Sun Grant Western Regional Center
Oregon State University

Bio-electrolysis: Novel Technology for Hydrogen Production from Lignocellulosic Biomass

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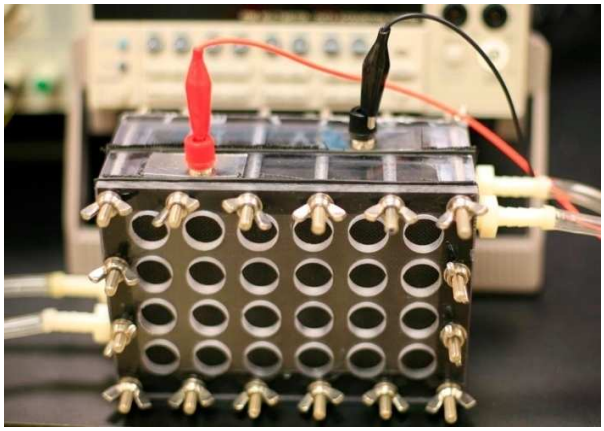
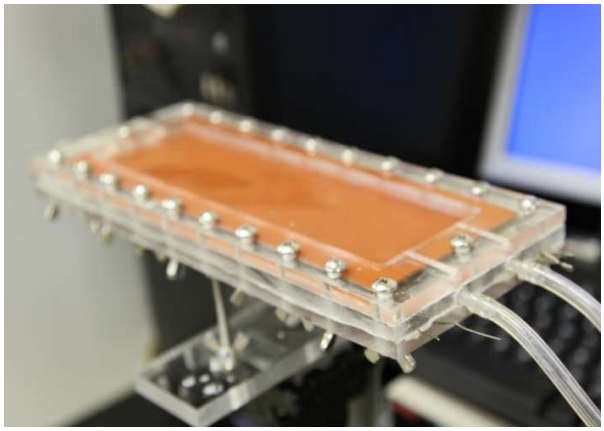
Overview

Hydrogen, one of the cleanest and most desirable fuels, is expected to play an increasingly important role in our economy. At present, non-renewable fossil fuels are the main sources of hydrogen production. The overall goal of the proposed research is to develop a novel bio-electrolytic process to generate hydrogen directly from renewable, abundant and readily available lignocellulosic biomass in a cost-effective manner. Dr. Liu, along with Kaichang Li (OSU), will examine the factors affecting hydrogen production from complex lignocellulosic biomass in order to improve the overall efficiency of the process. The team will use pine wood flour as the model lignocellulosic biomass. The successful completion of this project will result in the development of a novel process for hydrogen production from woody biomass.





Reactors.

Collaborators

Co-PI: Kaichang Li, Department of Wood Science, OSU

Yanzhen Fan, Department of Biological and Ecological Engineering, OSU

Hakan Bermek, Department of Molecular Biology and Genetics, Istanbul Technical University, Istanbul, Turkey

Funding Sources

U.S. Department of Transportation, Research and Innovative Technology Administration

Cost share: Oregon State University

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Accomplishments

The work completed so far has significantly enhanced the understanding of some fundamental issues about the kinetics and mechanisms of biohydrogen generation from lignocellulosic biomass using microbial electrolysis cells. The new single-chamber MEC design and the development of non-previous metal free cathode catalysts greatly increase the efficiency of the system and reduce the cost for cell fabrication, thus increase the practical application potential of this technology. The scientific publications and presentations the research team has made not only advance the development of knowledge and attract young people to the profession, but also initiated industrial collaborations for the commercialization of this technology. Future plans for this technology include optimizing the operational conditions of single-chamber MECs.

Specific activities toward project goals include:

- Evaluation of how individual sugar, a mixture of different sugars and other degradation byproducts derived from woody biomass affect the efficiency of hydrogen production
- Investigation of whether there is any compound in the hydrolysate of woody biomass that will inhibit the growth of microorganisms and lower the efficiency of hydrogen production
- Maximization of the hydrogen production through the modification of electrode materials

Peer-reviewed articles

1. Catal, T., Li,K., Bermek H., Liu, H. (2009) Sugar Utilization and Volatile Fatty Acid Production In microbial fuel cells. In preparation.
2. Hu, H., Fan, Y., Liu, H. (2009) Hydrogen Production in Microbial Electrolysis Cells Using Precious-metal-Free Cathode Catalysts (NiMo, NiW). *International Journal of Hydrogen Energy*. In press.
3. Catal, T. Bermek, H., Li, K., Liu, H. (2008). Electricity generation from disaccharides in microbial fuel cells. *Journal of Istanbul Technical University*. In press.
4. Hu, H., Fan, Y., Liu, H. (2008). Hydrogen Production Using Single-chamber Membrane-free Microbial Electrolysis Cells. *Water Research*, 42(15):4172-4178.
5. Catal, T., Li, K., Bermek, H., Liu, H. (2008) Electricity Production from Twelve Monosaccharides Using Microbial Fuel Cells. *Journal of Power Sources*, 175, 196-200.
6. Catal, T., Fan, Y., Li, K., Bermek, H., Liu, H. (2008) Effects of furan derivatives and phenolic compounds on electricity generation in microbial fuel cells. *Journal of Power Sources*, 180, 162-166.
7. Catal, T., Xu, S., Li, K., Bermek, H., Liu, H. (2008) Electricity generation from polyalcohols in single-chamber microbial fuel cells. *Biosensors and Bioelectronics*, 24, 855-860.

Project Dates

07/15/2007 – 06/30/2010