NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Identification of Catalysts and Materials for a High-Energy Density Biochemical Fuel Cell

Cooperative Research and Development Final Report

CRADA Number: CRD-09-345

NREL Technical Contacts:
Drazenka Svedruzic and Maria Ghirardi

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

CRADA Report
NREL/TP-7A10-58457
July 2013

Contract No. DE-AC36-08GO28308

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/help/ordermethods.aspx

Cover Photos: (left to right) photo by Pat Corkery, NREL 16416, photo from SunEdison, NREL 17423, photo by Pat Corkery, NREL 16560, photo by Dennis Schroeder, NREL 17613, photo by Dean Armstrong, NREL 17436, photo by Pat Corkery, NREL 17721.

Printed on paper containing at least 50% wastepaper, including 10% post consumer waste.

Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA Number: CRD-09-345

CRADA Title: Identification of Catalysts and Materials for a High-Energy Density Biochemical Fuel Cell

Parties to the Agreement: Lockheed Martin Space Systems Company

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources
Year 1	$ 00.00
Year 2	$ 00.00
Year 3	$ 00.00
TOTALS	$ 00.00

Abstract of CRADA work:

The proposed research attempted to identify novel biochemical catalysts, catalyst support materials, high-efficiency electron transfer agents between catalyst active sites and electrodes, and solid-phase electrolytes in order to maximize the current density of biochemical fuel cells that utilize various alcohols as substrates.

Summary of Research Results:

The aim of this project was to develop and demonstrate optimal pathways for complete oxidation of high-energy density fuels and to harvest the resulting electrons within a biochemical fuel cell for electricity generation. During the course of this CRADA, we identified two viable pathways and one or more biocatalysts for each step of the oxidation reaction. The biocatalysts were either produced by their native organisms or the respective genes were overexpressed in *E. coli*. The biocatalytic activity of each catalyst was demonstrated in aqueous solution, using quantitative and/or qualitative activity assays. We also demonstrated sequential catalytic fuel oxidation, involving multiple steps catalyzed by each of the identified enzymes. Successful implementation of an *in vitro* system involving synergistic activity of multiple biocatalysts presents unique challenges, and successful demonstration of the concept was one of the major objectives of this study. Indeed, similar studies of such complex systems are not common in the scientific literature.

Subject Inventions Listing: None **Report Date**: 05/09/13

Responsible Technical Contact at Alliance/NREL: Drazenka Svedruzic and Maria Ghirardi

This document contains NO confidential, protectable, or proprietary information.