Martin County
Hydrogen Fuel Cell Development

Elizabeth Rehbock

Microcell Corporation

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Project ID: FC074

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Overview

Timeline

- Start – 08/01/2008
- Finish – 07/31/2010

Barriers

- Barriers
  - Low precious metal loading
  - High volume manufacturing
  - Efficient heat recovery

Budget

- Project funding
  - DOE - $1,919,250
  - Cost Share - $600,386

Partners

- Martin County Economic Development Corporation
- Microcell Corporation

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Company Information

- Formed in 2000
- Funded by NIST in 2001
- R & D Facility
  - Raleigh, NC
- Manufacturing Facility
  - Robersonville, NC
- Product Focus
  - High efficiency, Micro-CHP and back up power products
- Technology Platform
  - Micro-tubular PEM fuel cells
- www.microcellcorp.com

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Microcell Technology

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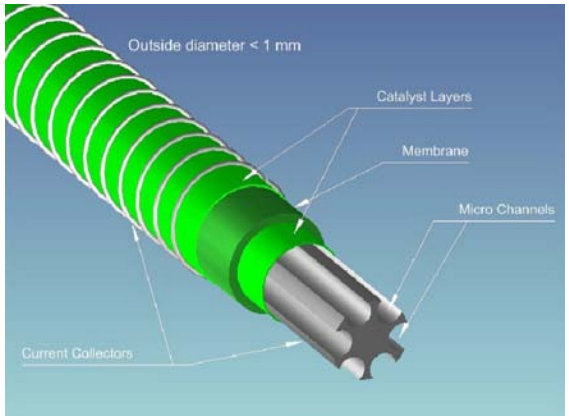
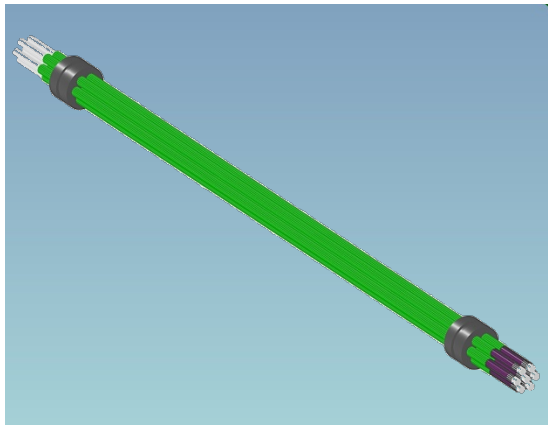


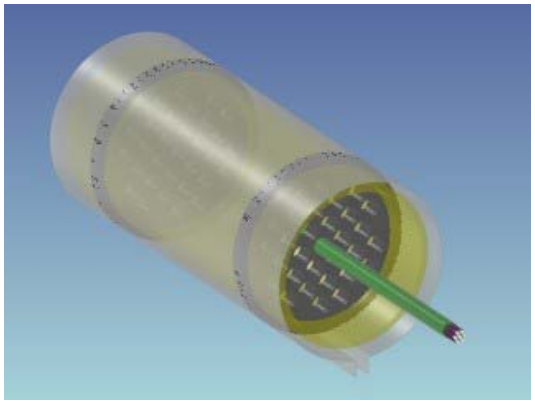
- Approximately 1-1.5W per cell
- Mass produced on automated extrusion line

Unicell



- 10 – 15W per Unicell
- Fuel, air and thermal management incorporated

Module



- Fuel cell Cores: 0.5-10kW

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Micro-CHP Fuel Cell Products

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Product Specification Data Sheet

PRODUCT CHARACTERISTICS	MGEN500	MGEN1000	MGEN2000
Fuel Cell Module			
Type	PEM	PEM	PEM
Power Output (Nominal)	500 W	1,000 W	2,000 W
Power Output (Peak)	750 W	1,250 W	2,500 W
Output Voltage	48 Vdc	48 Vdc	48 Vdc
Output Voltage Regulation	+/- 5%	+/- 5%	+/- 5%
Start Up Time	<1 min to 50% load	<1 min to 50% load	<1 min to 50% load
Optional Hot Water Heater			
Size	5 gallon	30 gallon	40 gallon
Temperature	Adjustable, 130° F max	Adjustable, 130° F max	Adjustable, 130° F max
Time to Temperature	1-2 hours	1-2 hours	1-2 hours
Dimensions (standard), inches	24x21x16	27x25x17	30x30x17
Custom	per specification	per specification	per specification
(Not including fuel storage)			
Fuel Supply			
Hydrogen	Industrial Grade	Industrial Grade	Industrial Grade
Fuel Pressure	>5 psi (supply) 5 psi (on board)	>5 psi (supply) 5 psi (on board)	>5 psi (supply) 5 psi (on board)
Operation			
Warranty	1 yr	1 yr	1 yr
Extended-Warranty (optional)	5 yr	5 yr	5 yr
Emissions			
Water	<0.75 liters/hour	<1.3 liters/hour	<2.0 liters/hour
Noise	<65 dBA at 1 meter	<65 dBA at 1 meter	<65 dBA at 1 meter
Heat	< 3415 BTU/hr at peak power	< 6830 BTU/hr at peak power	< 10245 BTU/hr at peak power
Control	Microprocessor with LED panel and alarms	Microprocessor with LED panel and alarms	Microprocessor with LED panel and alarms
Monitoring	Local/Remote	Local/Remote	Local/Remote

Specifications subject to change without notice.

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Markets/Customers

- Electric utility back-up power applications
- Data Centers
- Sub-stations
- Disaster Recovery
- Telecommunication
- Military

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Relevance

The main focus of the Martin County Hydrogen Fuel Cell Development Project is to advance the high volume manufacturing processes of a microfiber PEM fuel cell technology.

- Impact on barriers
  - Movement toward high-performance catalysts enabling ultra-low precious metal loading (DOE Multi-Year Research, Development and Demonstration Plan, Technical Plan – Fuel Cells - Barriers, Section 3.4.B).
  - Movement toward low-cost, high-volume manufacturing processes (DOE Multi-Year Research, Development and Demonstration Plan, Technical Plan – Fuel Cells - Barriers, Section 3.4.B).
  - Development of efficient heat recovery system for utilization of low-grade heat to achieve the most efficient systems for distributed power generation (DOE Multi-Year Research, Development and Demonstration Plan, Technical Plan – Fuel Cells - Barriers, Section 3.4.E).

Relevance

- Low precious metal loading – Stationary Applications
  - 0.6-0.7 mg/cm^2 Total Platinum loading – Current
  - <0.5 mg/cm^2 Total Platinum loading – Near term
  - <0.3 mg/cm^2 Total Platinum loading – Long term

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Relevance

- High volume manufacturing
  - All components of single cell are extruded on line continuously
  - Fully automated extrusion process
  - Reduced material and component cost
  - Each extrusion line capable of producing 1-3 MW of fuel cells per year

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Relevance

- Advanced heat recovery system for utilization of low-grade heat to achieve efficient combined heat and power systems
  - Combined Heat and Power efficiency of >85%
    - 40% electrical, 45% thermal
  - Net CHP efficiency of >70%

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Technical Approach

Milestones	Progress Notes	% Complete
Task 1 Milestone: Compare the output of fuel cells produced on the manufacturing line at 1 meter/minute and 2 meters/minute to verify that extrusion line production speed can be reliably increased at the manufacturing level with a negligible decrease in performance.	Production line equipment has been procured/constructed, commissioned and installed at manufacturing facility. Extrusion production line testing at 2 meters/minute is underway.	80%

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Technical Approach

Milestones	Progress Notes	% Complete
Task 2 Milestone: Verify that power output of cells produced with scaled up Nafion® process meets minimum performance requirements of the cell.	The membrane preparation system has been designed, constructed and installed at the manufacturing facility. Manufacturing level volumes of membrane materials are now produced and successfully extruded with the requisite rheology and properties.	100%

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Technical Approach

Milestones	Progress Notes	% Complete
Task 3 Milestone: Develop new programs and software to enhance human interface and operability of single cell wrapping machines. Update software capability to make unit more efficient and increase productivity.	A new software program was developed for the single cell wrapping machines to allow usage of newer and faster computers with enhancements to enable faster wrapping speeds and increased cell throughput.	100%

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Technical Approach

Milestones	Progress Notes	% Complete
Task 4 Milestone: Show that fuel cell module production at a manufacturing level can meet the same performance targets as those produced at the research and development level.	Manufacturing SOPs have been developed and production equipment has been purchased, installed and commissioned. Manufacturing employees have been trained and shown successful module production at the manufacturing level.	85%

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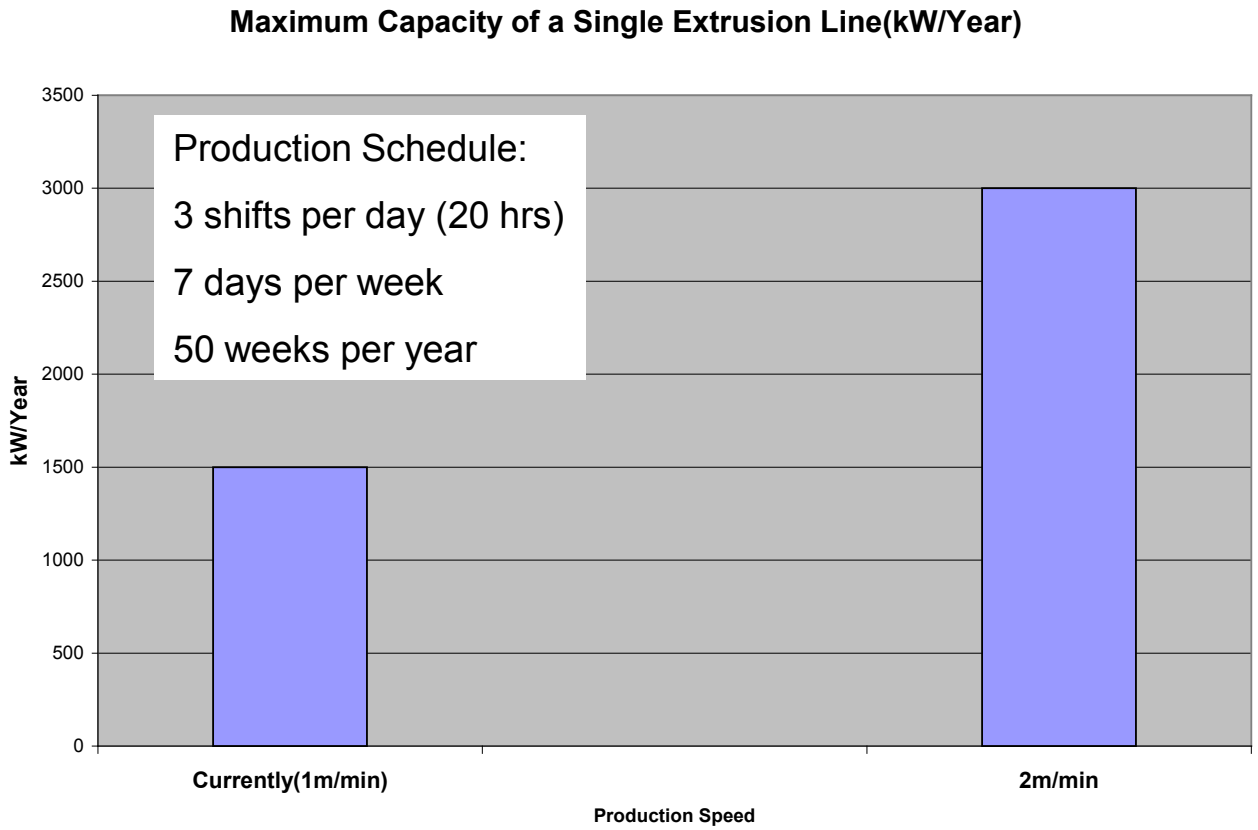
Technical Accomplishments and Progress

Increasing extrusion line speed increases production efficiency without negatively affecting cell performance showing the capability for high volume manufacturing.

(Work in Progress)



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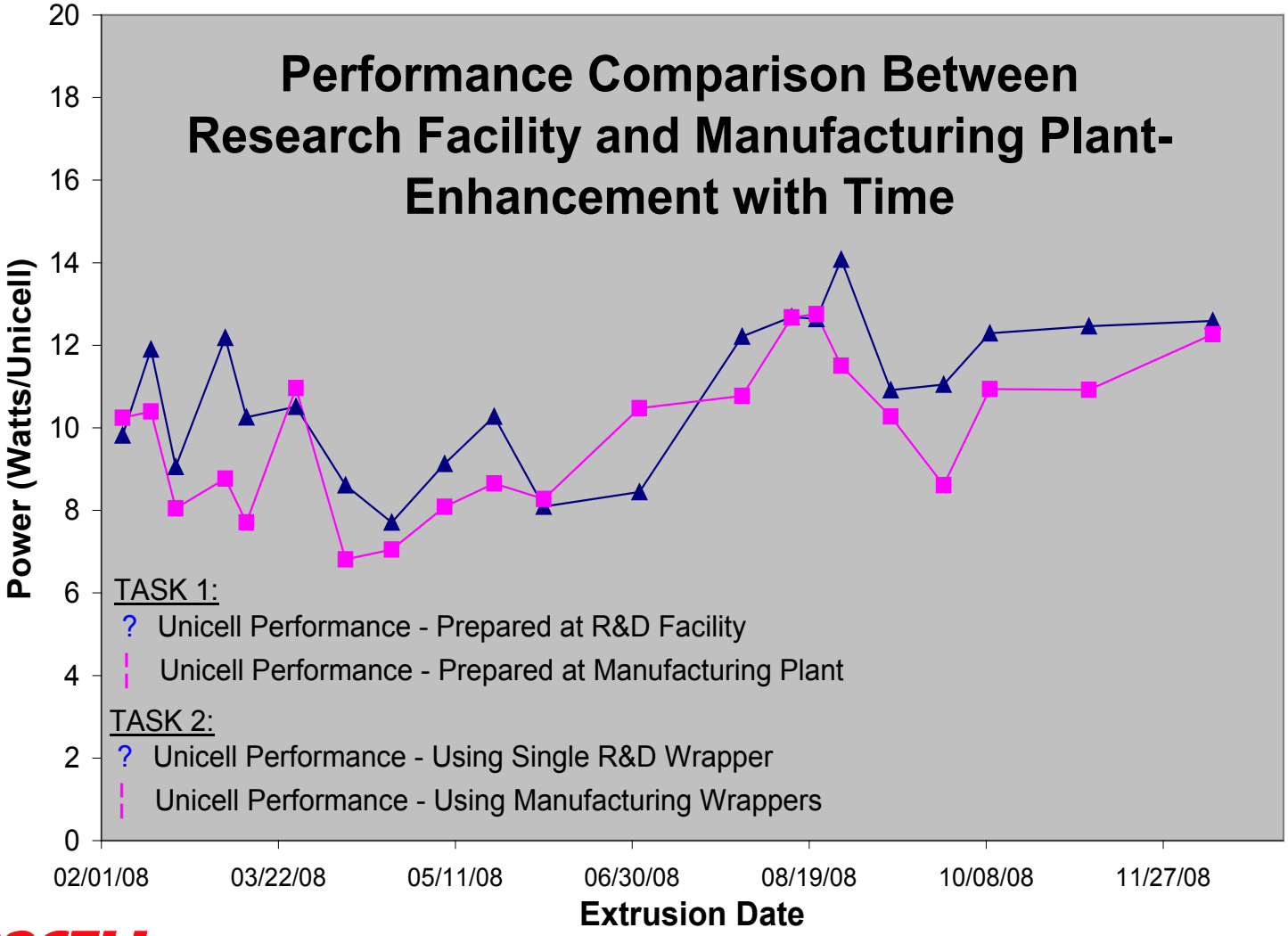
Technical Accomplishments and Progress (2008 Project)



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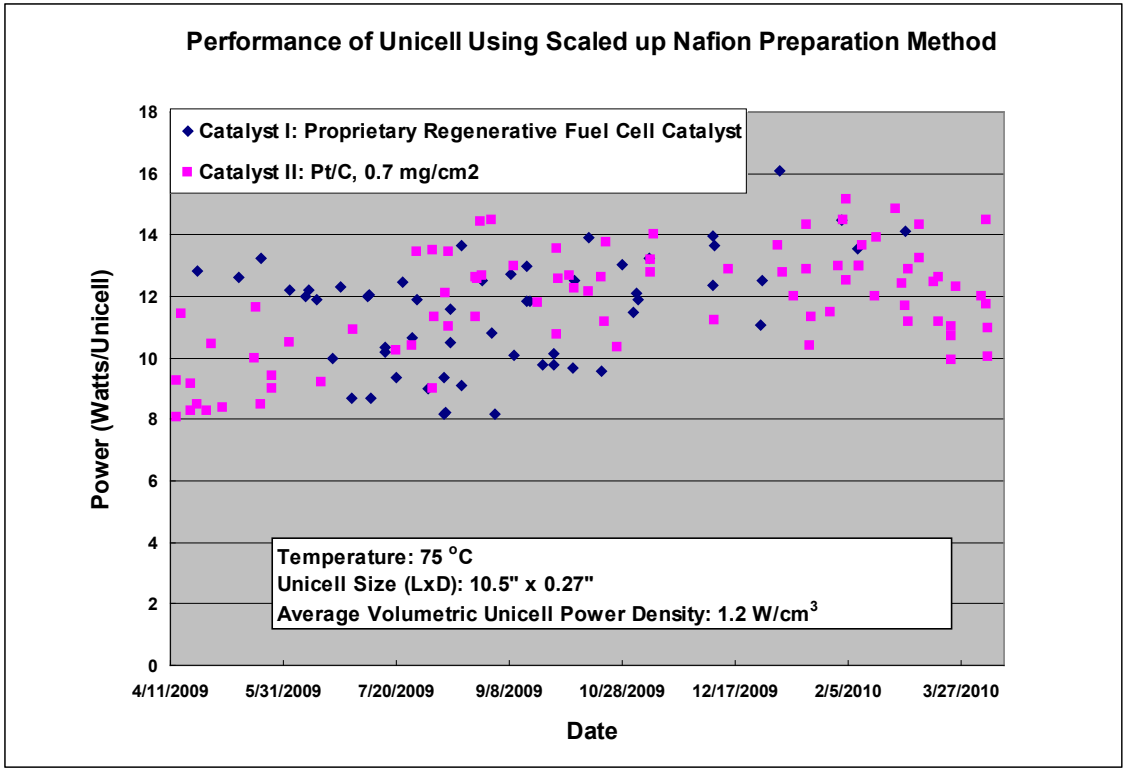
Technical Accomplishments and Progress

Develop and transfer new membrane production processes to manufacturing floor meeting minimum cell performance of 8-10 watts per unicell.



Nafion® is a registered trademark of E.I. du Pont de Nemours and Company

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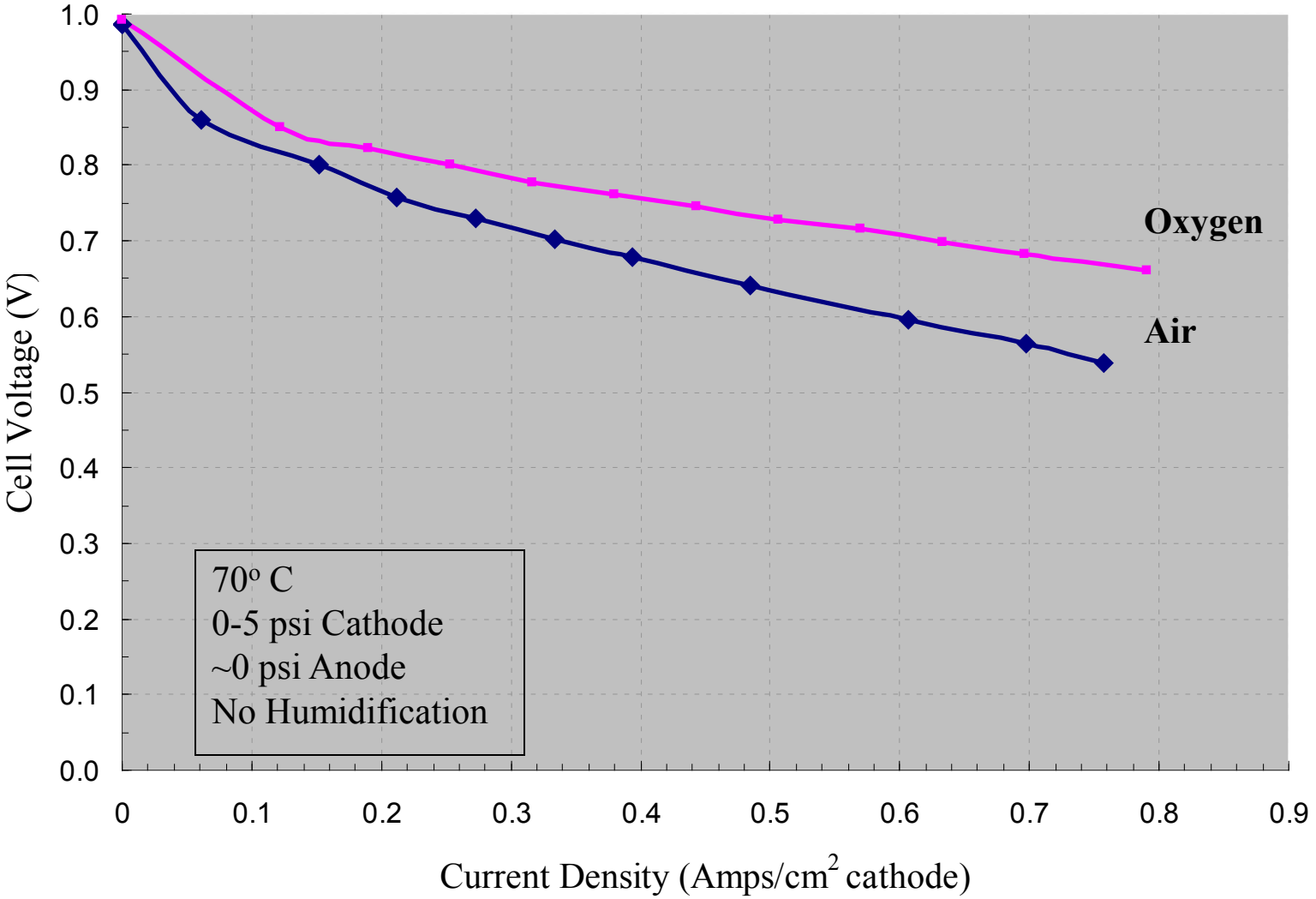
Polarization Curve - H_2 Fuel



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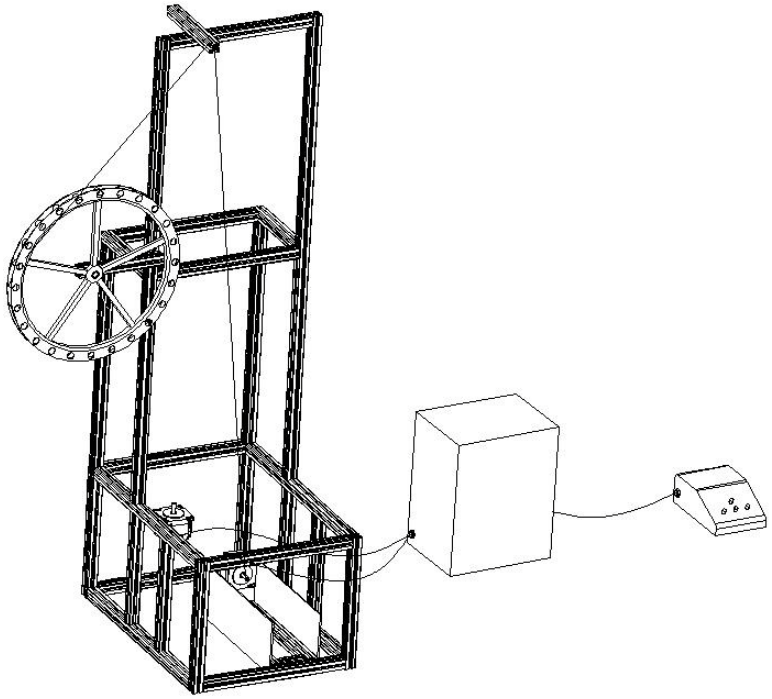
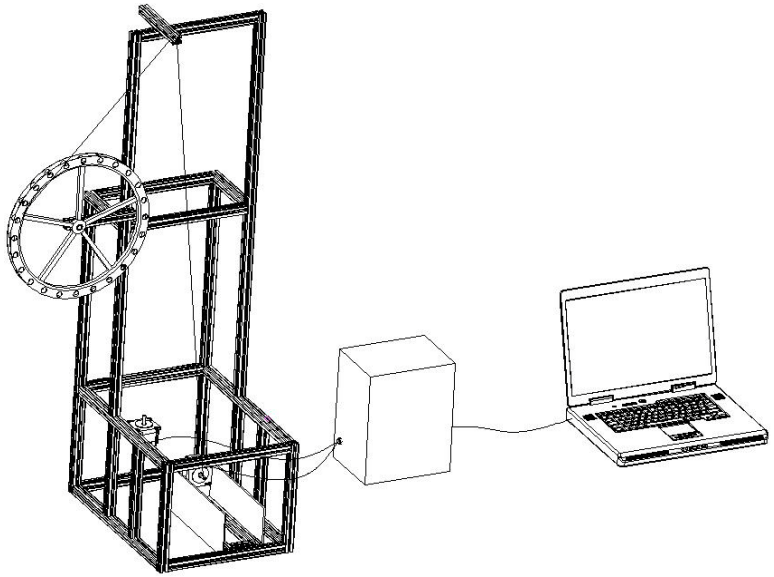
Technical Accomplishments and Progress



Push Button single cell wrapping machine



Automated laptop controlled single cell wrapping machine

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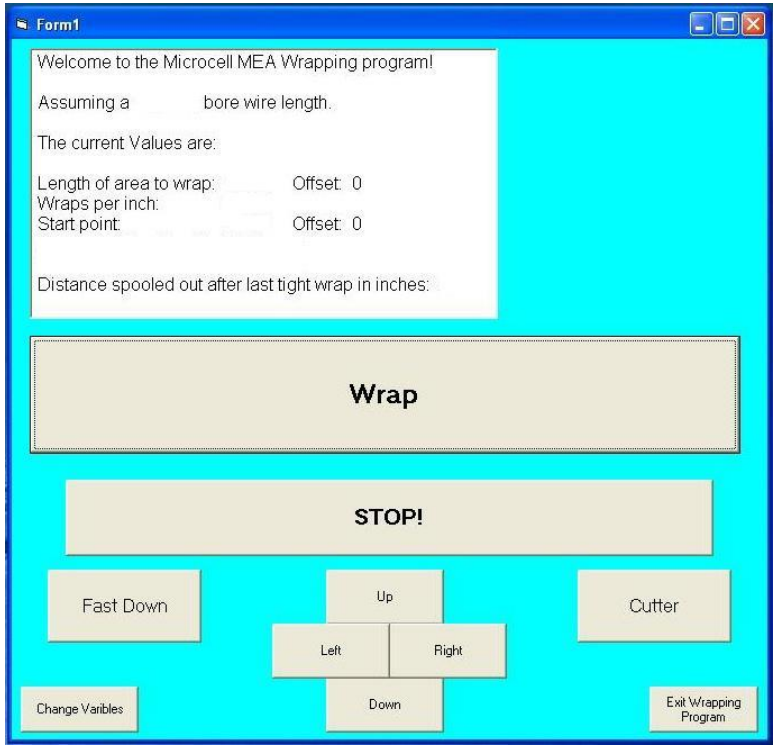
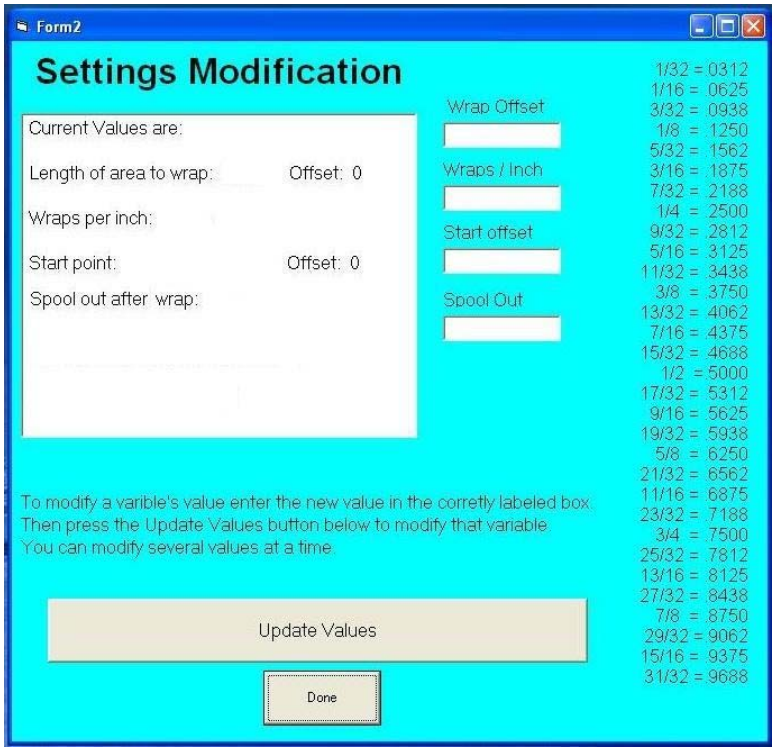
Technical Accomplishments and Progress

Design and develop industrial-grade automated cell production process equipment for mass production while maintaining quality and performance.





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Technical Accomplishments and Progress

Successfully transfer production of fuel cell modules to manufacturing plant while maintaining quality and performance.

Fuel Cell Module Characteristics

	Production	R&D
Operating Temperature	65-70C	65-70C
Module Size (inches)	3"OD x12"L	3"OD x12"L
Voltage	12	12
Single Cell Voltage	0.6	0.6
Current(A)	44.2	45
Power (W)	530	540

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Collaborations

- Martin County Economic Development Corporation – Prime
- Microcell Corporation - Sub

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Proposed Future Work

FY10/FY11	Task 1	Scale manufacturing process to produce 3 kW commercial units
FY10/FY11	Task 2	Reduce total catalyst loading to < 0.5 mg/cm^2
FY10/FY11	Task 3	Implement Lean Engineering practices at the manufacturing facility
FY10/FY11	Task 4	Further enhance and optimize cell extrusion process

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Summary

Relevance	To transfer a microfiber fuel cell technology's manufacturing process from a research and development level to a manufacturing environment and evaluate various parameters including production speed and product quality.
Approach	Task 1: Compare the output of fuel cells produced on the manufacturing line at 1 meter/minute and 2 meters/minute to verity that extrusion line production speed can be reliably increased at the manufacturing level with a negligible decrease in performance. Task 2: Verify that power output of cells produced with scaled up Nafion® process meets minimum performance requirements of the cell. Task 3: Develop new programs and software to enhance human interface and operability of single cell wrapping machines. Update software capability to make unit more efficient and increase productivity. Task 4: Show that fuel cell module production at a manufacturing level can meet the same performance targets as those produced at the research and development level.

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Summary

Technical Accomplishments and Progress	Task 1: Production line equipment has been procured/constructed, commissioned and installed at manufacturing facility. Extrusion production line testing at 2 meters/minute is underway. Task 2: The membrane preparation system has been designed, constructed and installed at the manufacturing facility. Manufacturing level volumes of membrane materials are now produced and successfully extruded with the requisite rheology and properties. Task 3: A new software program was developed for the single cell wrapping machines to allow usage of newer and faster computers with enhancements to enable faster wrapping speeds and increased cell throughput. Task 4:Manufacturing SOPs have been developed and production equipment has been purchased, installed and commissioned. Manufacturing employees have been trained and shown successful module production at the manufacturing level.
Collaborations	Martin County Economic Development Corporation – Prime Microcell Corporation - Sub
Proposed Future Work	Task 1: Scale manufacturing process to produce 3 kW commercial units Task 2: Reduce total catalyst loading to < 0.5 mg/cm^2 Task 3: Implement Lean Engineering practices at the manufacturing facility Task 4: Further enhance and optimize cell extrusion process