
II.F.7 Photoelectrochemical Hydrogen Production

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Contract Number: To be determined

Subcontractors:

University of Hawaii at Manoa, Honolulu, HI
Intematix Corporation, Moraga, CA
Southwest Research Institute, San Antonio, TX
Duquesne University, Pittsburgh, PA

Start Date: To be determined

Projected End Date: To be determined

Technical Targets

This project is conducting fundamental materials and device studies related to the development of multi-junction thin-film hybrid photoelectrodes (HPEs) for photoelectrochemical hydrogen production. Insights gained from these studies will be applied toward the design and synthesis of HPE-based systems that meet the DOE 2010 production targets, especially efficiency, durability and cost. Specific goals toward reaching the longer-term targets include:

- Development of low-cost photoactive materials with 1-sun photocurrents greater than 6 mA/cm² and with sufficient durability to meet the lifetime requirement
- Development of supporting solid-state devices with sufficient current and voltage output
- Development of necessary process integration techniques
- Demonstration of materials/device fabrication process scale-up for commercialization
- Generation of an energy/economic analysis for hydrogen production cost based on the developed technology

Objectives

- The demonstration of a multi-junction photoelectrochemical solar-powered hydrogen production system with 7.5% solar-to-hydrogen (STH) conversion efficiency and 1,000 hours operational life
- The identification of commercialization paths toward DOE plant production cost targets

Technical Barriers

This project addresses the following technical barriers from the Photoelectrochemical Hydrogen Production from Water section (3.1.4.2.6) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (AP) Materials Efficiency
- (AQ) Materials Durability
- (AR) Bulk Materials Synthesis
- (AS) Device Configuration Design
- (AT) Systems Design and Evaluation

Approach

The research approach focuses on the development of HPE technology – a thin-film multi-junction monolithic photoelectrode for direct water splitting patented by the University of Hawaii (UH), illustrated in Figure 1. HPE technology is based on low-cost materials such as metal foil substrates, as well as amorphous silicon and metal-oxide thin films, and utilizes scalable fabrication processes for commercial manufacture. Specific research and development areas within this approach include:

- Accelerated Research and Development of Photoactive Materials
 - high-throughput fabrication and screening of material modifications
 - doping for improved photo-response
 - film texturing for improved surface area
 - guidance by theoretical calculations
 - guidance through detailed analysis of existing high-performance materials

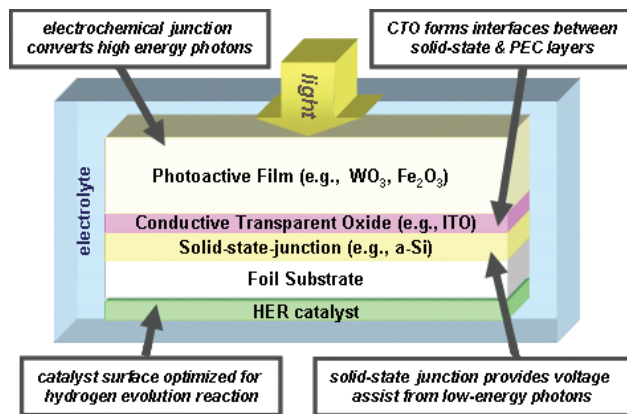


FIGURE 1. The Hybrid Photoelectrode Structure Showing the Function of Constituent Thin Film Layers

- Hybrid Photoelectrode Device Development
 - development of suitable solid-state junctions for device integration
 - prototype demonstration (several cycles) based on best available materials
- Scale-up and Commercialization Evaluation
 - medium-scale fabrication of HPE component films on cluster tool
 - large-scale fabrication of photoactive oxide film (WO_3 , etc.) on vacuum roll system
 - economic/energy analysis of HPE technology based on current state and projections

FY 2006 Progress

This project did not receive funding in FY 2006. DOE plans to initiate funding in FY 2007.