ElectroChem, Inc.
Company Profile
ElectroChem, Inc. envisions a future where a sustainable global economy resides in harmony with a clean, healthful environment.
ElectroChem’s founder Dr. Vinod Jalan, began work in the fuel cell industry in 1967.
ElectroChem Established its Corporate Headquarters Near Boston, Massachusetts
Electrochem’s Strength

• Active in the Fuel Cell Business Since 1986 in Research and Product Development

• Fuel Cell Stack Design and Fabrication Expertise

• Fuel Cell System Design and Fabrication Expertise

• Sales Experience With over 700 Customers in 70 Countries
• Unsurpassed Reputation in the Fuel Cell Industry
A Brief History

1986  *ElectroChem* is founded

1992  *Dr. Radha Jalan* becomes President and CEO of ElectroChem

1992  *First* to develop and sell a portable fuel cell system

1993  *First* to develop computerized test equipment

1995  *First* fuel cell company to be online: [www.fuelcell.com](http://www.fuelcell.com)

2002  *First* to develop a 5 independent cell test station

2005  Received *Massachusetts High Tech All Star Energy Award*

2006  Developed *Non-flow-through IFF Fuel Cell* for Space and Underwater power plant

2012  Patented *IFF (Integrated Flow Field)* cell design

[www.fuelcell.com](http://www.fuelcell.com)
ElectroChem’s Global Customers
More than 600 customers in 5 Continents

www.fuelcell.com
ElectroChem was the first to bring fuel cell products to the Internet at www.fuelcell.com
ElectroChem is one of the leading suppliers of fuel cell technology. Their products have added convenience, reliability and quality to our research and to the strive towards commercialization of a global fuel cell market. With a 20 year track record, and pioneering work with NASA, we are confident to turn to ElectroChem for quality test equipment.”

Johann Steyn, Chemical Engineer, Project AuTEK, Mintek, South Africa

“ElectroChem’s carbon backed electrodes are high performance and work extremely well. The company is very responsive and willing to custom tailor electrodes to meet our specifications.”

Dr. Gordon Calundann, CTO, PEMEAS GmbH/USA

www.fuelcell.com
Fuel Cell Test Equipment

“ElectroChem’s test station allows us to spend more time on our work and not on constantly monitoring the equipment. The company is a great industry resource.”

Richard Lewis, Development Engineer, Ballard Material Products

<table>
<thead>
<tr>
<th>Test Capability</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Methanol Test Capability</td>
<td>Manual Test Station</td>
<td>Ultima Multi-Cell Test Station</td>
</tr>
<tr>
<td>Gas Control /Humidifier</td>
<td>Automatic Electronic Load</td>
<td>Dual Range or Reformate Gas /Humidifier</td>
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</table>

www.fuelcell.com
ElectroChem Air Cooled Stack

<table>
<thead>
<tr>
<th>Model</th>
<th>EC-A500</th>
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<tbody>
<tr>
<td>Power</td>
<td>500 W</td>
</tr>
<tr>
<td>Number of cells</td>
<td>35</td>
</tr>
<tr>
<td>Dimension</td>
<td>24 x 36 x 15 cm</td>
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<tr>
<td>Weight</td>
<td>4 kg</td>
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<tr>
<td>Operating pressure</td>
<td>&lt; 21 psig</td>
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<tr>
<td>Operating temperature</td>
<td>55-60 °C</td>
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## ElectroChem Water Cooled stack

<table>
<thead>
<tr>
<th>Model</th>
<th>EC-500</th>
<th>EC-1000</th>
<th>EC-1500</th>
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<tr>
<td><strong>Power</strong></td>
<td>500 W</td>
<td>1000 W</td>
<td>1500 W</td>
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<tr>
<td><strong>Number of cells</strong></td>
<td>10</td>
<td>20</td>
<td>35</td>
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<tr>
<td><strong>Dimension</strong></td>
<td>17 x 24 x 12 cm</td>
<td>17 x 24 x 19 cm</td>
<td>17 x 24 x 34 cm</td>
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<td><strong>Weight</strong></td>
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<td>2.3 kg</td>
<td>3.5 kg</td>
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<td><strong>Operating pressure</strong></td>
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<td>&lt; 21 psig</td>
<td>&lt; 21 psig</td>
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<tr>
<td><strong>Operating temperature</strong></td>
<td>55-60 °C</td>
<td>55-60 °C</td>
<td>55-60 °C</td>
</tr>
<tr>
<td>Model</td>
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<td>Date received</td>
<td>Quantity Received</td>
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<tr>
<td>----------------</td>
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<tr>
<td>EC-CC1-060T</td>
<td>Carbon Cloth - Treated</td>
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<td>EC-20-10-7 Custom</td>
<td>Custom Electrode</td>
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<td>EFC-01-02</td>
<td>Fuel Cell Hardware</td>
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<td>FC25-MEA</td>
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<td>Nafion Membrane 211</td>
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<td>EC-NM-212</td>
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<td>EC-TP1-02</td>
<td>Nafion Membrane 211</td>
<td>3/10/2009</td>
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<td><strong>SUMMARY</strong></td>
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<td><strong>45</strong></td>
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</table>

**Quality Rating (%):** 100.0

ElectroChem’s (EC) “Product Quality” graded by Customers as Excellent – example of Toyo’s evaluation of EC compliance with ISO9001 standards.
ElectroChem Research Contracts

Layered PEM Stack

Integrated PEMFC Flow Field Design for
Gravity Independent Passive Water Control

Novel Conductive Water Removal Membrane
(CWRM) for PEM Passive Fuel Cell Operation

Feasibility of Electrolyzer Based Home Refueling System for
Advanced Plug-in Hydrogen Vehicle Applications

Develop High Efficiency Liquid-feed PEM Electrolyzer
Based on Integrated Flow Field (IFF) Structure

Develop Hyrophilic Conductive Coating Technology
with High Oxidation Resistance for Non-flow-through
PEM Fuel Cells and Electrolyzers

Advanced PEM Based Hydrogen Home Refueling Appliance
ElectroChem’s Customers In Contract R&D
Multilayered, Cost Effective Separator Plate

ElectroChem achieved Cost Reduction in Required Separator Plates

From $145 to $10

(a) Conventional Plate Design
(b) Layered Plate Design

www.fuelcell.com
Lower Balance of Plant Cost Technology

ElectroChem’s Integrated Flow Field (IFF) design has demonstrated to be stable at 0% excess oxygen (Non-flow-through operation). This has an enormous implications for higher system reliability and lower cost.
The ElectroChem IFF fuel cell achieves high energy efficiency by running on 100% fuel utilization.

**Benefits**
- Broad power ranges
- Quick start-up
- Rapid response to dynamic load changes
- 1-to-3 power ratio
- Minimal moving part and parasitic loads
- Low maintenance cost

![ElectroChem IFF Stack Test Load Profile](image)

4-cell, 200 cm² active area, 260 watt power output

www.fuelcell.com
Advanced Conductive Water Removal Membrane

- Solution for the Water flooding problem
- High electrical conductivity
- Low cost bipolar plate design

www.fuelcell.com
High Efficiency Hydrogen Production

ElectroChem’s membrane research produces more H₂ while using less electricity through electrolysis
## ElectroChem’s Innovations

<table>
<thead>
<tr>
<th>Name of Patent</th>
<th>Patent Number</th>
<th>Issue Date</th>
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<tbody>
<tr>
<td>Hydrogen/Fluorine Power Generating System</td>
<td>5,607,784</td>
<td>Mar 4, 1997</td>
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<tr>
<td>Integrated Flow Field (IFF) Structure for Use in Electrochemical Cells</td>
<td>8,313,870</td>
<td>Nov 20, 2012</td>
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ElectroChem, Inc.  
[www.fuelcell.com](http://www.fuelcell.com)
Fuel Cell System Design
Fuel Cell Powerplant for NASA’s 2nd Generation Reusable Launch Vehicle
First “commercial” fuel cell system sold to DOE in 1992 to power CD player
ElectroChem Featured in NASA Spinoff 1999

SBIR Technology Success Story

A new millennium technology headed for wider application in cars, homes, and power plants is the fuel cell. Operating like a battery but never in need of recharging, fuel cells run on hydrogen and oxygen. The heart of a fuel cell consists of an electrolyte sandwiched between two electrodes. An electrochemical reaction between the gases produces electrical energy; water, and heat. The cell’s waste product is water vapor, which can be used again in the system when broken down into hydrogen and oxygen. Clean running, efficient fuel cells are considered ideal for an energy-hungry world that is also endeavoring to reverse worrisome environmental issues.

ElectroChem, Inc., in Woburn, Massachusetts, has focused its engineering energies on solid polymer, or proton exchange membrane (PEM), fuel cells. The high-tech firm has sold hydrogen-oxygen fuel cells to the commercial market as a result of research performed under NASA’s Small Business Innovation Research (SBIR) program at the Glenn Research Center.

Glenn and the NASA Wallops Flight Facility needed a hydrogen-oxygen PEM fuel cell for use aboard balloon-carryed science platforms. The balloon-routed power system of choice is based on ElectroChem’s PEM fuel cell technology sponsored by NASA SBIR funds.

NASA needed a high-power, long-duration power system to energize electronic equipment. Moreover, the power system had to deliver power continuously, in a safe, reliable manner, and under a wide variance in temperature and pressure. ElectroChem met the challenge. The final result was a working hydrogen-oxygen fuel cell stack producing 500 watts of power. Water heat from the fuel cell maintained proper operating temperatures for the fuel cell, electronic equipment, and payload water.

Similar to NASA’s scientific balloons, business at ElectroChem has also soared skyward. The firm has gone from being solely a research company to commercialising products resulting in revenues of around $750,000 a year. Sales of its “fuel cell in a suitcase” have blossomed, with various government agencies and private industries, both in the United States and abroad, purchasing the energy-providing units. ElectroChem has started marketing its latest product, the EC-PowerPak200, a fan-cooled 200-watt fuel cell power system with automatic water draining and AC power outlets. Customers can plug in an assortment of appliances, such as radios, into the fuel cell outlets.

Other uses for the PEM fuel cell include recreational vehicles, stand-alone regenerative power systems, rural electrification, and using it as a power source for underwater vehicles. ElectroChem is committed to further fuel cell research, aimed at reducing fuel cell prices to a range that residential homeowners can afford.

Recent studies of the fuel cell market suggest sales reaching $1.3 billion by 2005. ElectroChem’s main goal is to develop small fuel cell power systems up to 5 kilowatts. This would allow the company to enter niche markets, then expand to cover off-grid applications in developing countries. To further critical research, the firm has established fuel cell laboratories in the United States and abroad.

“ElectroChem envisions a future where a sustainable global economy resides in harmony with a clean, healthy environment. Its mission is to provide fuel cell technology and products that this society will require for its energy supply,” says Radha Jalan, CEO of ElectroChem.
Balloon Fuel Cell Power System

NASA Lewis Research Center’s Electrochemical Technology Branch has teamed with the NASA Wallops Flight Facility to demonstrate the operation of a hydrogen-oxygen proton exchange membrane (PEM) fuel cell for application in the upper atmosphere. NASA Wallops’ Balloon Programs Branch has a requirement for a high-power, long-duration power system for use on a scientific balloon platform. The current power system will not meet those needs. The objective of this program is to deliver a 200-W (minimum) fuel cell system that can deliver approximately 10 kWh of electrical energy.

The Lewis team is responsible for designing, building, testing, and delivering a flight power system capable of meeting mission requirements. This power system will be based on a hydrogen/oxygen fuel cell developed as a result of a NASA Lewis Phase I Small Business Innovation Research (SBIR) PEM fuel cell program with ElectroChem, Inc.

The remote system must deliver power continuously, in a safe, reliable manner. It must be able to accommodate extreme ambient conditions, including a temperature range of -70 to 100 °F and a pressure range of 14.7 to below 1 psia. Waste heat, which is normally rejected by fuel cell systems, will be used to maintain proper operating temperatures for the fuel cell and the accompanying ancillary components, including the electronic equipment. It will also be used to maintain the temperature of the product water and to aid in proper water storage and/or discharge.

In addition to the extreme environmental conditions, the fuel cell power system must be able to withstand the physical forces and accelerations that will be encountered over the course of the mission. These forces are expected to reach as high as 8 to 10g. The initial flight is scheduled for early Summer 1997, and pending successful operation, the system will be reused on subsequent experimental balloon flights. The next planned program phase is to scale-up the fuel cell power system to 96 kWh of electrical output.

Lewis contact:
Dr. Patricia L. Loyerelle, (216) 433-2180, Patricia.Loyerelle@wm.nasa.gov
Authors: Dr. Patricia L. Loyerelle and Dr. Thomas M. Maloney (82264)
Headquarters program office: OSS

www.fuelcell.com
Popular Science magazine sees the credibility of ElectroChem’s vision of ECcell: a fuel cell and electrolyzer system.
ElectroChem, Inc.’s Emerging Product: ECcell™ Energy Storage System

ElectroChem’s ECcell™ Power System

- 4 kW, 4 hr Capacity
- Sealed System
- Reliable Design
- Long Life without Service
- Environmentally Safe
- Essentially Solid State

Power Inverter & System Controller

Uses
- Solar
- Wind
- Grid
- Biomass
- Telecom
- Computer Networks
- Homes

Power Sources

4' 7”

Uses
- Solar
- Wind
- Grid
- Biomass
- Telecom
- Computer Networks
- Homes
ECcell™ is Designed for a 10 Year Lifetime Reliability

Modular Design Adaptable for Various Applications
– Vary Fuel Cell Size to Desired Power Level
– Vary Electrolyzer Size for Different Regeneration Times
– Vary Gas Storage Sizes for Different Run-Times

ECcell™ Provides its Own Hydrogen Gas Fuel by Electrolyzing Water
- Entry Opportunity Into Premium Backup Power Markets
- EC has the proven technology to make a product which is affordable to the consumer and profitable to the manufacturer without high volume manufacturing.
The Market – HHR System

“We are working on the technology where we can charge hydrogen into fuel-cell vehicles at homes. So probably in the next 10 years we will get some level of infrastructure in place.”

Takeo Fukui, Chief Executive Officer, Honda Motor Company

Honda CEO Vies for Green Mantle, John Murray, June 16, 2008
Feasibility of Electrolyzer Based Home Refueling System for Advanced Plug-in Hydrogen Vehicle Applications

Final Report, April 2008

ElectroChemin’s Home Hydrogen Refueler System – HHR™

- High Pressure H₂ Output
- O₂ Venting
- AC/DC Converter & System Controller
- Pressure Regulators
- Water Condensers
- Electrolyzer Stack with Cooling Fans
- Tap Water Input
- Cooling Fan
- Water Reservoirs
- High Pressure Water Pump
- DI Water Cartridge

www.fuelcell.com
Conclusions

ElectroChem’s research continues to produce ground-breaking technological improvements in fuel cell theory, components, and sophisticated testing equipment for fuel cell research around the globe.

ElectroChem’s fuel cell research encompasses the needs of a diverse customer base; from powering NASA endeavors to developing a cost effective product to answer developing nations’ energy needs.

ElectroChem is interested in developing strategic relationships/partnerships with educational institutions, government agencies, and other business entities.

ElectroChem will continue to push the envelope of fuel cell technology and develop research successes into economically viable, commercial products.