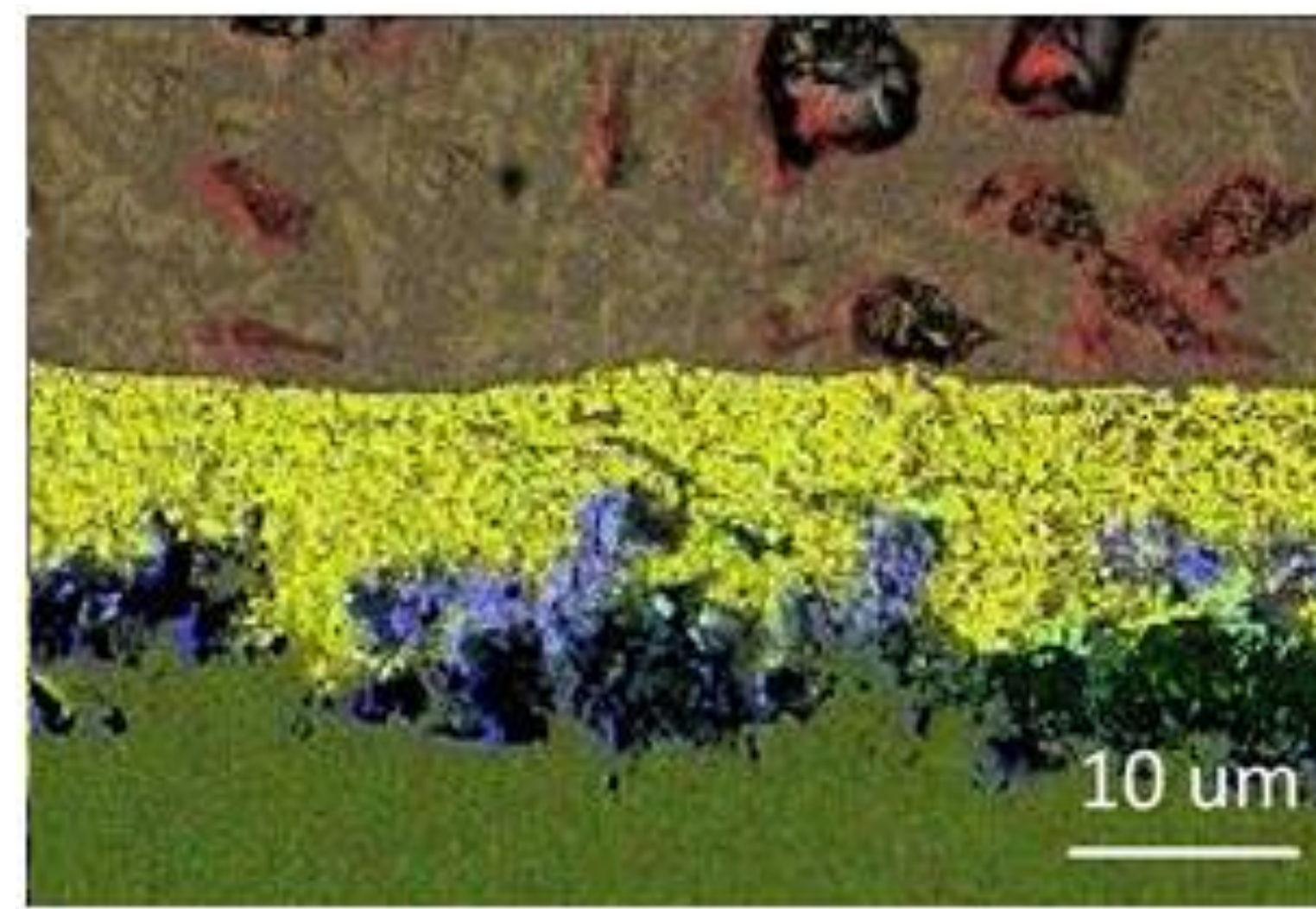


Recent Sealing Developments for Solid Oxide Fuel and Electrolysis Cells

This work was supported by the Department of Energy through SBIR Program: DE-SC0018534

GasLok™ Sealing Concept

- Seals remains a persistent issue facing SOFC developers
- Reliable cost-effective seal required to achieve:
 - Long-term durability (< 0.2 % degradation per 1000 hours)
 - Cost targets (Stack \$225/kW)
- GasLok is cost-effective, manufacturable sealing approach
- Designed to address critical issues associated with current sealing technologies:
 - Improve durability and thermal cycling performance

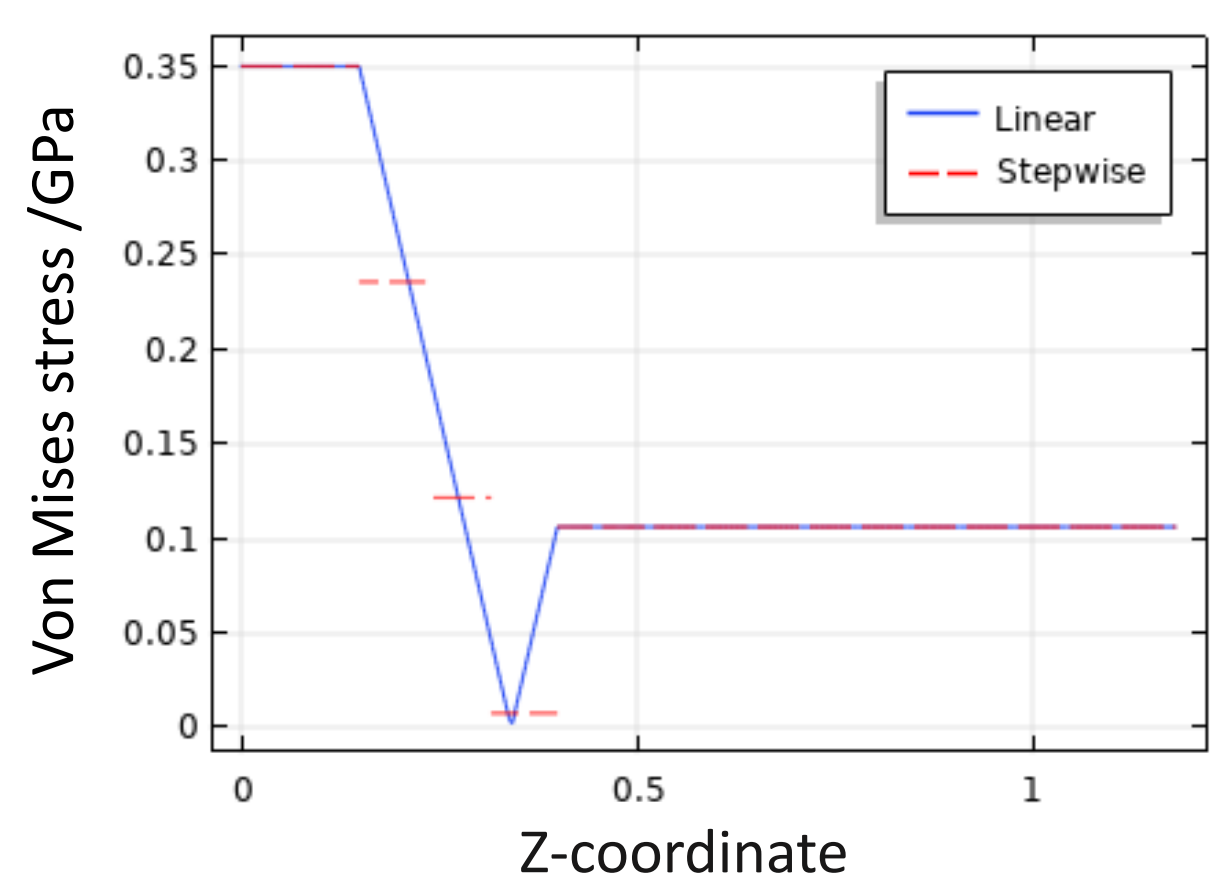


- Composite-Glass Seal**
 - Multi-layer tape seal with graded CTE to improve thermal cycling
 - Crystalline or amorphous glass matrix
- Corrosion-Resistant Sealing Coating**
 - Ceria protective coating
 - Prevent detrimental seal/IC interactions
- AlumiLok™ Pre-Coating**
 - Roughened surface for adherent coating
- Metal Interconnect**

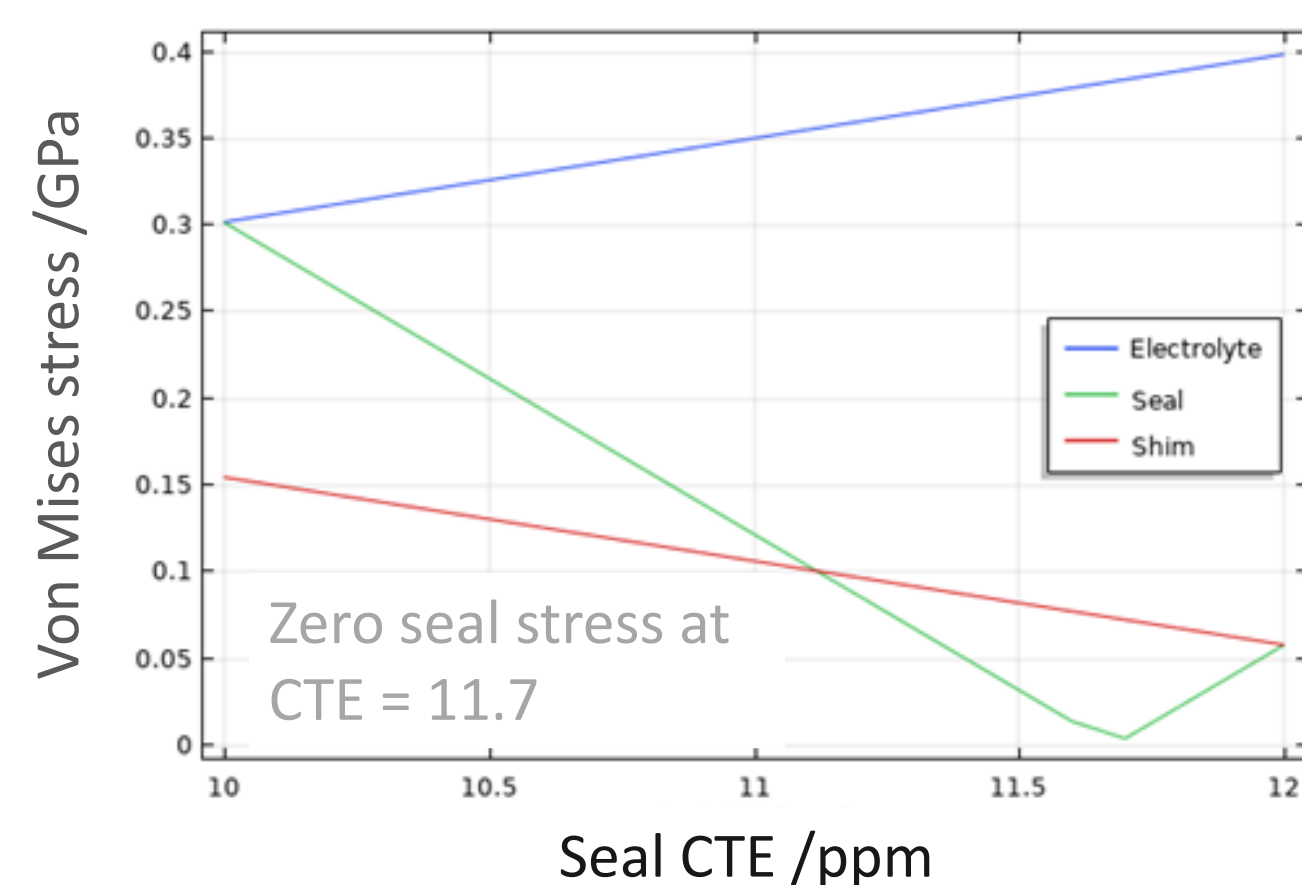
Thermomechanical COMSOL Modeling of Seal Behavior

- Guide optimization of the graded seal and critical design parameters
- Strengthen graded-seal value-proposition
- Alternative approach based on optimization of seal CTE to achieve zero stress state – experimental validation of model in progress

COMSOL Model - Graded Seal



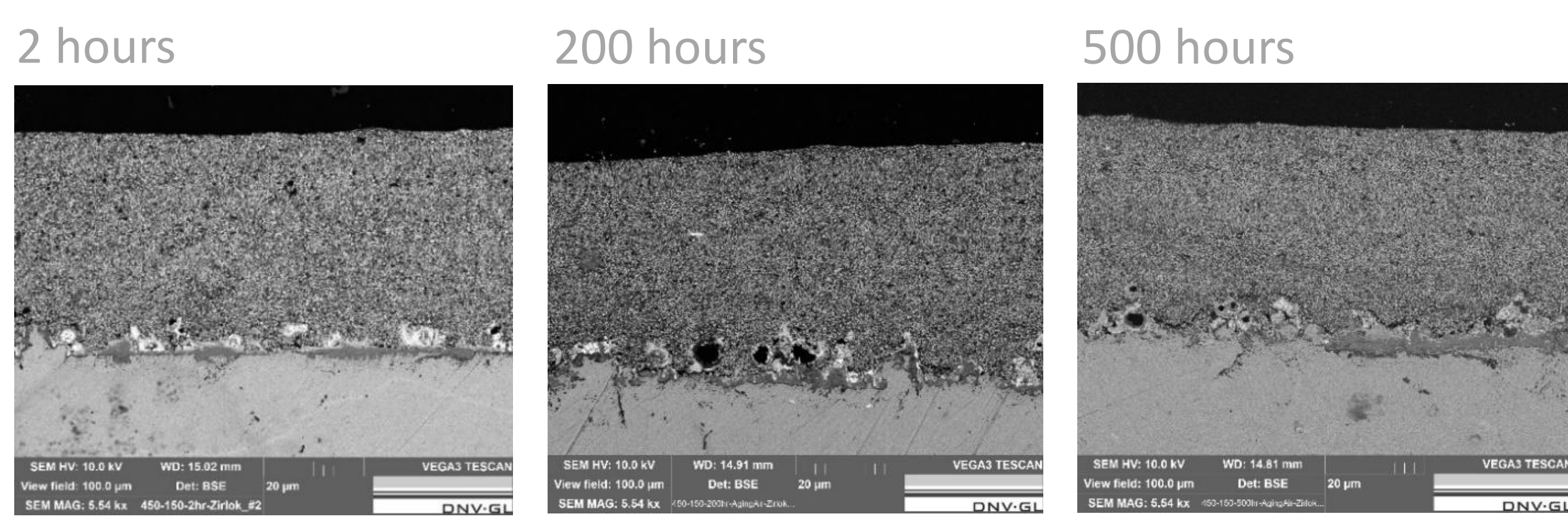
Identification of zero stress state



GasLok Coating Stability

- Anode side coating failure identified as key degradation mechanism
- More stable coating formulations under investigation

Promising Alternative Sealing Coating

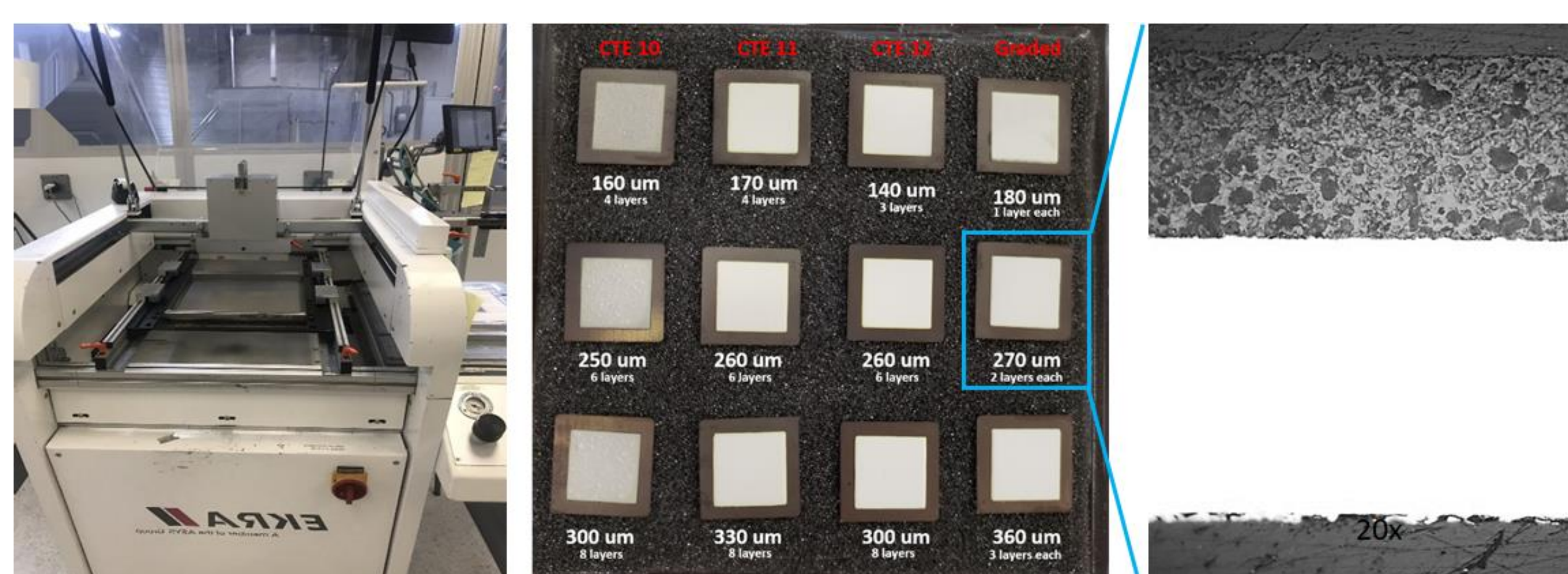


Exposure to air at 800 °C

Manufacturability – Screen-Printed Integrated Seal/Shim

- Successful GasLok adoption requires seal format that easily integrates with customer's cell platform and manufacturing process
- Developed an integrated seal/shim product
- Graded seal screen-printed directly onto metallic shim

Screen-Print System Screening Process Parameters Graded seal

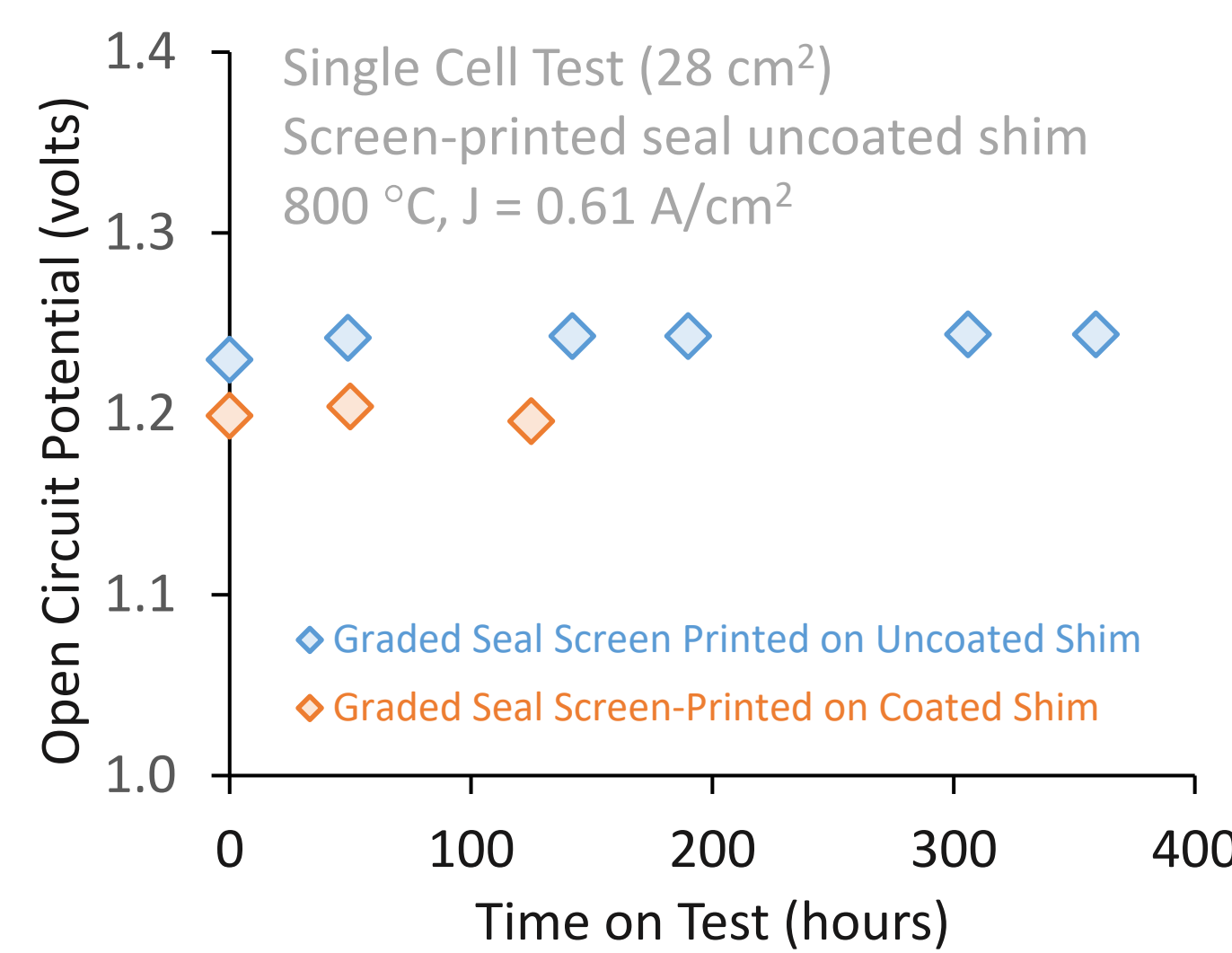


- New integrated seal/shim sealing product provides key benefits
 - Screen-printing allows minimizes materials loss – lower cost
 - Simplified stack build (reduced alignment issues)

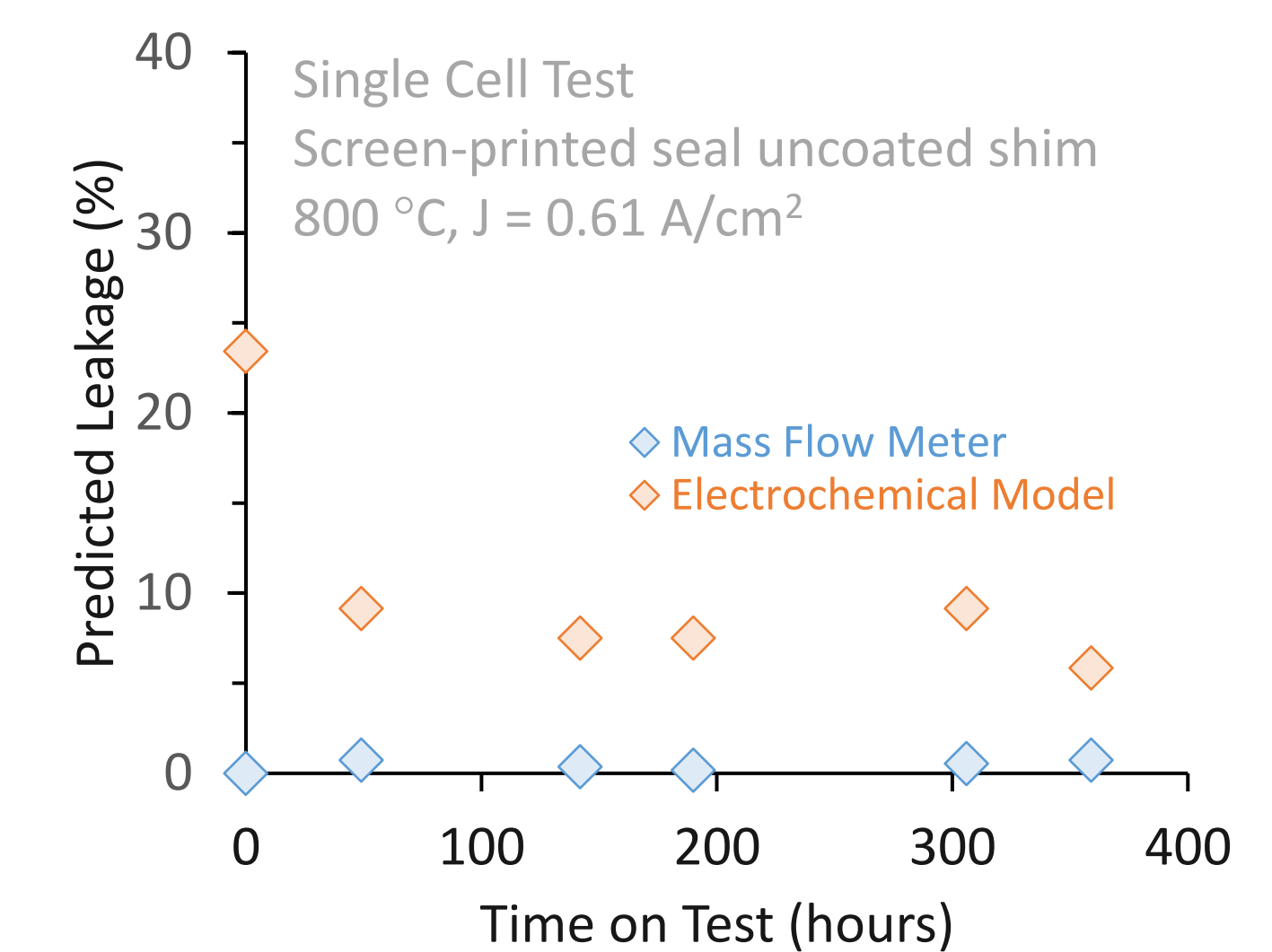
Single-Cell SOFC Testing

- Electrolyte-supported single cell (28 cm² active area) used to assess seal performance and stability under SOFC conditions.
- Have developed electrochemical model to assess sealing based on OCV

Single-Cell Durability



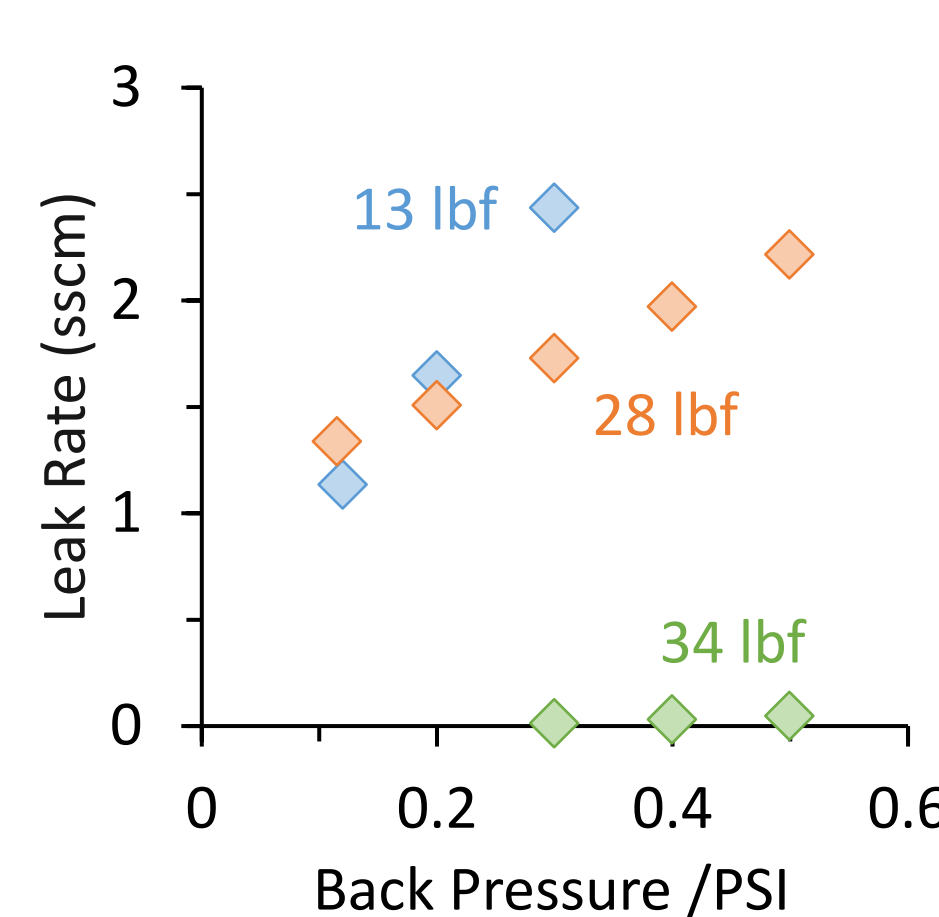
Electrochemical Model



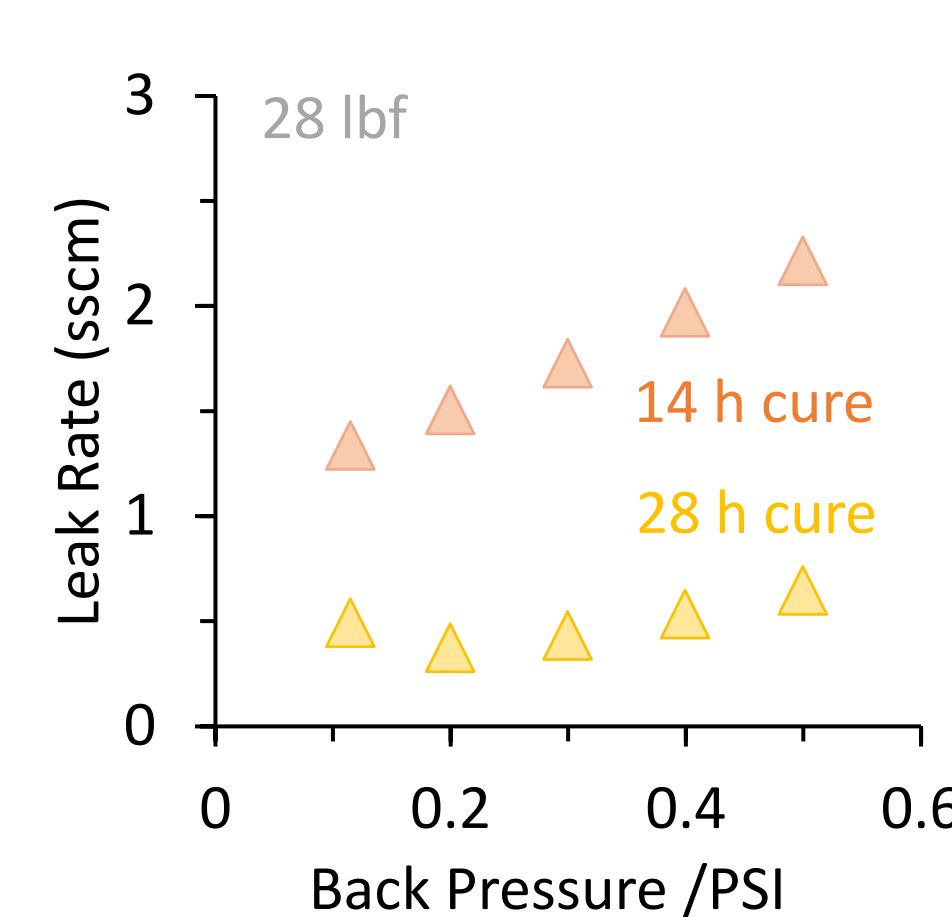
Alignment of Seal Curing and SOFC Conditioning

- Using offline-seal testing to down-select stack conditioning protocol
- Investigate the effect of stack compression and curing time and temperature

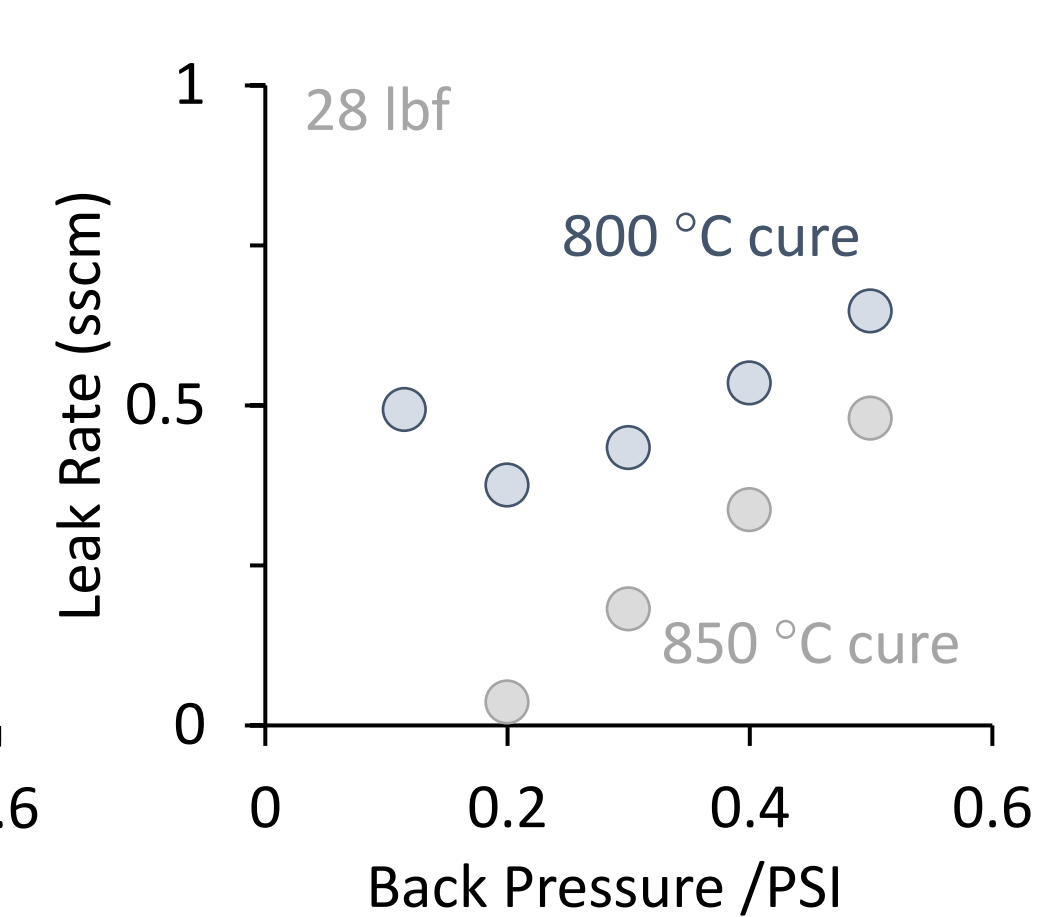
Compression



Curing Time



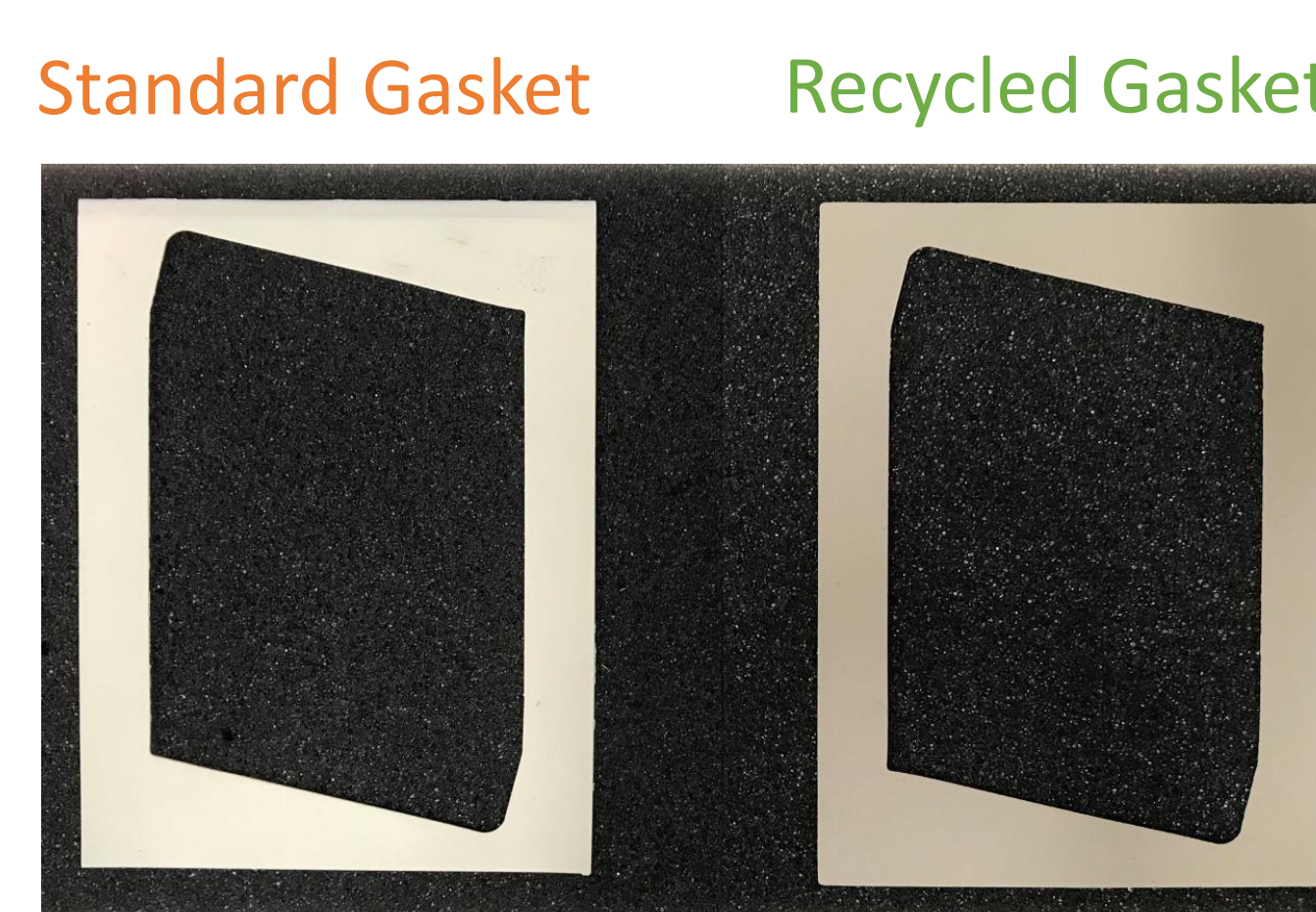
Curing Temperature



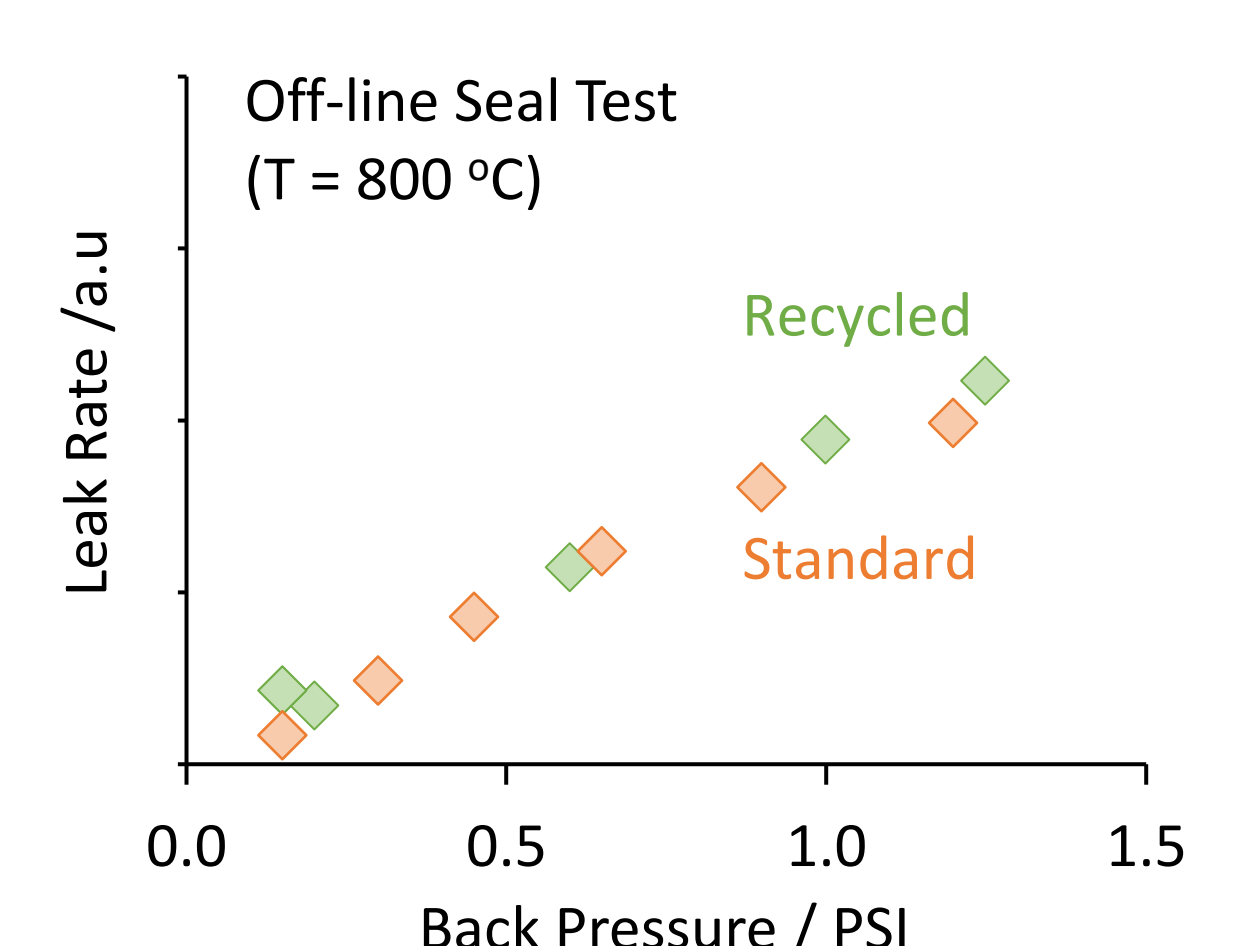
Cost-Reduction – Recycled Seal Tape Gaskets

- For reduce the cost of tape-cast seal gaskets need to minimize materials loss
- Demonstrated that scrap seal tape can be successfully recycled which minimizes materials loss during casting of picture-frame seals
- Equivalent seal performance with recycled tape gaskets demonstrated

Recycled Seal Tape Gaskets



Recycled Seal Performance



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