Hydrogen Production in Microbial Fuel Cells

A. What is this technology?

● Microbial fuel cells (MFCs) are bioelectrochemical devices that convert chemical energy stored in biomass into electrical energy utilizing microbial metabolic processes at the fuel cell anode.
● The resulting voltage of the microbial fuel cell can be used to support electrolytic hydrogen production at the cathode at very low input electrolysis voltage (theoretically ~ 0.2 V vs. > 1.2 V for common electrolysis cells).

B. What problem does it address?

● Hydrogen as a fuel, energy carrier, and valuable chemical is facing increasing interest.
● Electrolytic hydrogen synthesis requires high voltages and is thus very energy intensive.
● Hydrogen production in MFCs combines microbial processes with electrolytic hydrogen synthesis, whereby the majority of the electrolysis voltage is provided by microbial processes.

C. What is the significance of this solution?

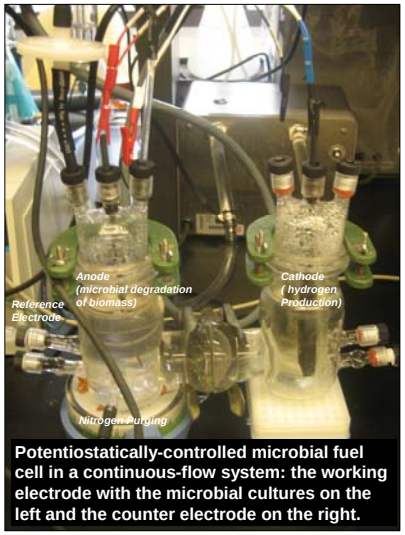
● Hydrogen production cathodes are available from electrolysis cells, thus the main focus of research is the performance of the microorganisms in the anodic chamber.
● To minimize the external voltage input, we have to maximize the microbial voltage generation. Therefore, we have to understand how microbial communities work together in breaking down complex organic material and efficiently transferring electrons out of metabolic processes to the anode.
● To do this, we study defined mixed cultures for the conversion of sugars to electricity to learn about microbial interactions and the food networks that are established.

D. Who could use this technology?

Companies or wastewater treatment plants interested in converting biomass to fuels or chemicals.

E. How is this technology unique?

Using this technique, the majority of the energy needed for *clean* hydrogen production derives from microbial biomass degradation rather then from nonrenewable sources.



Potentiostatically-controlled microbial fuel cell in a continuous-flow system: the working electrode with the microbial cultures on the left and the counter electrode on the right.

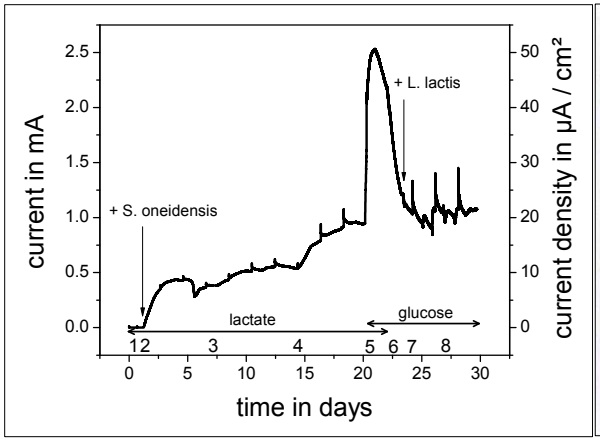
Stage of Development

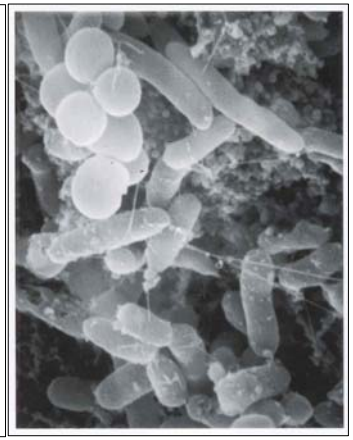
Research with defined mixed cultures on the anode side is being performed to understand the processes that are crucial for maximizing the microbial power generation.

Moving Forward

Production of clean hydrogen on the cathode side after the microbial anode system is optimized.

PARTNERSHIP OPPORTUNITY





Defined microbial mixed culture of *Shewanella oneidensis* and *Lactococcus lactis*. Left: electricity production from lactate and glucose over time. Right: SEM image of the culture biofilm on the anode electrode.

Researchers

Michael Cotta, ARS, Peoria, IL
Miriam Rosenbaum, ARS, Peoria, IL
Jeff Fornero, Washington University
Largus Angenent, Washington University

Contact Information

Michael Cotta, Fermentation Biotechnology Research Unit
National Center for Agricultural Utilization Research
(309) 681-6500. Mike.Cotta@ars.usda.gov

USDA ARS MWA BIOENERGY RESEARCH
Challenges for Today. Solutions for Tomorrow.

www.ars.usda.gov/mwa