



SCALABLE AND COST EFFECTIVE BARRIER LAYER COATING TO IMPROVE STABILITY AND PERFORMANCE OF SOFC CATHODE



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Project Objectives

- To develop a scalable and cost-effective electrophoretic deposition (EPD) coating process to achieve a dense barrier layer between a YSZ electrolyte and the cathode in a SOFC to significantly improve both stability and performance of SOFC cathodes;
- To systematically investigate the interaction between doped ceria barrier layers and LSCF cathode, and the effects on oxygen reduction reaction (ORR) kinetics, electrochemical performance, and long-term stability of cathodes to achieve optimal barrier layer composition and thickness.

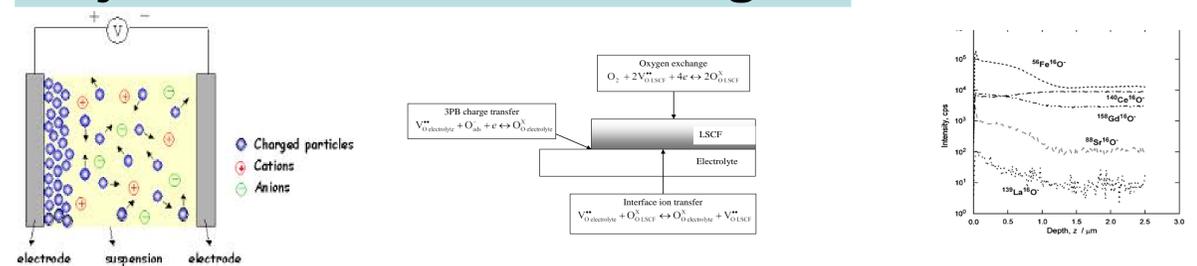
Proposed Project Benefits

| Method | Screen Printing | Dip Coating | Spin Coating | Electroplating | Thermal Spray |
|--------------------------|-----------------|-----------------|-----------------|----------------|-----------------|
| Green-body Porosity | High | High | High | Low | Medium |
| Coating time (~5µm) | Seconds/minutes | Seconds/minutes | Seconds/minutes | Minutes/hours | Seconds |
| Cost | Low | Low | Low | Low | Medium |
| Scalable | Yes | Yes | Difficult | Yes | Yes |
| Composition Control | Easy | Easy | Easy | Moderate | Easy |
| Thickness Control (~5µm) | Easy | Easy/moderate | Easy/moderate | Moderate | Difficult |
| Coat on non-flat surface | Difficult | Easy | Moderate | Easy/moderate | Easy |
| Sintering | Required | Required | Required | Usually not | Usually not |
| Method | Tape Casting | PLD | Sputtering | CVD/ALD | EPD |
| Green-body Porosity | High | Low | Low | Low | Low |
| Coating time (~5µm) | Seconds/minutes | Hours | Hours | Hours | Several minutes |
| Cost | Low | High | High | High | Low |
| Scalable | Yes | No | Yes | Yes | Yes |
| Composition Control | Easy | Moderate | Moderate | Moderate | Easy |
| Thickness Control (~5µm) | Easy | Moderate | Moderate | Easy/moderate | Easy |
| Coat on non-flat surface | Easy | Easy/moderate | Easy/moderate | Easy/moderate | Easy/moderate |
| Sintering | Required | Usually not | Usually not | Usually not | Required |

Project Team

- Funding Agency: NETL-SECA
- Funding Number: DE-FE0023407
- Universities: West Virginia University & Northwestern University
- Industrial Partner: Fuel Cell Energy

Major Research Methodologies



EPD to achieve dense barrier layer

Study ORR kinetics @GDC/LSCF interface

Measure cation diffusivity in GDC under over potential

Project Timeline

| ID | Task | Year 1 | | | | Year 2 | | | | Year 3 | | | |
|-----|---|--------|----|----|----|--------|----|----|----|--------|----|----|----|
| | | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| 1.0 | Project Management | | | | | | | | | | | | |
| 2.0 | Developing EPD Barrier Layer Coatings on YSZ Electrolyte | | | | | | | | | | | | |
| 2.1 | Coating Development | | | | | | | | | | | | |
| 2.2 | Sintering Optimization | | | | | | | | | | | | |
| 2.3 | Coating Characterizations | | | | | | | | | | | | |
| 3.0 | Investigation on ORR Kinetics of LSCF-Doped Ceria Interface | | | | | | | | | | | | |
| 3.1 | Symmetric and half-cells | | | | | | | | | | | | |
| 3.2 | EIS characterization | | | | | | | | | | | | |
| 3.3 | Optimization of cathode composition | | | | | | | | | | | | |
| 4.0 | Investigation on Cation Interdiffusion in Barrier Layers and Its effects on Performance and Long-term Stability of SOFC Cathode | | | | | | | | | | | | |
| 4.1 | Diffusion profiles by SIMS | | | | | | | | | | | | |
| 4.2 | XTEM analysis | | | | | | | | | | | | |
| 4.3 | Electrochemical investigation | | | | | | | | | | | | |
| 4.4 | Cation ions diffusion during cell operation | | | | | | | | | | | | |
| 4.5 | Determination of optimized barrier layer thickness | | | | | | | | | | | | |
| 5.0 | Evaluation of Performance and Stability of EPD Barrier Layer in Industrial Cells | | | | | | | | | | | | |
| 5.1 | Performance and Stability Testing | | | | | | | | | | | | |
| 5.2 | Industrial Evaluation | | | | | | | | | | | | |
| 5.2 | Post-mortem Analysis | | | | | | | | | | | | |
| 6.0 | Cost Analysis | | | | | | | | | | | | |

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