NEXTECH MATERIALS

SOFC Materials Technology Development in Support of SECA

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Managing Director
NexTech Materials, Ltd.

SECA Core Technology Workshop
Pittsburgh, PA
November 16, 2001

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Overview

- NexTech Background
- Multilayer Fuel Cell Program
  - Technical Accomplishments
  - Current Status and Future Plans
- Commercialization Plan
  - Our Mission
  - Where we fit within SECA
  - How we will get there
- Closing Comments

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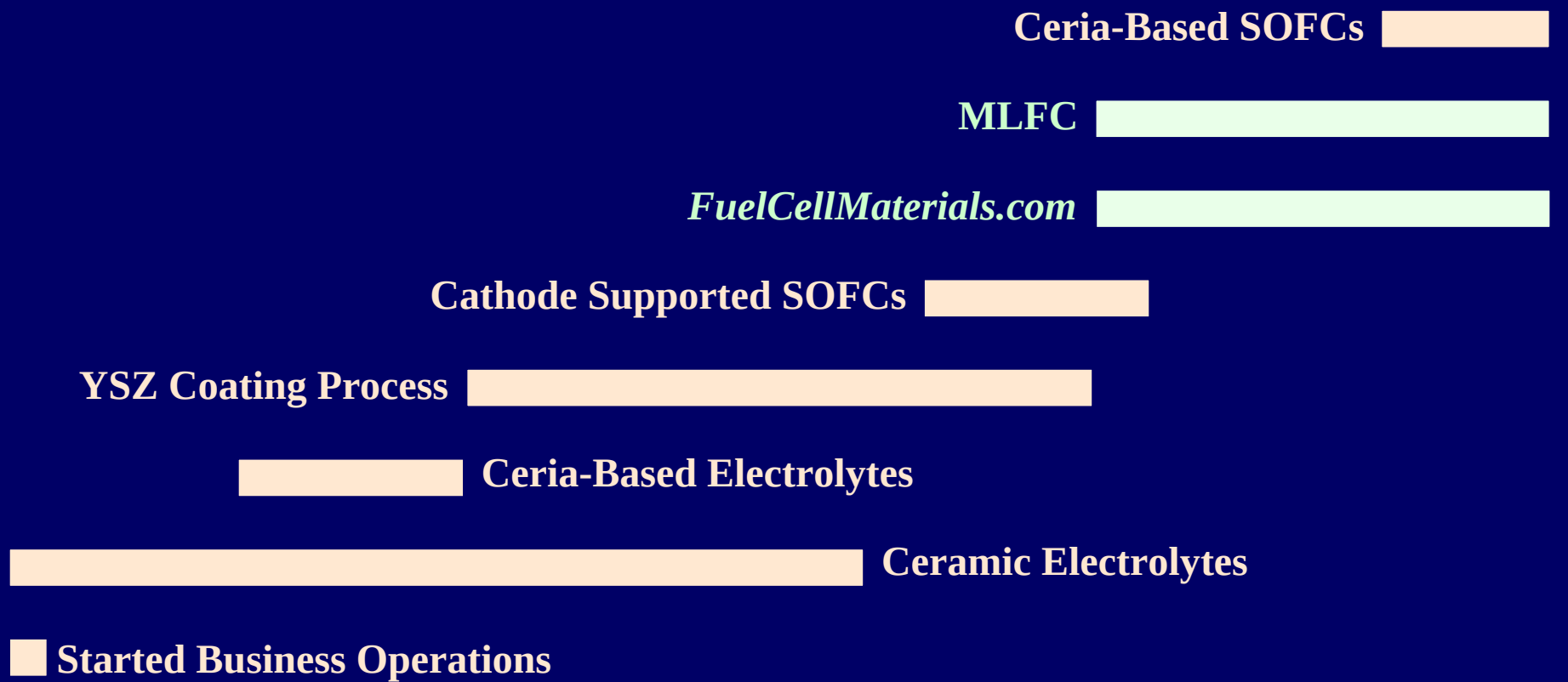
NexTech SOFC History



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SOFC Core Competencies

- Electrolytes – A range of high performance, innovative ceramic powders and coatings
- SOFC Materials: Low-temperature cathode and composite anode materials
- Ceramic Technology: Powder processing, tape casting, screen printing, and co-sintering of ceramic multilayers

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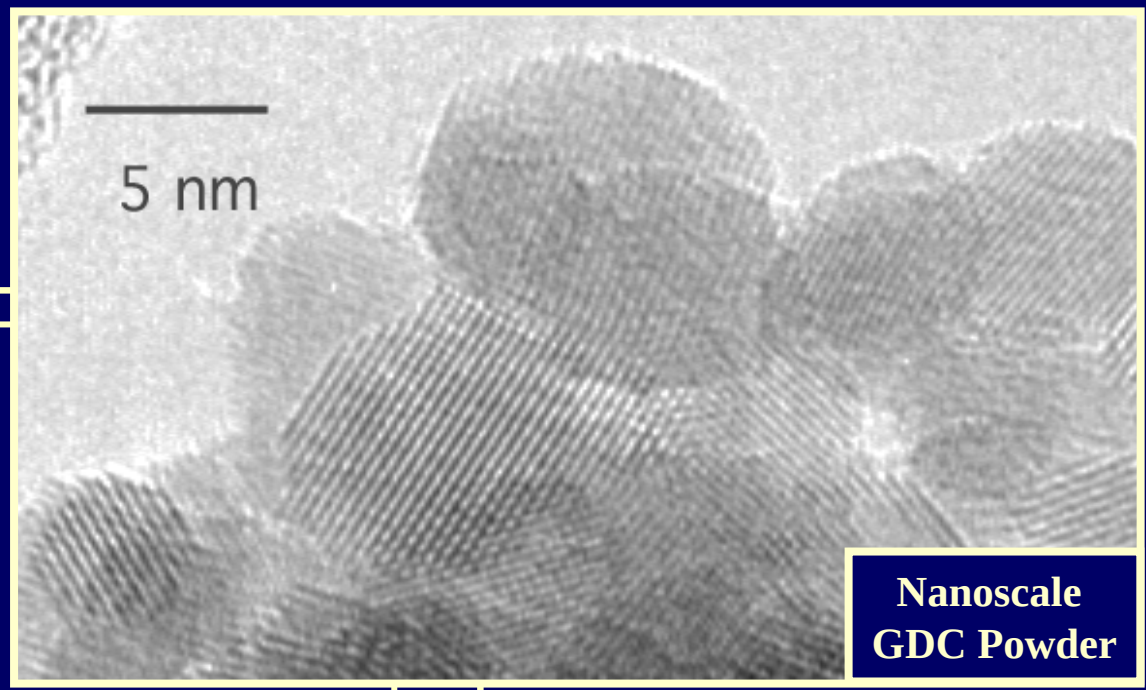
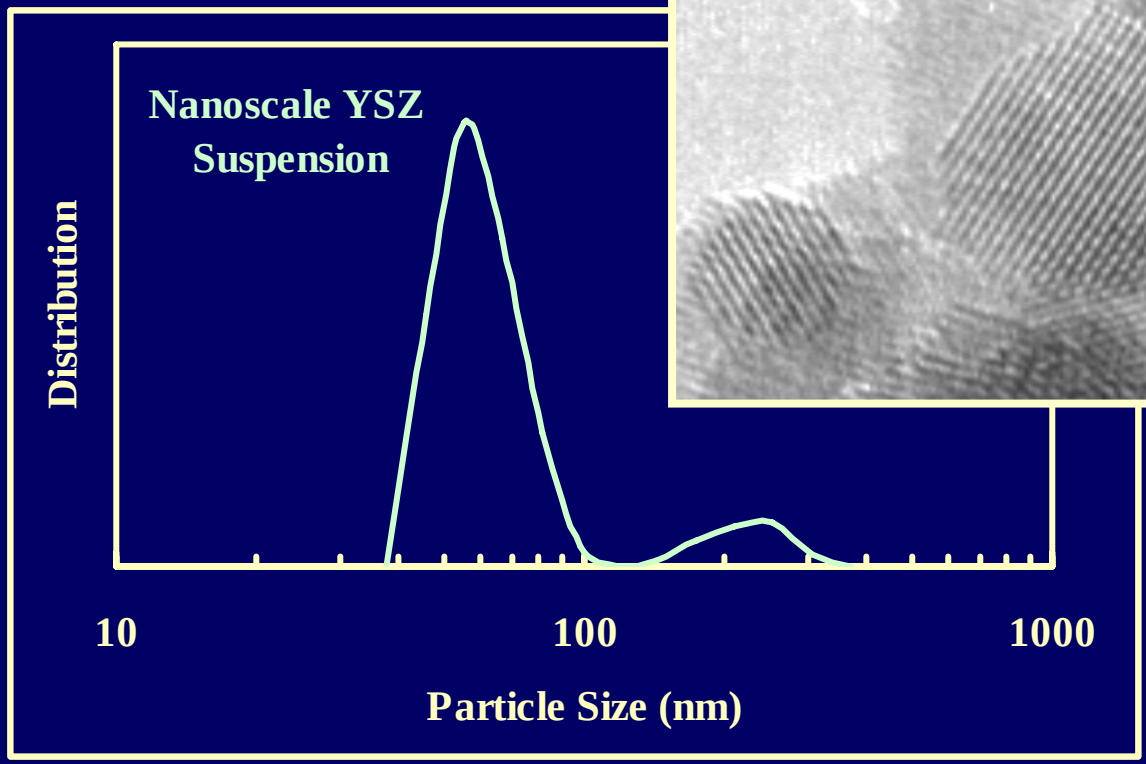
Nanoscale Electrolytes





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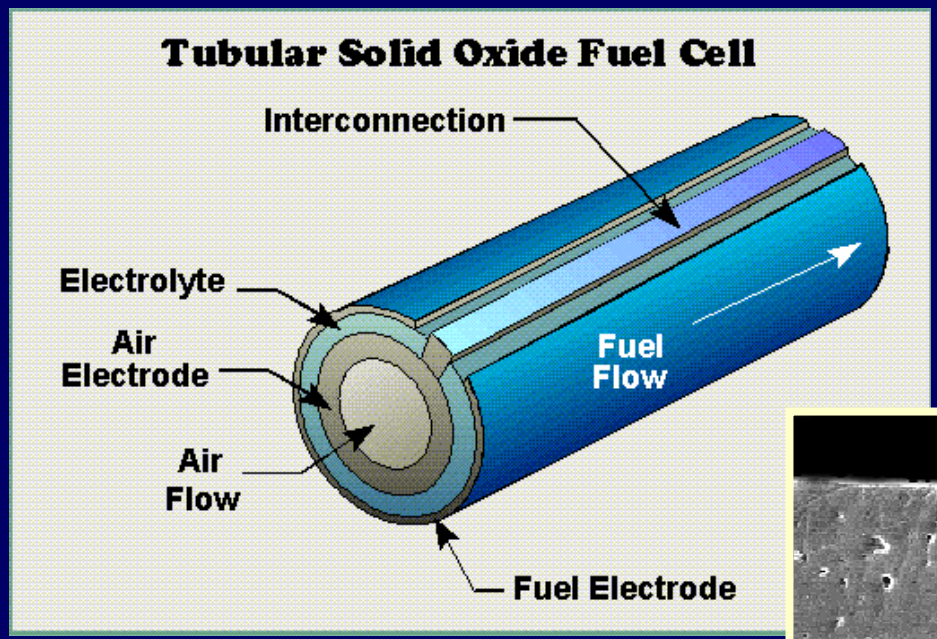
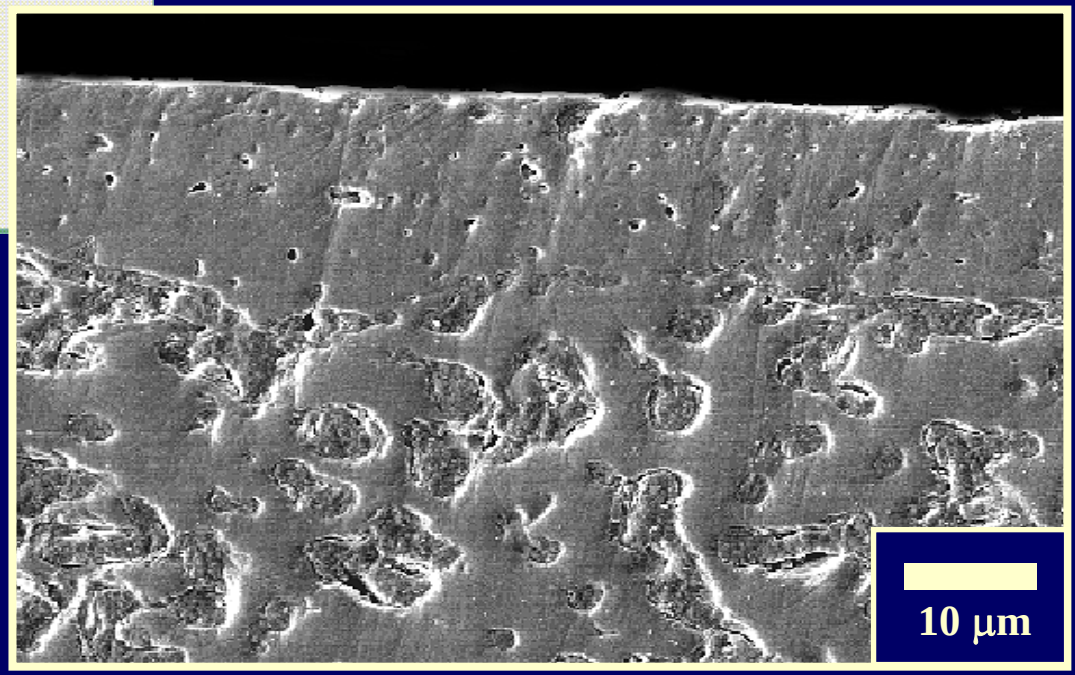
YSZ Coating Process



Tailored nanoscale suspension allows for preparation of dense YSZ coatings in a single deposition and sintering cycle.



U.S. Patent Pending

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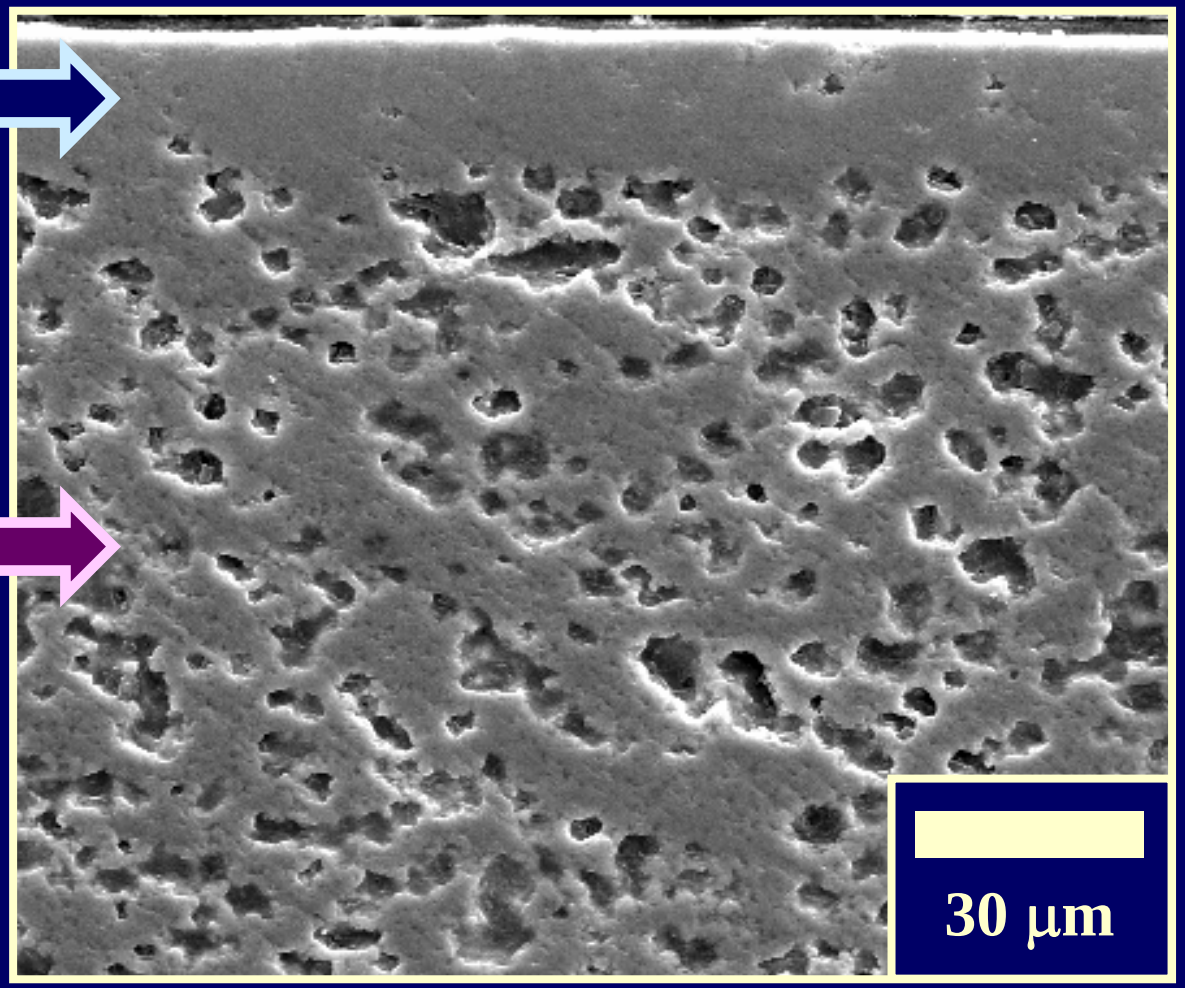
Anode-Supported Cells

Colloidally deposited YSZ Film (NexTech)

Tape Cast Anode Substrate (ORNL)



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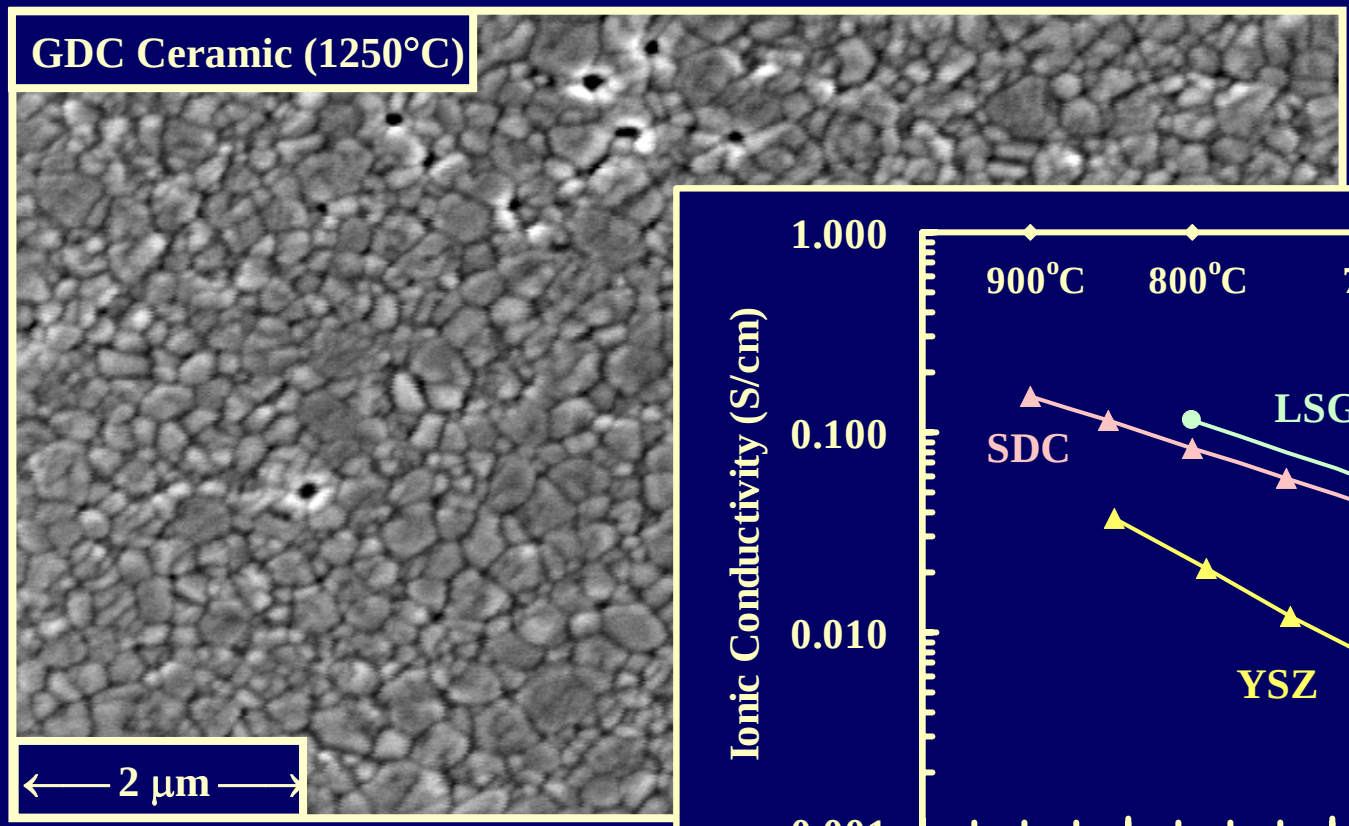
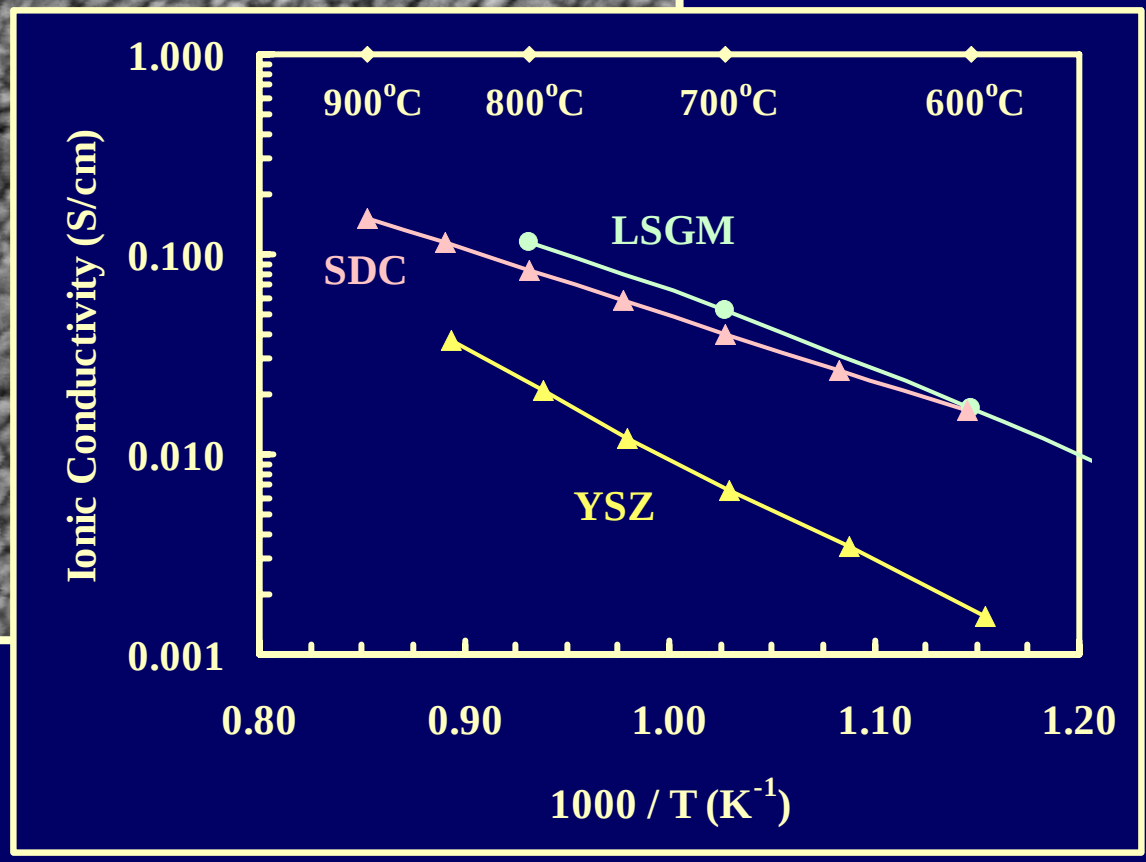
Ceramic Electrolytes





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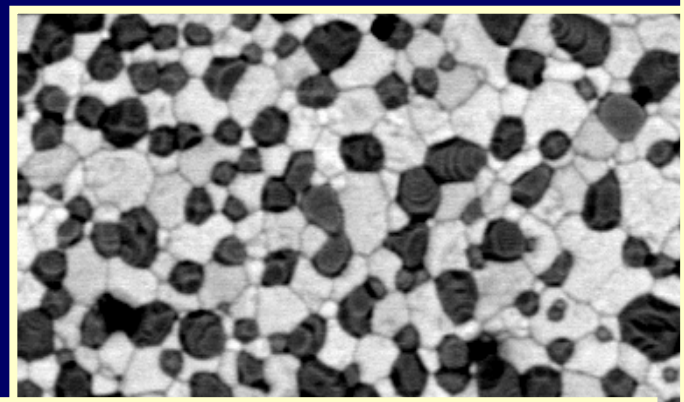
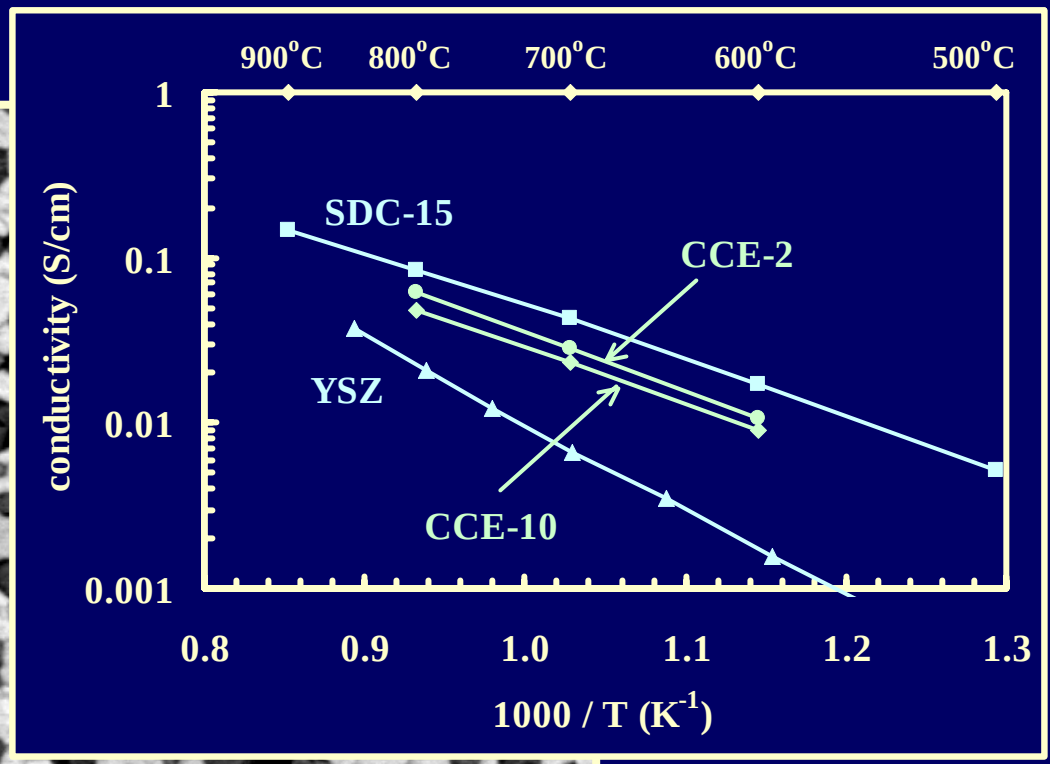
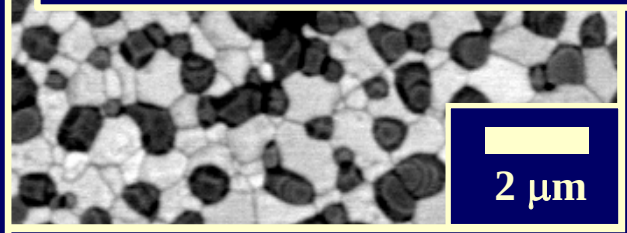
Composite Ceria Electrolyte







Mechanical Properties

Property	SDC	CCE-10
Hardness (Hv, kg/m^2)	780	940
Strength (MPa)	65	86
Toughness (K_{IC}, $MPa\text{-}m^{1/2}$)	0.9	1.8

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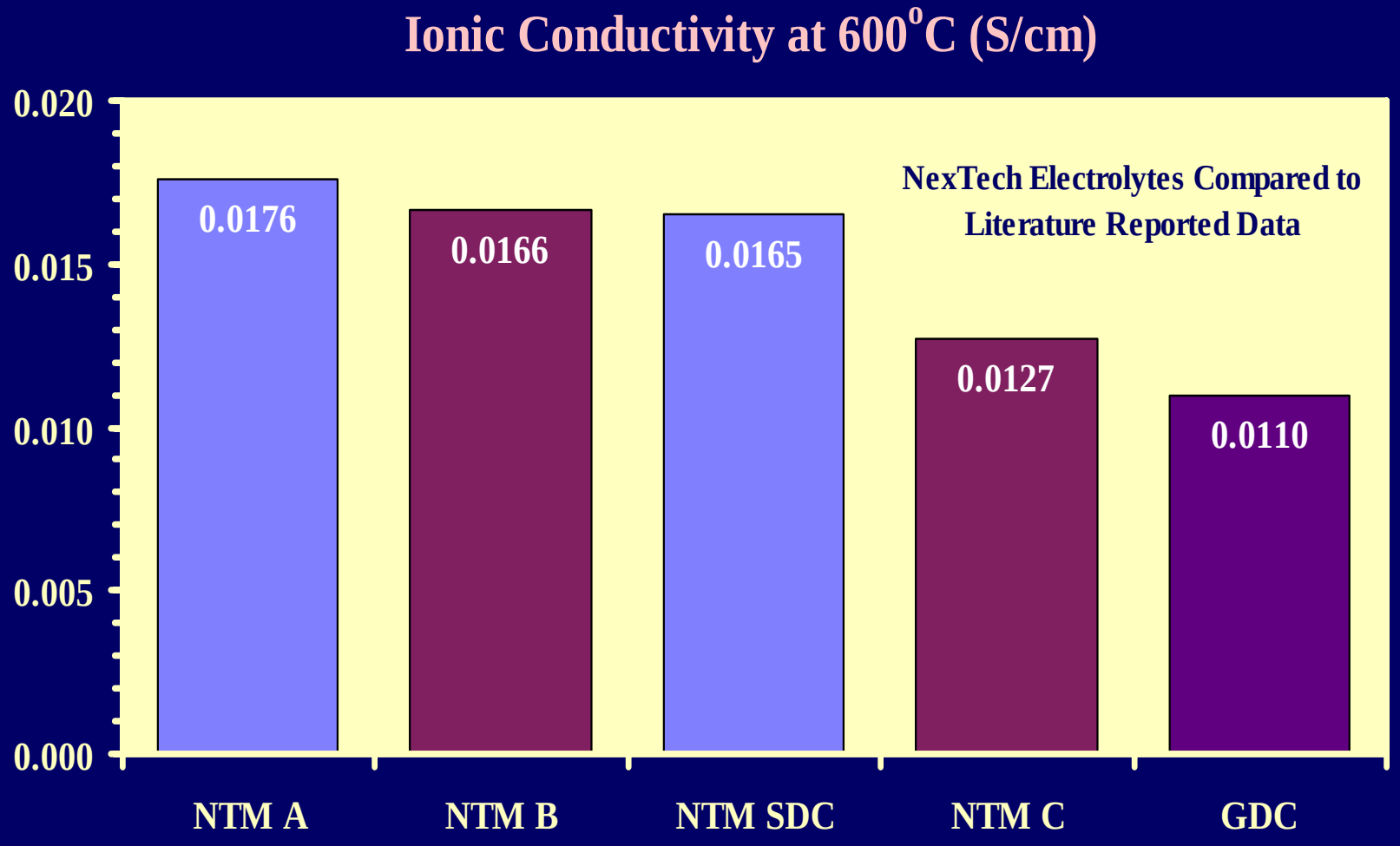
Proprietary Ceria Electrolytes



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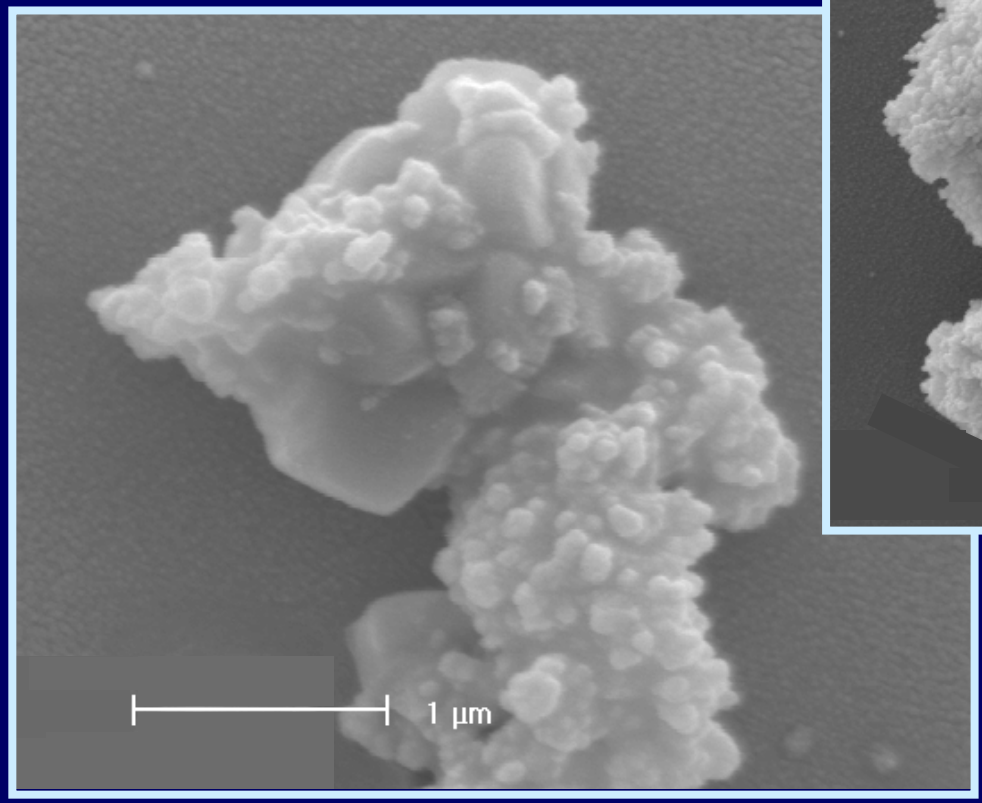
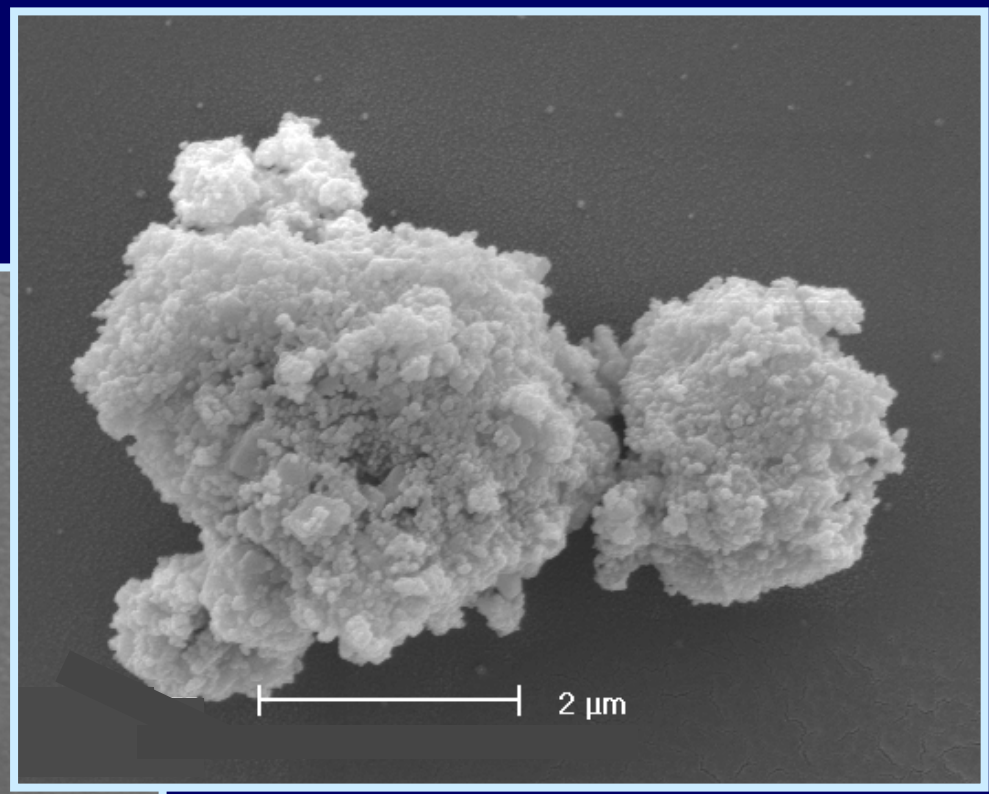
Nano-Composite Electrodes

Conventional Method





New Method

U.S. Patent Pending

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MLFC Fabrication Facility

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Low-Cost Manufacturing of Multilayer Ceramic Fuel Cells

DOE Contract No. DE-AC26-00NT40706

Program Manager: Bill Dawson

Principal Investigator: Scott Swartz

Project Manager: Don Collins

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Program Plan

Phase I (3 months)

Manufacturing Cost and Risk Assessment

Michael A. Cobb & Co.
Advanced Materials Technologies
Gas Technology Institute

Phase II (12 months)

Development of Fabrication Processes for Planar Cells

NexTech Materials
Oak Ridge National Laboratory
University of Missouri-Rolla

Phase III (9 months)

SOFC Testing, Destructive and Non-Destructive Testing

Northwestern University
Gas Technology Institute
Ohio State University

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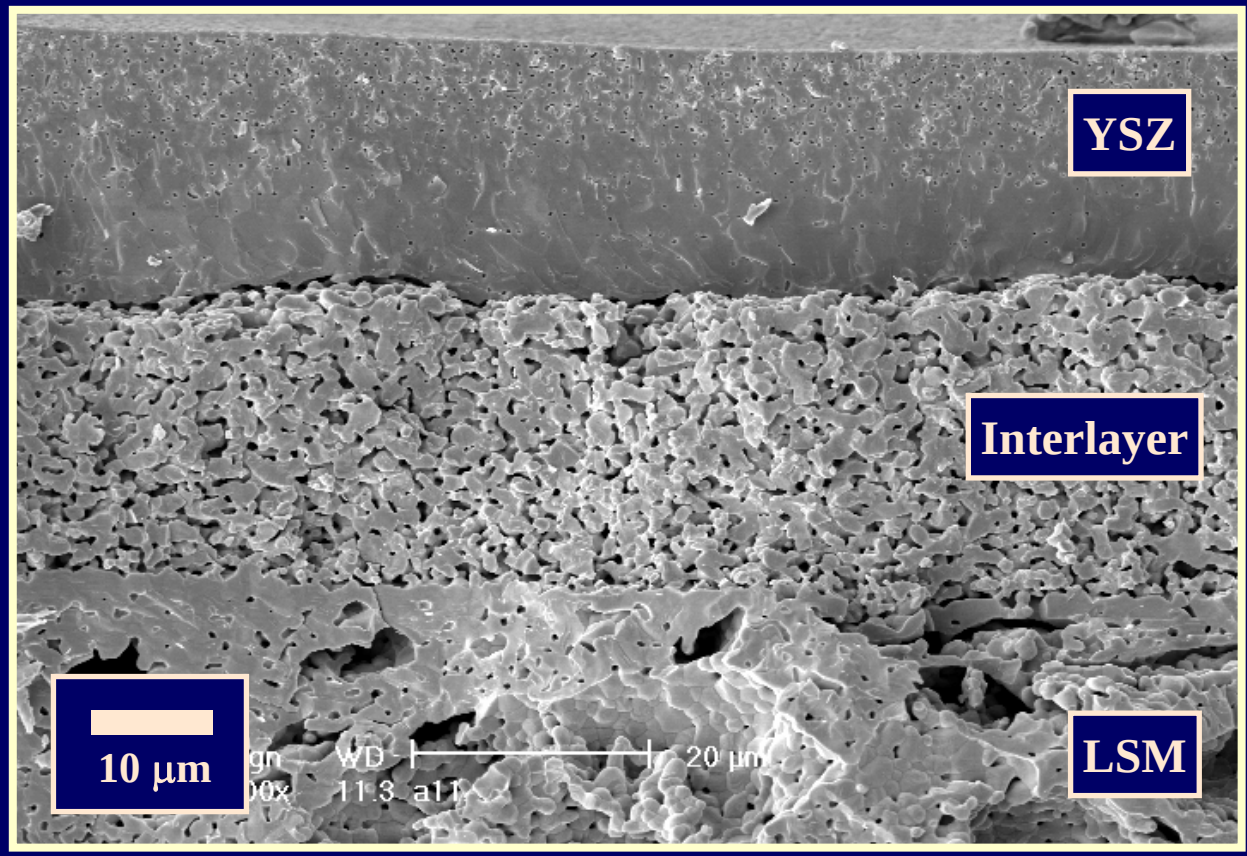
Cathode Supported Cells

- Tape Casting (Cathode)
- Colloidal Spray (Electrolyte)
- Co-Sintering
- Screen Printing (Anode)



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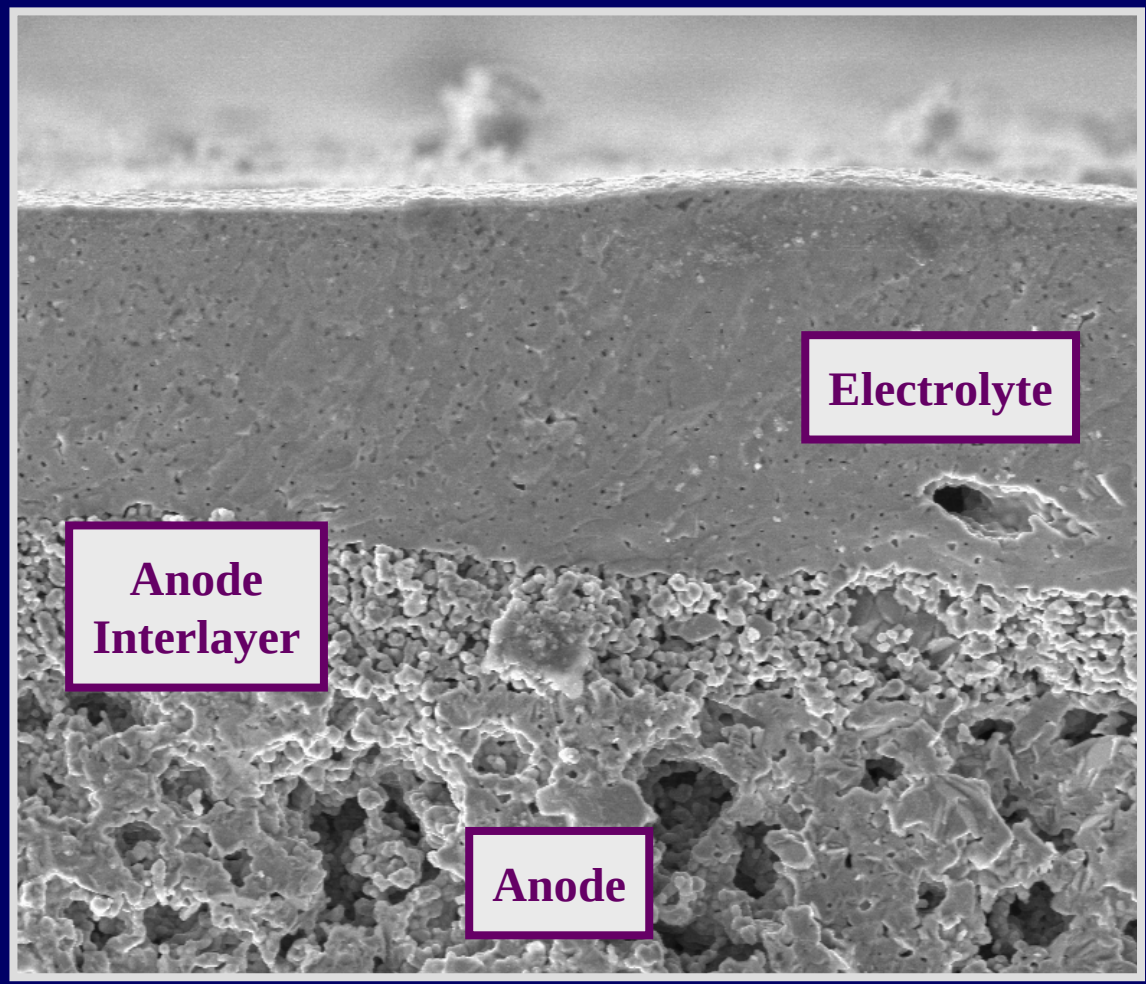
Anode-Supported Cells

- Tape Casting (Anode)
- Screen Printing (Electrolyte)
- Co-Sintering
- Screen Printing (Cathode)



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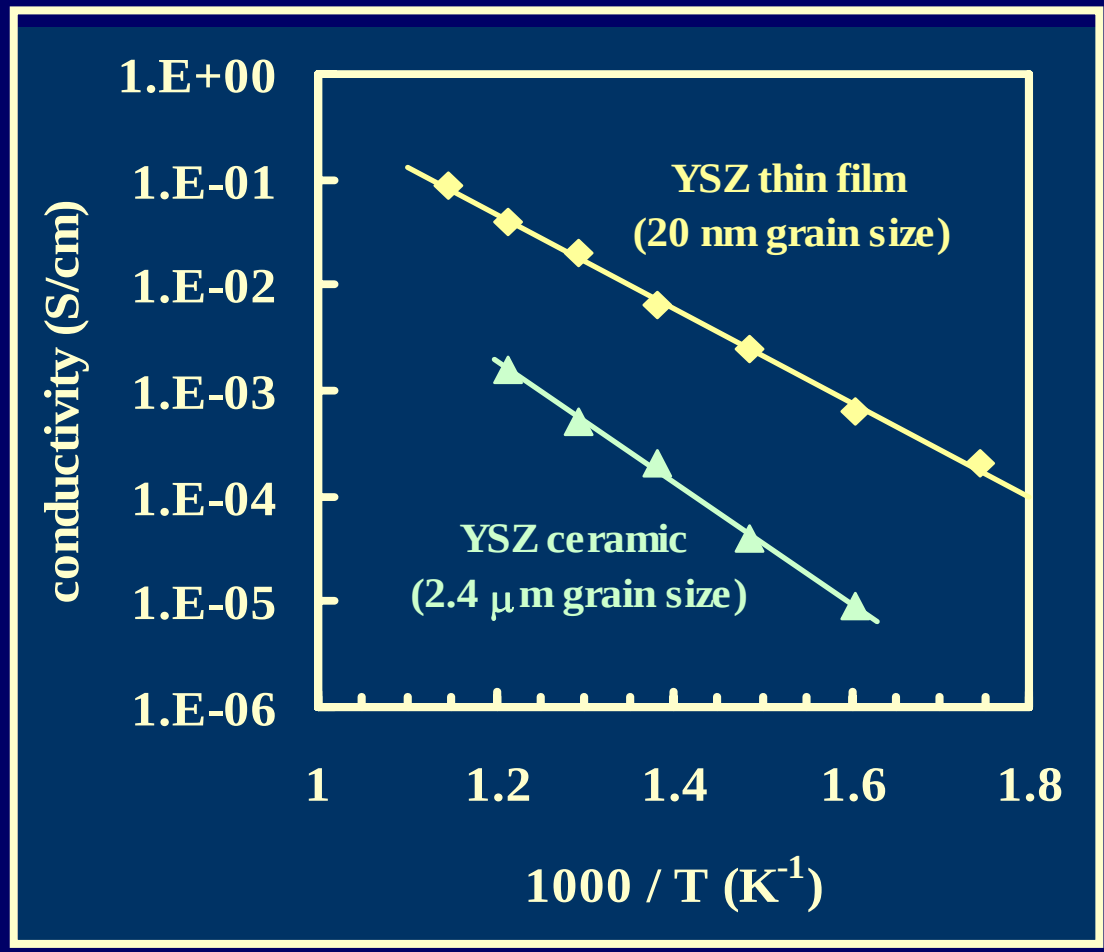
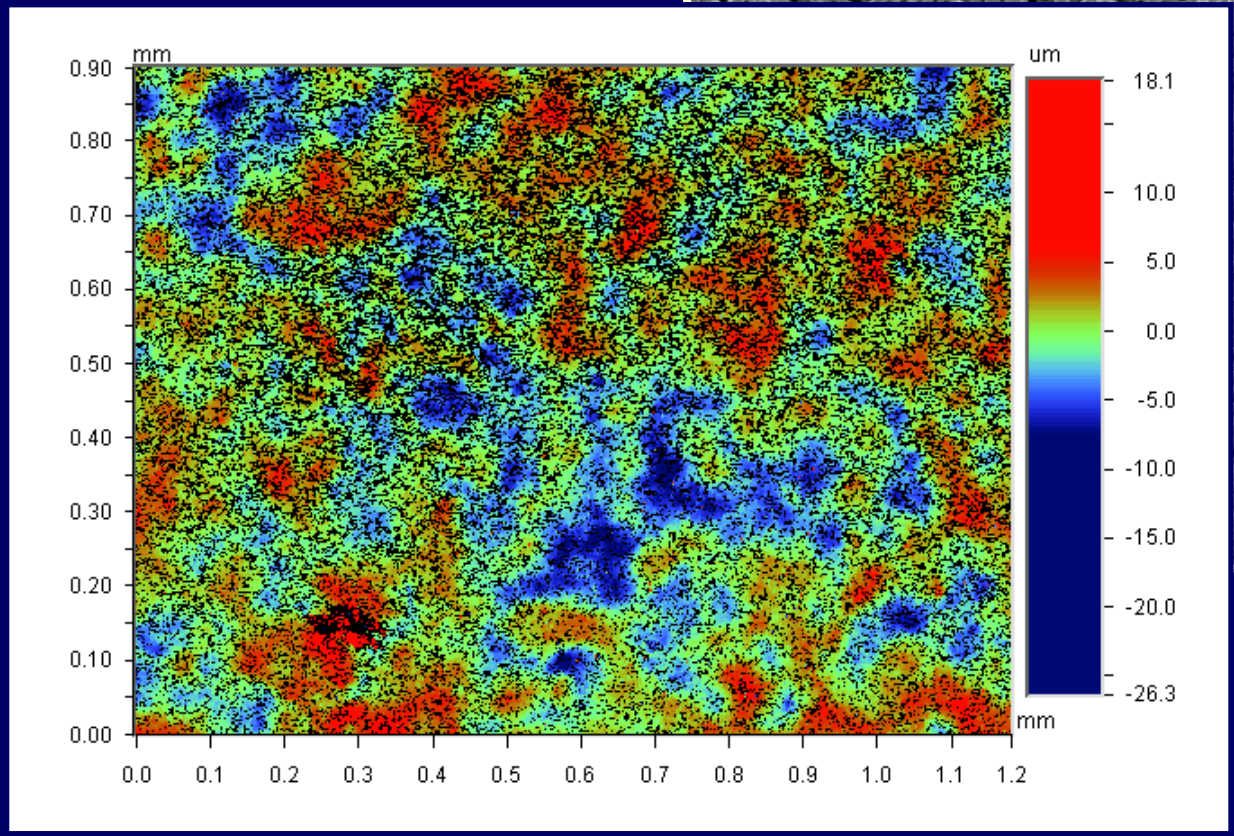
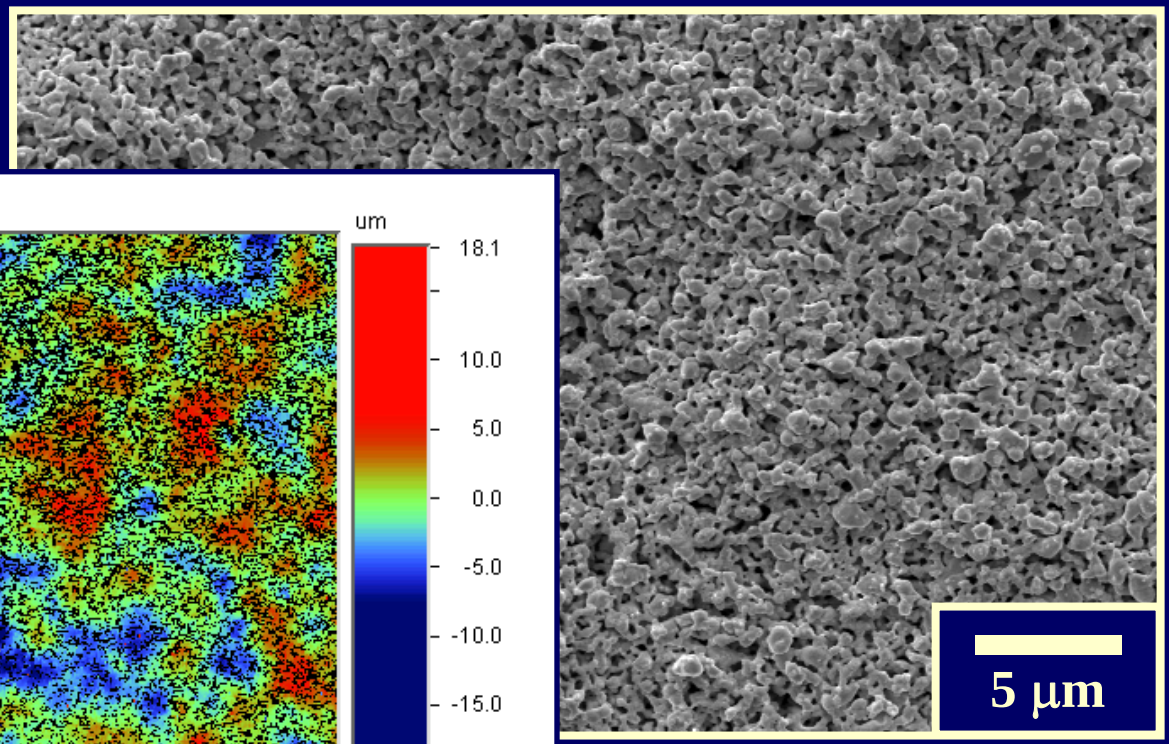
Spin-Coated Electrolytes

- Tape Casting (Cathode)
- Sintering
- Spin Coating (Electrolyte)
- Screen Printing (Anode)



Optical Profilometry





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Phase III Test Plan

Functional Interlayers (Anode or Cathode)

Support Electrode (Anode or Cathode)

Cathode Material

Thickness, Porosity
Perovskite Composition
Ceria Additions

Anode Material

Thickness
Porosity
Nickel Content

Electrolyte Layers (Thickness, Density)

Fabrication Methods

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SOFC Business Plan

- ***Our Mission:***
  - ***Become leading supplier of innovative SOFC materials and manufacturing technology***
  - ***Be materials leader in cost reduction, product reliability, and commercial implementation***
  - ***Be recognized worldwide for technical excellence, integrity, and cooperation***

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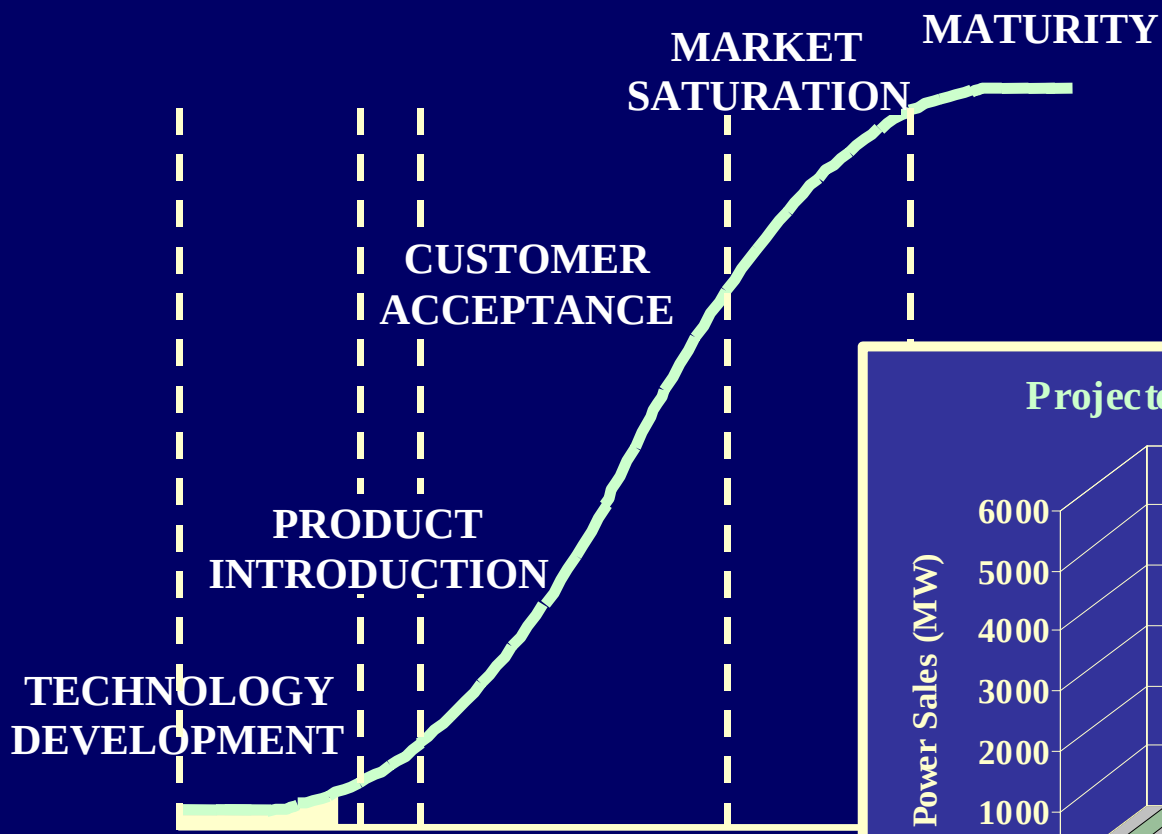
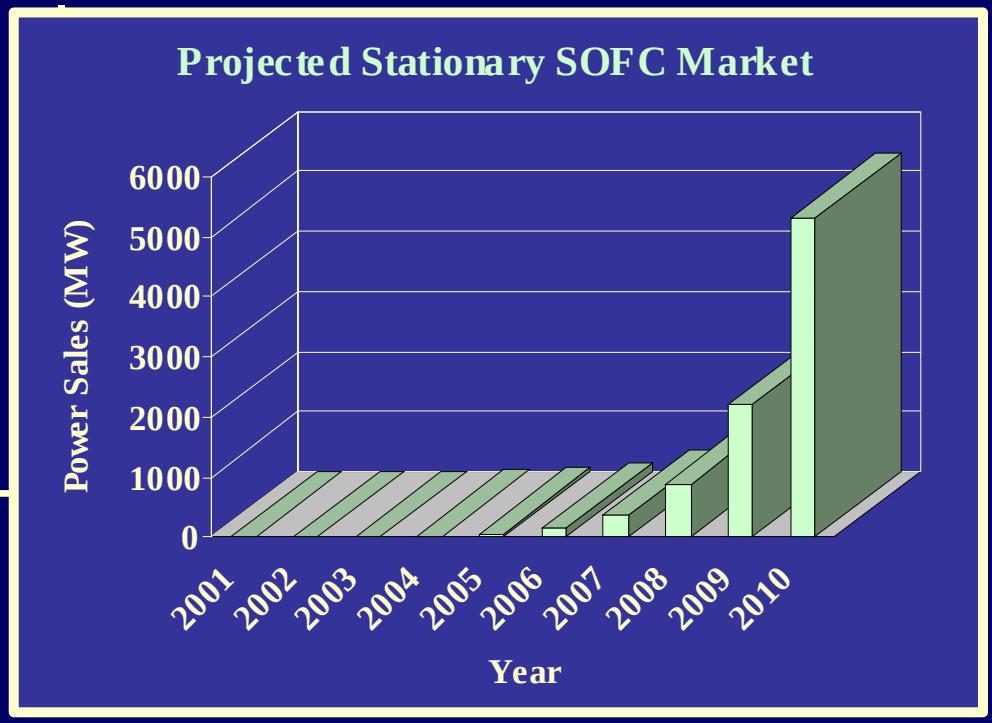
Market Opportunity





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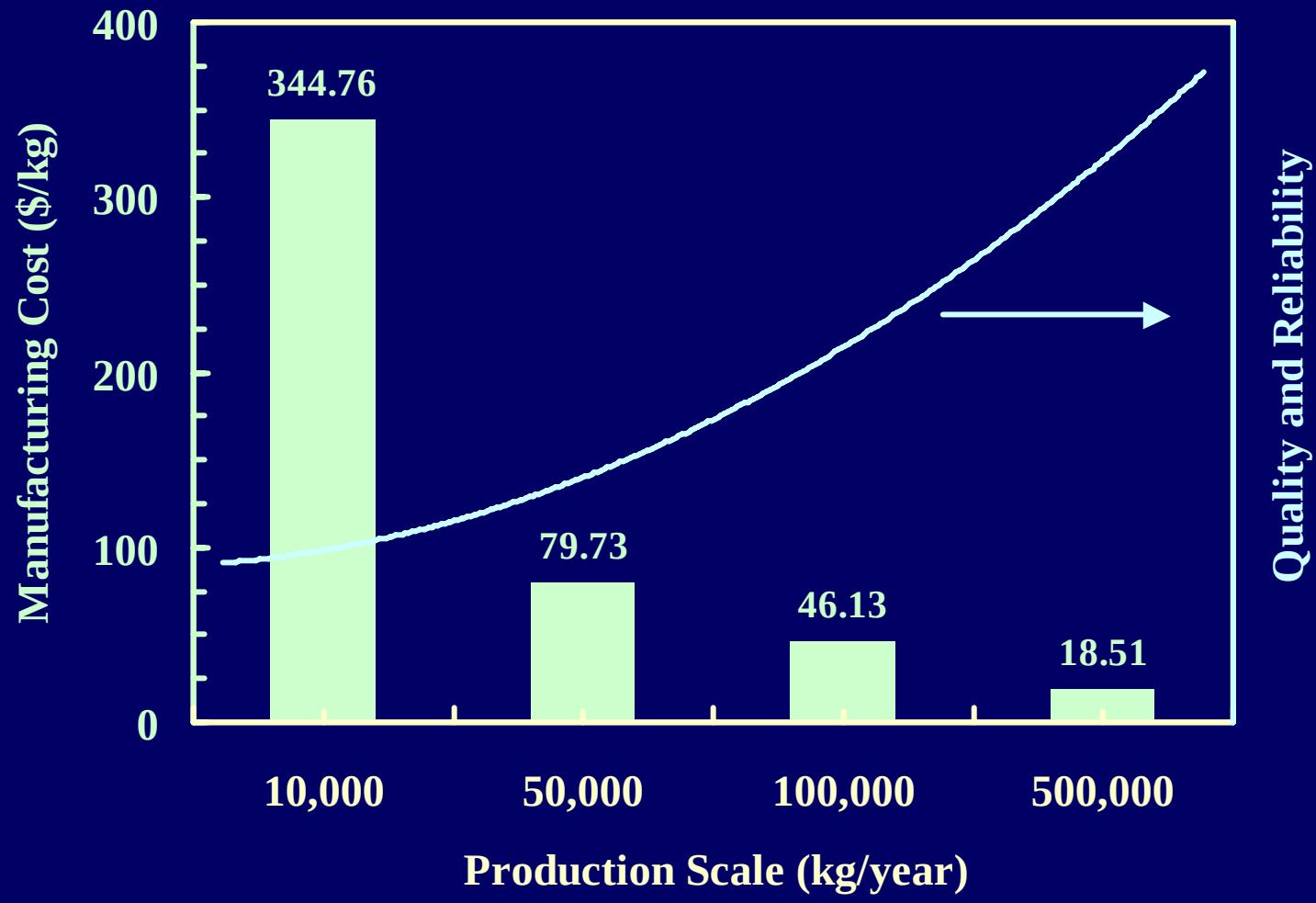
Scale-Up of YSZ Production



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How to Get There?

- Supplying materials for qualification to developers in 15 countries
- Beginning scale-up activities
- Currently seeking investors/strategic partners for scale-up/market penetration
- SECA participation

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FuelCellMaterials.com

Electrolyte Products

- Nanoscale Powders
  - YSZ
  - Sc-doped Zirconia
  - Ceria-Based Formulations
- Nanoscale Suspensions
  - YSZ
  - Ceria-Based Formulations
- Conventional Powders
  - LSGM
  - Bismuth-Based Formulations
- SOFC elements (coming soon)

Electrode Products

- Cathode Powders
  - LSM, LSF, LSCF, etc.
  - LSM/YSZ, LSF/GDC, etc.
  - Custom Formulations
- Porous LSM Substrates
- Anode Powders
  - NiO/YSZ, NiO/GDC
  - CuO/GDC
  - Custom Formulations
- Screen printing inks

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Why Work With Us?

- ☑ Innovative Products
- ☑ Products Engineered for Applications
- ☑ Knowledge of Manufacturing
- ☑ Path to Cost Reduction

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Acknowledgments

- Mike Cobb and Kirby Meacham (Cobb & Co.)
- Jim Stephan (Advanced Materials Technologies)
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- John Lannutti (Ohio State University)
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