

Visitor Research Report

Visitor Name: Mr. Dane Hansen
Brigham Young University

Area of Research: Biotemplate for Nanoparticles and New Enzymes for Hydrogen Production

Period of Visit: June 25, 2007 through June 24, 2008
Period of Report: January 1, 2008 through June 24, 2008

Goal:

The main goal of this project was to conduct initial research into a new series of catalysts for the direct electrochemical conversion of carbohydrate chemical energy into electrical energy. I am a new graduate student, however, so to accomplish that goal I have had to concurrently learn electrochemistry through reading appropriate books and journal articles and then to solidify the knowledge that I am gaining by summarizing it in a literature review that will be attached to my prospectus.

Strategy:

The strategy of the group I am working with has two parts. This series of catalysts has never been investigated for use as carbohydrate catalysts, so the first part of the strategy was to learn about them, through experiments and through reading proper literature.

The second part of the strategy is to test the catalysts in a fuel cell system, which is where research currently taking place. This phase is for applying the knowledge gained in the previous phase to develop a cell that can generate the highest current possible at a reasonable voltage.

Accomplishments:

During the application of the first part of our strategy, the strengths and weaknesses of the catalysts and the sugars being worked with have been identified. These characteristics include stability under various physical conditions, including pH and temperature, and also the coulombic efficiency with which the sugar is utilized. Through experiments with different compounds a mechanism is being established by which the catalyst works in the oxidation of carbohydrates. Also, by using the correct conditions it has been shown that the catalyst can work with more than just carbohydrates, that the catalyst can in fact catalyze the oxidation of ketones and alcohols.

The second part of the strategy, developing the fuel cell, has already seen the increase of the current of the cell by 1000 times, up to 20 mA/cm² while a positive voltage is maintained between the working and counter electrodes. This was accomplished by developing the best conditions for the cell to operate and using the carbohydrate that is

most active to the catalyst. The best performing and most stable catalyst from the group of catalysts has been identified. The pH conditions and temperature this particular catalyst generates the highest current in the cell has also been identified. With the proper conditions and fuel, it has been found that the catalyst can, at room temperature, generate a current density that is quite high vs. comparable carbohydrate fueled cells.

Future Work:

The work with the cell will continue, optimizing it for higher electrical current output. The catalyst, which is currently only being used in solution, will be immobilized and studied using a rotating-disk electrode (RDE).

Pending Publications:

I am co-author on a completed paper detailing the accomplishments of the group. This paper has been submitted to the Journal of the Electrochemical Society and we are currently generating our responses to the reviewers' comments. Also, our work has led to a patent on our catalyst and related compounds

Seminar Presented:

During my time here I have twice given presentations to the principal investigator and all the other researchers in the research group.