VIII.3 Fuel Cell and Hydrogen Research (New Project)*

Elias Stefanakos (Primary Contact), Matthew Smith, John Wolan, Burt Krakow, Don Morel, Ashok Kumar, Chris Ferekides, Kenneth Buckle, Lawrence Langebrake, and John Baumgardner
Clean Energy Research Center
University of South Florida
4202 E Fowler Ave.
Tampa, FL 33620
Phone: (813) 974-4413; Fax: (813) 974-5250; E-mail: stefanak@eng.usf.edu

DOE Technology Development Manager: Antonio Bouza
Phone: (202) 586-4563; Fax: (202) 586-9811; E-mail: Antonio.Bouza@ee.doe.gov

Subcontractors:
Yogi Goswami, Solar Energy and Energy Conversion Lab, University of Florida, Gainesville, FL
Clovis Linkous, Florida Solar Energy Center, University of Central Florida, Cocoa, FL
Elena Shembel, Ener1 Inc., Fort Lauderdale, FL

*Congressionally directed project

Objectives

• Improve promising thermochemical, photo-electrochemical and photocatalytic hydrogen production methods.
• Investigate storage of hydrogen in transition metal complex hydrides and porous nano-composite polymers that contain modified fullerene compounds and carbon nanotubes.
• Develop electrodes and Polymer Electrolyte Membrane (PEM) membranes that can operate reliably in the temperature range of 100-150°C.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Production, Hydrogen Storage and Fuel Cells sections of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Production
• V. High- and Ultra-High-Temperature Thermochemical Technology
• O. Photoelectrochemical Efficiency
• G. Efficiency of Gasification, Pyrolysis, and Reforming Technology

Storage
• N. Lack of Understanding of Hydrogen Physisorption and Chemisorption

Fuel Cells
• O. Stack Material and Manufacturing Cost
• Q. Electrode Performance
Approach

- Study and quantify the reactor kinetics of the cycle described as the University of Tokyo Cycle #3.
- Develop nano-particle oxide supported catalysts for improvement of the biomass gasification process.
- Develop a tandem all thin-film solar cell based on a cadmium selenide and copper indium gallium selenide structure with a target open circuit voltage above 1.45 volts.
- Develop an electrolytic cell based on mixed sulphates and phosphates of cesium and barium to operate in the 100-150 °C range.
- Synthesize transition metal complex hydride, $\text{Mg}_2\text{FeH}_6$, by employing chemical and mechano-chemical processes and by doping it with Ti and Zr compounds and/or substituting Na/Li in the host structure.
- Improve the operating temperature of PEM fuel cells by pursuing a variety of materials concepts for the solid polymer electrolyte including, zeolites and Nafton/clathrate composite membranes.
- Catalytic improvement by doping electrodes with newly developed catalysts, such as Pt/Ru, Pt/Pd, Pt/Ag bimetallics.