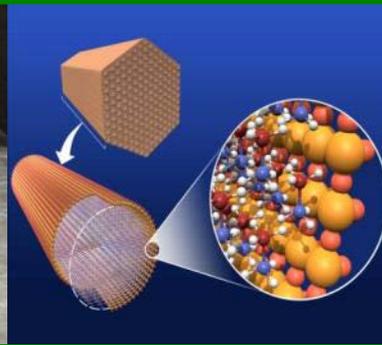




U.S. DEPARTMENT OF
ENERGY



Manufacturing Sub-program - Session Introduction -

Nancy Garland

2011 Annual Merit Review and Peer Evaluation
May 12, 2011

- Goals
 - Develop and demonstrate technologies and processes that will:
 - Reduce the cost of components and systems for fuel cells, storage, and hydrogen production
 - Grow the domestic supplier base
- Objectives
 - Enable the reduction in cost of fuel cell stacks from \$1500/kW to \$15/kW by 2015
 - Enable the reduction in cost of forecourt compression from \$4/kg/hr to \$3/kg/hr by 2015

Move hydrogen and fuel cells from laboratory-scale production into high-volume, low-cost manufacturing

Fuel Cells

Lack of: High-Volume Membrane Electrode Assembly (MEA), Bipolar Plate, and Balance-of-Plant Manufacturing Processes
High-Speed Sealing Techniques
Automated Stack Assembly

Storage

High Cost of Carbon Fiber
Lack of Carbon Fiber Fabrication Techniques for Conformable Tanks

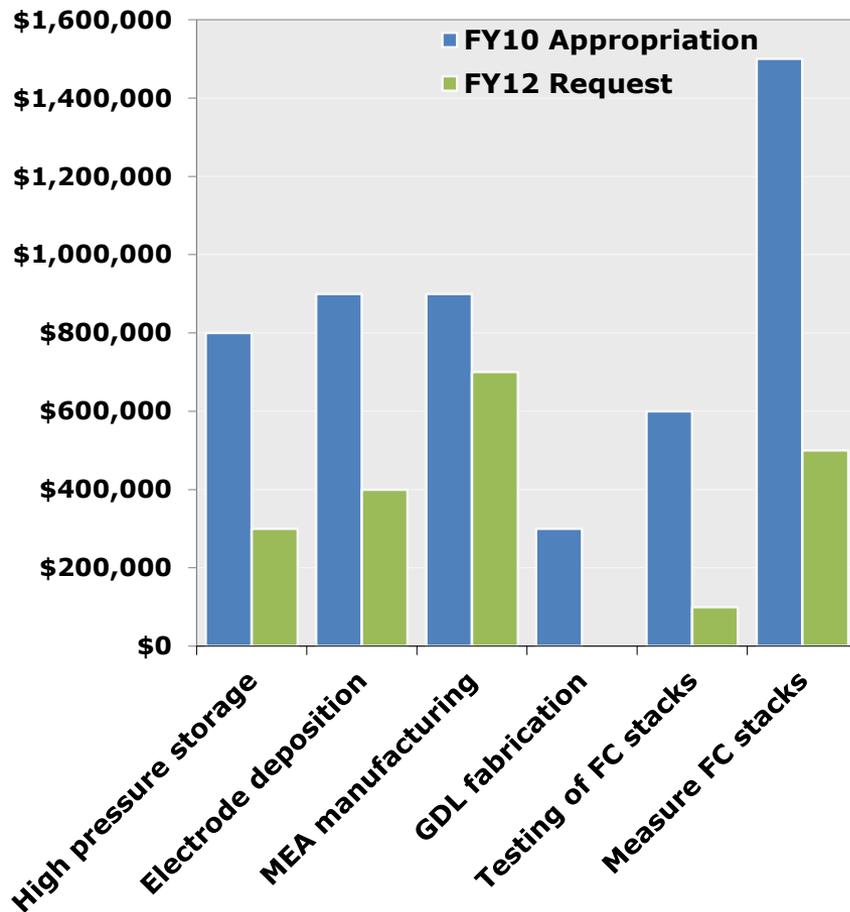
Hydrogen Production

Lack of: Automated Joining, Coating, Stamping, and Extrusion Processes
Continuous Manufacturing and Modularization Processes



FY 2010 Appropriation = \$5 M*

FY 2012 Request = \$2 M



*FY11 appropriation to be determined.

EMPHASIS

- Develop novel, robust, ultrasonic bonding processes for MEAs to reduce MEA-pressing cycle time
- Develop real-time, online measurement tools to reduce/eliminate ex situ characterization, sampling, and testing
- Develop and demonstrate innovative precision fiber placement and commercial filament winding for high-pressure carbon composite tanks
- Conclude efforts on streamlining GDL fabrication techniques

Progress: GDL Fabrication Cost Reduction

Reduced cost of GDLs by more than 50% and increased manufacturing capacity more than 4x since 2008

Project Approach:

➤ Reduce high material & manufacturing costs:

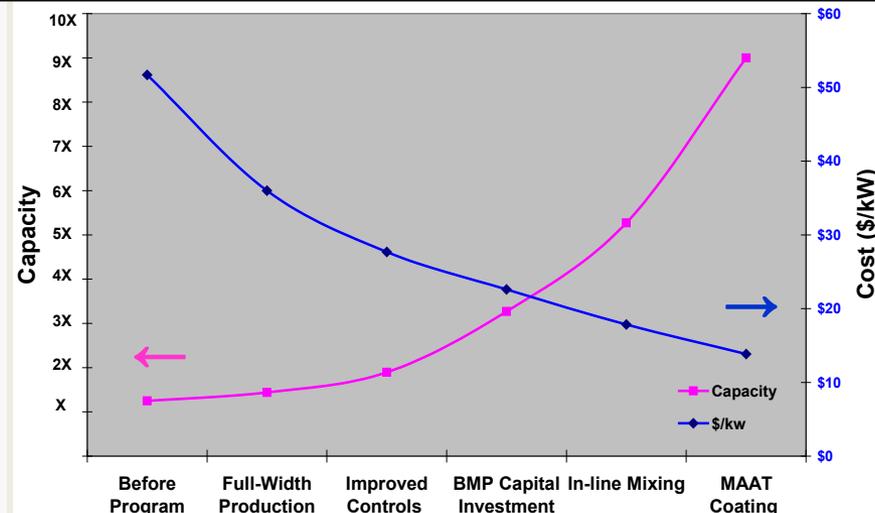
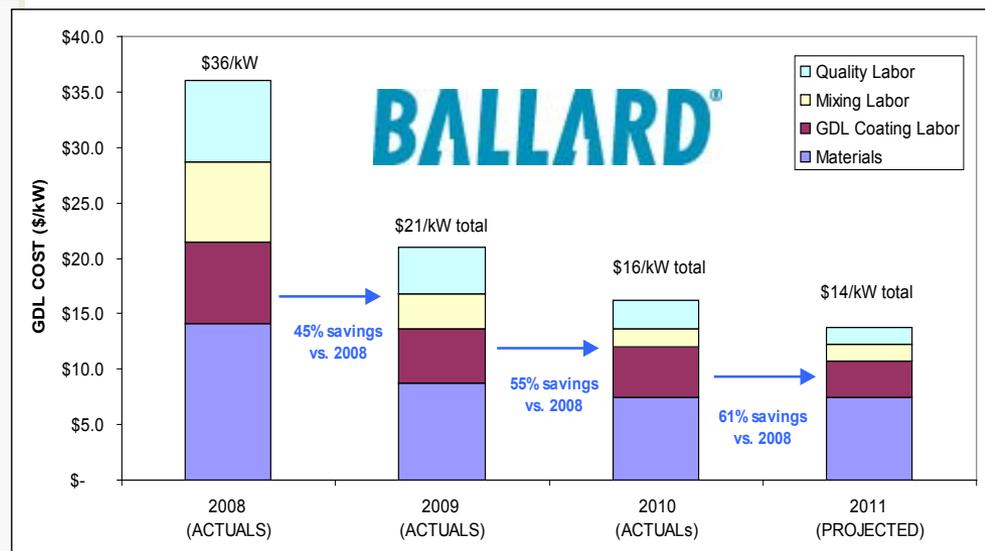
- Eliminate process steps, improve production yields, reduce scrap and increase production efficiency

➤ Develop high-volume MEA (GDL) processes:

- Process modifications introduced in this project have increased production volumes nearly 4-fold

➤ Improve low levels of quality control and inflexible processes:

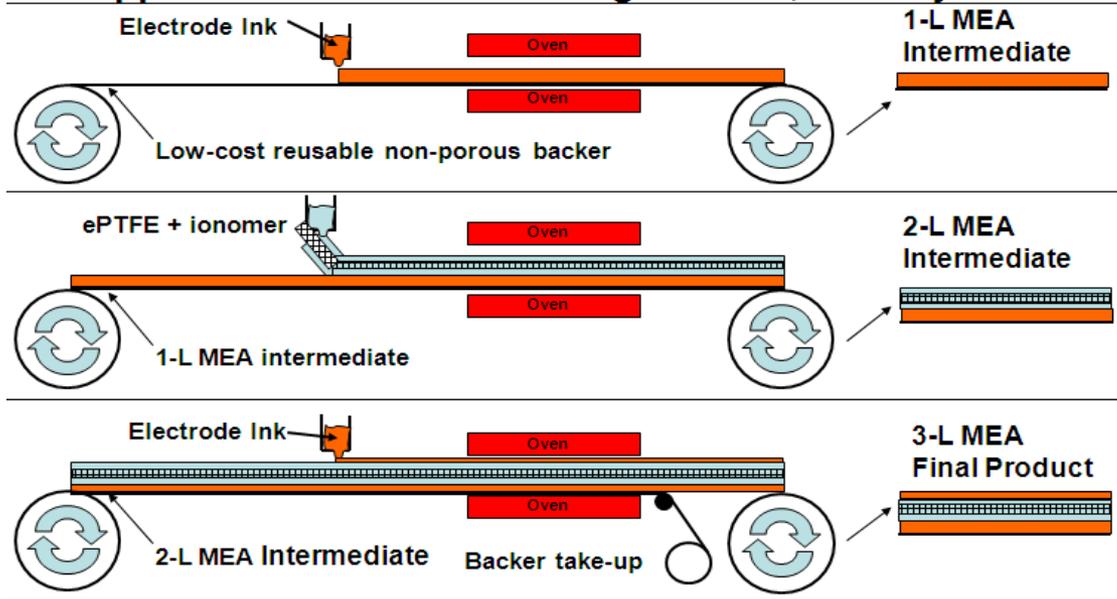
- Introduce new quality control technologies such as mass flow meters to control MPL loadings, provide more uniform properties and reduce the amount of ex situ testing required
- Add an in-line visual inspection station as a final quality tool to improve processing efficiency and accuracy



Progress: Low-cost, durable MEAs

Increased performance by 200 mA/cm² at 0.4 V
by improving the membrane/anode interface through direct coating

Approach: Low-Cost MEA Mfg Process, Primary Path



Reduce MEA & Stack Costs

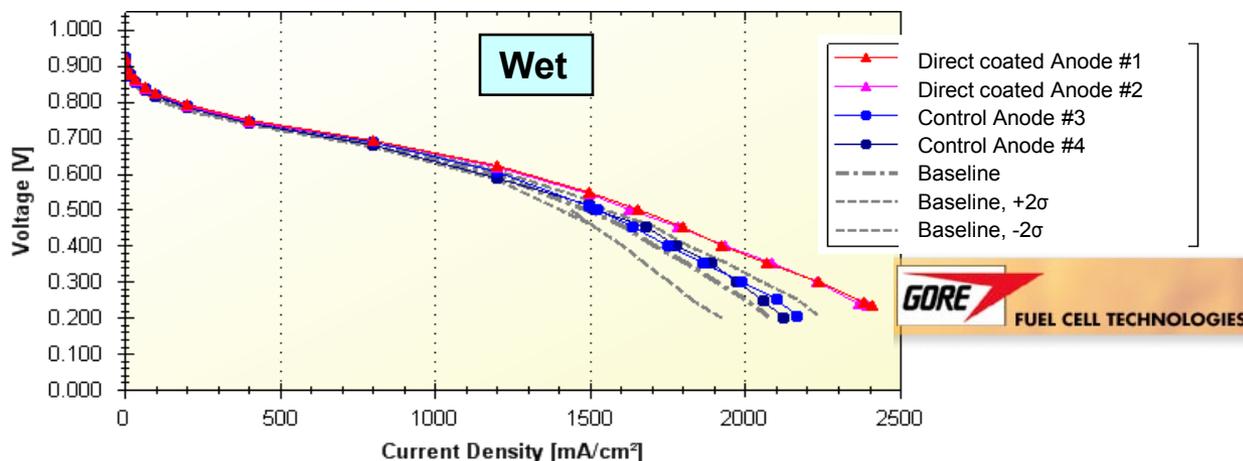
- Eliminate intermediate backer materials
- Reduce number & cost of coating passes
- Minimize use of solvents
- Reduce conditioning time & cost

Enabling Technologies:

- Direct coating: Use coating to form at least one membrane–electrode interface
- Gore's advanced ePTFE membrane reinforcement & advanced PFSA ionomers enable durable, high-performance MEAs
- Model mechanical stress and heat / water management to accelerate low-cost MEA optimization
- Advanced fuel cell testing & diagnostics

Explore new 3-Layer MEA Process

- Investigate equipment configuration for MEA production
- Investigate raw material formulations
- Map process windows for each layer of the MEA



Progress: Developing diagnostics for MEA manufacture

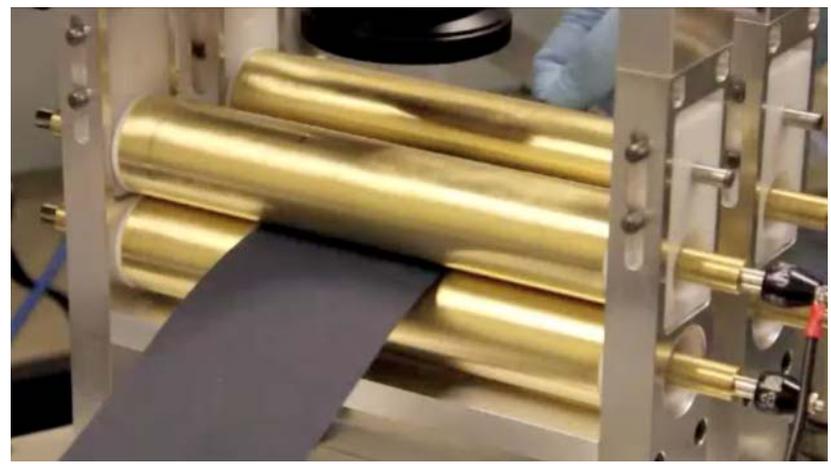
Achieved areal image of catalyst layer uniformity, technique can be scaled up for in-line testing

Project Approach:

Evaluate and develop in-line diagnostics for MEA component quality control, and validate in-line

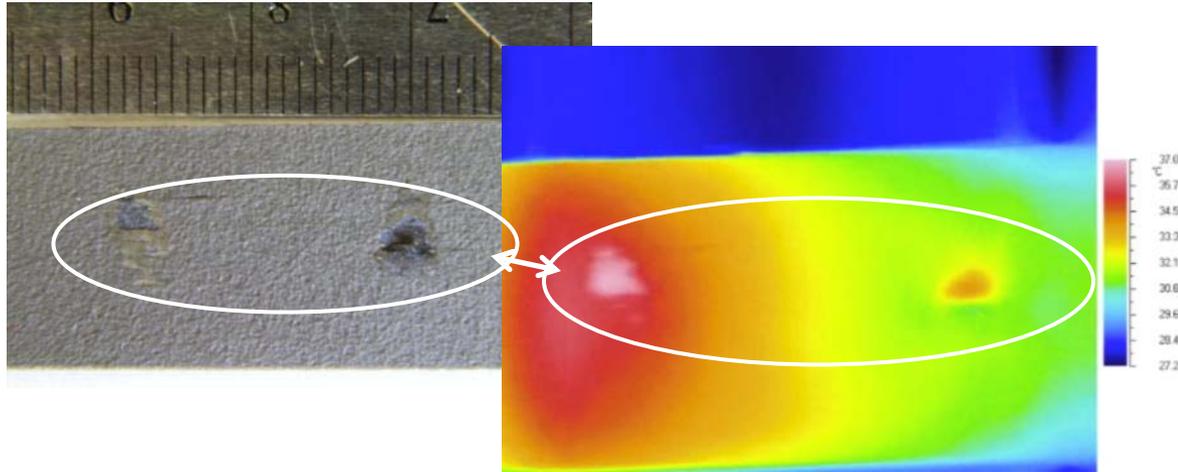
Investigate the effects of manufacturing defects on MEA performance and durability to understand the accuracy requirements for diagnostics

Integrate modeling to support diagnostic development and implementation



Example:

- DC excitation of catalyst-coated membrane causes thermal response
- Defects change catalyst layer resistance, thus altering the thermal response
- IR camera provides rapid, quantifiable 2D data



Major Milestones and Workshops

Go / No-Go decision point for Modular, High-Volume
Fuel Cell Leak-Test Suite and Process:
6/30/2011 Achieve 5 pph capacity, 50 pph throughput design

FY 2011

2011: Complete development
of standards for metrology of
PEM fuel cells

2011: Stationary
Manufacturing
R&D Workshop:
status, prospects
and R&D needs

FY 2012

2012: Develop
continuous in-line
measurement for
MEA fabrication

FY 2013

2013: Demonstrate
pilot scale processes
for assembling stacks

- This is a review, not a conference.
- Presentations will begin precisely at the scheduled times.
- Talks will be 20 minutes and Q&A 10 minutes.
- Reviewers have priority for questions over the general audience.
- Reviewers should be seated in front of the room for convenient access by the microphone attendants during the Q&A.
- Please turn off all cell phones, BlackBerries, etc.
- Photography and audio and video recording are not permitted.

- Deadline for submitting final review form is May 20th at 5:00 PM EDT.
- ORISE personnel are available on-site for assistance. A reviewer-ready room is set up in *The Boardroom* (next to Salon A) and it will be open Tuesday – Thursday from 7:30 AM to 6:00 PM and Friday 7:30 AM to 2:00 PM.
- Reviewers are invited to a brief feedback session at 12:30 PM today, in this room.

Manufacturing

DOE Headquarters
Nancy L. Garland
Acting Manufacturing Team Leader
202-586-5673

Nancy.Garland@ee.doe.gov

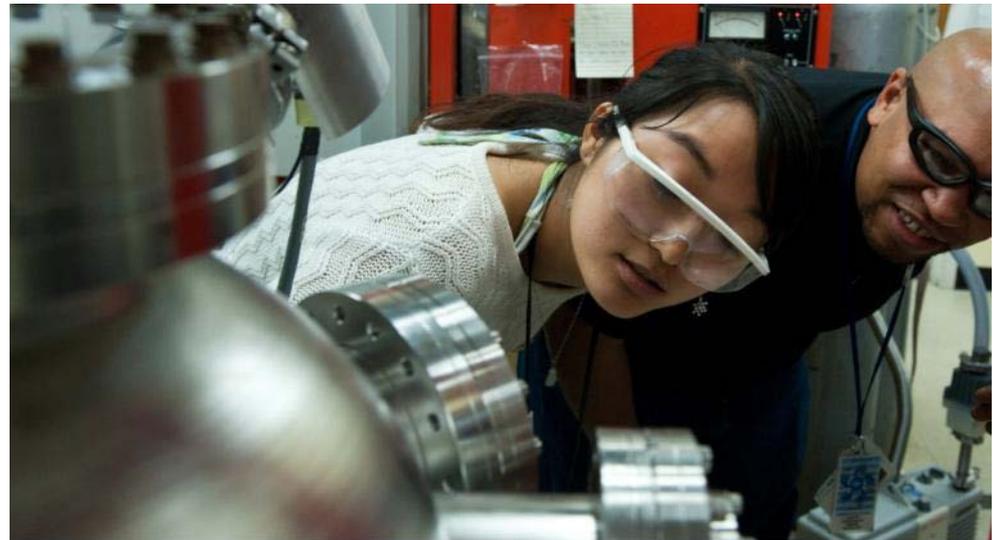
Pete Devlin
Peter.Devlin@ee.doe.gov
202-586-4905

Golden Field Office :
Jesse Adams

Technical Support:
Cassidy Houchins (SRA)

- Fuel Cell Technologies Program Opportunities Available
 - Conduct applied research at universities, National Laboratories, or other research facilities
 - Up to five positions are available in the areas of hydrogen production, hydrogen delivery, hydrogen storage, and fuel cells
- Applications are due June 30, 2011
- Winners will be announced mid-August
- Fellowships begin in mid-November 2011

www.eere.energy.gov/education/postdoctoral_fellowships/



**Postdoctoral fellowships in
hydrogen and fuel cell research ▶**

- **Electrode Deposition**
 - BASF
- **High Pressure Storage**
 - Quantum
 - PNNL
- **MEA Manufacturing**
 - ORNL
 - RPI
 - Gore
- **GDL Fabrication**
 - Ballard Material Products
- **Testing of FC Stacks**
 - UltraCell
 - PNNL
 - LLNL
- **Measurement of FC Stacks**
 - NIST
 - NREL
 - LBNL