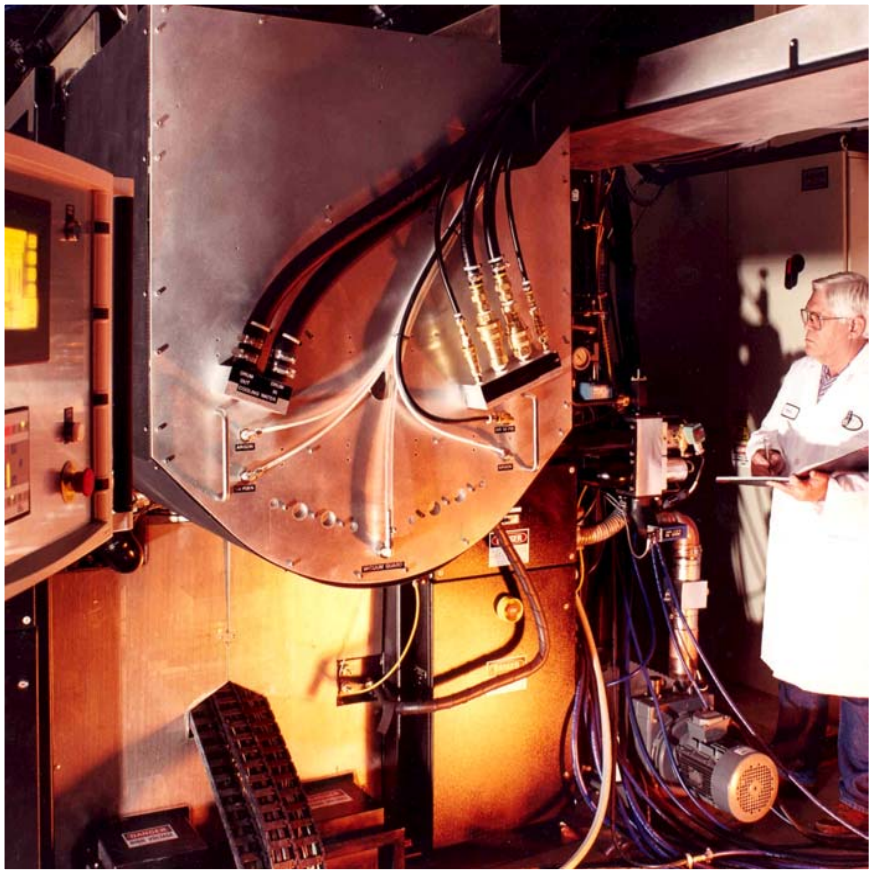


Design and Installation of a Pilot Plant for High-Volume Electrode Production

James H. Arps, Manager

Surface Engineering Section

Southwest Research Institute

DOE Hydrogen and Fuel Cells Merit Review Meeting

May 19, 2003

Key Contributors

- SwRI
  - Bruce Lanning
  - Walt Machowski
  - Forrest Campbell
  - Jim Riggs
- W.L. Gore and Associates
  - Jeff Kolde
  - Dave Lane
  - Simon Cleghorn
  - Nick Sisofo
- General Motors
  - Julie Wang
  - Matt Fay
  - Mark Mathias

Overview

- Introduction/relevance to DOE objectives
- Program goals
- Technical accomplishments
- Future plans

MEAs-The Heart of the Fuel Cell

Fuel Cell Catalyst Issues

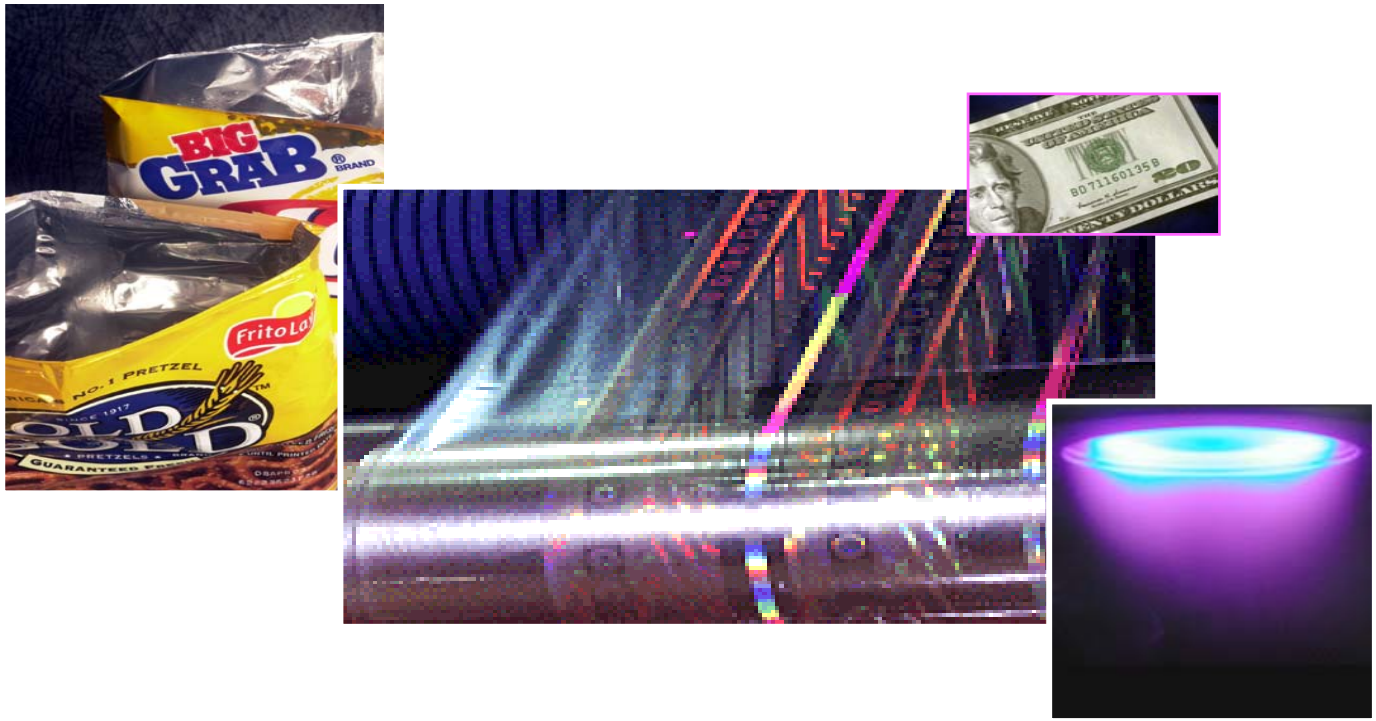
Deposition Approaches

- **Rolling/spraying**
- **Screen printing**
- **Solution casting/hot pressing**
- **Other emerging methods**

Challenges

- **Uniformity**
- **Achieving low Pt loadings (AND good performance)**
- **Volatile organic species**
- **Process can be labor intensive**
- **Cost**

Vacuum Web Coating



- A preferred method for high-volume treatment of polymeric materials
- Advantages
  - Highly Controllable Deposition
  - Ultra-Thin Layers
- Applications
  - Packaging
  - Anti-Counterfeit

Relevance to DOE Objectives

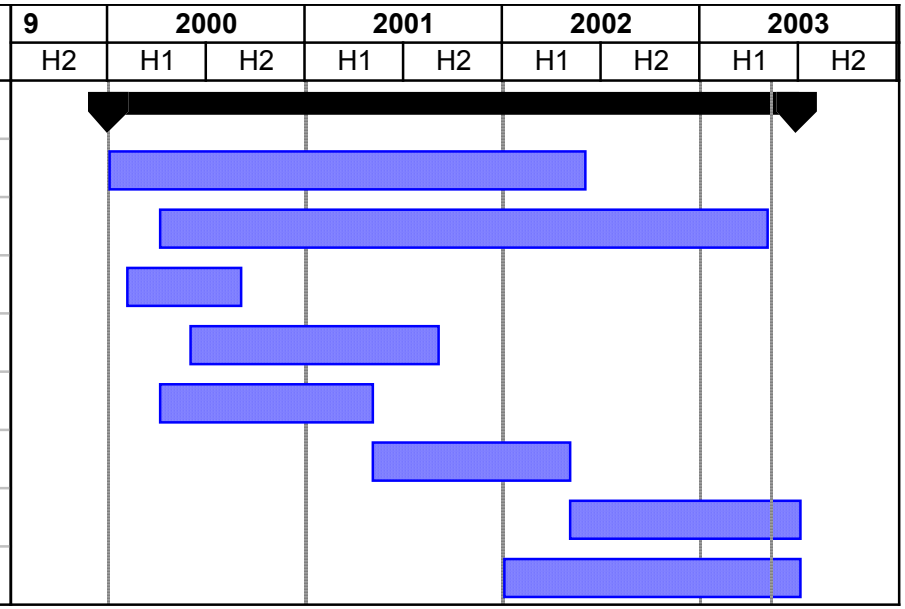
- Significantly reduce overall MEA cost by developing low precious metal loading vacuum catalyzation methods (0.2 g/rated kW by 2010).
- Improve prospects for practical implementation of FC technology in high-volume applications by demonstrating scalable, high-throughput manufacturing technology.
- Evaluate performance of materials under relevant fuel cell operating conditions to confirm process viability.

Primary Project Objectives

- Design, install, and demonstrate pilot manufacturing equipment capable of catalyzing up to 100,000 m^2 of electrode materials per year.
- Optimize loading, uniformity, composition, and throughput of catalyzed materials.
- Produce MEAs and benchmark against commercially available products.
- Incorporate MEAs into 2 “short” stacks and deliver to ANL for test and evaluation.

Timeline

ID	Task Name
1	**SwRI timeline**
2	Catalyst Optimization
3	MEA and Materials Testing
4	Process Cost Analysis
5	Large Area Proof of Concept
6	System Design and Specifications
7	System Construction and Installation
8	Pilot Trials and System Optimization
9	Stack Development and Testing

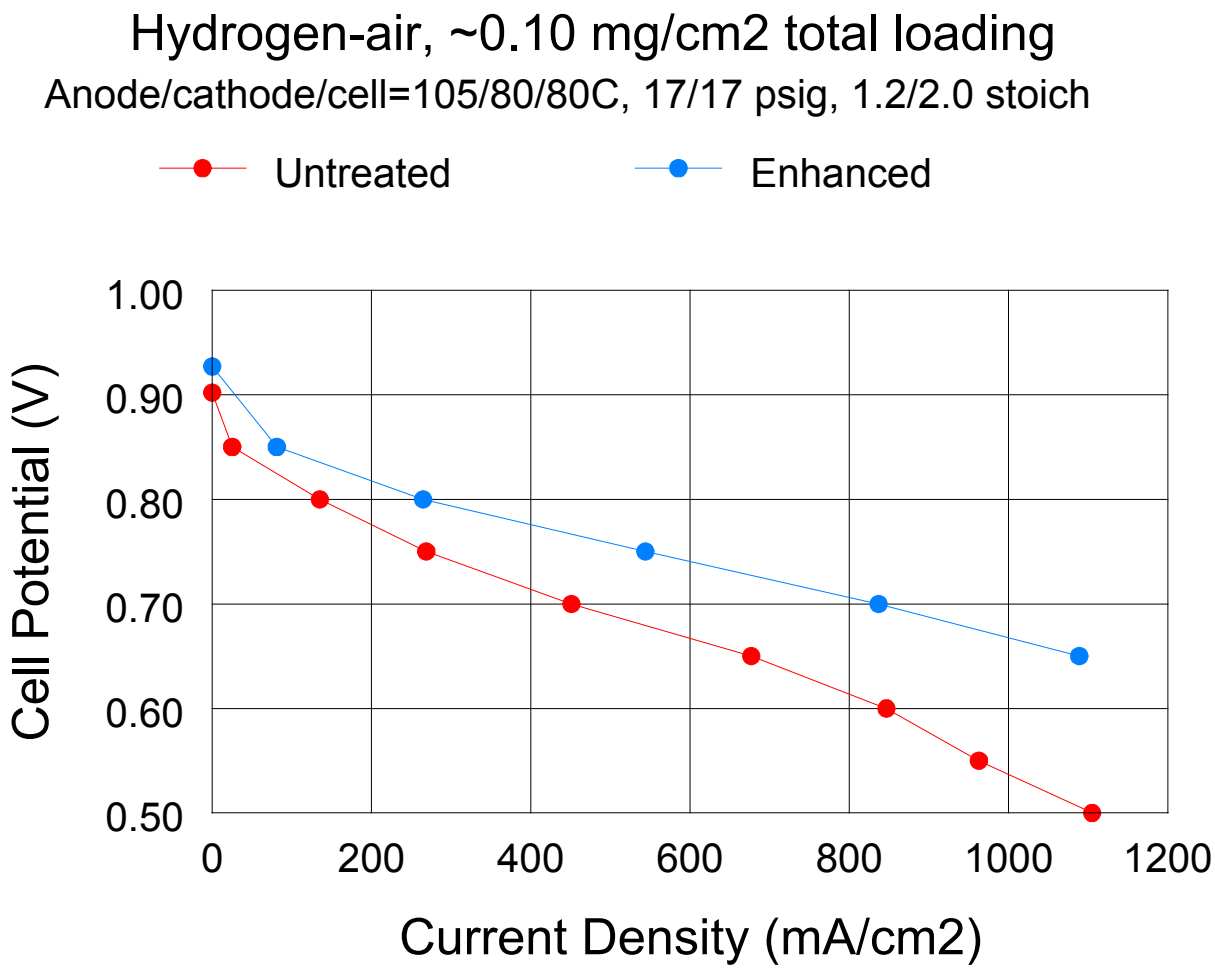


- **Major Milestones**
  - **Validated MEA fab/test methods**
  - **Completed MEA catalyzation cost analysis (go/no-go)**
  - **Pilot system complete and on-line**
  - **MEAs delivered to Gore and GM for testing and evaluation**

Sample Electrode Material

- Several thousand linear feet of material supplied by W.L. Gore and Associates for use in pilot manufacturing trials .

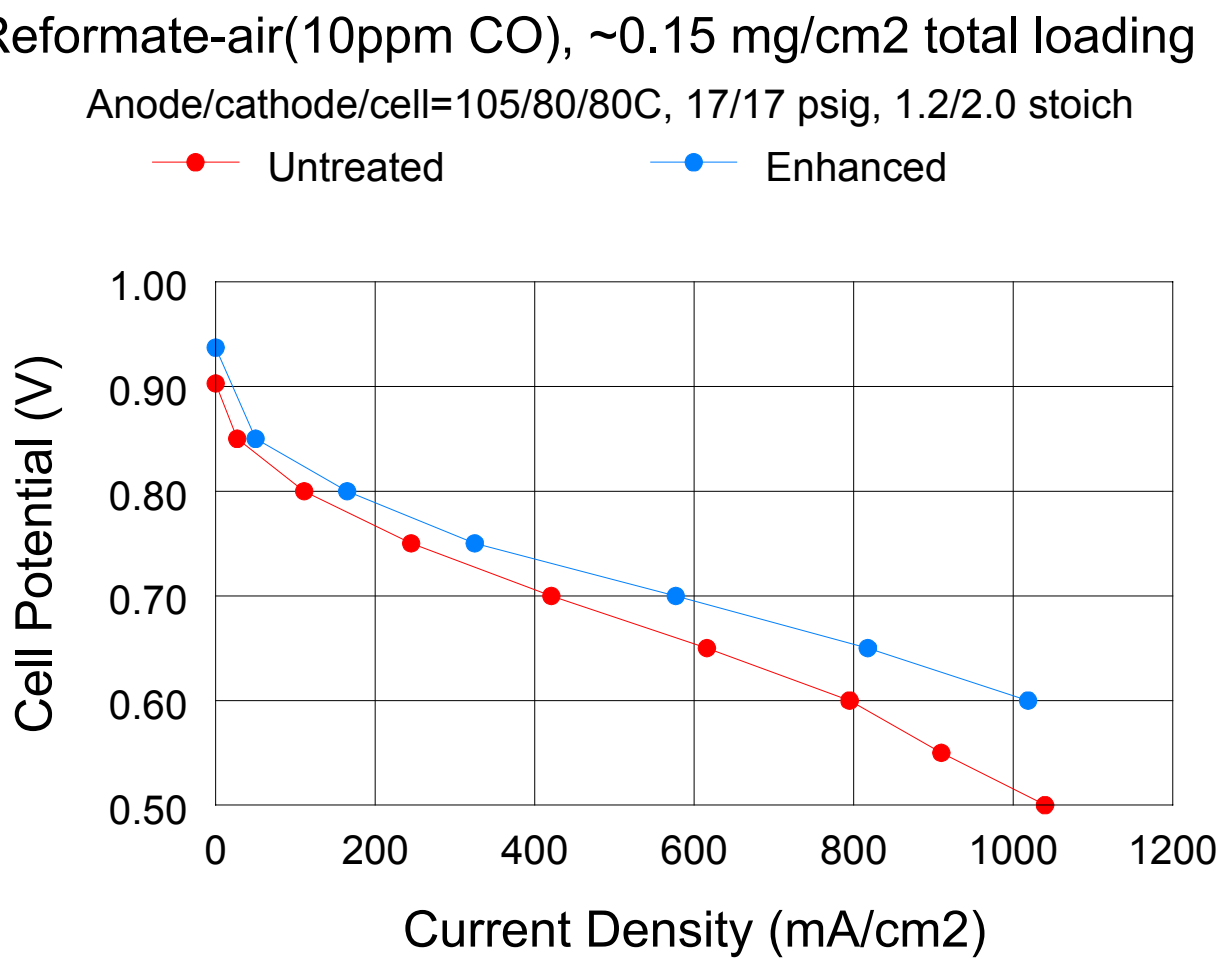
Sample MEA Performance H2-Air



MEA Performance Reformate-Air

Reformate-air(10ppm CO), ~0.15 mg/cm2 total loading

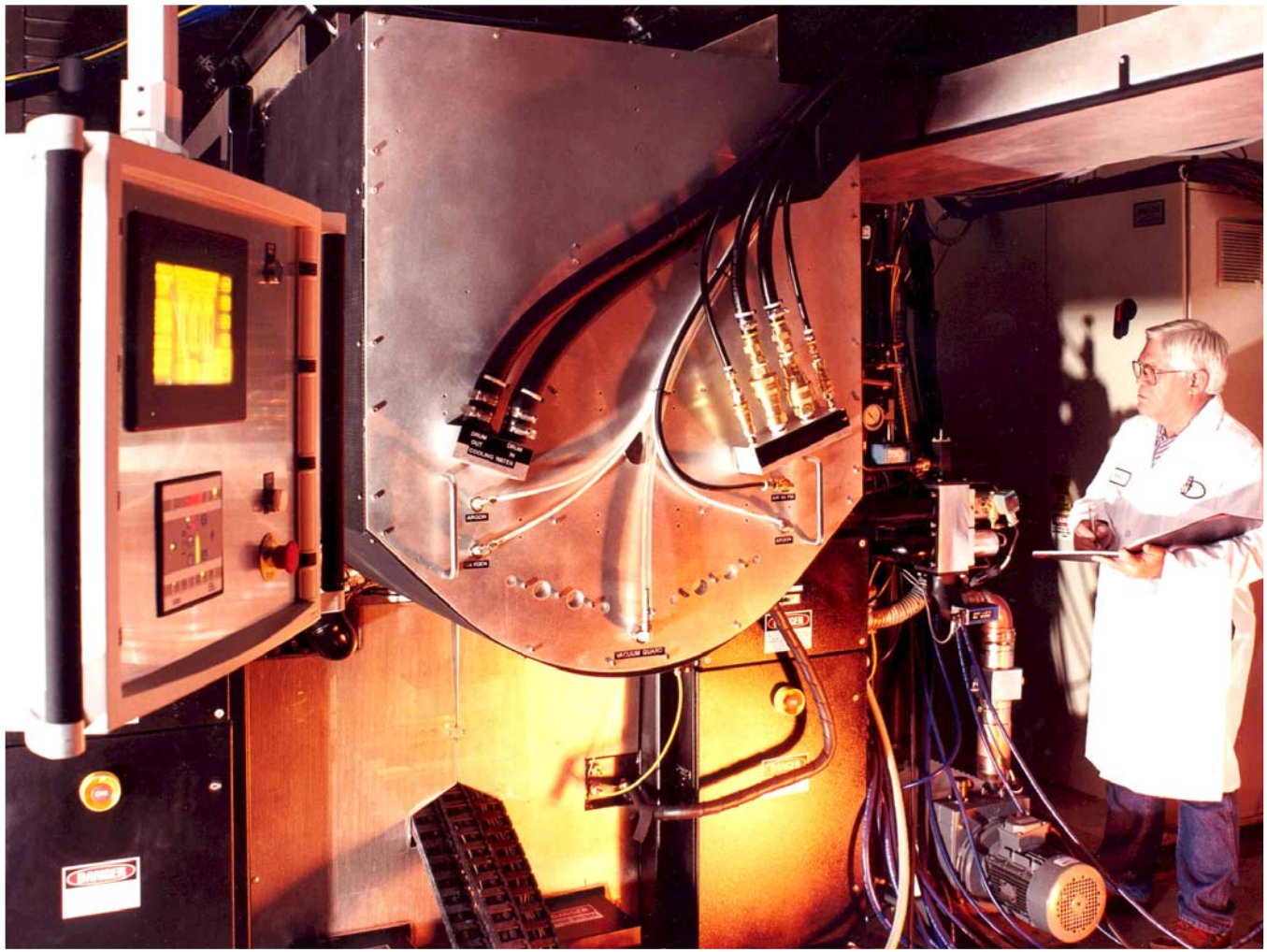
Anode/cathode/cell=105/80/80C, 17/17 psig, 1.2/2.0 stoich



SwRI Fuel Cell Material Manufacturing Facility

- Fully automated, touch-screen control
- Data logging of critical process parameters
- Real-time closed-loop control of catalyst deposition rate
- Estimated ability to catalyze enough electrode materials to make ~10,000 fuel cell “engines” each year

Virtual Tour of Facility



Accomplishments in Past Year

- Catalyzed over 3000 linear feet of electrode material as part of ongoing system optimization and production yield studies.
- Demonstrated >85% recovery of unused catalyst from shielded areas.
- Investigated effects of cell assembly, GDM, and test conditions on performance of vacuum catalyzed materials in conjunction with Gore and GM.
- Fabricated and delivered sufficient full scale (800 cm^2) MEAs for short stack evaluation at GM on reformate and H_2/air.

Remaining Tasks

- Completion of small cell durability testing at Gore.
- Conduct additional electrochemical impedance testing in concert with Gore to further investigate effects of certain key pilot system parameters.
- Final testing and delivery of stacks to ANL.

Directions for Future Research

- Large area, ultra-thin Pd alloy membranes for hydrogen purification.
- Catalysts for unitized reversible fuel cells.
- Non-precious metal fuel cell catalysts.