Session: Biofilm application

Metal disco: Perfect partnership opportunities for electroactive biofilms?

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Electroactive microorganisms (EAM) perform extracellular electron transfer (EET) for coupling their energy metabolism with the reduction of insoluble electron acceptors beyond their cell membrane. Due to this unique metabolic trait, electroactive microorganisms attracted considerable interest over the last two decades. Nevertheless, their thermodynamic characterization is still in its infancy and a comprehensive analysis of the energy fluxes during EET and the efficiency of the energy converting reactions are still missing. However, assessing the metabolic efficiency of EAM represents an essential aspect for deciphering their ecological role and for leveraging their biotechnological potential.

Biocalorimetry allows the thermodynamic characterization of microbial systems by measuring their heat production. Based on a previously developed bioelectrocalorimeter, the heat and energy flows during cultivation of electroactive biofilms formed at different metal electrodes were analyzed. The respective microbial electrochemical Peltier heats (mePh) were derived by performing redox titration experiments. The mePh is an entropic effect at the cytochrome/solid electron acceptor interface during direct EET. It represents a metabolic trade-off: A high mePh should decrease biomass yield but provides thermodynamic driving force for growth. Furthermore, the electrodes were analyzed with scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy to characterize the elemental composition of electrode surfaces and to visualize the biofilms formed thereon.

The experiments show that the mePh of all tested metals are substantially lower compared to graphite electrodes suggesting increased biomass yields of *Geobacter* biofilms at metal electrodes. Moreover, the results lay the foundation for a first complete energy balances of EAM performing EET and for identifying the thermodynamically most suitable electrode materials for improving the energy efficiency of microbial electrochemical technologies.