Tape-Calendered SOFC Stack Development

Nguyen Q. Minh (nguyen.minh@alliedsignal.com; 310-512-3515)
Brandon Chung (chungb@alliedsignal.com; 310-512-3999)
Kurt Montgomery (kurt.montgomery@alliedsignal.com; 310-512-1557)
AlliedSignal Aerospace Equipment Systems
2525 West 190th Street
Torrance, CA 90504-6099

Abstract

Recent SOFC stack development efforts at AlliedSignal have been focused on demonstrating operation and performance at reduced temperatures (600 to 800 °C). A cost-effective process based on tape calendering has abeen developed for making reduced-temperature thin-electrolyte cells, and a stack design concept for this application has been evaluated. Use of thin-electrolyte cells reduces stack internal resistances, thus permitting efficient operation at lower temperatures. The proposed stack design incorporates thin-electrolyte cells with metallic interconnect assemblies (made from thin foils) to form a compact, lighweight structure. SOFC stacks based on this design have demonstrated excellent performance and high power densities.

To date, tape-calendered SOFC stacks of up to ten-cell height and 100-cm^2 footprint area have been fabricated. Stacks of various sizes have been tested and have shown excellent performance at reduced temperatures. For example, the power output of a two-cell stack (25-cm^2 footprint area) is about 26 W at 800 °C with hydrogen fuel and air oxidant (power density of 670 mW/cm^2). A five-cell stack (100-cm^2 footprint area) produces about 270 W at 800 °C (600 mW/cm^2) and 170 W at 700 °C (375 mW/cm^2). High stack power densities (1.03 kW/kg and 0.90 kW/L at 800 °C) have been demonstrated.

This paper discusses the development status of the tape-calendering process and the fabrication and operation of tape-calendered stacks at reduced temperatures.

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Tape Calendered SOFC Stack Development

Fuel Cells '97 Review Meeting

FETC, Morgantown, WV

August 26-28, 1997

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Tape Calendered SOFC Stack Development

- Approach
  - Reduced - Temperature Operation
  - Tape Calendering for Cell Fabrication
  - Stack Design
    - Low Cost
    - High Performance
    - Light Weight and Compactness
- Funding
  - GRI (Dr. Kevin Krist)
  - DARPA (Drs. Larry Dubois, Robert Rosenfeld, Robert Nowak)

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Reduced-Temperature SOFCs

- Operating Temperature of 600° - 800°C
- Conventional Materials with Thin YSZ Electrolytes
- Key Advantages
  - Wider Material Choice
  - Increased Cell Life
  - Reduced Fuel Cell Cost
  - Improved Reliability

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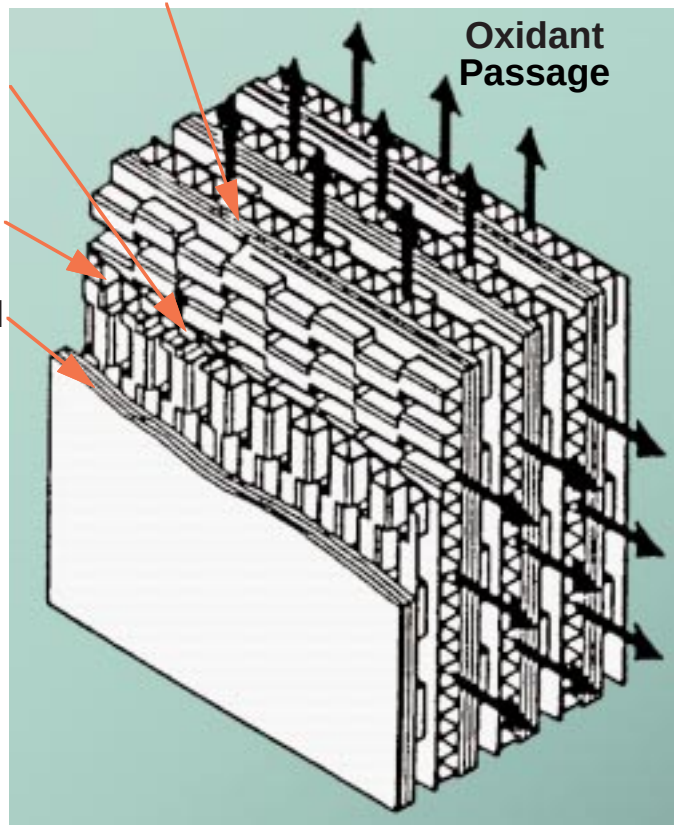
Stack Configuration



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Design Features

Thin-Film Electrolytes to Permit Efficient Operation at Reduced Temperatures

Lightweight Metallic Structures to Achieve High Power Densities

Low-Cost Materials and Fabrication Processes

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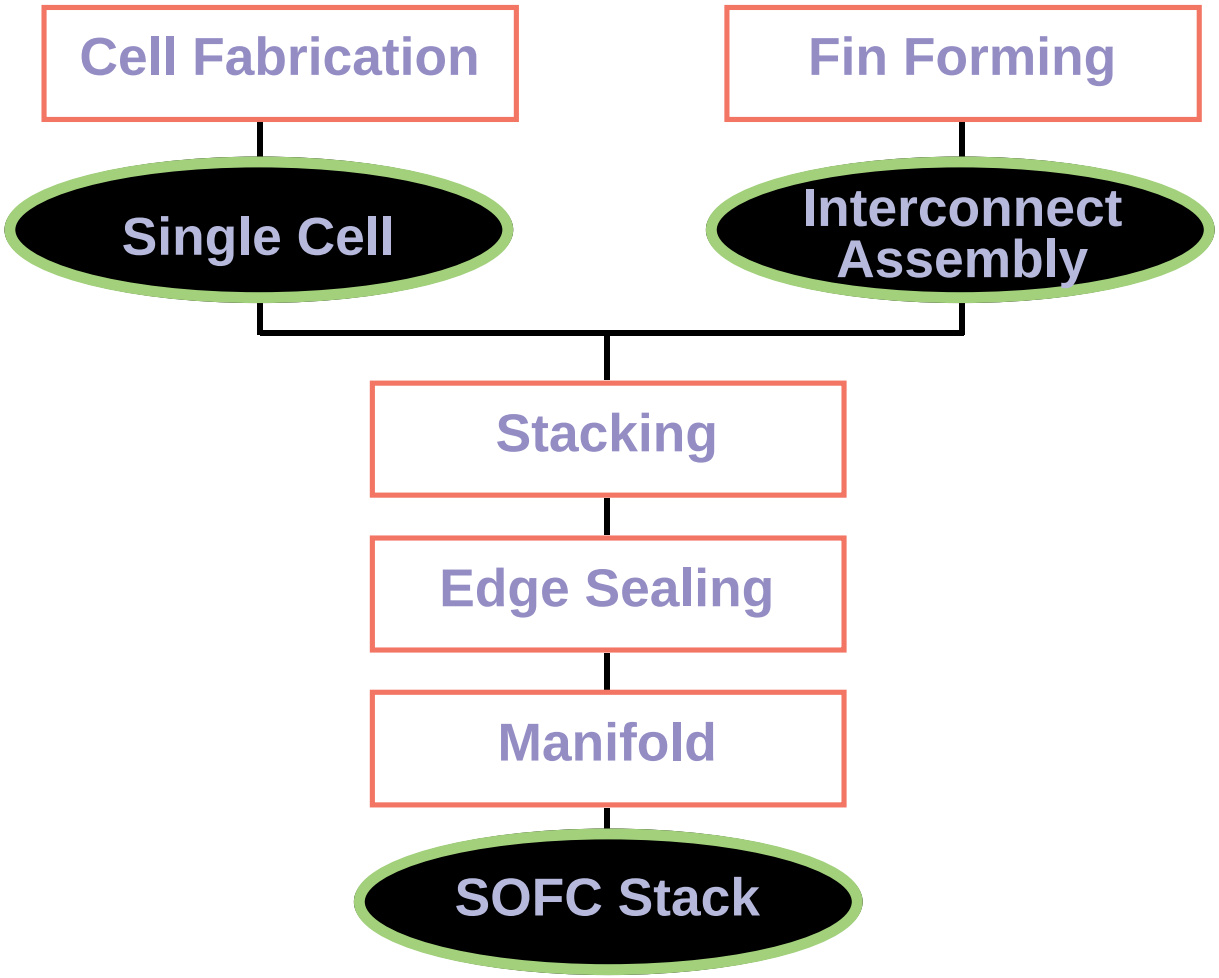
Stack Assembly Processes



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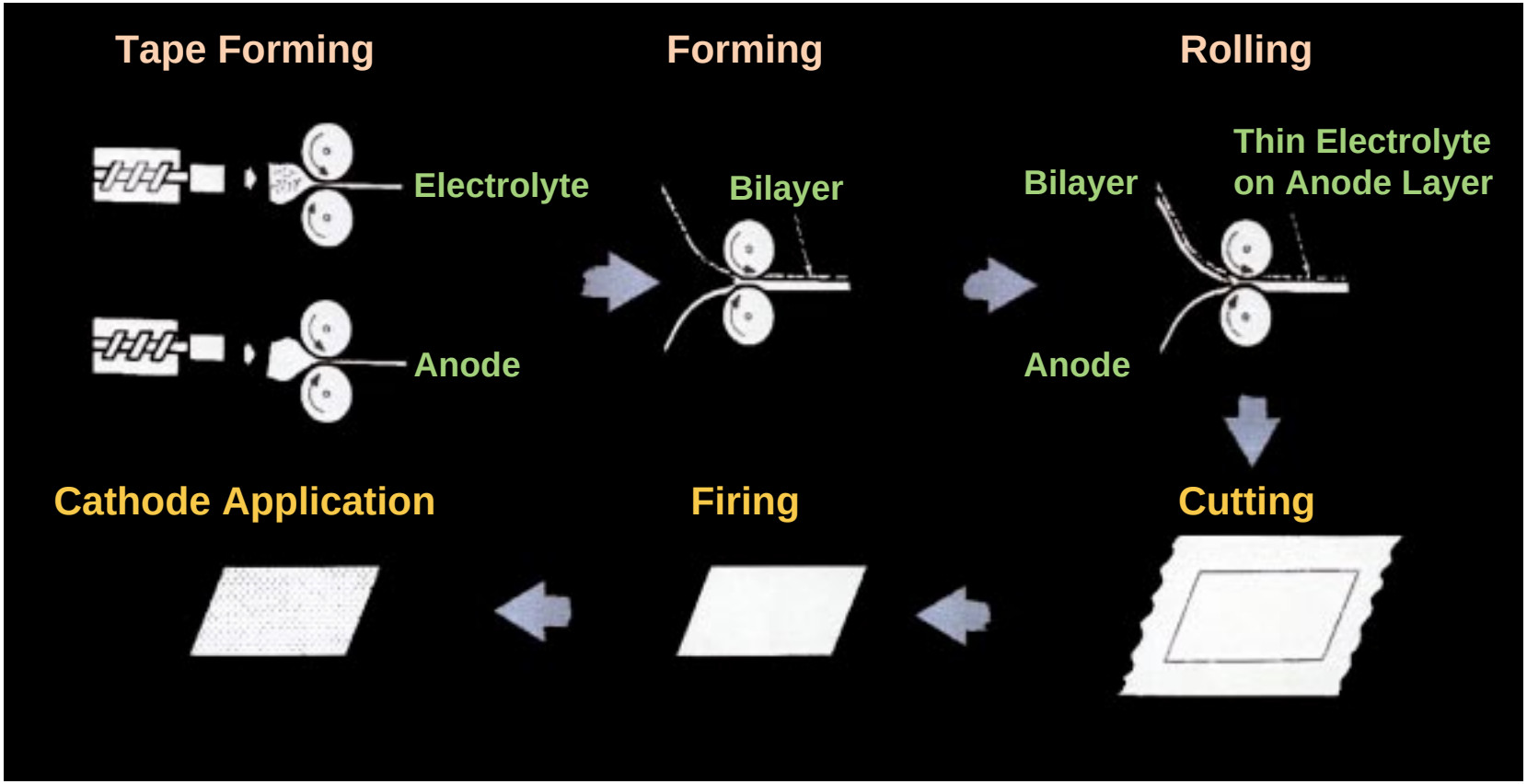
Thin-Electrolyte SOFC Fabrication Sequence



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Photograph of Single Cell

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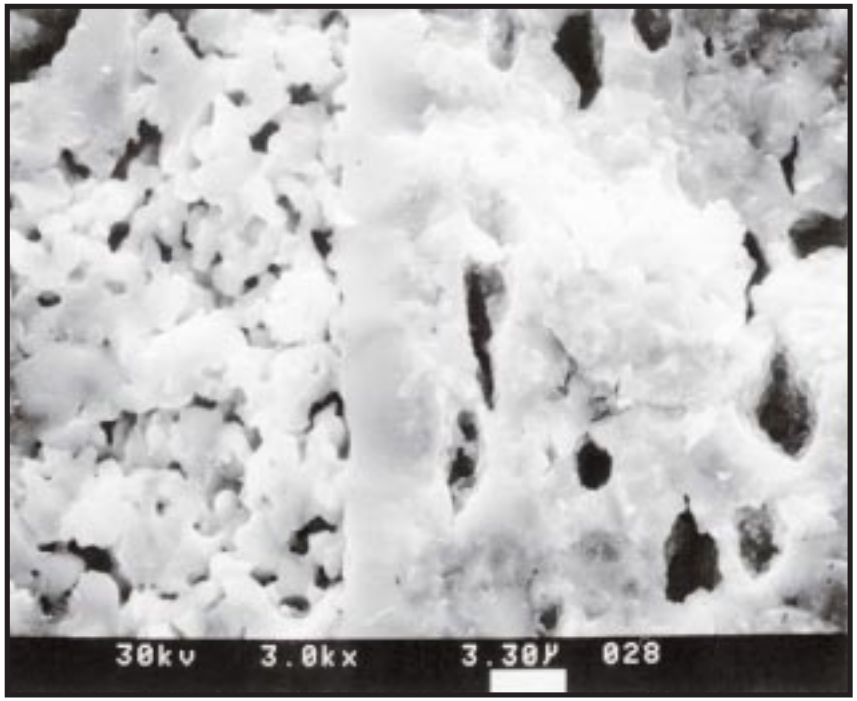
Thin Electrolyte Cell

Fracture Surface

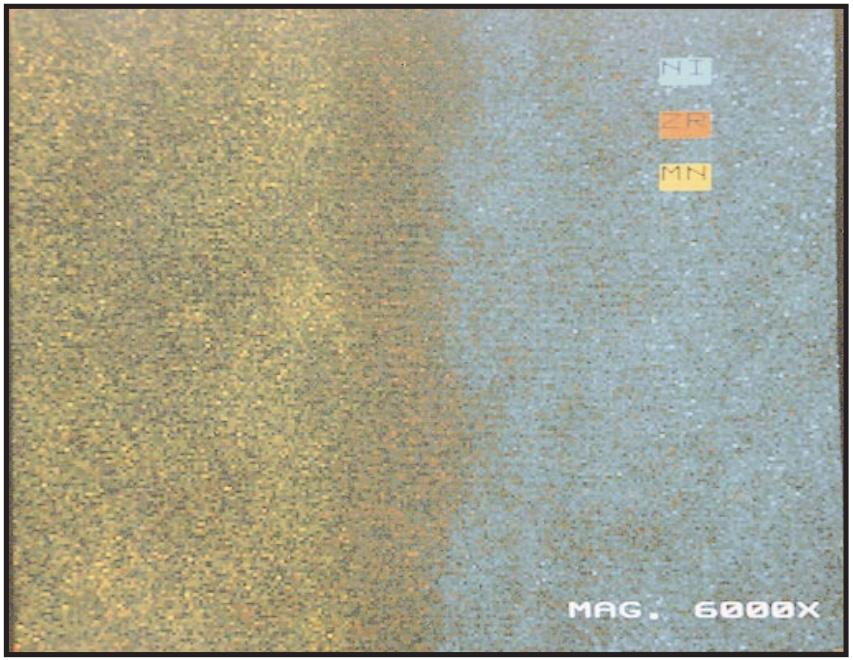
$LaMnO_3$
Cathode

ZrO_2
Electrolyte

NiO/ZrO_2
Anode



Element Mapping



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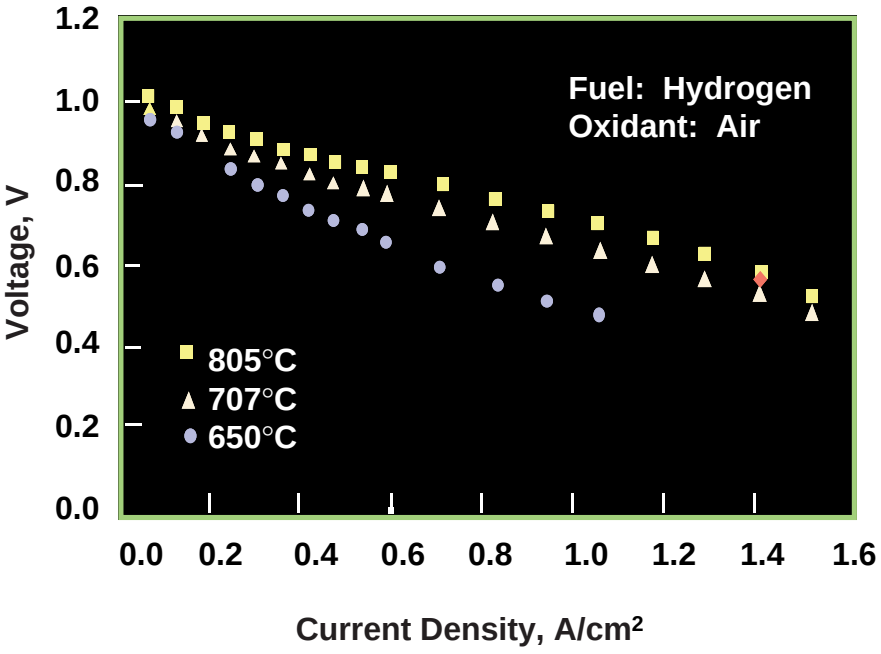
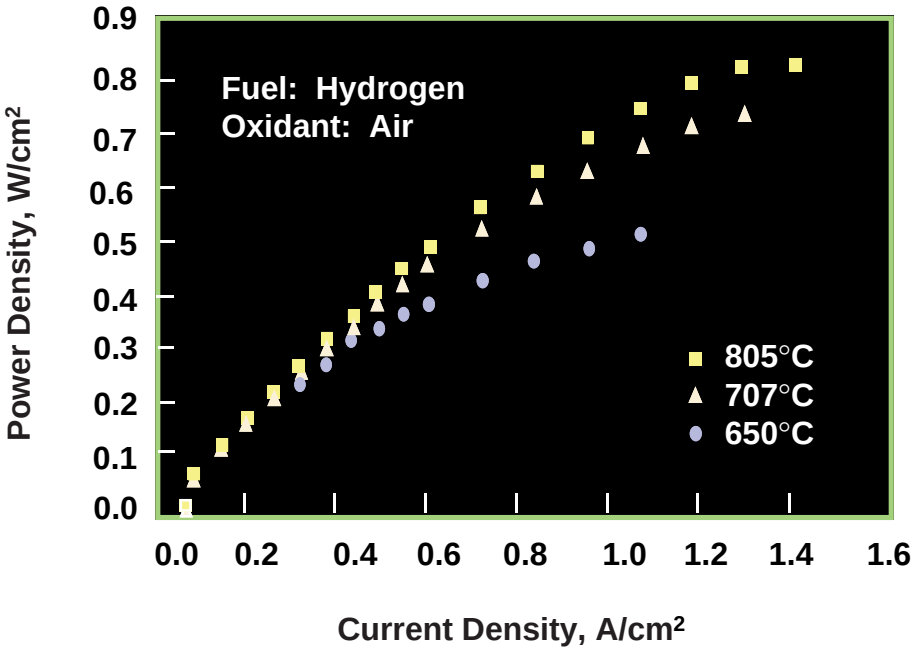
Performance of Thin-Electrolyte Single Cell





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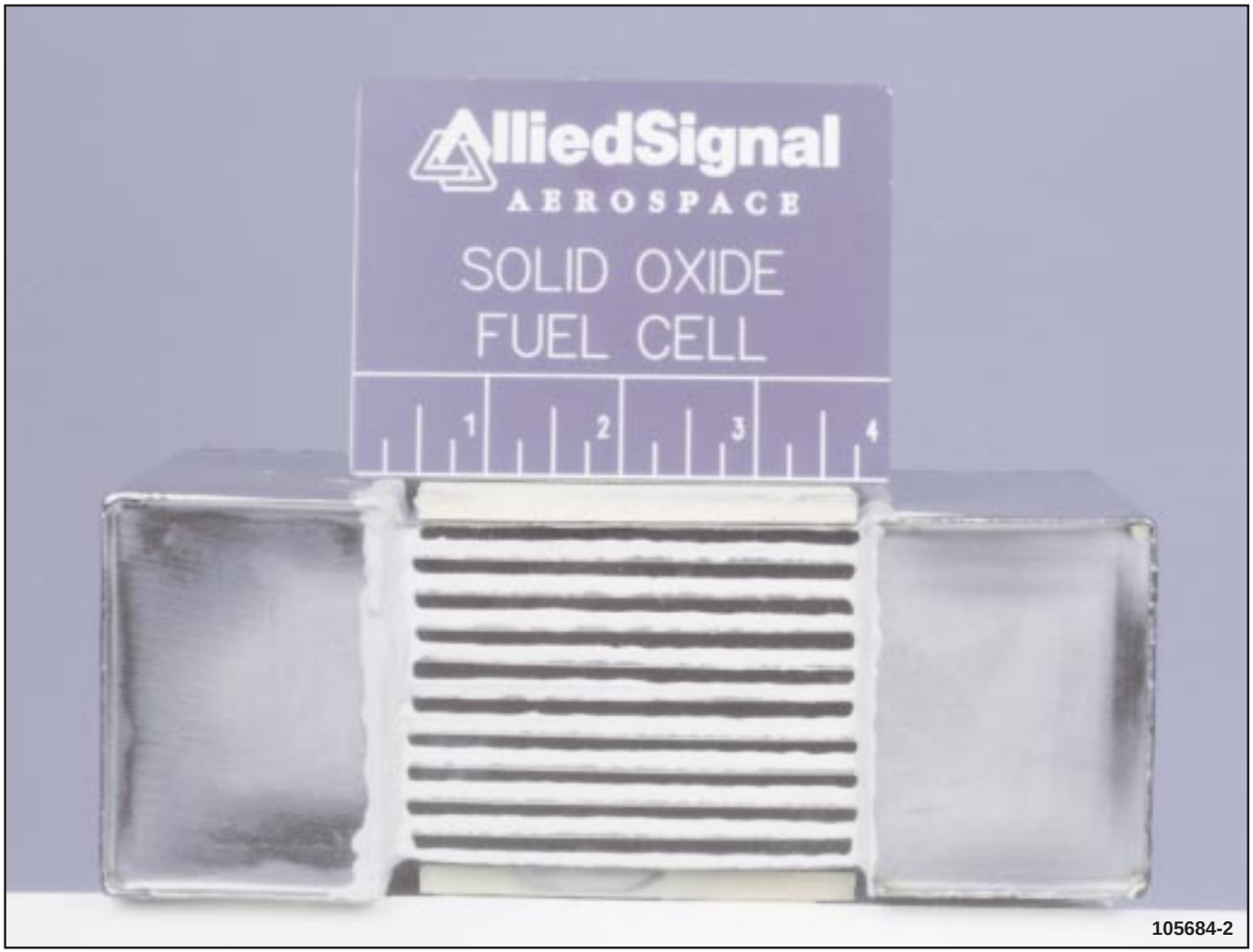
Ten-Cell Stack



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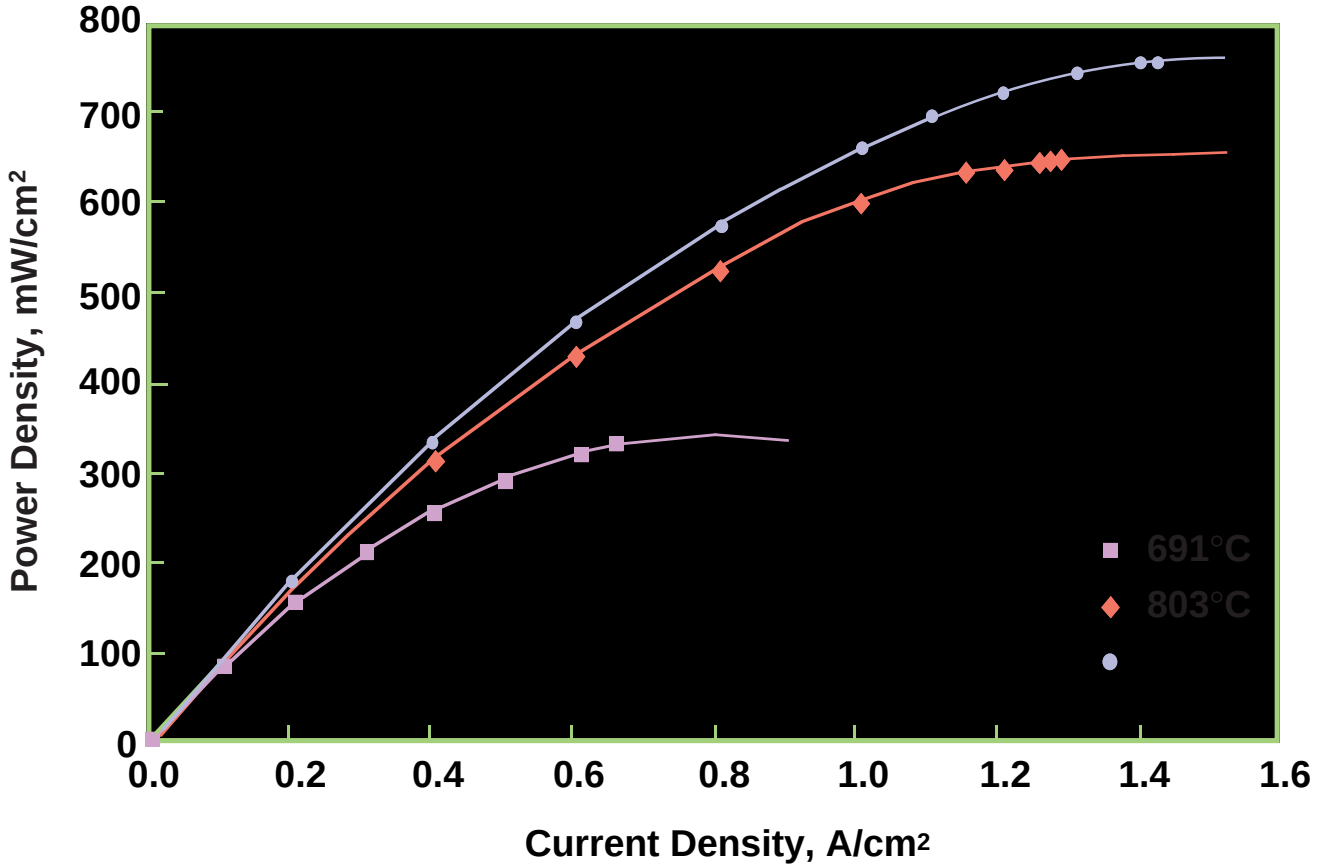
Power Density Curves of Two-Cell Stack



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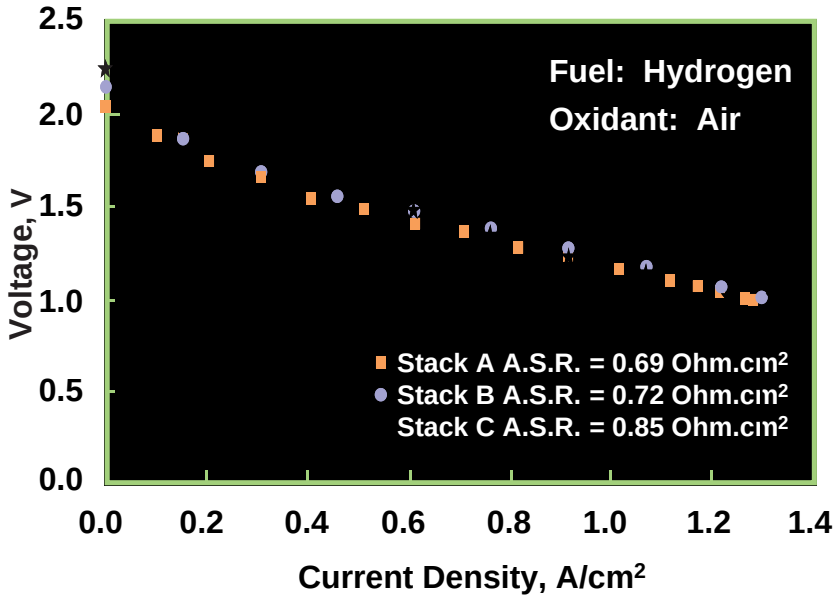
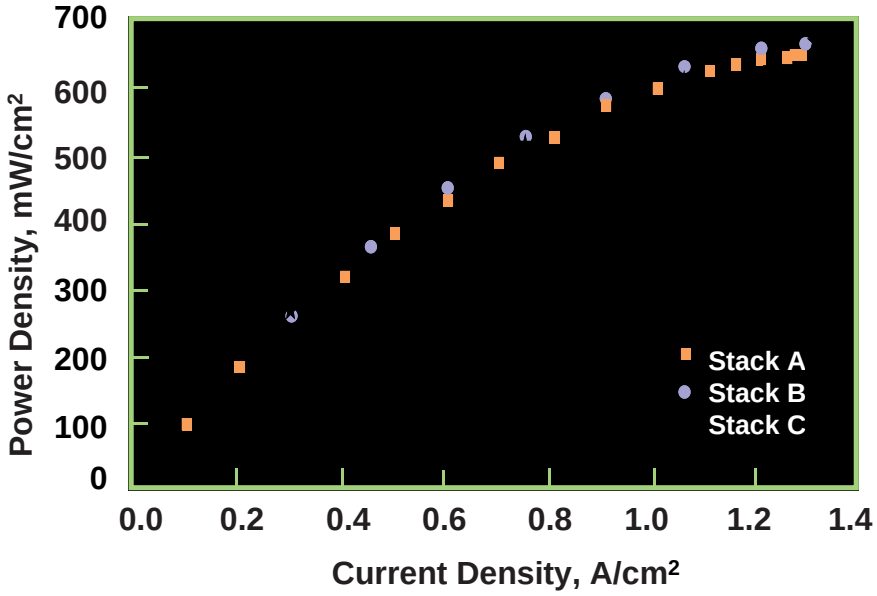
Performance of Two-Cell Stacks





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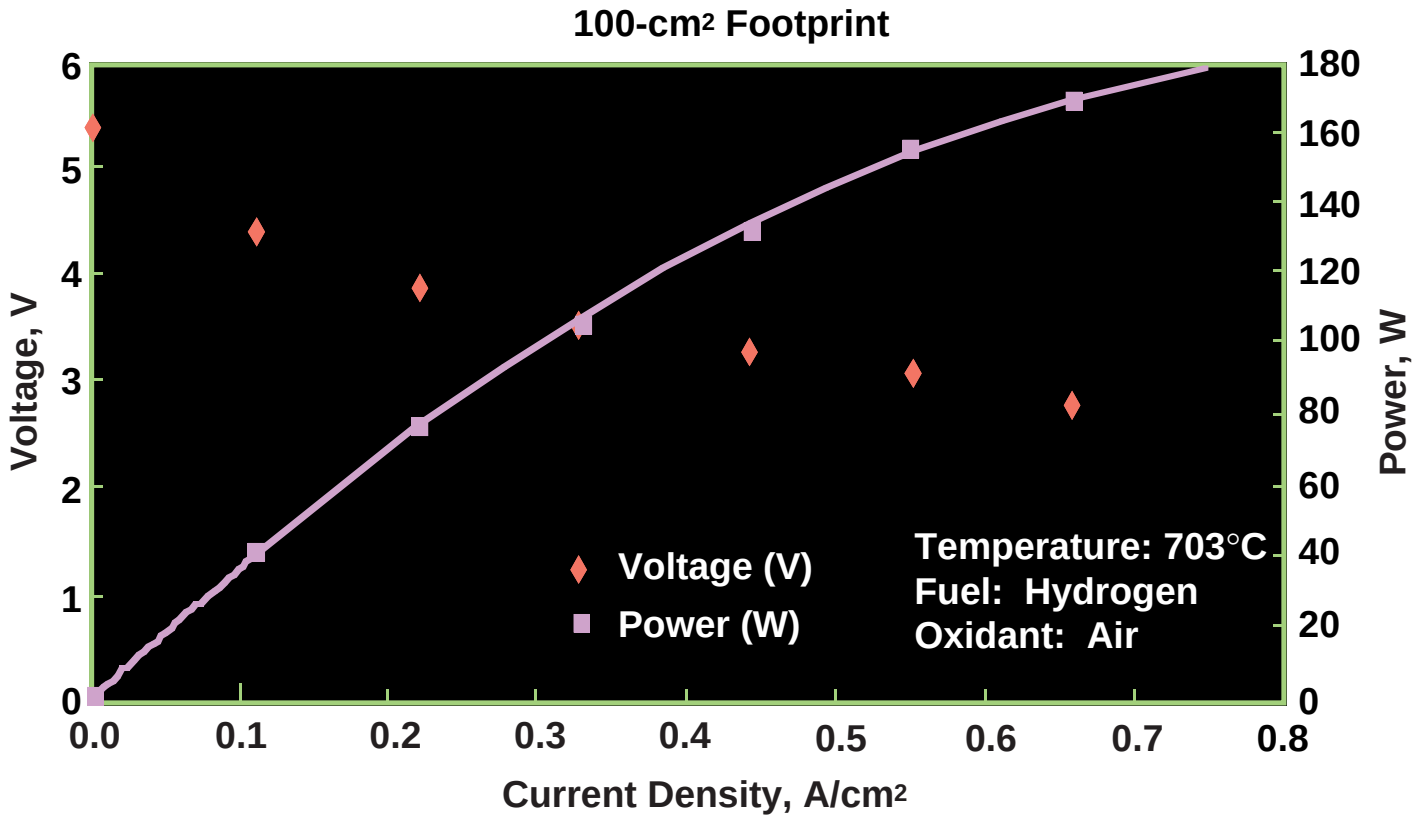
Performance Curves of Five-Cell Stack



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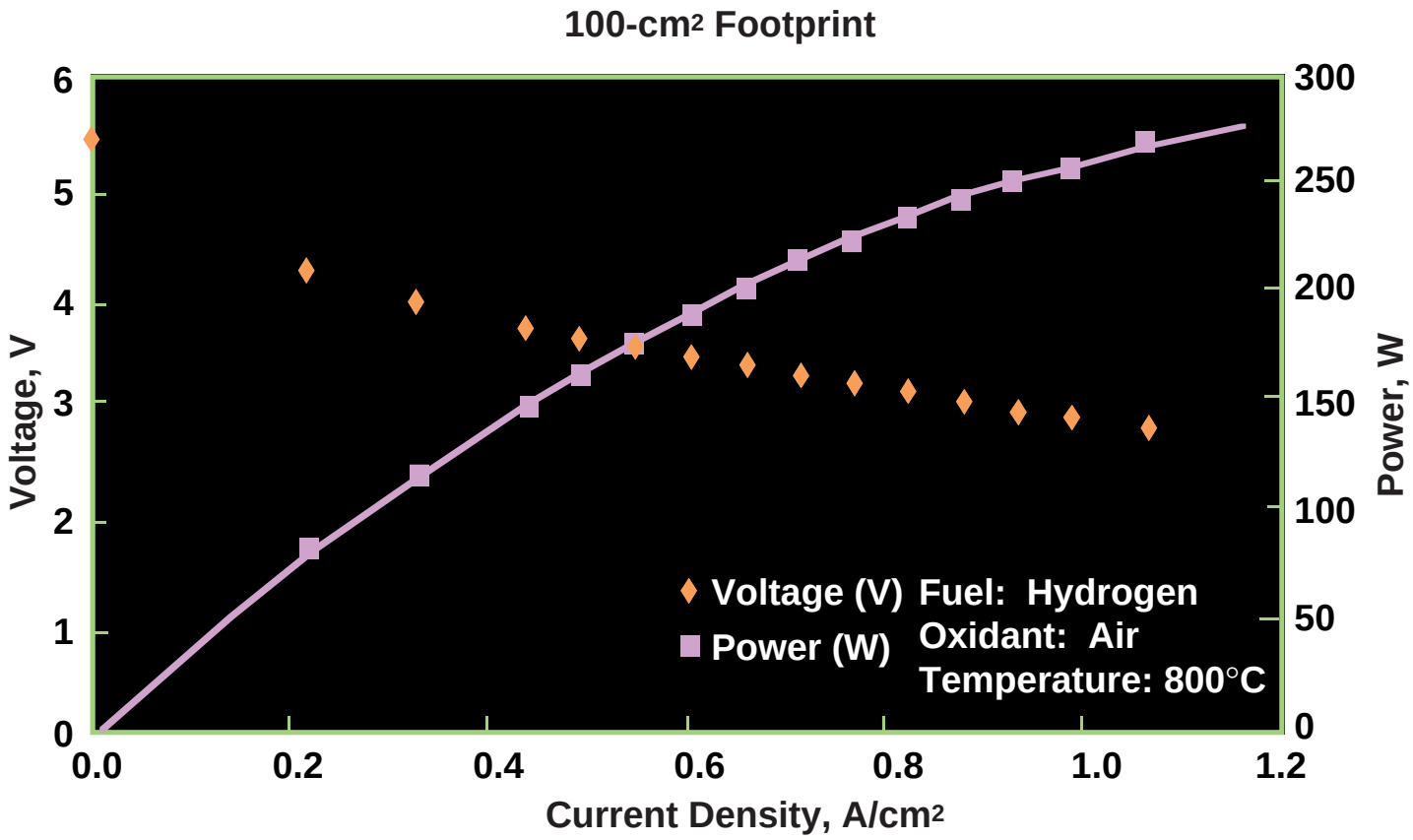
Performance Curves of Five-Cell Stack



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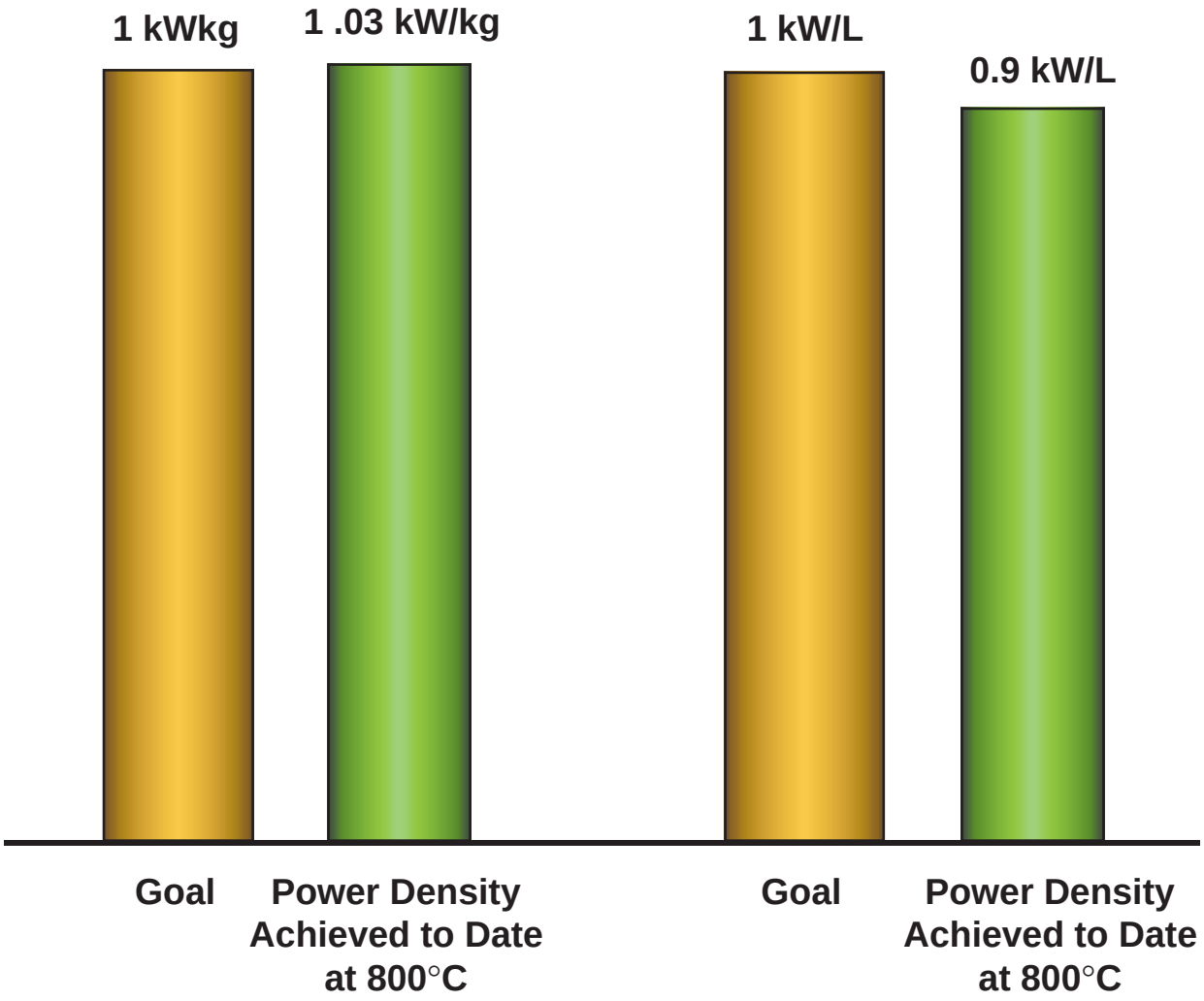
Stack Power Densities



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Technological Issues

- Performance Losses in Stacking
- Sealing
- Thermal Cycling
- Life

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Summary

- **Reduced-Temperature Operation Demonstrated (e.g., 5-Cell Stack, 100-cm^2 Footprint. 270 W at 800°C)**
- **Excellent Stack Performance Achieved at Reduced Temperatures (e.g., 600 mW/cm^2 at 800°C)**
- **Several Issues to Be Addressed (Performance Losses in Stacking, Sealing, Thermal Cycling, Life)**