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where energy meets environment

Functional SOFC Interfaces Created by Aerosol-Spray Deposition

July 4th 2018

OUTLINE

1. Introduction
2. Coatings for SOFC Applications

AlumiLok™	*Supircat*™	*GasLok*™	*CeriLok*™
Protection Coating	Internal Reforming	Seal Coating	Cell Development

3. Conclusions

Our vision is to create a better world through energy innovations.

We collaborate with leading global customers and partners to transform powerful ideas into solutions that make energy production safer, more efficient, and environmentally responsible.

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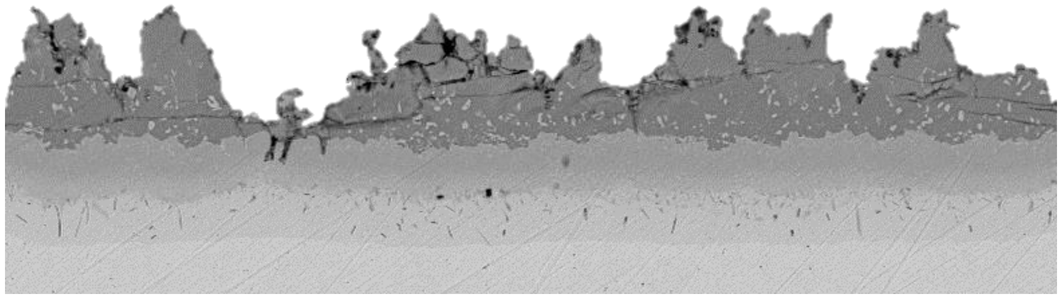
PRODUCT DEVELOPMENT

Development initiatives at intersection of energy and environment

SOFCs	Sensors	Materials	Catalysts	Protective Coatings
Stationary and Military	Transportation and Energy Markets	SOFCs and energy storage	H2 and chemicals production	SOFC and high Temperature

Coating microstructure enables a range of applications

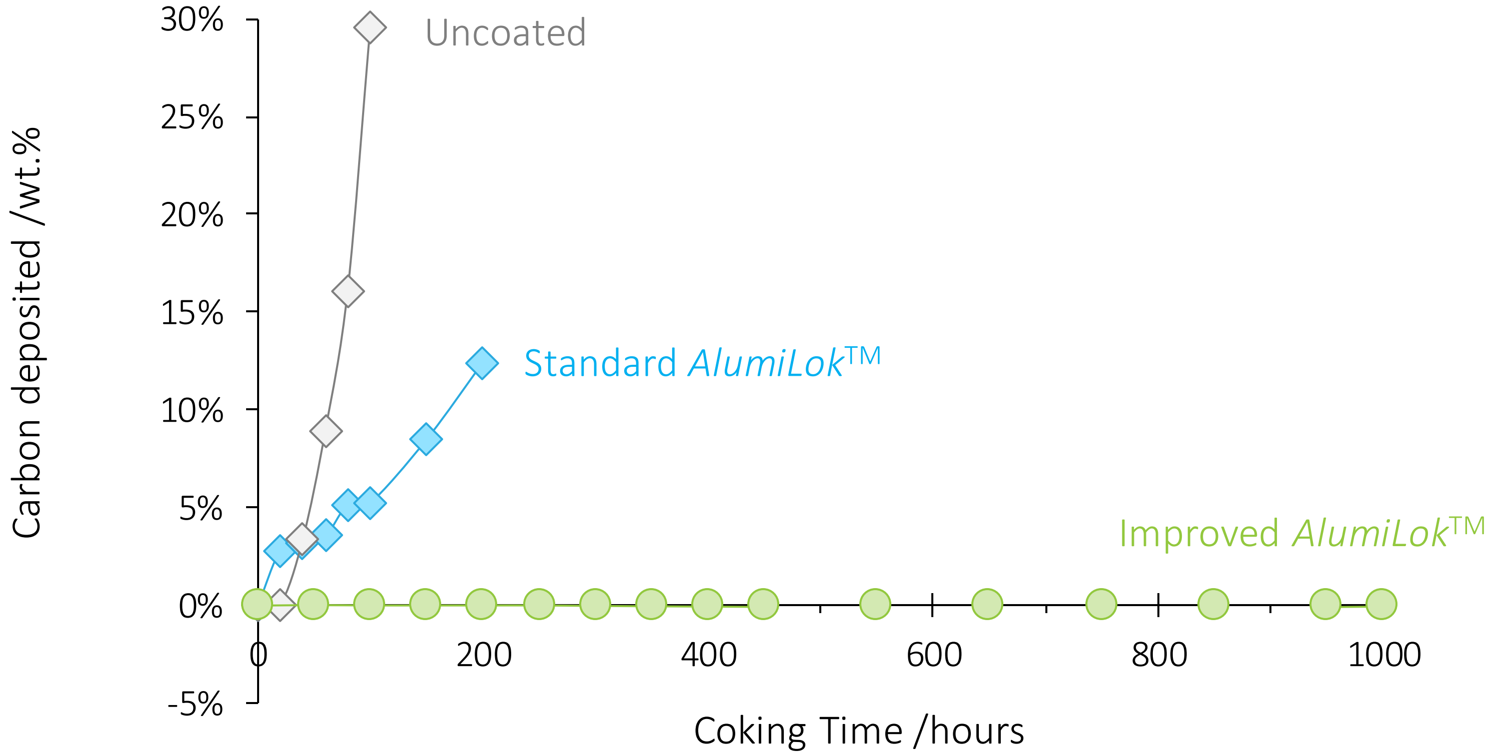


Alumina/aluminide surface
Oxidation, Cr Volatility, Coking Resistance

Interconnect	Balance-of-Plant	Seal/Electrical Isolation	Catalyst support
			

COKING RESISTANCE

Microstructural control enables excellent coking resistance

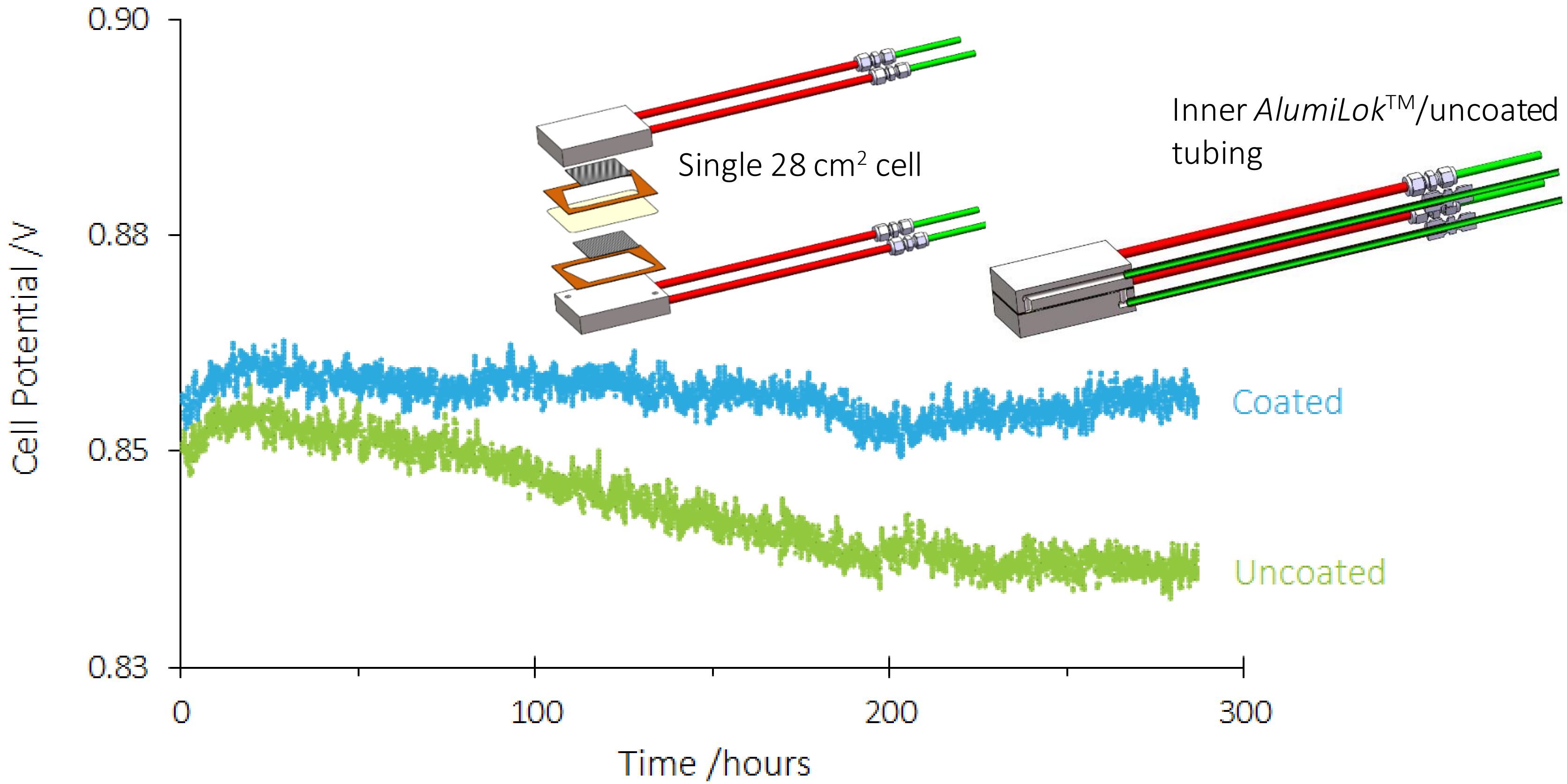


Temperature: 550 C, Pressure 5 psi

Gas Composition: 33% H_2, 30 % CO_2, 25 % CO, 12 % CH_4

BOP CHROMIUM RETENTION

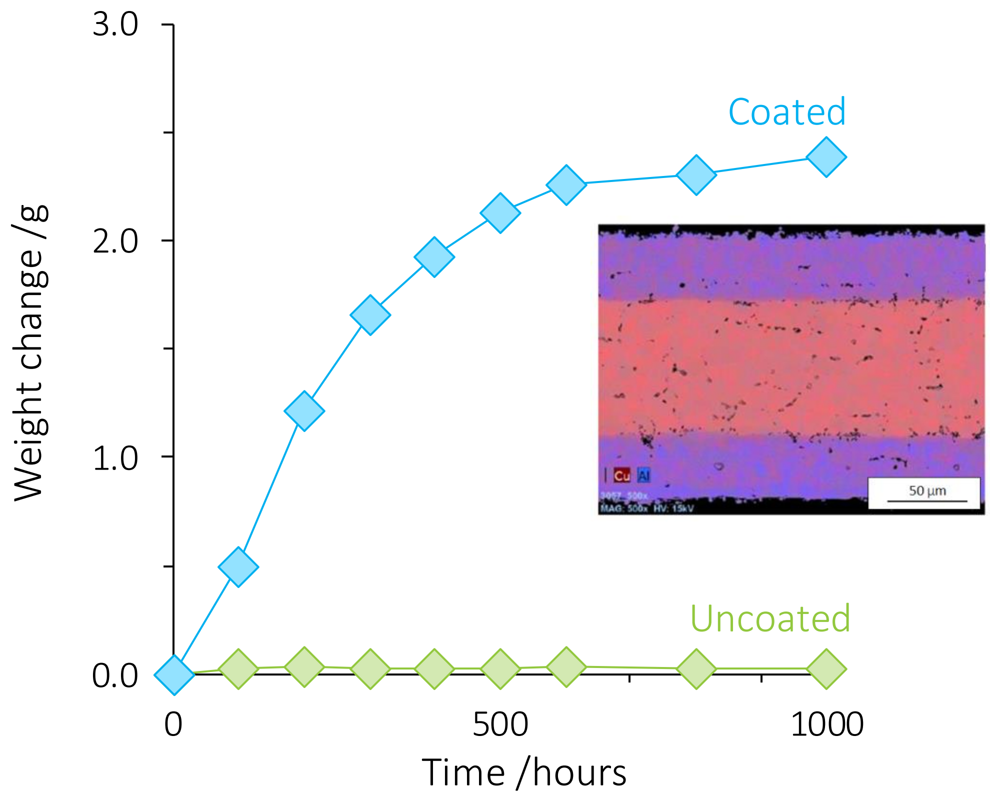
Effect of BoP coating on cell performance

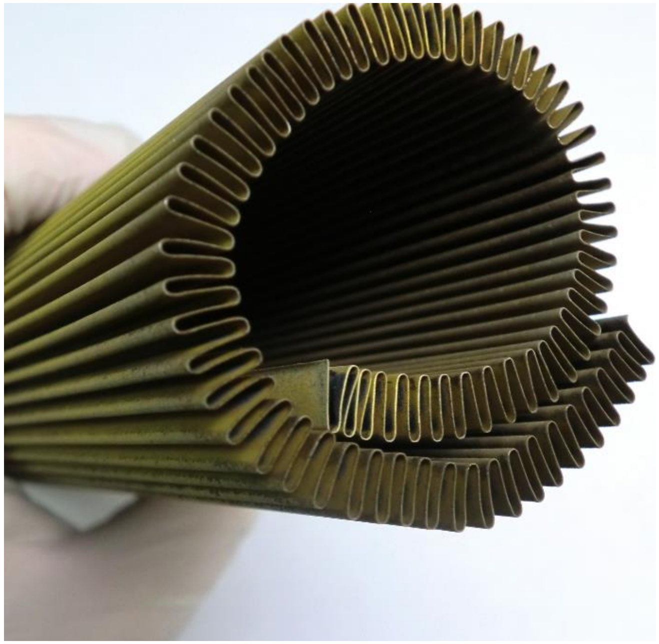


Temperature: 800 °C, Current: 15 A, BoP: 316SS
Fuel Flow/Composition: 450 sccm H_2, 290 sccm air w/ 3 % H_2O

COPPER PROTECTION

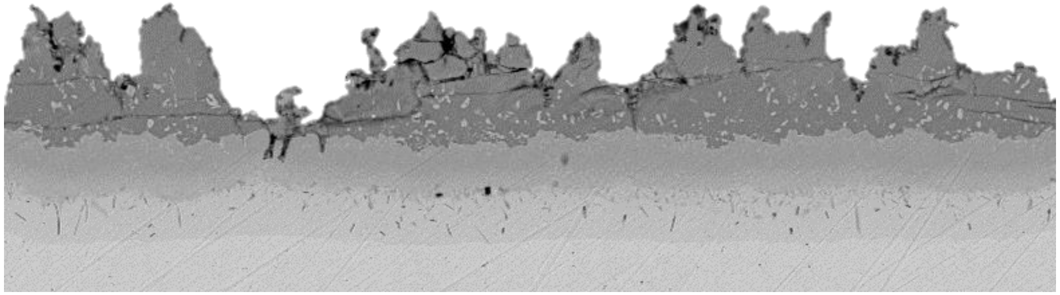
Coating is amenable to other substrates





Temperature: 650 °C
Gas Composition: Air

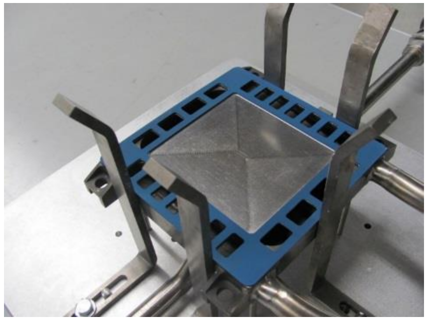
Coating microstructure enables a range of applications



<u>Rough surface for mechanical anchoring</u>

Surface pre-treatment for functional coatings

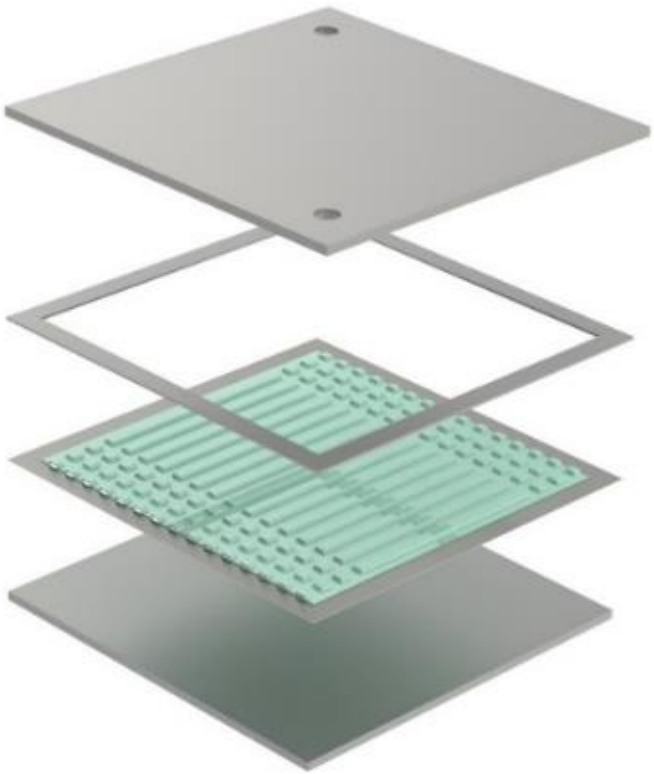
Interconnect	Balance-of-Plant	Seal/Electrical Isolation	Catalyst support



IR CATALYST COATING

Catalytic insert to complement on-cell reforming

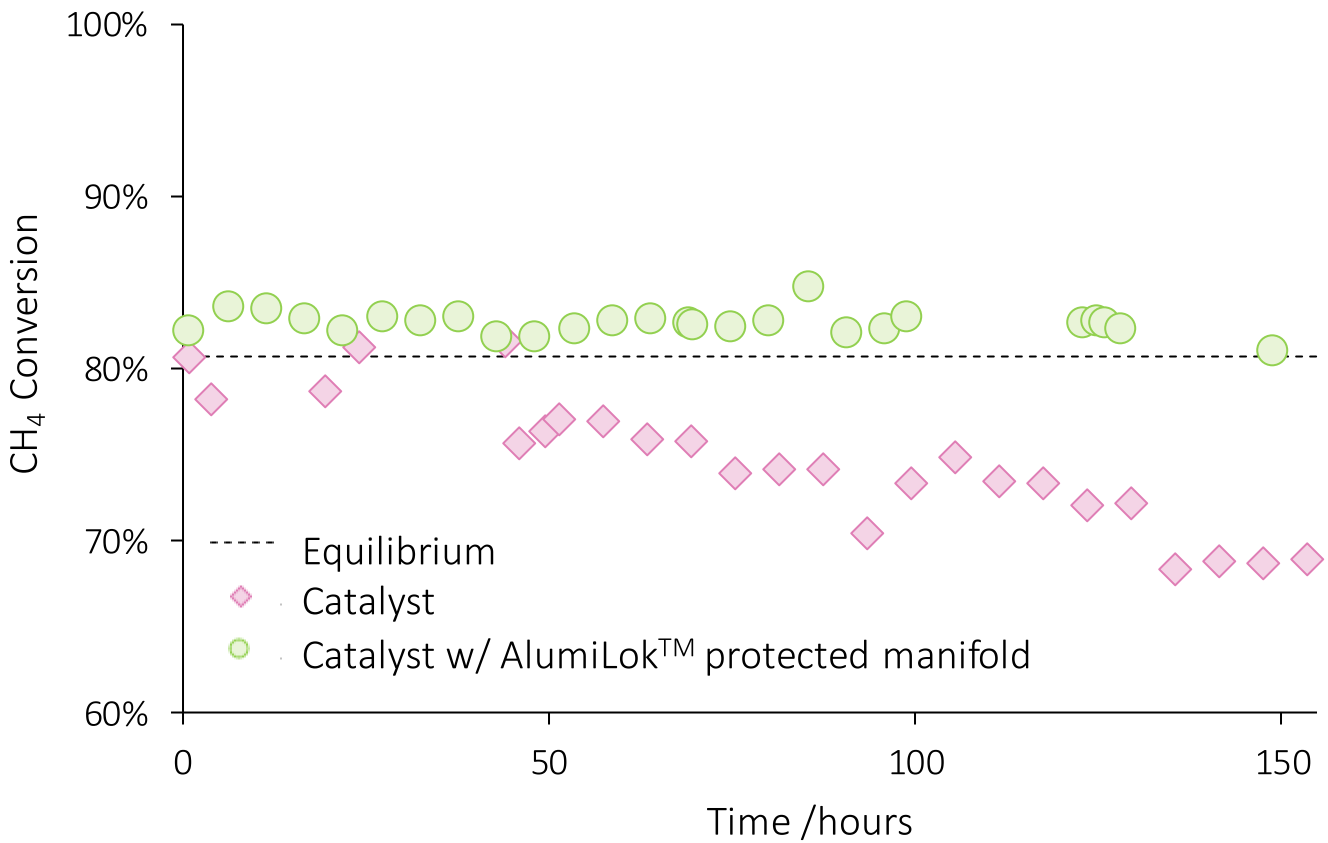
Manifold assembly design



AlumiLok™ coated Crofer plate

MANIFOLD PROTECTION

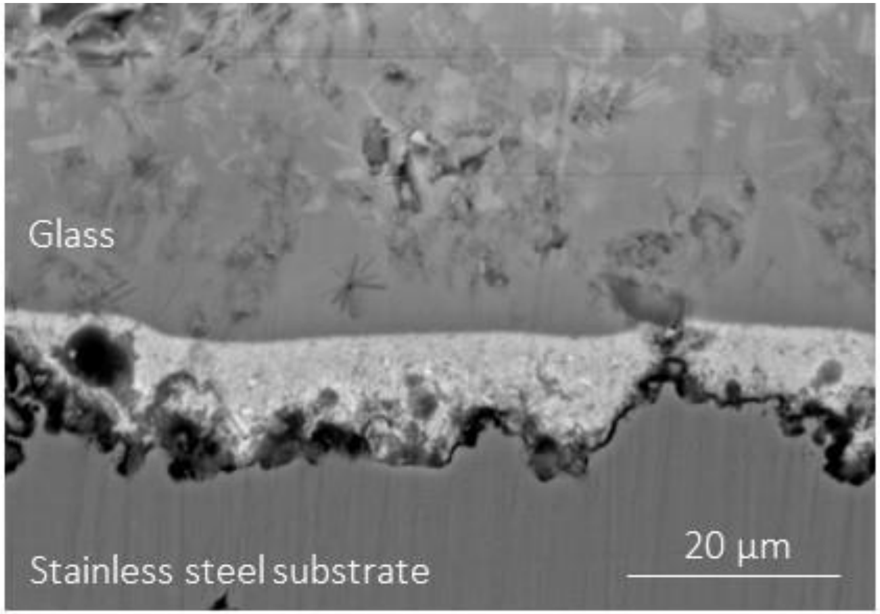
AlumiLok™ protected manifold prevents deactivation



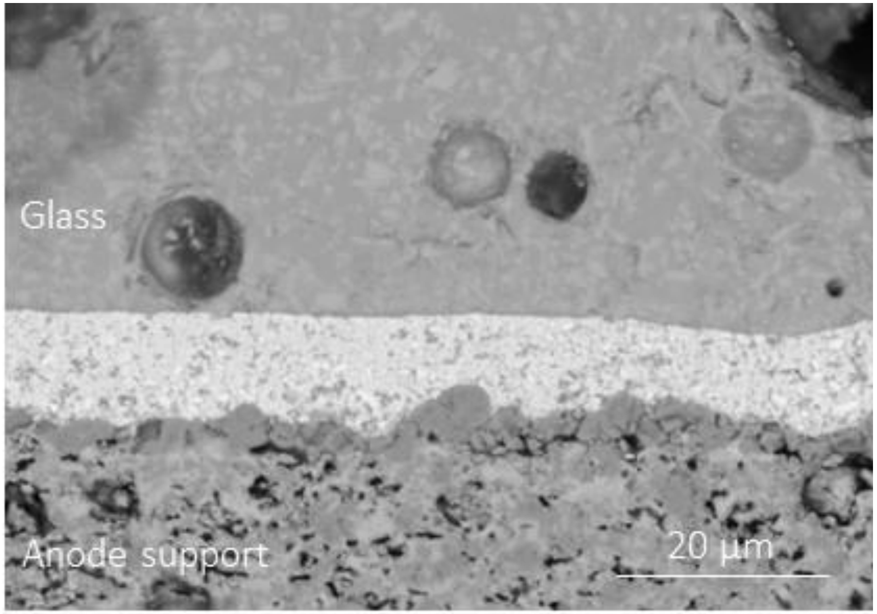
Temperature: 630 °C, Pressure 1 bar
Gas composition: Methane, Steam S/C = 2.5, GHSV: 5000/hour

Interfacial coating protects substrate from glass seal corrosion

Glass/steel interface

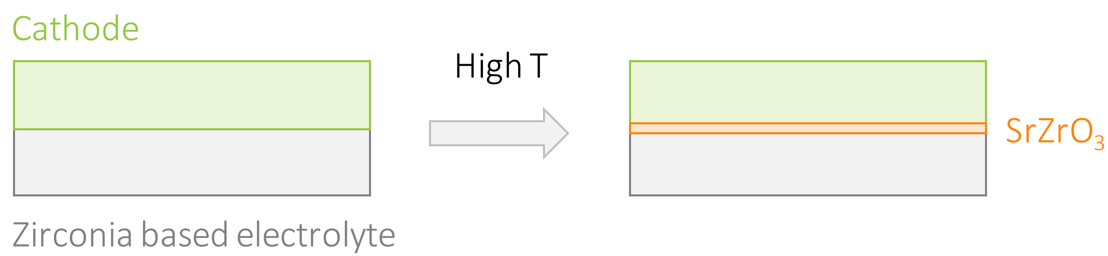


Glass/porous anode support interface

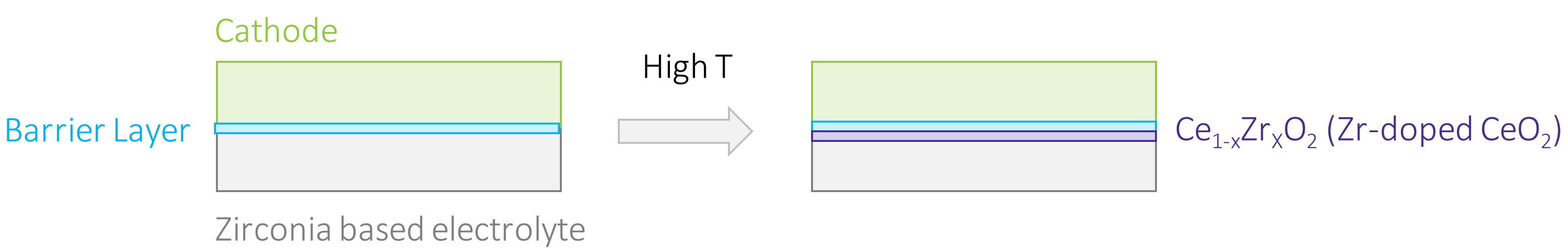


Low T barrier layer needed to achieve low R interface

Formation of $SrZrO_3$ at interface between cathode-zirconia electrolyte

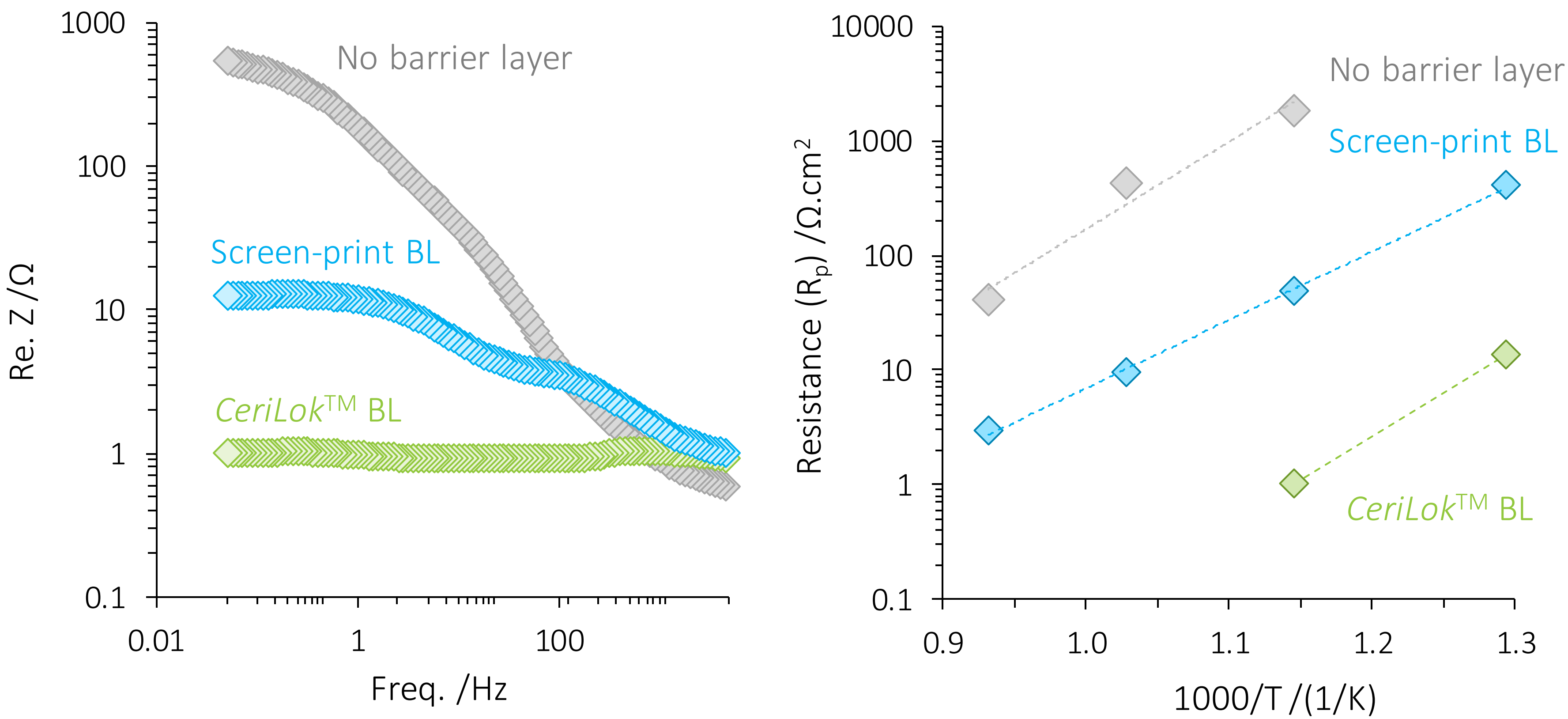


High T processing - interfacial ZDC layer



EIS RESULTS

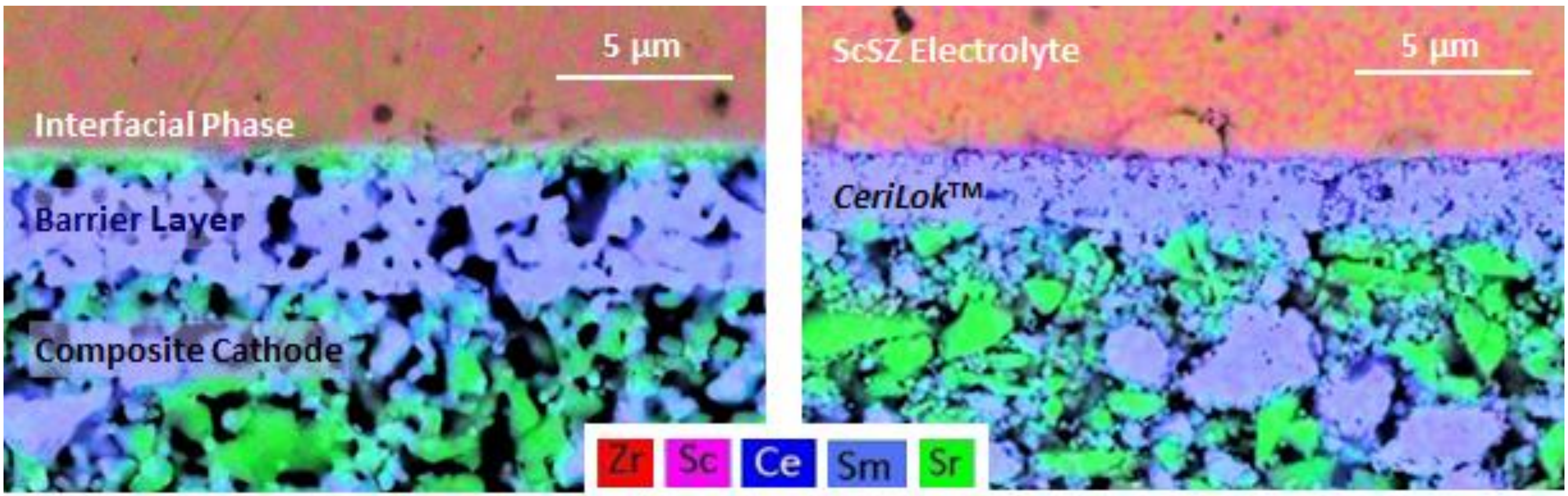
Identified process to achieve low R cathode-electrolyte interface



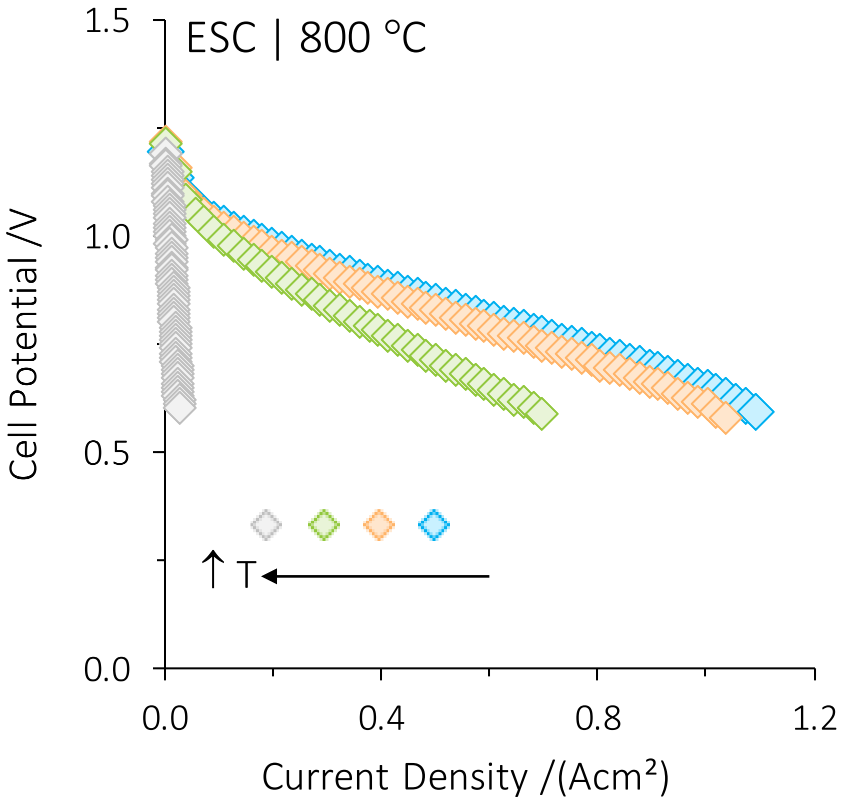
CERILOK™ MICROSTRUCTURE

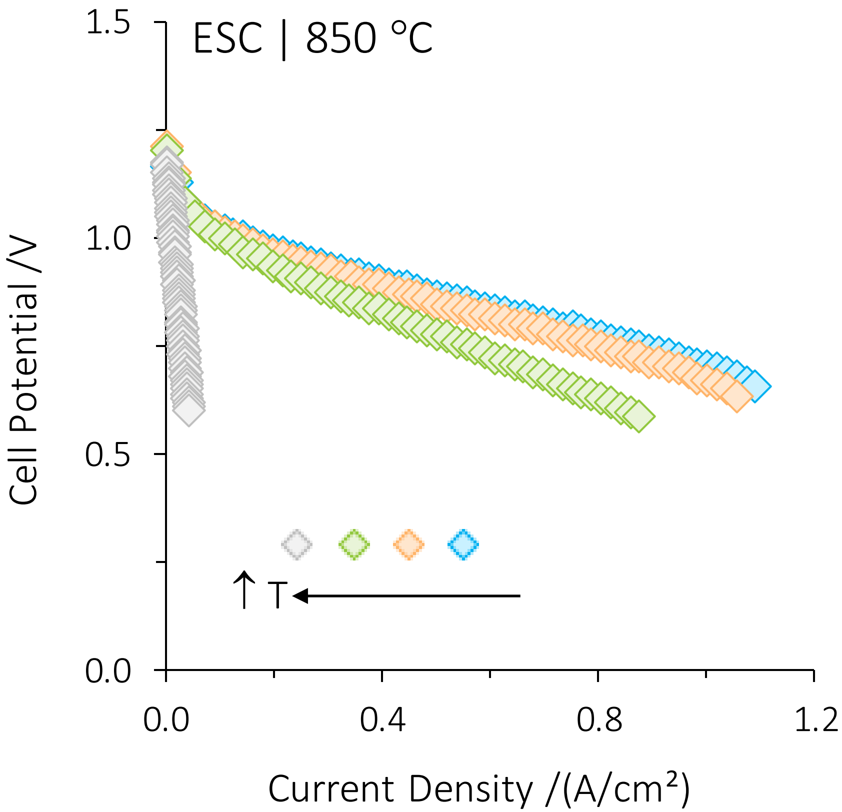
Prevention of resistive phase formation at electrolyte interface

Screen-printed | *CeriLok*™



Low-sintering temperatures are critical for high performance





Temperature: 800-850 °C

Gas composition: 0.5 SLPM $H_2|N_2$, 1.50 SLPM air

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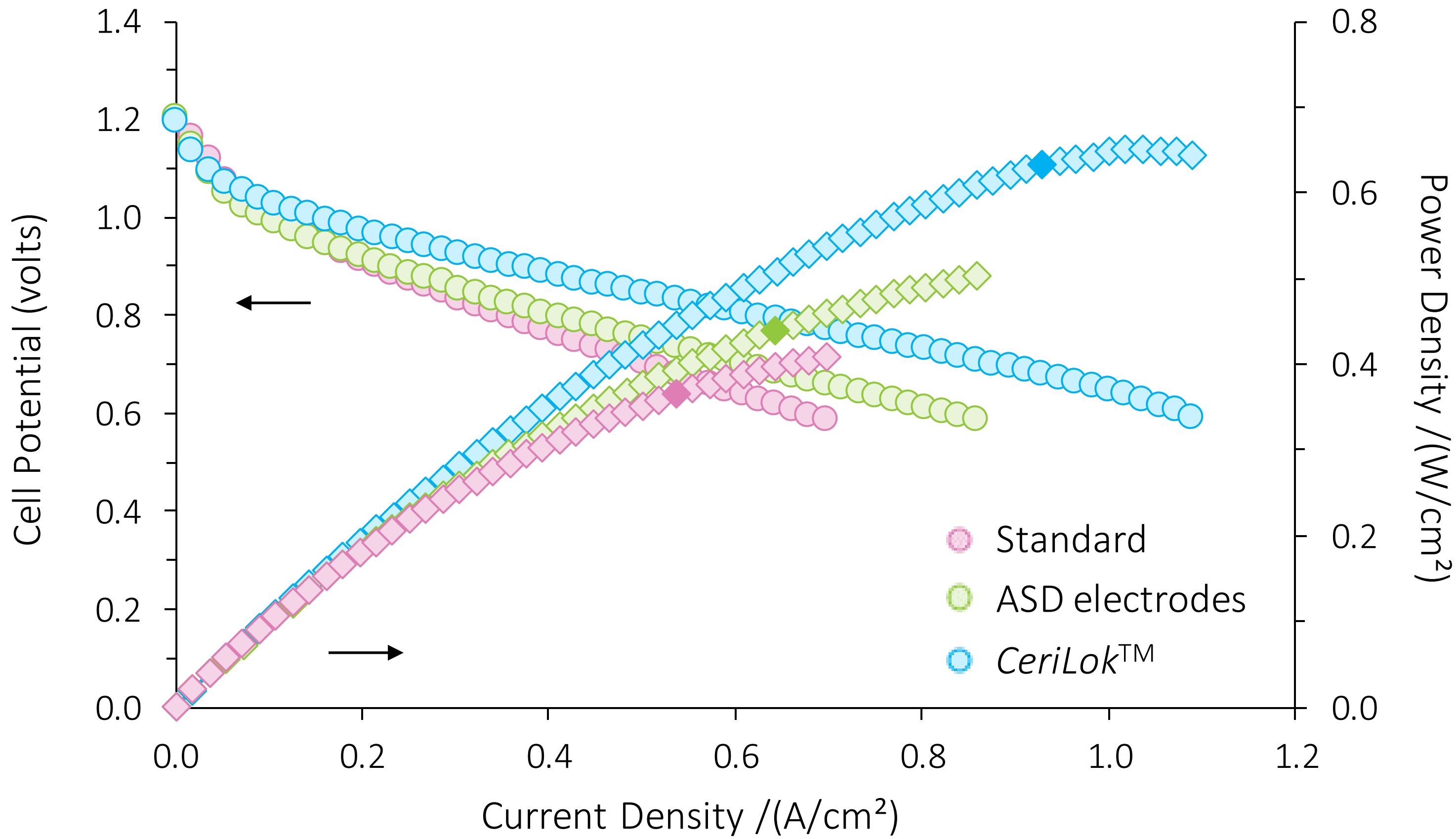
CELL PERFORMANCE

Low-temperature (*CeriLok*™) process significantly improves performance

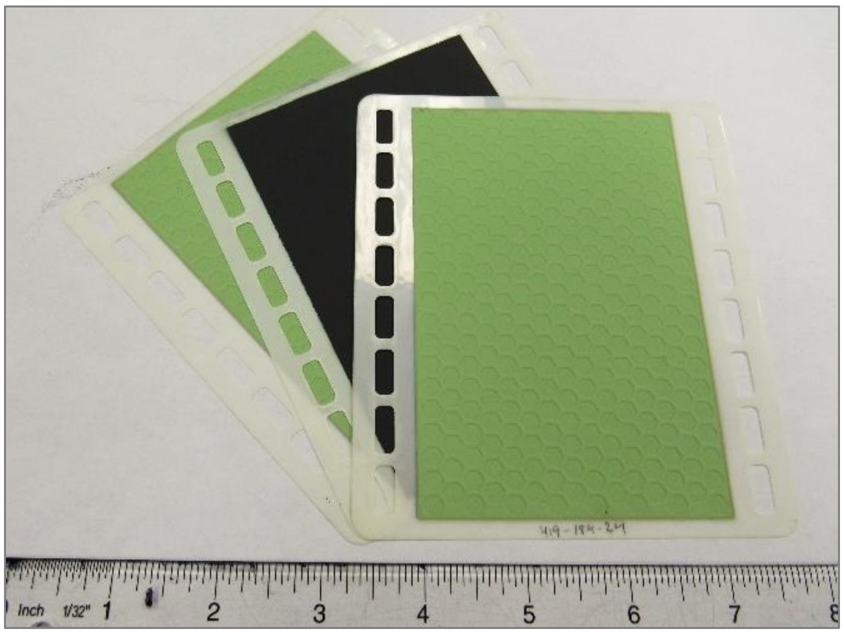


Temperature: 800 °C

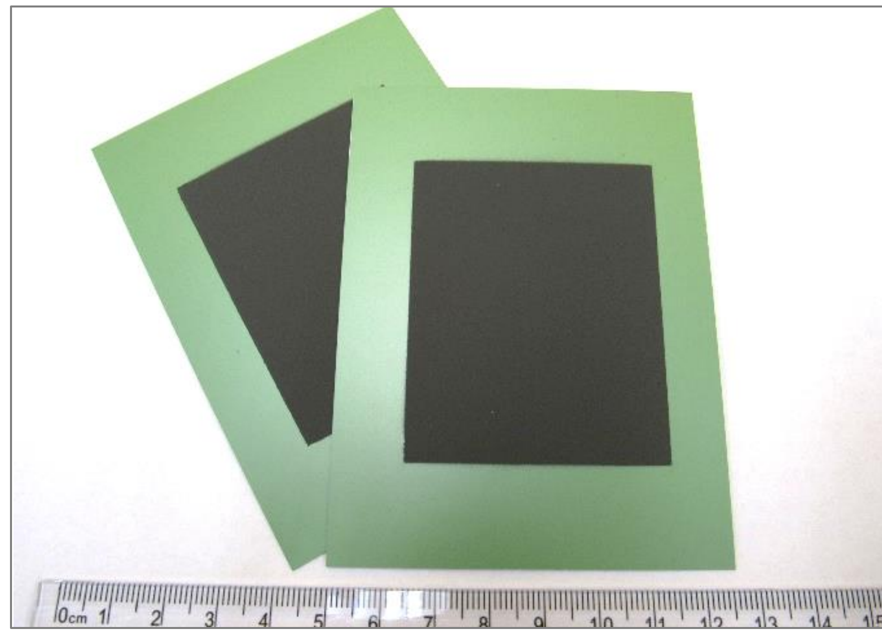
Gas Composition: 0.5 SLPM H_2|N_2, 1.50 SLPM air

CeriLok™ process amenable to ESC and ASC platforms

Electrolyte-supported cells

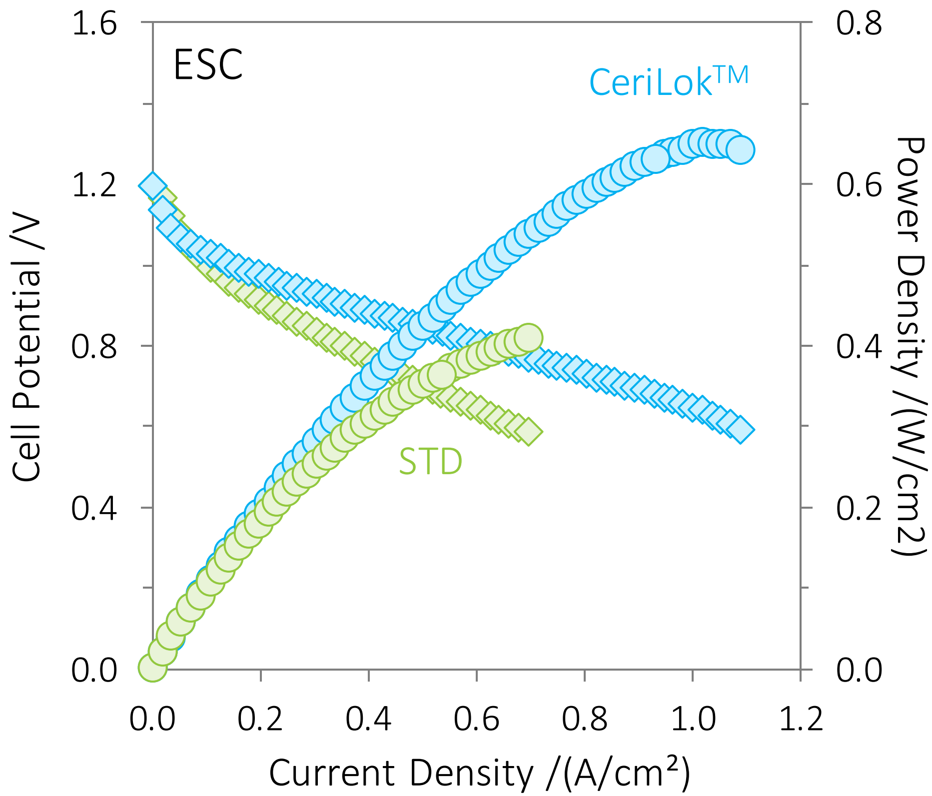


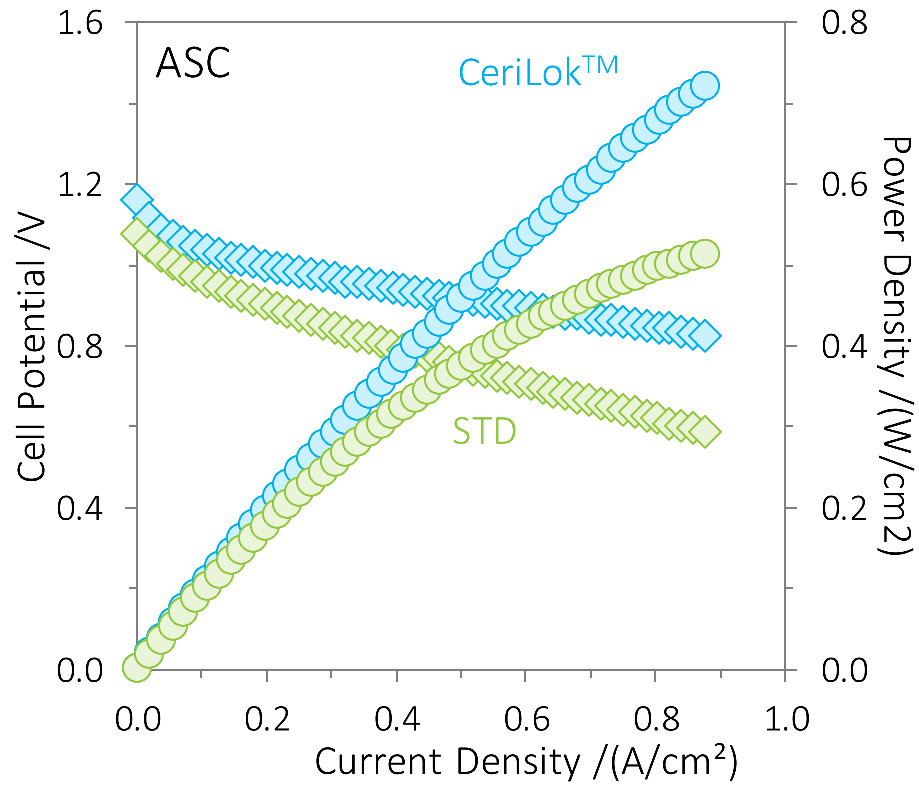
Anode-supported cells



SINGLE CELL PERFORMANCE

Similar cell performance improvement seen for ASCs





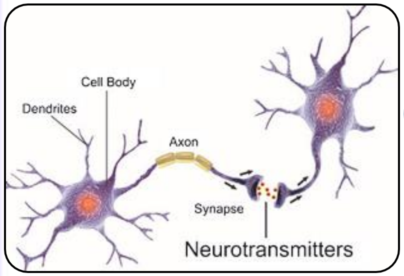
Temperature: ESC 800 °C, ASC 700 °C

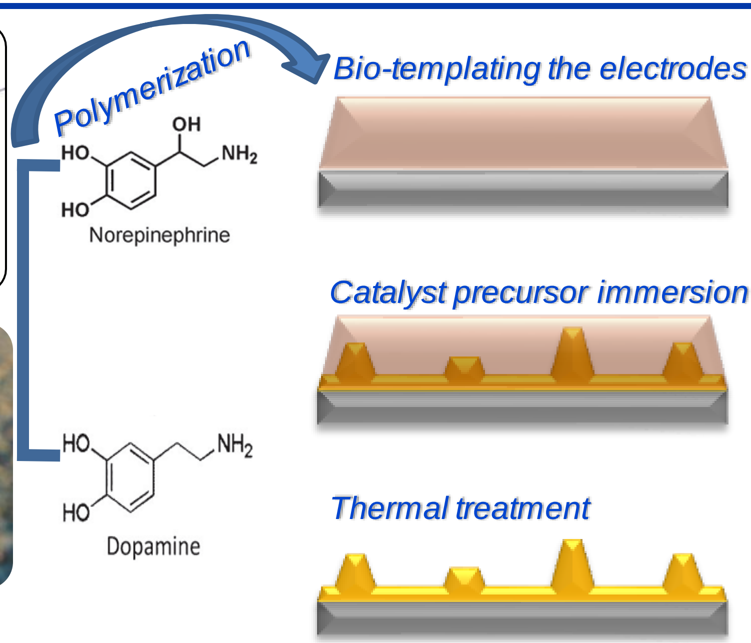
Gas composition: 0.5 SLPM $H_2|N_2$, 1.50 SLPM air

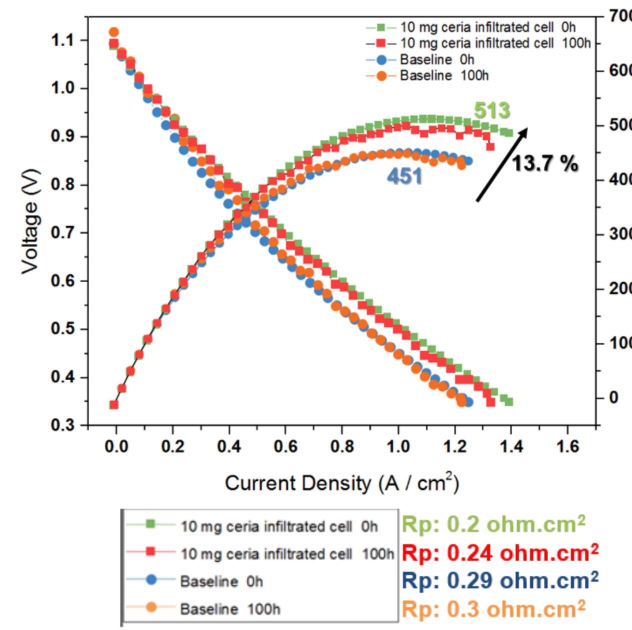
Bio-surfactant Assisted SOFC Electrode Infiltration*

Ozcan Ozmen & Edward M. Sabolsky, West Virginia University

- *Objective:* *Impregnate (infiltrate) a liquid solution (or dispersion) into a SOFC anode microstructure in order to deposit nano-catalyst within the anode electrode by a single step infiltration/firing protocol.*
- *Purpose:* *To enhance electrochemical reactions, such as the oxidation reaction kinetics, by increasing TPB area and providing higher charge-transfer kinetics.*
- *Polymerized mussel inspired catechols, such as dopamine and nor-epinephrine can be used as a* ***bio-adhesive surfactant for metal/metal oxide substrates and locally chelates metal salt precursors*** *with higher homogeneity and efficiency (single step infiltration)*







31 % reduction in Rp at 0th hour
20 % reduction in Rp at 100th hour

Patent Pending: US Patent Application No. 14/963,564

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CONCLUSIONS

1. Demonstrated applicability of ASD to address cell and stack-level challenges
2. Value-proposition of *AlumiLok*^{TM} coating has evolved
3. *CeriLok*^{TM} provides material and processing enhances to provide cell performance improvements for both ESC and ASCs

If you would like more information please stop by our Booth (B03)

ACKNOWLEDGEMENTS

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- Grant DE-SC0018534 Dr. Jai-Woh Kim

University of West Virginia

- Dr. Ed Sabolsky and Ozcan Ozmen

BACKUP