarity metal reduction pathway of *Shewanella* by scanning electrochemical microscopy

David Crisostomo, Gongping Chen, C. Ruth McNees, Sean J. Elliott, and David E. Cliffel
Vanderbilt University
7330 Stevenson Center, Vanderbilt University, Nashville, TN 37235

Shewanella oneidensis bacteria has gained interest due to its flexibility in respiring a variety of species, including insoluble metal oxides and toxic metal species. This ability to transfer electrons to a material that cannot freely diffuse through the cell membrane is known as dissimilarity metal reduction (DMR). It has been shown that while performing the DMR process, *Shewanella* produces current on a variety of electrodes, demonstrating a potential avenue for clean energy and water purification. While there are several proposed mechanisms for this process, *Shewanella* appears to have a greater reliance on soluble electron shuttles, in the form of flavins, to perform DMR. Despite this discovery, direct *in situ* detection of the production and use of these electron shuttles remains a challenge.

In this research, scanning electrochemical microscopy (SECM) is used to detect the current generated from the DMR process. SECM has high spatial resolution and is capable of real time monitoring of electron transfer, providing information on the reactivity and topography of the bacteria on a substrate. Using these capabilities, SECM was used not only to investigate the indirect DMR pathway, but also to spatially determine flavin production and consumption of *Shewanella* biofilms. In addition, SECM can also monitor the cellular viability and electron transfer capabilities under a variety of conditions, including differing substrates, pHs, and redox mediators.

Understanding the DMR pathways is necessary in the optimization of bioenergy and bioremediation applications, both of which are possible solutions for the energy-water nexus.

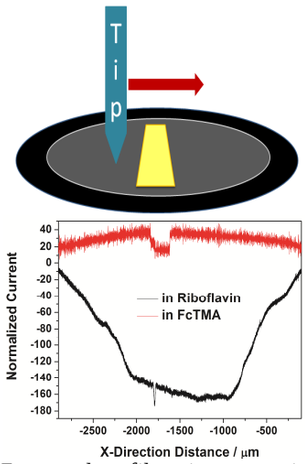

Figure 1. A 7 µm carbon fiber tip was positioned 20 µm away from the glassy carbon substrate and run in the x-direction across the biofilm strip to measure the current generated in riboflavin versus FcTMA.