

### 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,  $Mg_2FeH_6$ , 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 Nafion/clathrate composite membranes.
- Catalytic improvement by doping electrodes with newly developed catalysts, such as Pt/Ru, Pt/Pd, Pt/Ag bimetallics.