**Quantifying Specific Resistances at Multiple Interphases in Microbial Reverse Electrodialysis Cells Using Multichannel Electrochemical Impedance**

Roland D Cusick1,2, Fang Zhang2,Marta C. Hatzell2,and Bruce E. Logan2

1Department of Civil & Environmental Engineering, University of Illinois at Urbana-Champaign, USA; [rcusick@illinois.edu](mailto:rcusick@illinois.edu)

2Department of Civil & Environmental Engineering, Penn State University, USA

Microbial reverse electrodialysis cells (MRCs) enhance power production and treatment of wastewater by operating microbial fuel cells electrodes on either side of a reserse electrodialysis membrane stack. When current is generated in a MRC, internal resistance creates voltage drops, reducing power production. Internal resistance can be classified as solution, membrane, kinetic, diffusion and capacitive resistances. The sum of all of these resistances can be easily quantified from the slope of a linear polarization curve. To differentiate between ohmic, capacitive, diffusive and kinetic resistances in a cell, electrochemical impedance spectroscopy must be employed. In this workshop we present a novel method of simultaneously quantifying resistances at the three interphases of a MRC (anode, membrane stack, and cathode) by operating multiple galvanostatic EIS channels in a stack arrangement.

**Reference and Counter Electrode Positions Affect Electrochemical Characterization of Bioanodes in Different Bioelectrochemical Systems**

Fang Zhang, Jia Liu, Ivan Ivanov, Marta C. Hatzell, Wulin Yang, Yongtae Ahn, and Bruce E. Logan

Department of Civil & Environmental Engineering, Penn State University, USA; [fuz105@psu.edu](mailto:fuz105@psu.edu)

The placement of the reference electrode (RE) in various bioelectrochemical systems is often varied to accommodate different reactor configurations. While the effect of the RE placement is well understood from a strictly electrochemistry perspective, when the bioanode is used as the working electrode (WE), there are impacts on exoelectrogenic biofilms in engineered systems that have not been adequately addressed. Increased distances between the RE and counter electrode (CE) in microbial fuel cells (MFCs) can alter bioanode characteristics through the acclimation to different anode potentials. Therefore, interpretation of electrochemical test results, such as cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), requires considerations of RE placement and bioreactor acclimation. In this workshop, I will show both from electrochemical and biological perspectives, how the RE and CE positions affect the CV and EIS characterization, using two different MFC configurations: spaced electrode configuration and separator electrode assembly configuration. I will also discuss the optimal RE position and methods to minimize errors in those electrochemical tests.

**Measurement of Electron Transport Rates through Electrochemically Active Biofilms**

Darryl A. Boyd1, Jeffrey S. Erickson2,Jared N. Roy3, Rachel M. Snider2,4,Sarah M. Strycharz-Glaven2, and Leonard M. Tender2\*

1National Research Council, Washington, DC 20001, USA

2Center for Bio/Molecular Science and Engineering, Naval Research Laboratory, 4555 Overlook Ave., SW, Washington, DC, 20375, USA

3George Mason University, Manassas, VA 20110, USA

4BioTechnology Insititute, University of Minnesota, Saint Paul, MN 55108

*\**[Tender@nrl.navy.mil](mailto:Tender@nrl.navy.mil) (Authors listed alphabetically)

The general approach to investigate the mechanism of electron transport through a material is to place the material between two electrodes and measure the dependency of the rate of electron transport through the material from one electrode to the other, in the form of electrical current, on the potentials applied to the electrodes. Materials utilizing different mechanisms of electron transport exhibit different current-potential dependencies. Theory and methodology will described for performing biofilm electron transport rate measurements and interpreting the results. The goal of this presentation is to enable researchers to perform electron transport rate measurements on their own electrochemically active biofilms.