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Functional Interfacial Layers to Reduce Detrimental Cell Interactions

MS&T 2018, Columbus OH

Our R&D focuses on the intersection between energy and environment

SOFCs	Sensors	Materials	Catalysts	Coatings
Stationary & Military	Transportation & Energy Markets	SOFC & Energy Storage	H_2 and Chemicals	SOFC & High T





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Today's talk will highlight Nexceris' coating development

Internal Reforming

- Tailored catalyst coating for enhanced on-cell reforming capability

Sealing Interface

- Enhanced stability through composite seal formulations with corrosion-resistant coatings

Electrolyte/Cathode Interface

- Low-resistance interface achieved through low-temperature processing

Active-area interconnect interface

- Case-study of scaling up manufacturing

To support this development we've built out our pilot-scale coating facility

Aerosol-Spray Deposition

- Two USI PRISM 300 spray systems

Heat Treatment

- Controlled atmosphere and air furnaces

Testing Capabilities

- Coating adhesion and microstructure
- Electrical ASR/EIS testing
- Single and stack-level performance testing

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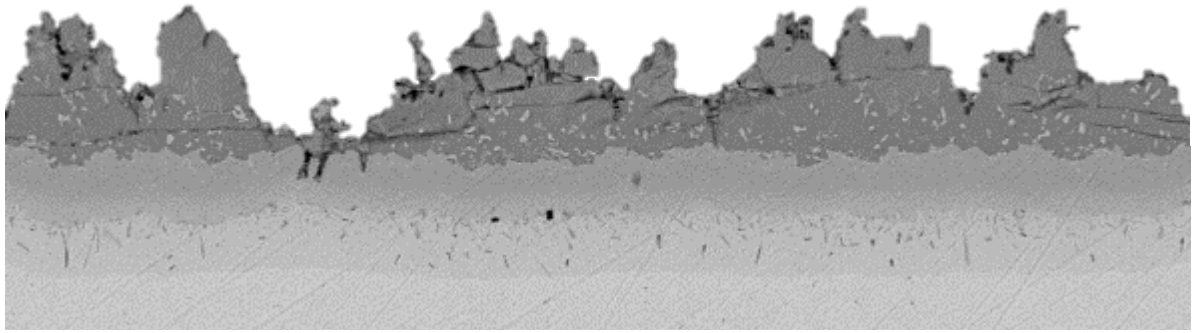
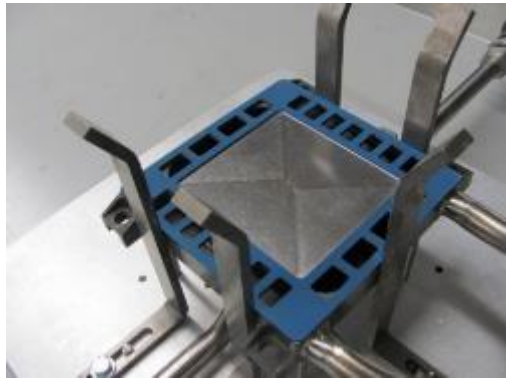
Aluminization process creates a lot of opportunities



Interconnect

Balance-of-Plant

Seal/Electrical Isolation



Catalyst Support

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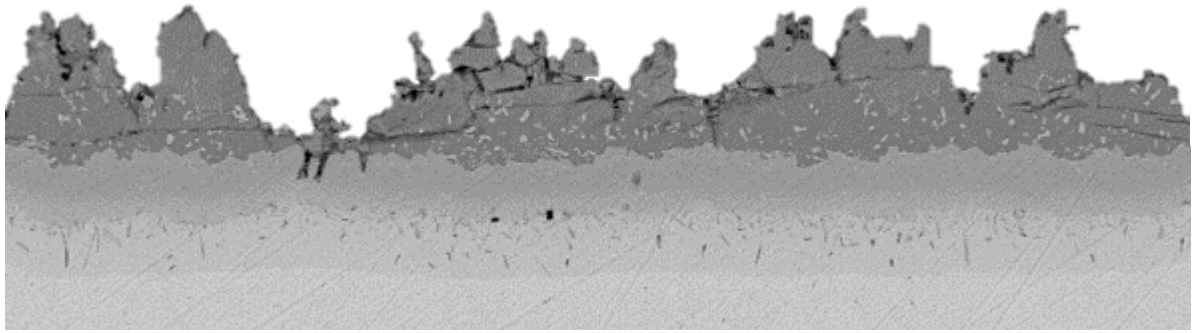
Aluminide/alumina surface provides high temperature protection

Alumina/aluminide surface



Interconnect

Balance-of-Plant

Seal/Electrical Isolation

Catalyst Support

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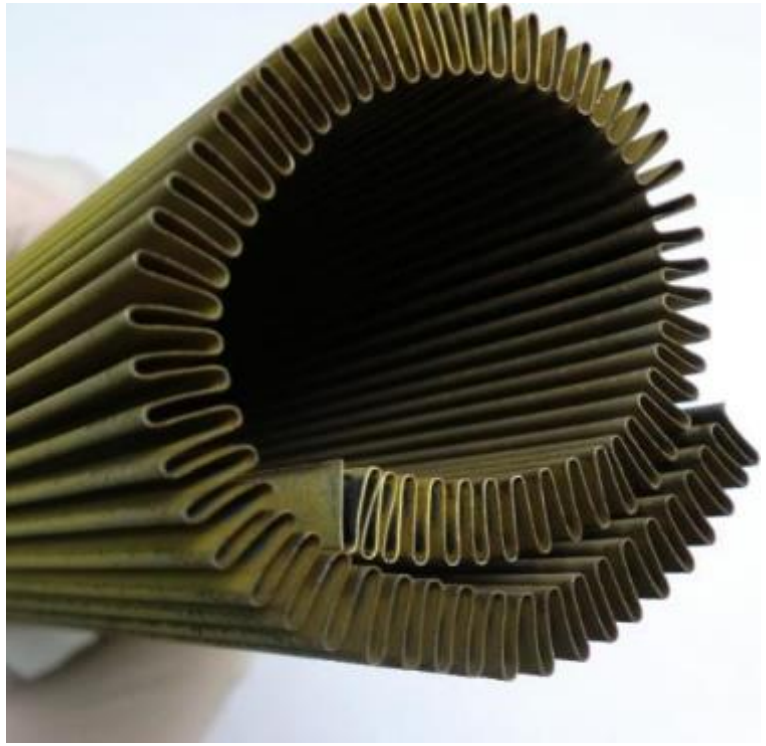
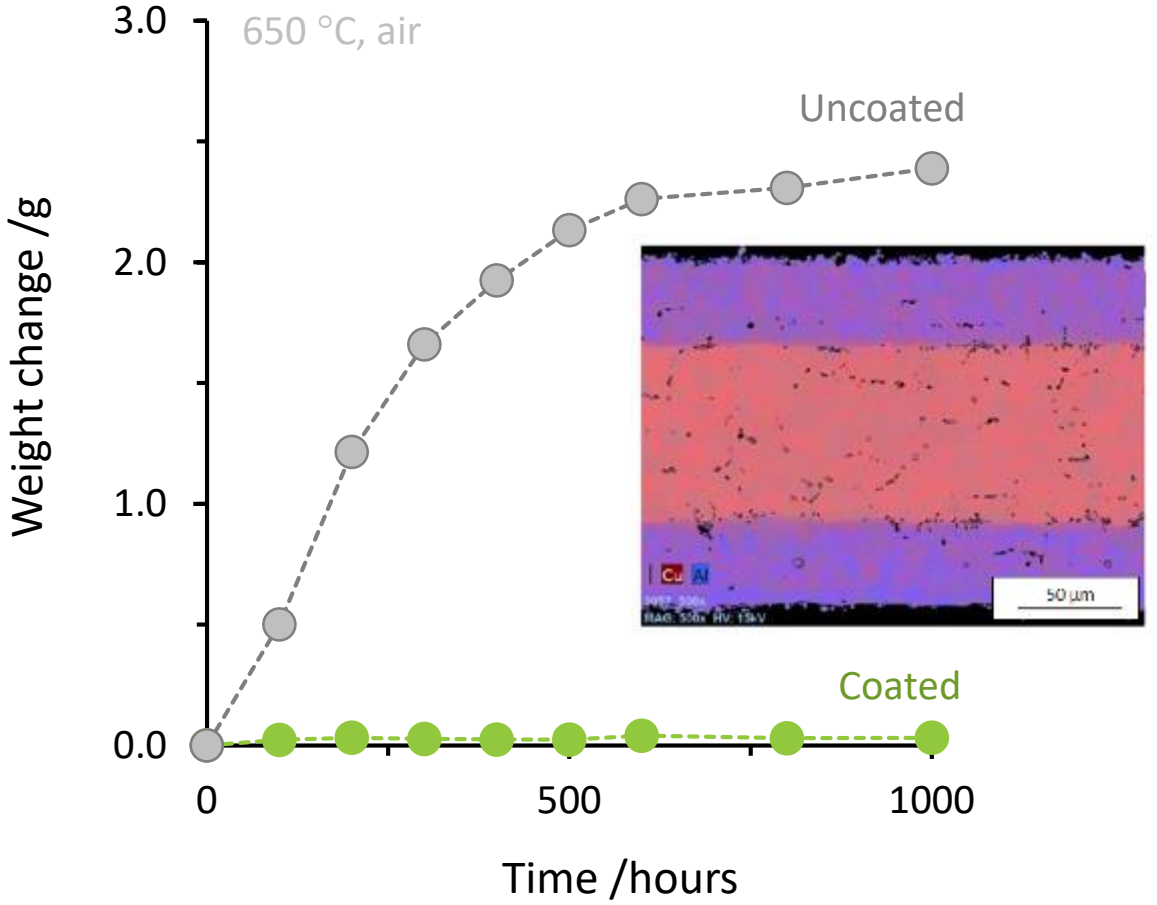
We've investigated a lot of potential applications





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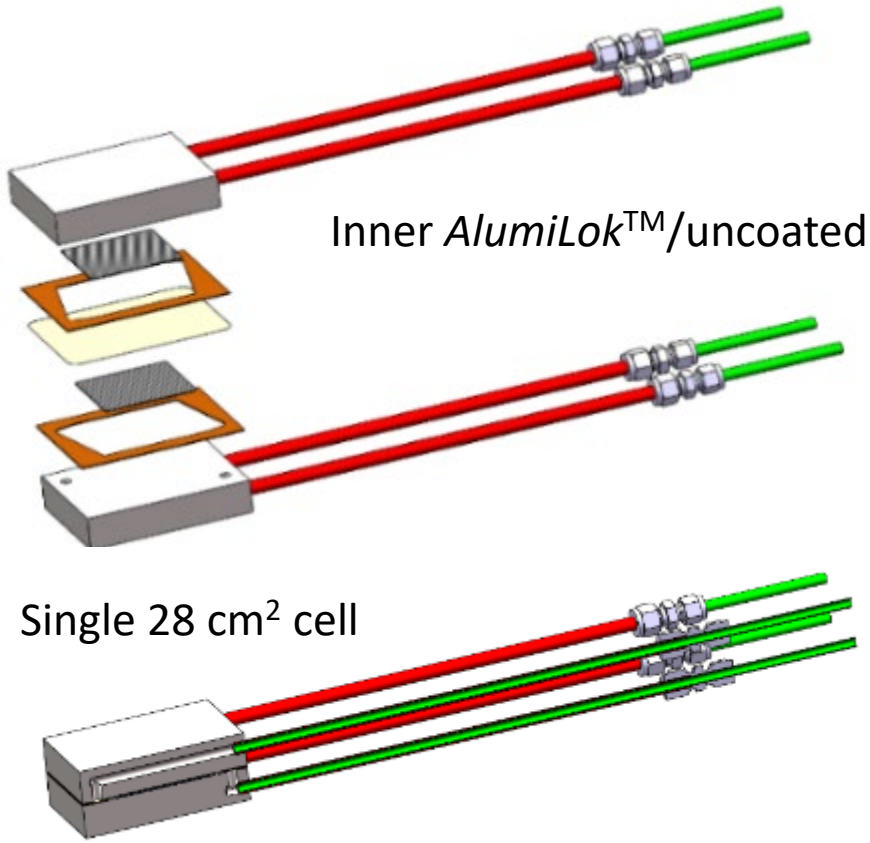
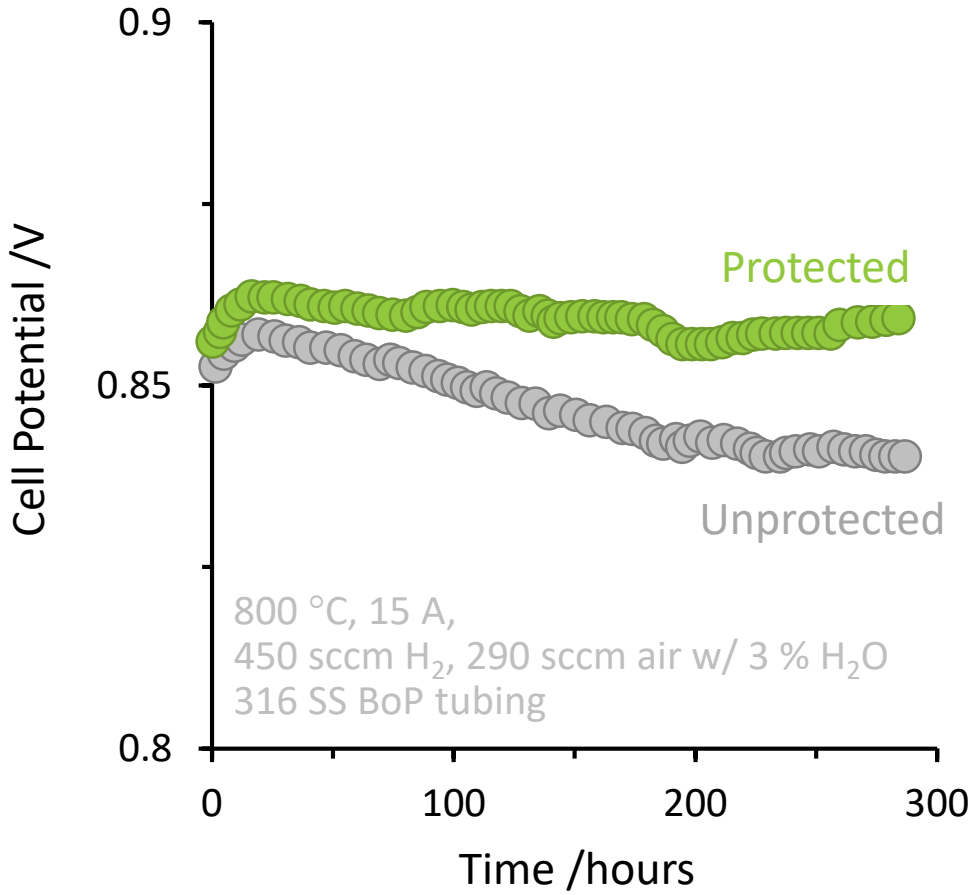
Important to correlate benefit of coating on cell performance





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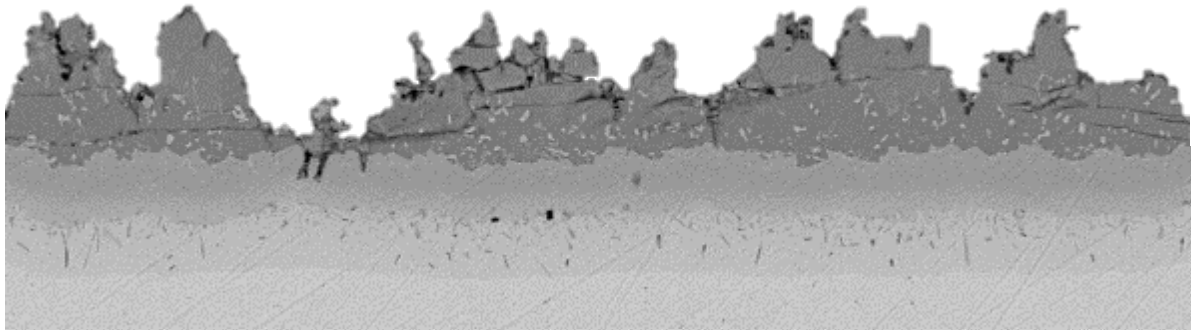
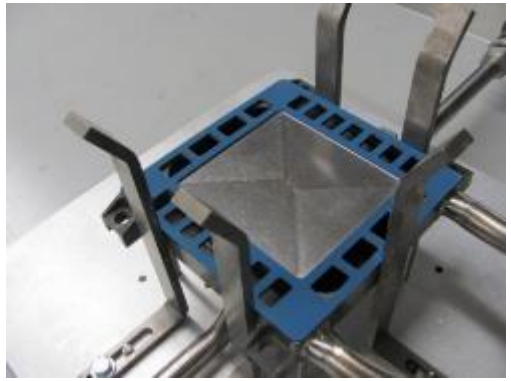
Aluminization process creates a lot of opportunities



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

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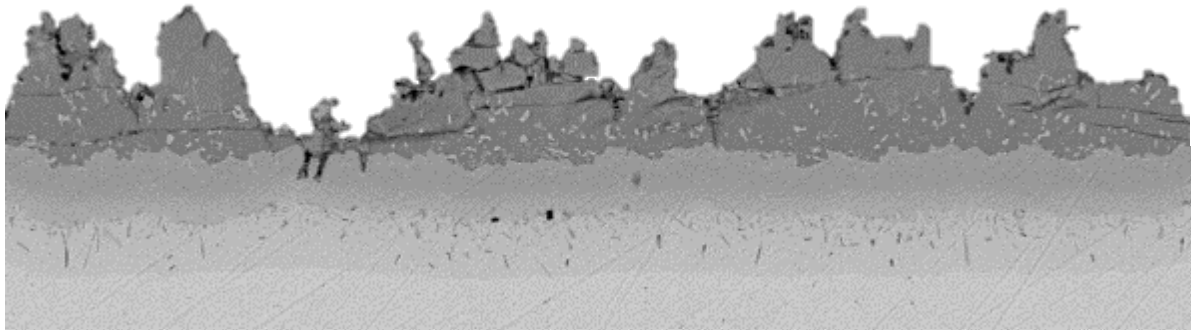
Roughened surface provides mechanical anchoring for coatings

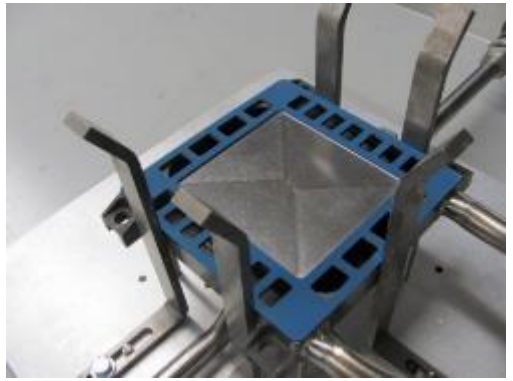


Roughened Surface

Interconnect

Balance-of-Plant

Seal/Electrical Isolation



Catalyst Support

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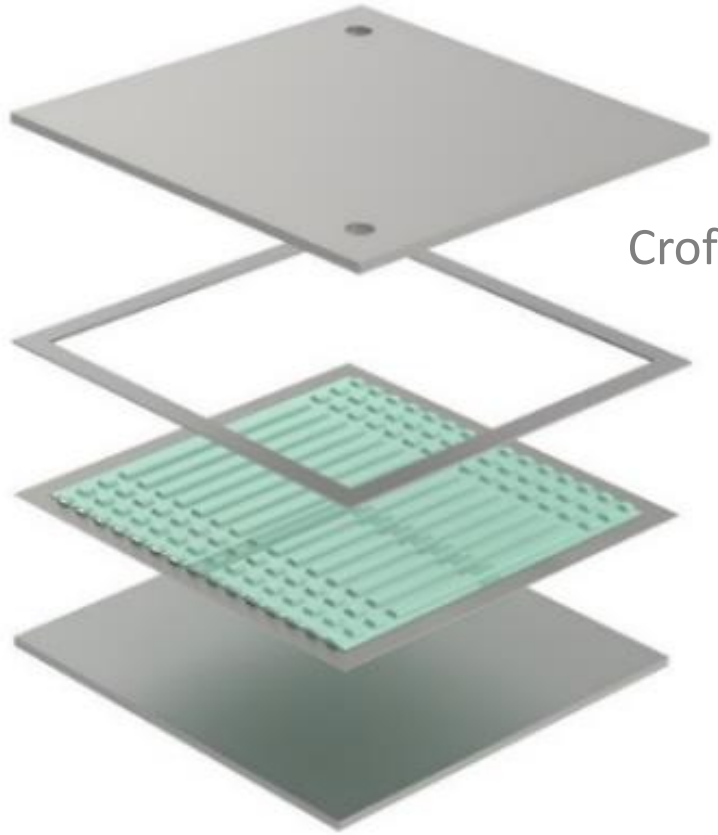
Use coating as a pre-treatment for catalyst coatings

AlumiLok™ coated Crofer plate

1 inch

Manifold assembly design



Crofer manifolds

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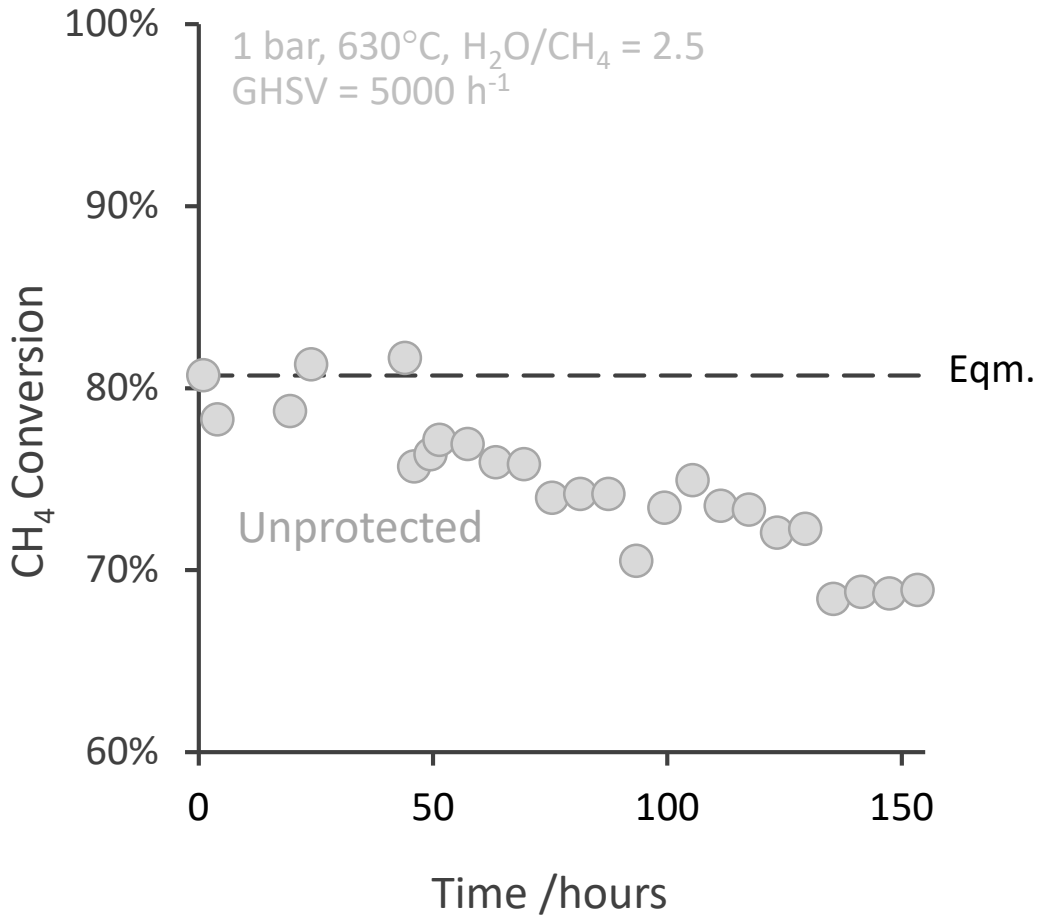
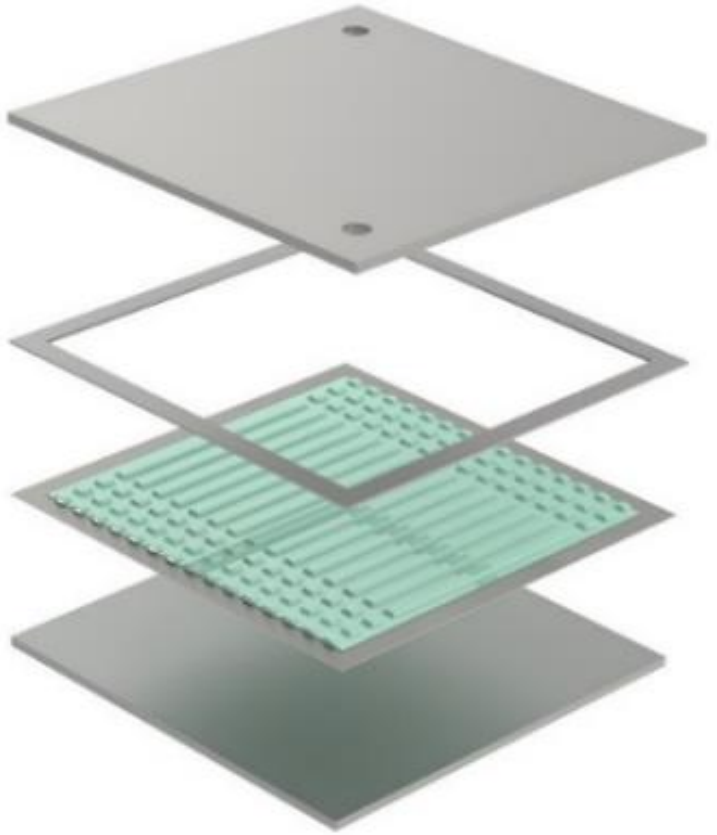
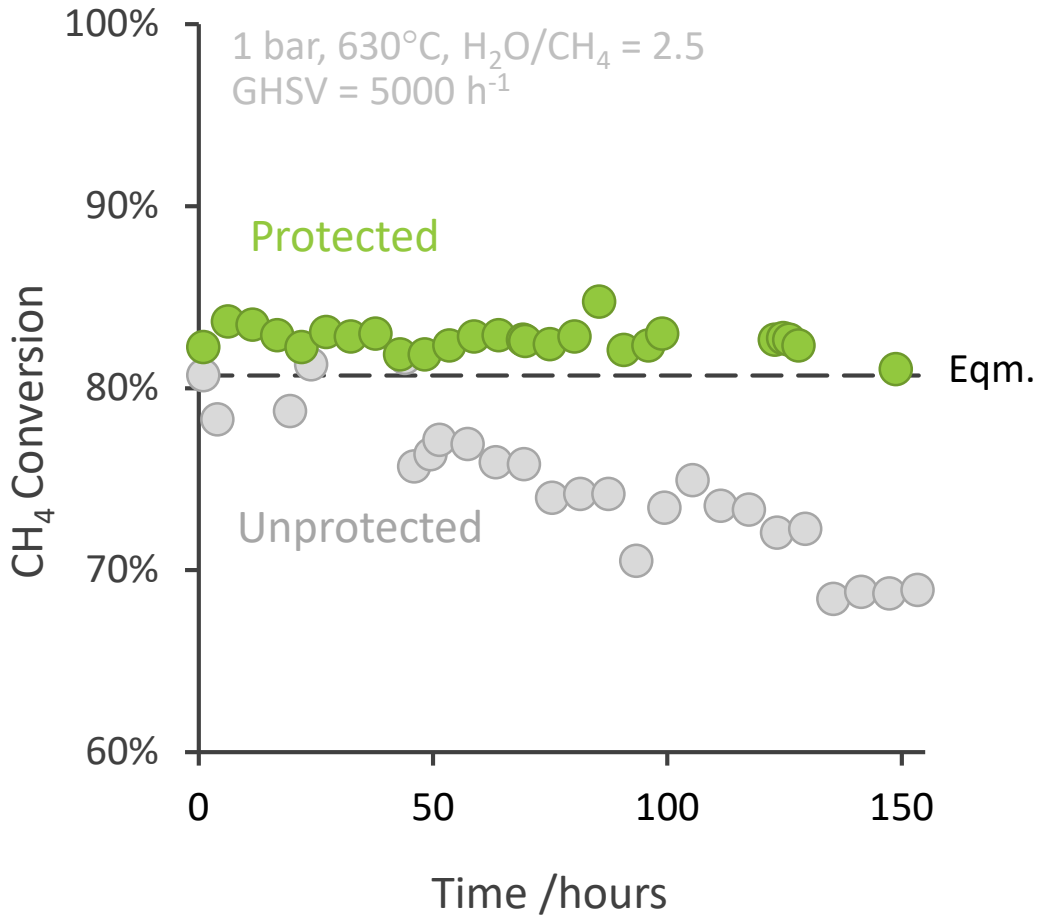
Initial catalyst stability low due to Cr poisoning



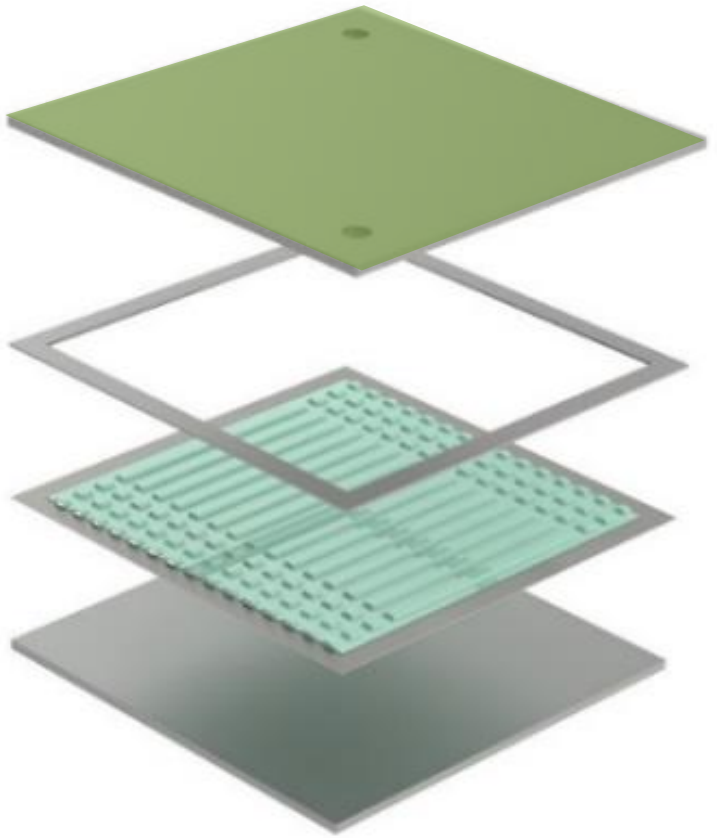
Unprotected manifolds – Cr volatilization



Catalyst stability correlates to coating protection



Protected manifolds – prevent Cr volatilization



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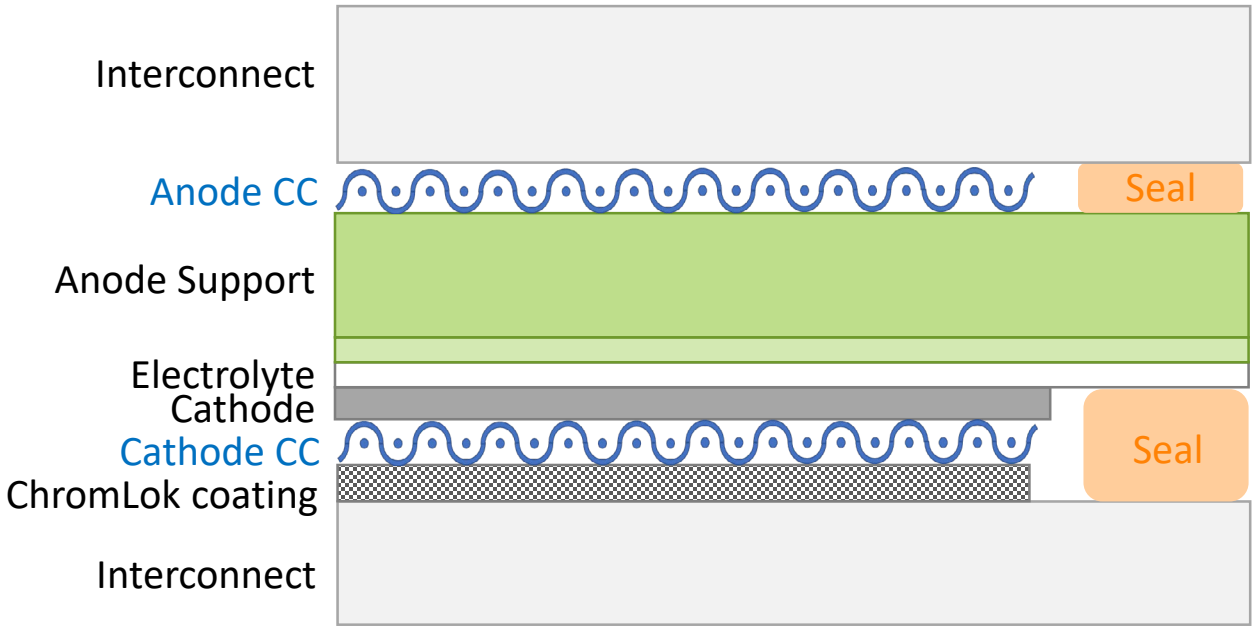
Sealing is one of the most vexing challenges in SOFC development



Sealing is a complex issue with many requirements:

- Gas tight seal
- Mechanical standoff
- Mechanical compliance under compression
- Mechanical integrity against cycling
- Damage tolerance, or recover seal hermeticity
- Avoid formation deleterious phases

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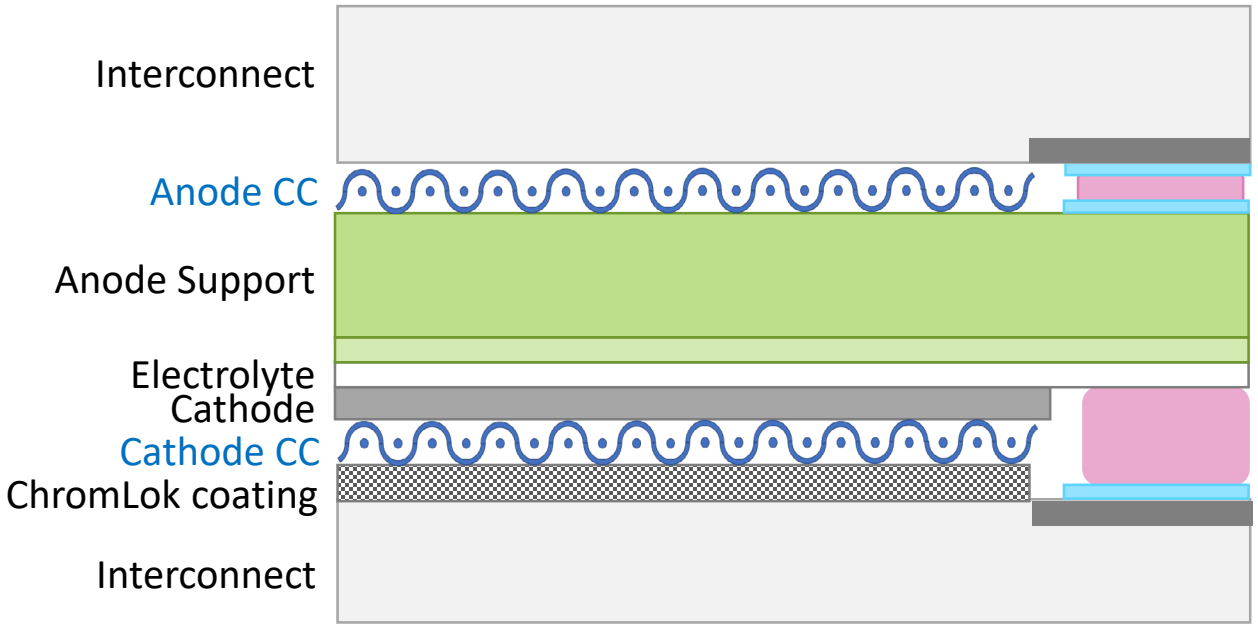
We are developing a new composite sealing concept – *GasLok*™



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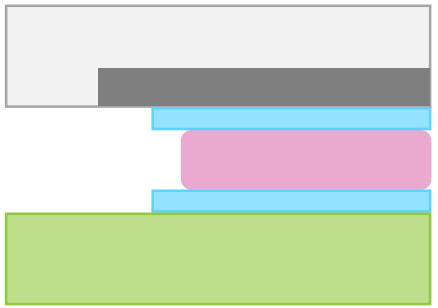
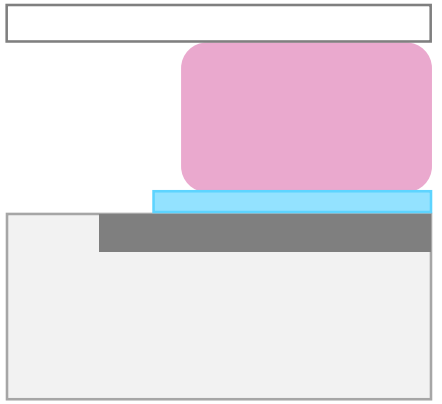
Combination of graded composite seal and protective coatings

Anode-IC sealing



Electrolyte-IC sealing



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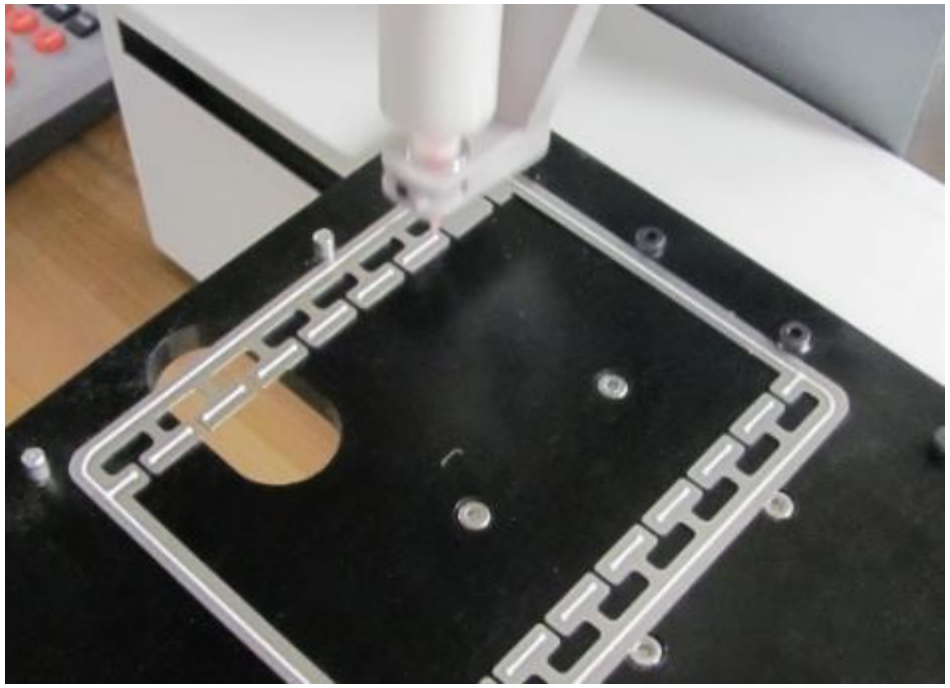
GasLok can be applied in various sealing formats

Composite seal ink



Composite seal gasket

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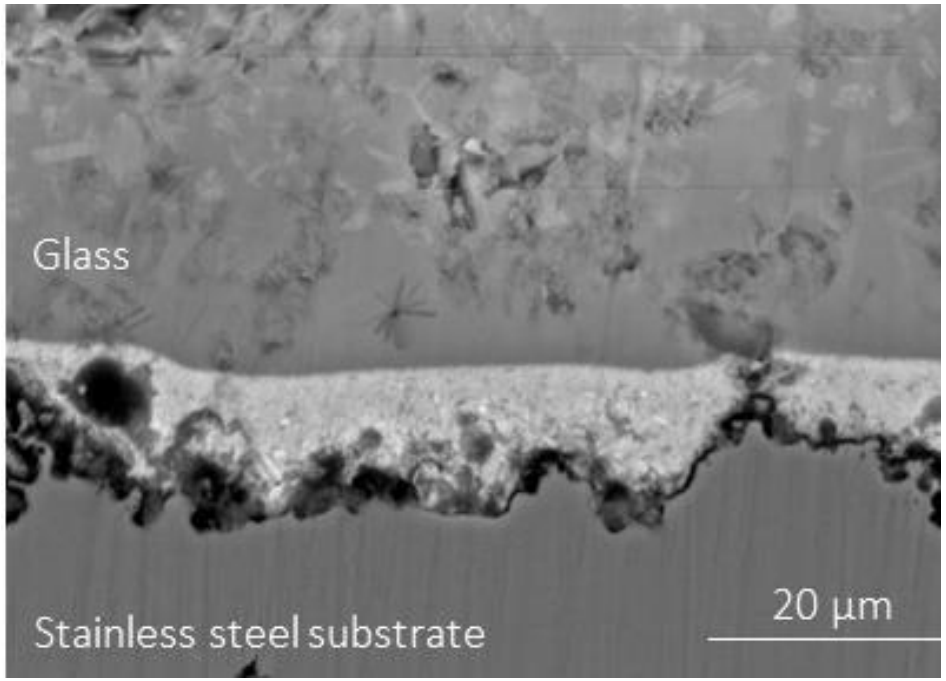
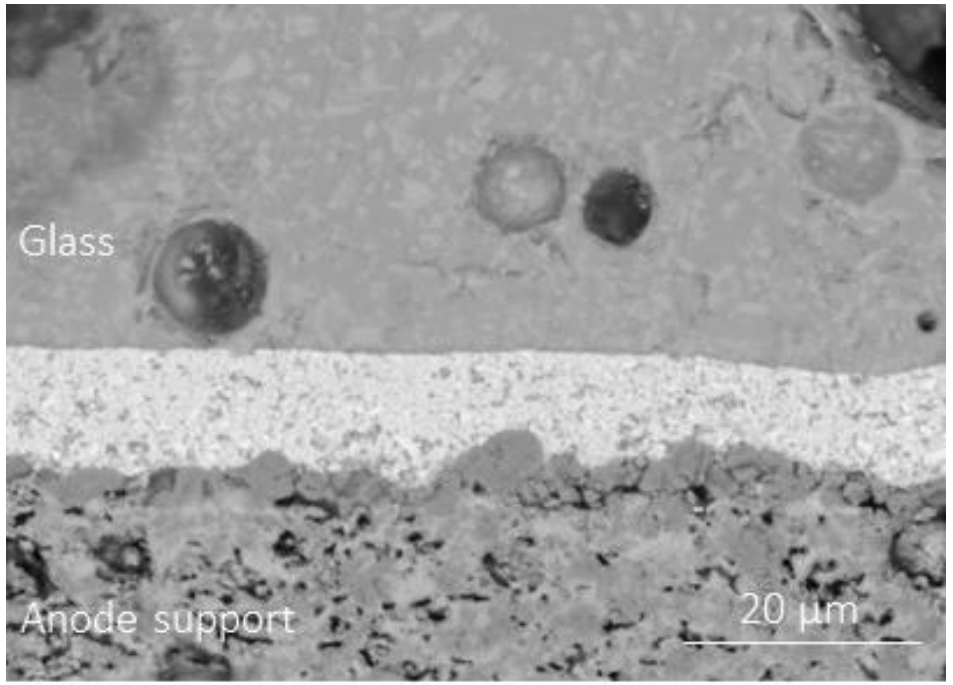
The protective coating can be applied to different interfaces

Glass/steel IC (or shim) interface



Glass/anode support interface



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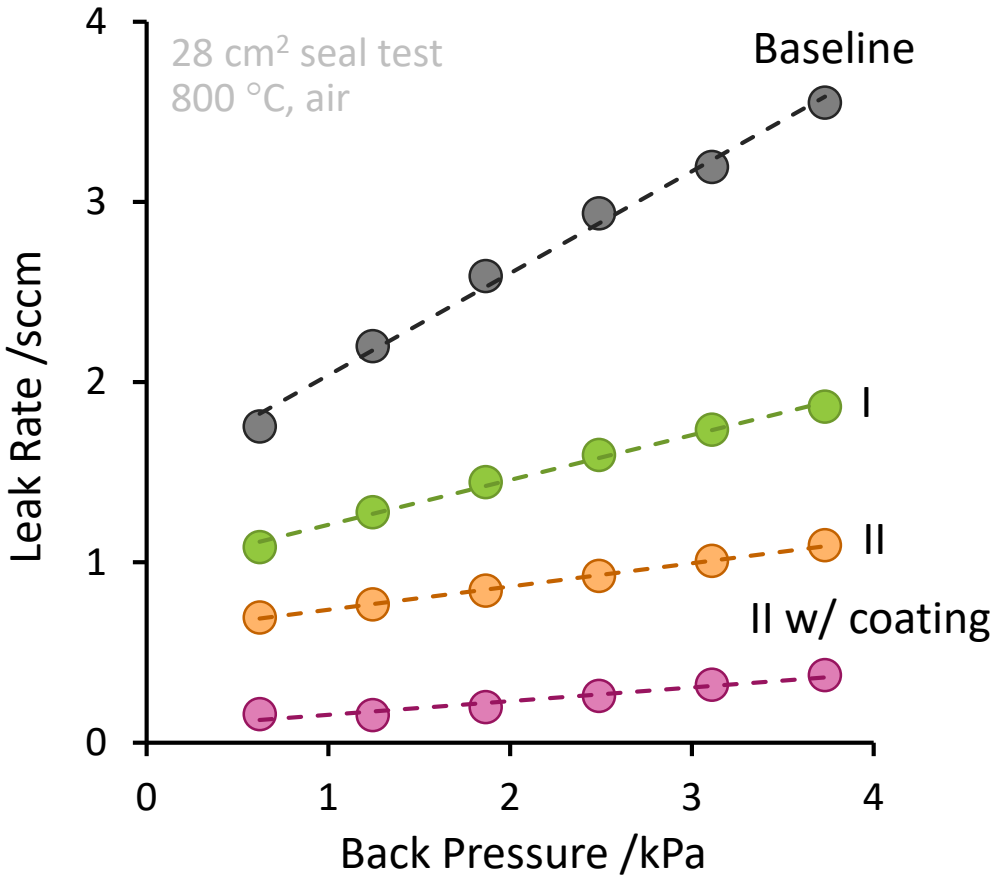
GasLok demonstrates significant improvement in sealing



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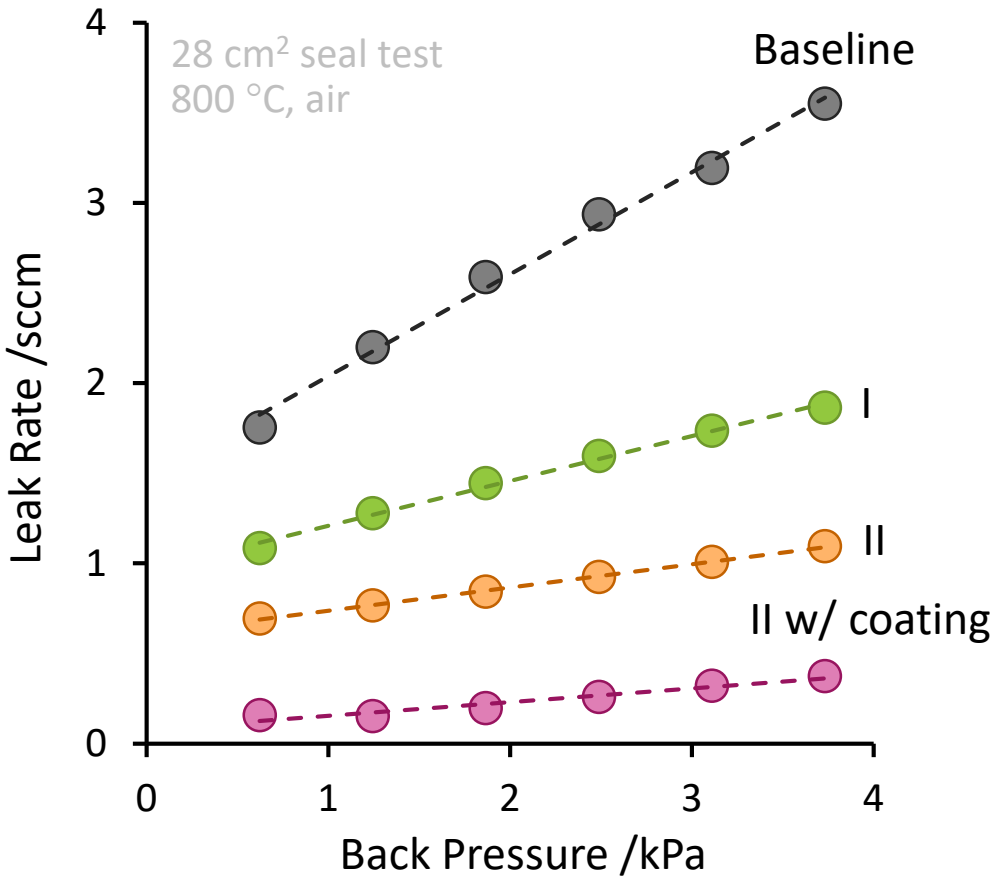
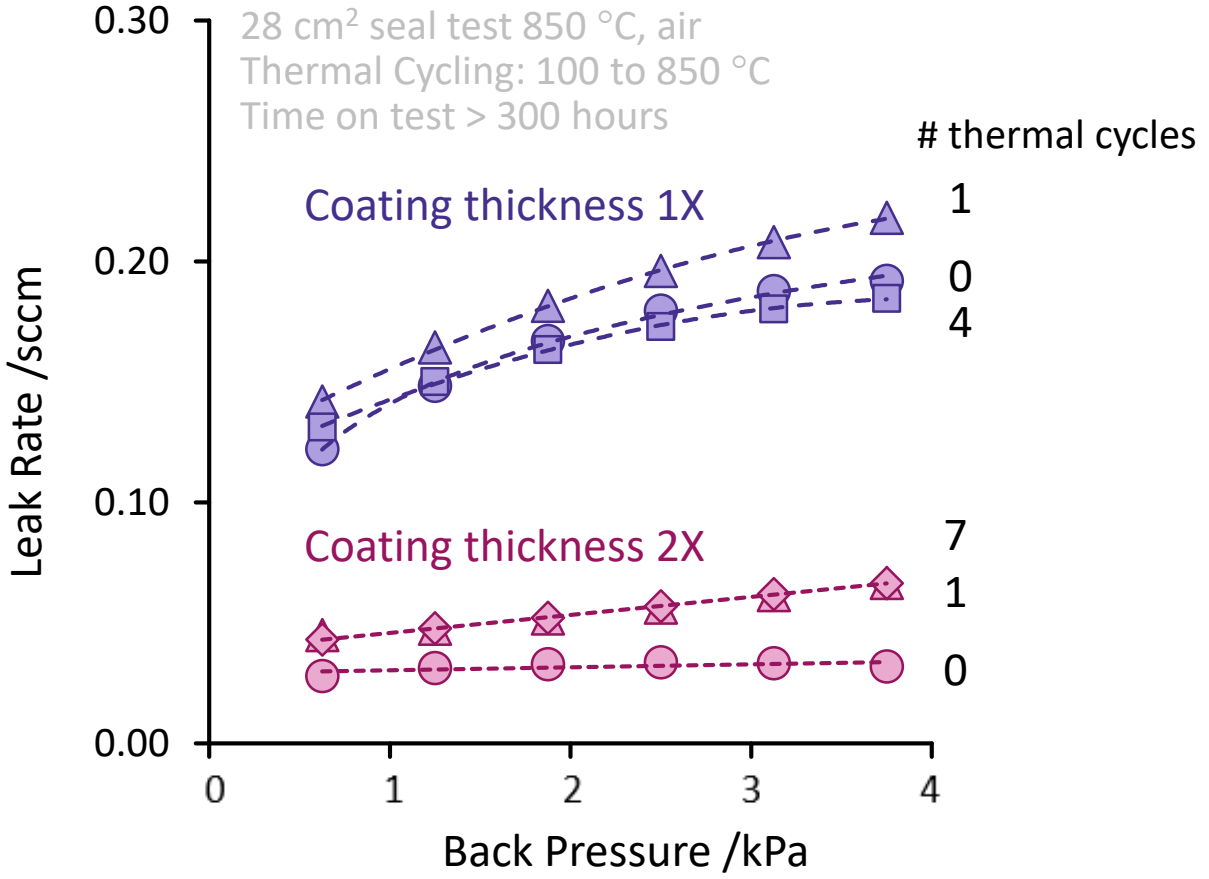
Seal is able to withstand multiple thermal cycles





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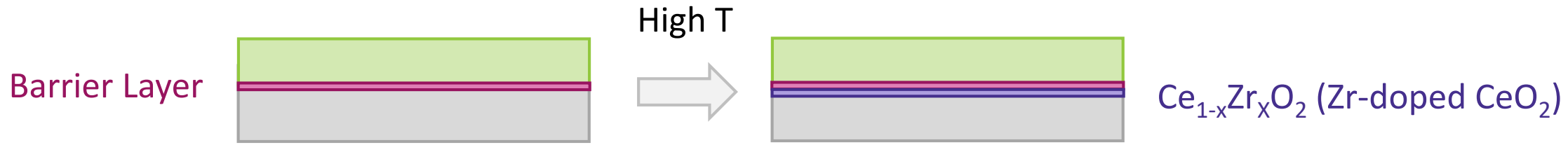
Cathode/electrolyte interface promising location for cell improvement

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

High T processing - interfacial ZDC layer



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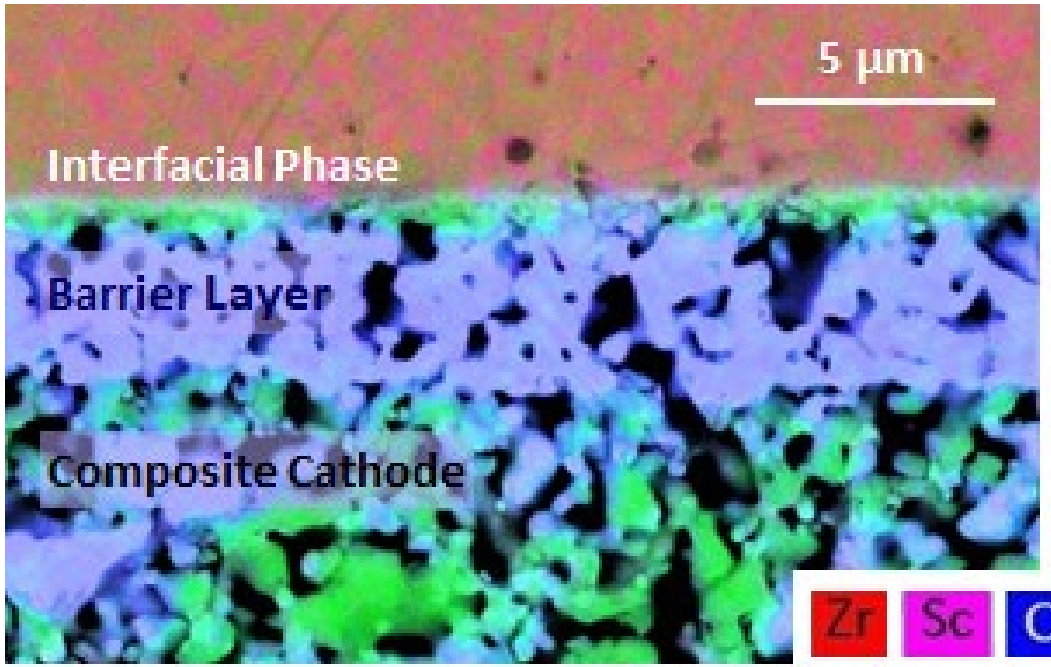
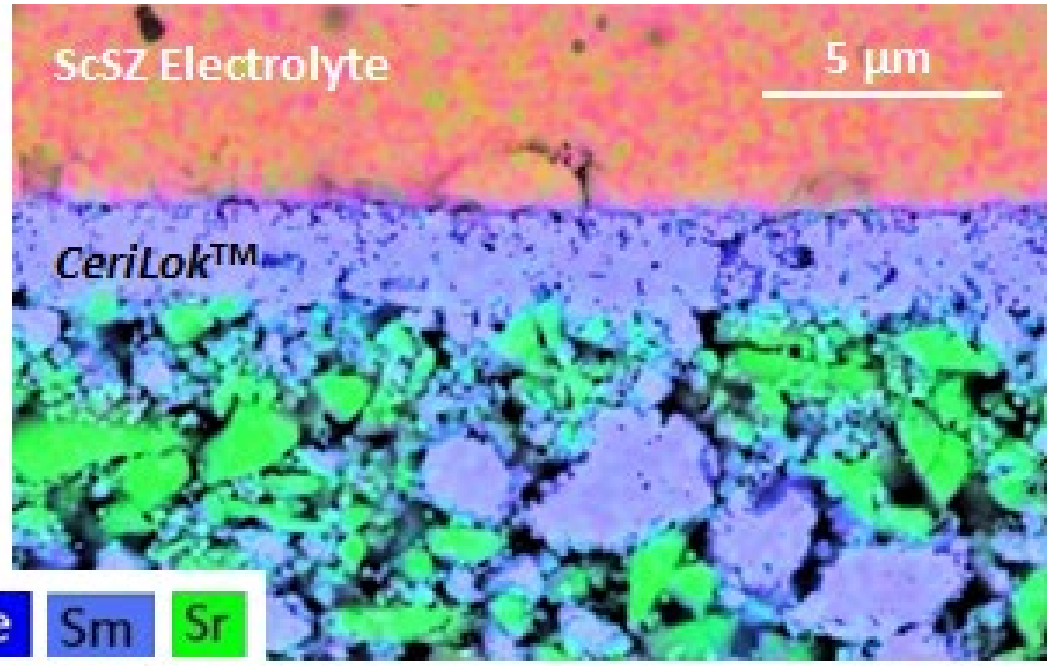
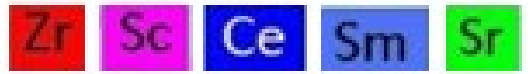
Developed *CeriLok*™ coating to detrimental interfacial phases

Screen-printed



CeriLok process





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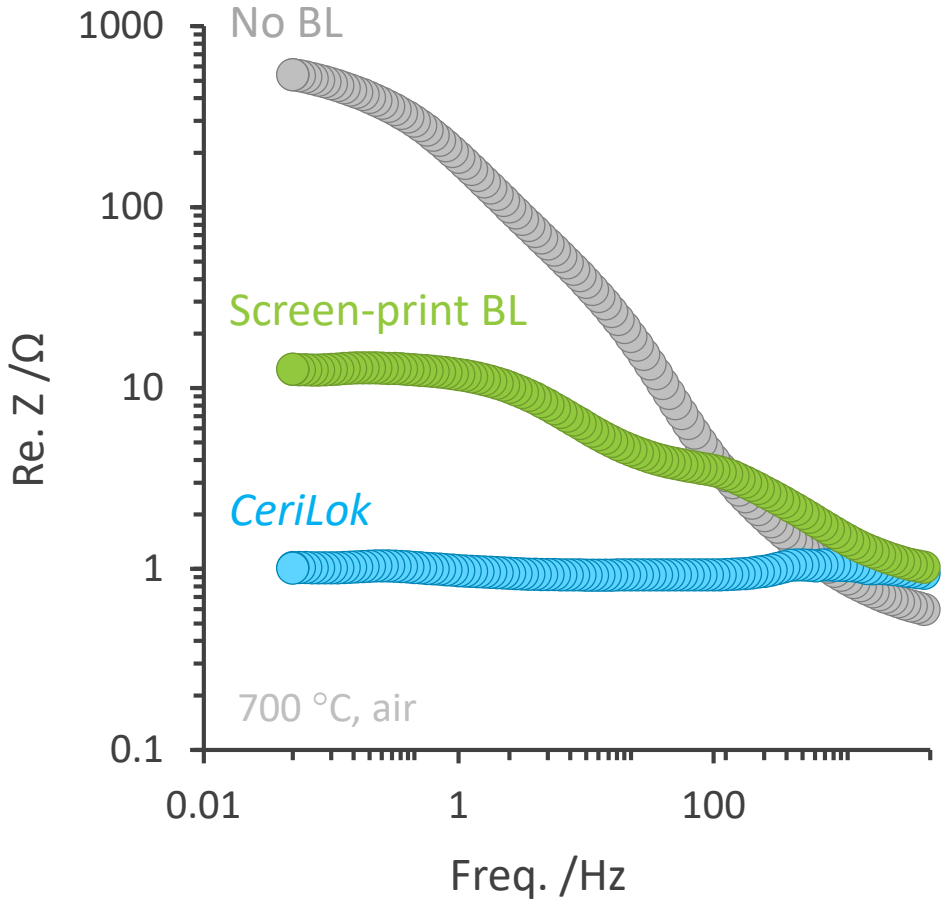
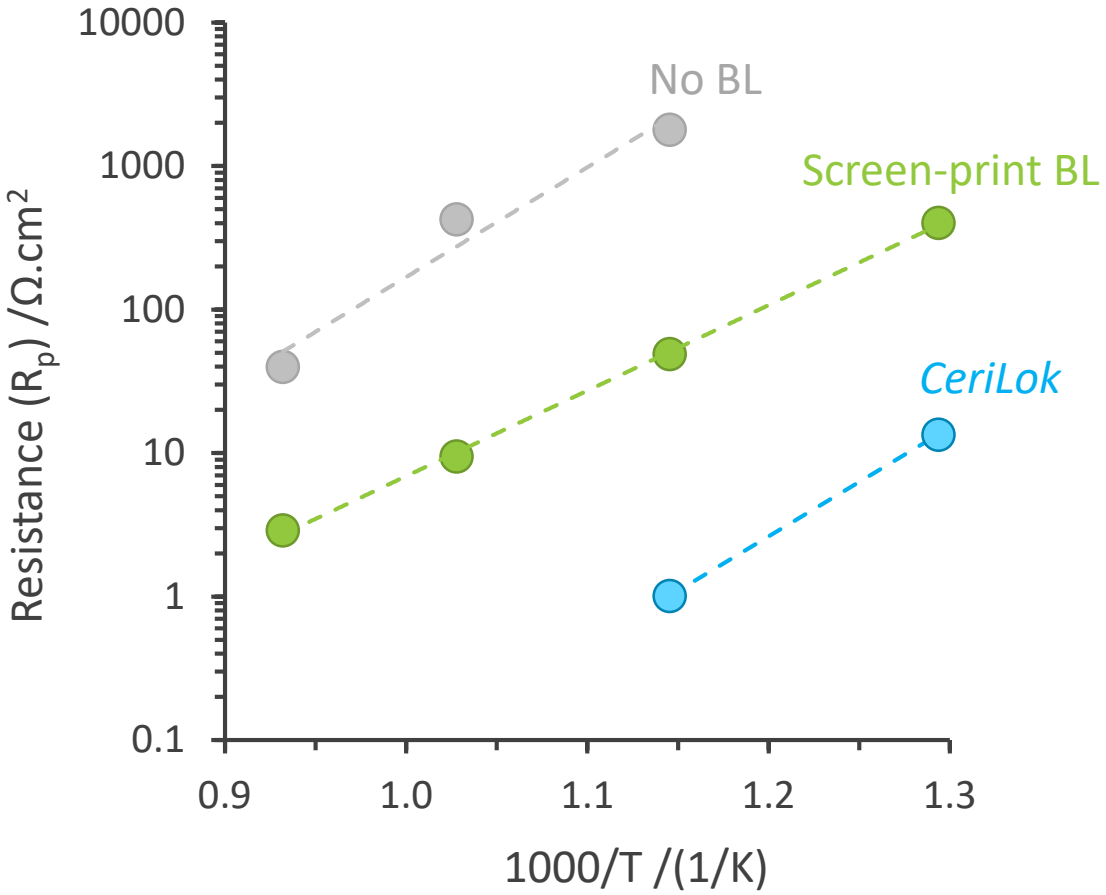
This enables a low resistance cathode/electrolyte interface





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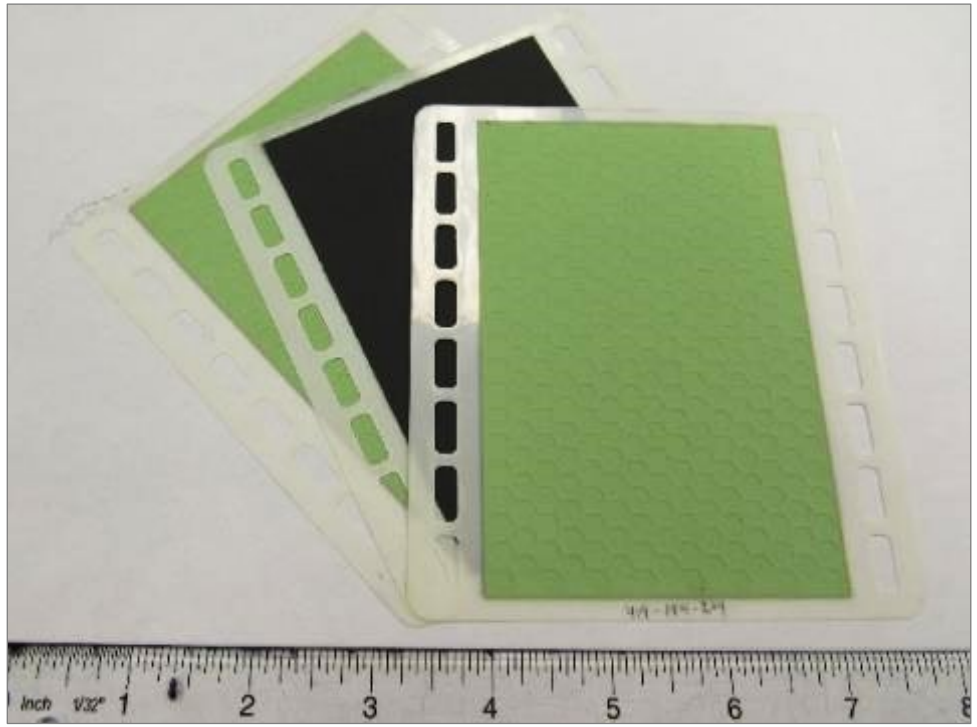
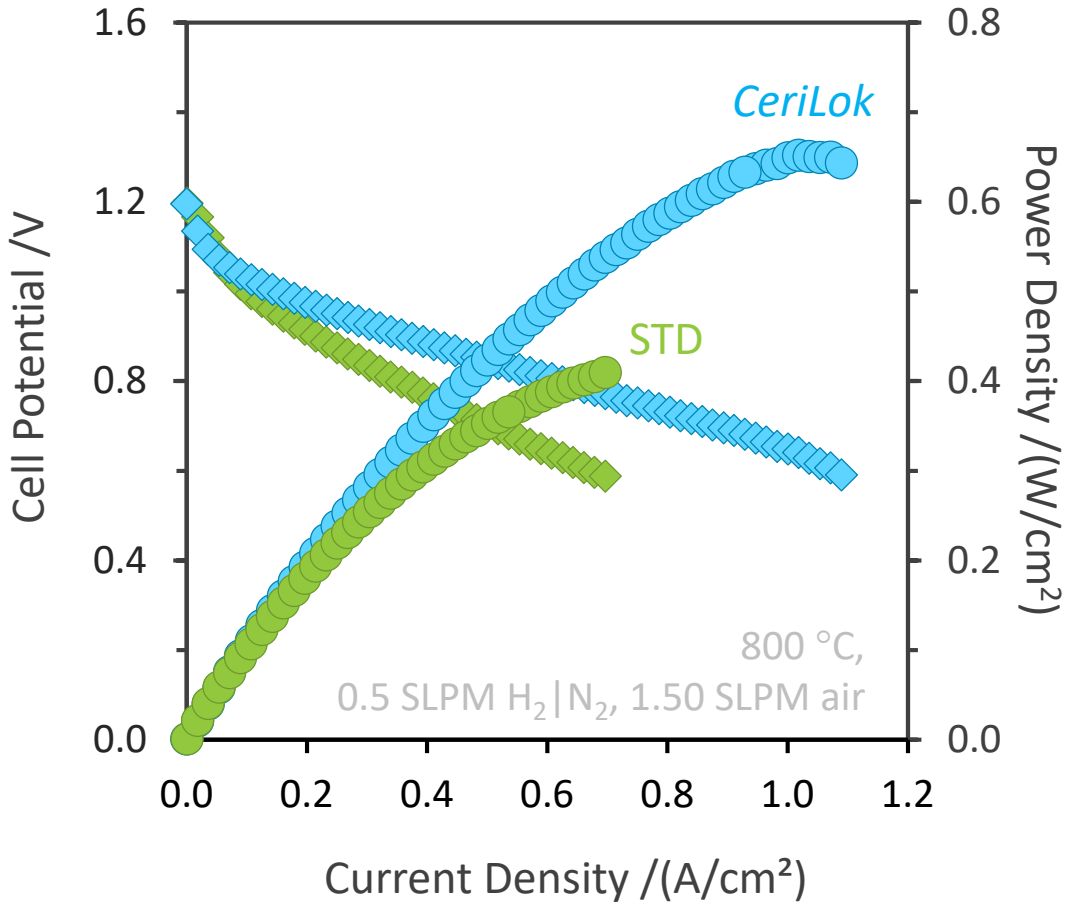
CeriLok developed on ESCs – demonstrates significant cell enhancement





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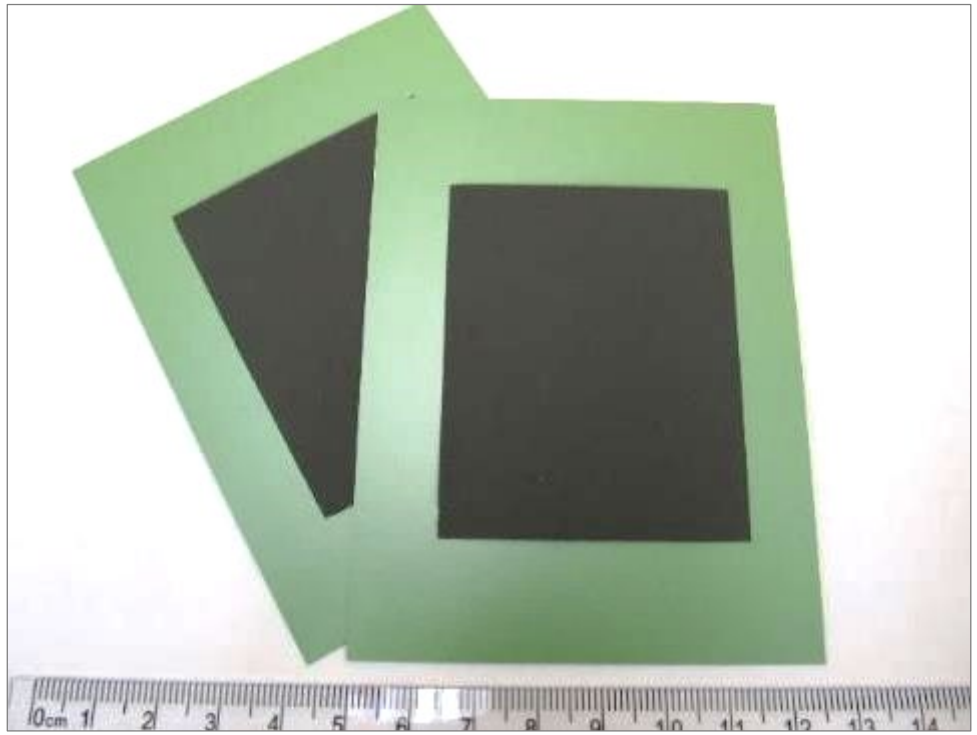
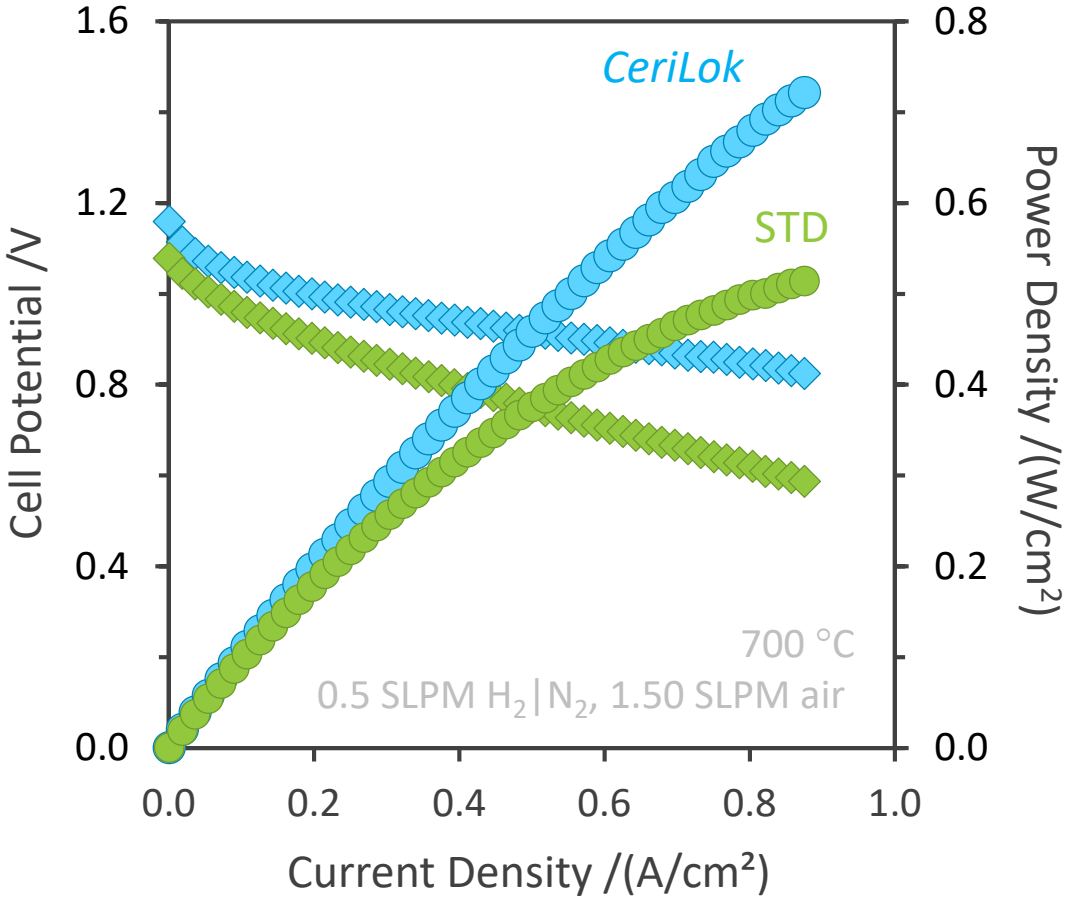
Technology has also been demonstrated for ASCs with similar results





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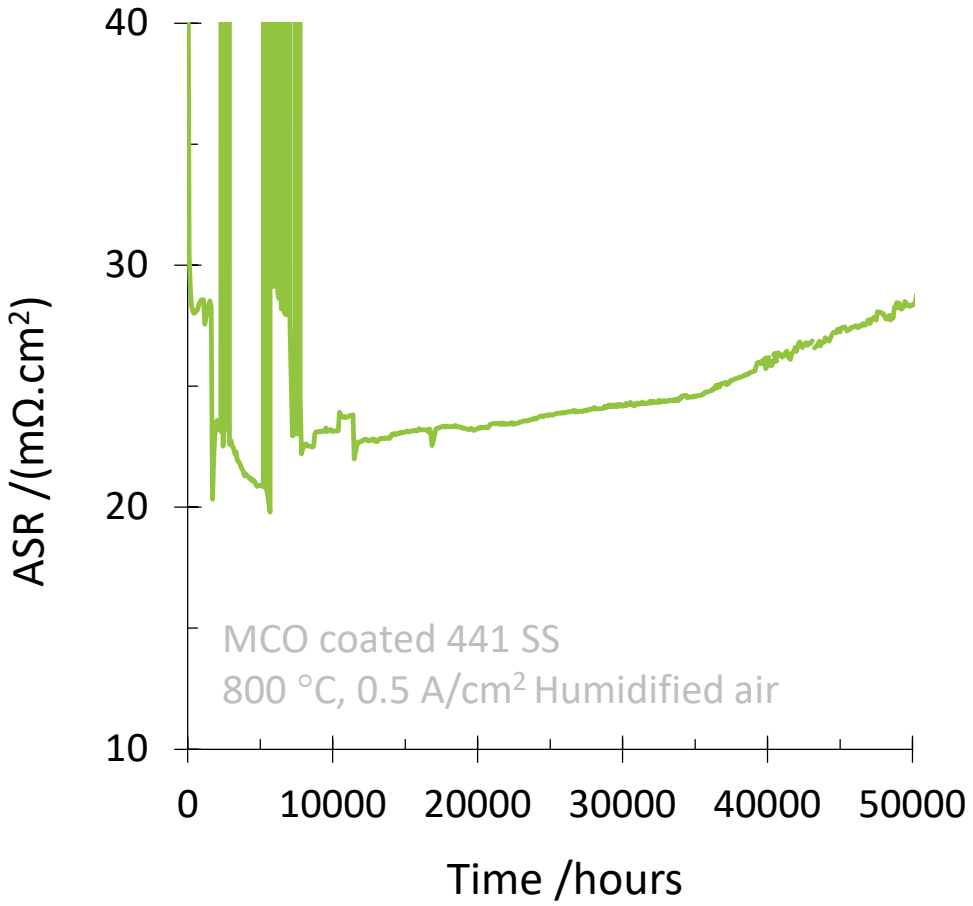
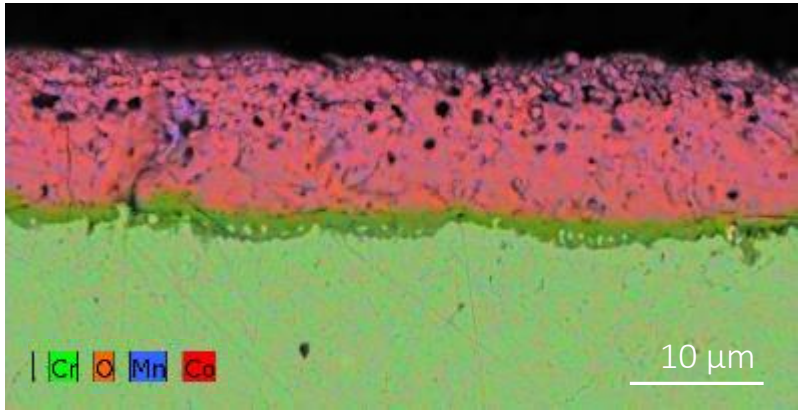
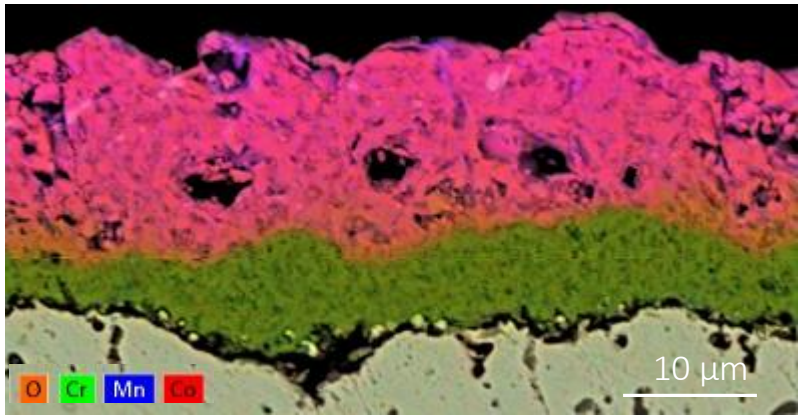
Successfully transferred our *ChromLok*™ interconnect coating



As Processed



Post 50,000 Hours



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Conclusions

Demonstrated applicability of ASD to address cell and stack-level challenges

- Opportunity to engineer critical interfaces

Value-proposition of aluminization coating has evolved:

- Opportunity to engineer critical interfaces

CeriLok – improved electrolyte/cathode interface

- Demonstrated significantly improved cell performance improvements
- Amenable to both ESC and ASCs

GasLok – tailored sealing interfaces

- Demonstrated enhanced sealing and thermal cycleability

Acknowledgements

Nexceris

- Operations Team
- Fuel Cell Business Unit

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