

Composite, High Temperature Seals for Gas Separation Membrane Devices

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SBIR Phase I

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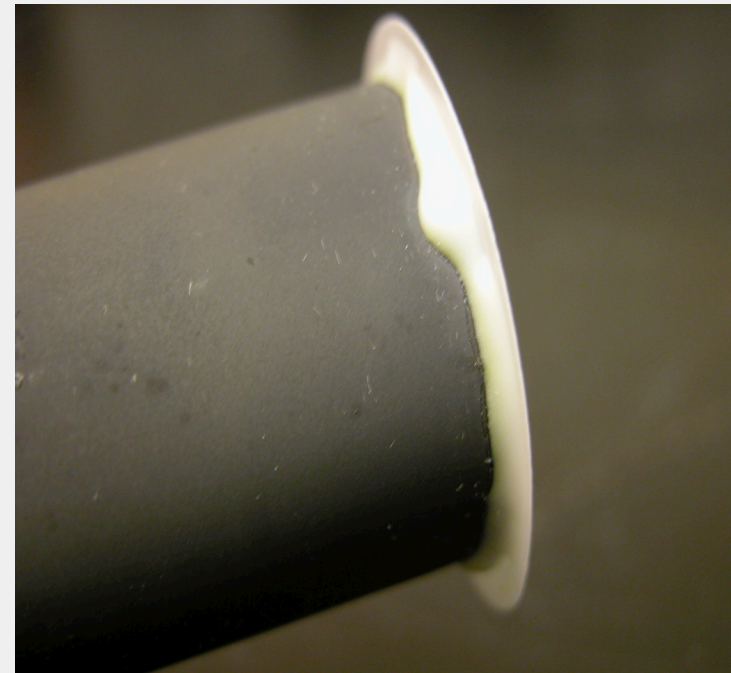
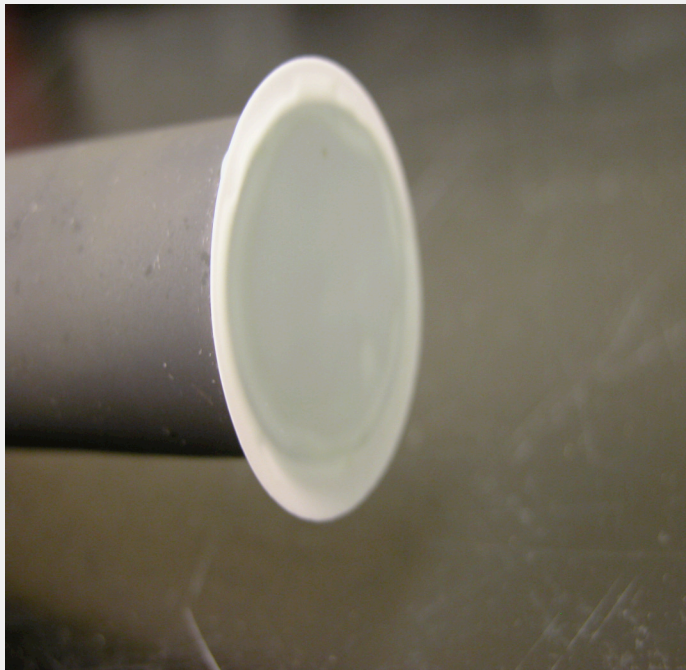
Approach

- **Composite Mixture**
 - Vitreous Phase -
 - Control softening point,
 - Sealing temperature,
 - Adhesion
 - Compliancy
 - Crystalline Phase -
 - CTE control
 - Stability
 - Flatter viscosity (T) curve
 - Mixtures of different ratios
 - Overall CTE
 - Flow control
 - Potential for graded seal

Materials Evaluation Planned

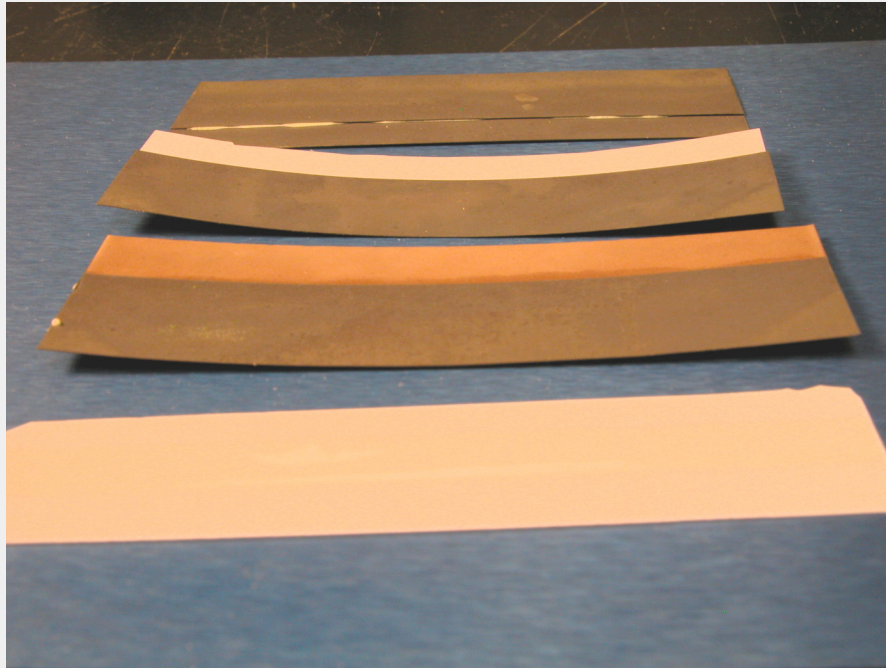
- **Ceramics**
 - Oxygen ion conductors
 - Zirconia
 - Lanthanum Gallate
 - Mixed conductors
 - Strontium Ferrite
 - Lanthanum Cobaltite
- **Metal**
 - Stainless steel
 - Super alloys

Ceramic-metal seal



- **Zirconia electrolyte on Stainless steel tube**
(B20008 seal)

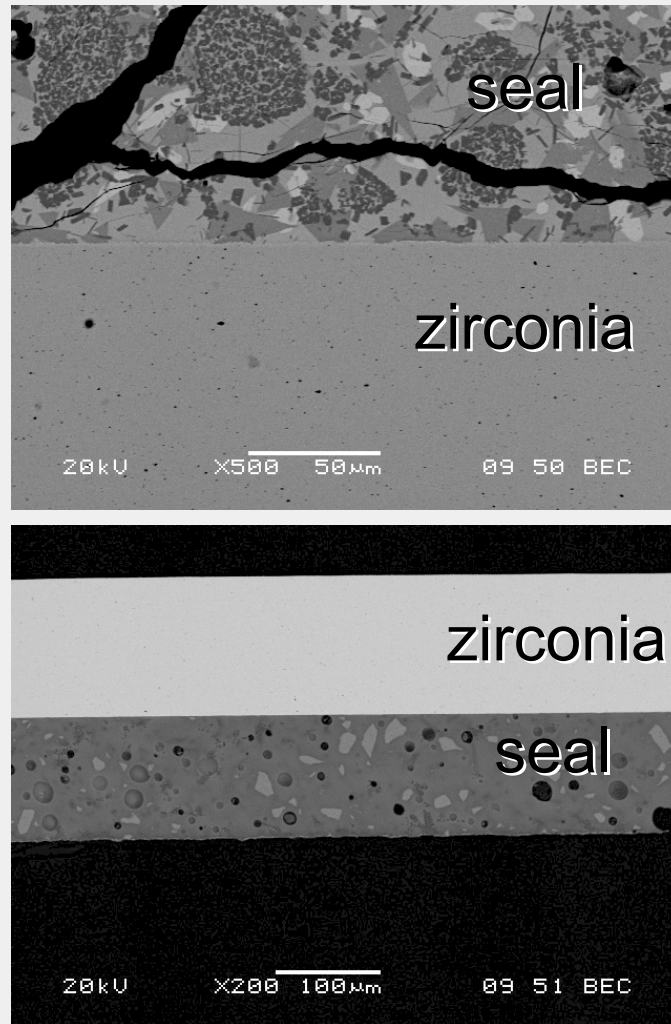
Sealing of Materials Combinations



- SS - SS
- Zirconia - SS
- Gallate - SS
- Zirconia - Zirconia

- Flat specimens when components have matching CTE (SS-SS & Zirconia-Zirconia)
- With CTE mismatch graded seal may be suitable

Zirconia - Seal Interface



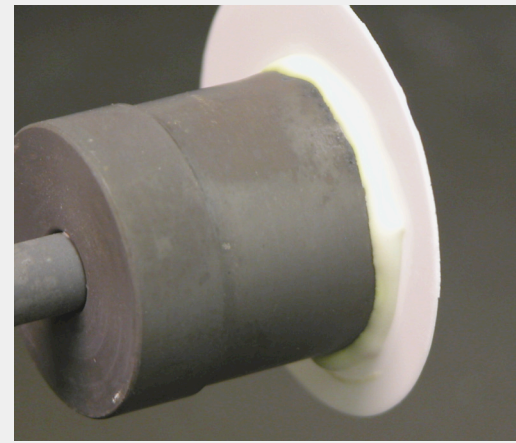
- **Initial trial (Batch B20004)**
 - Large CTE mismatch
 - Poor distribution of phases
 - Interfacial cracks
- **Batch 20008**
 - Closer CTE
 - Better distribution of phases
 - Well-bonded interface

Hot Test Rig (Zirconia on SS Holder)



- **As Fabricated**

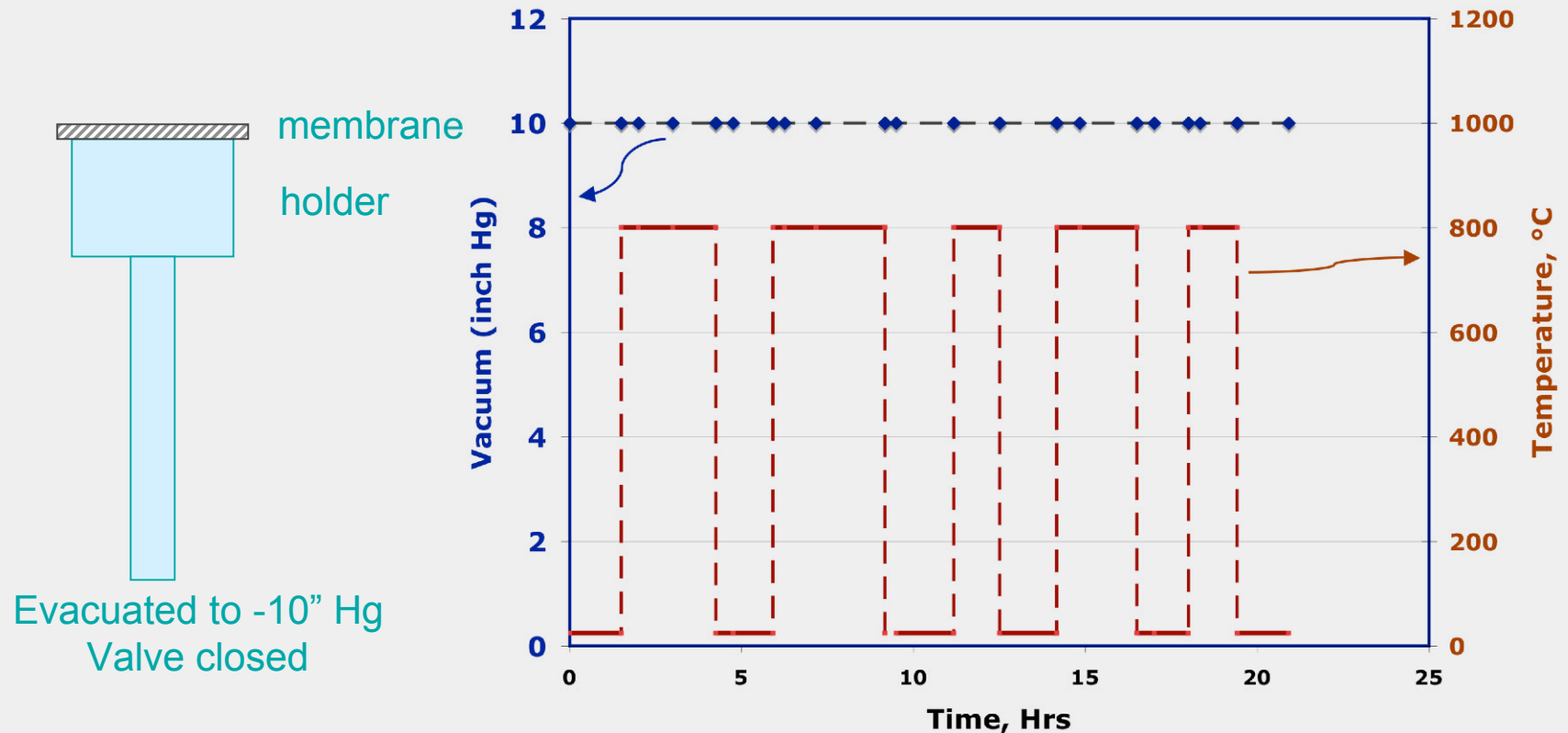
SECA CTP Tampa, FL



- **After Five Thermal cycles to 800°C
(Pressure test at RT and 800°C)**

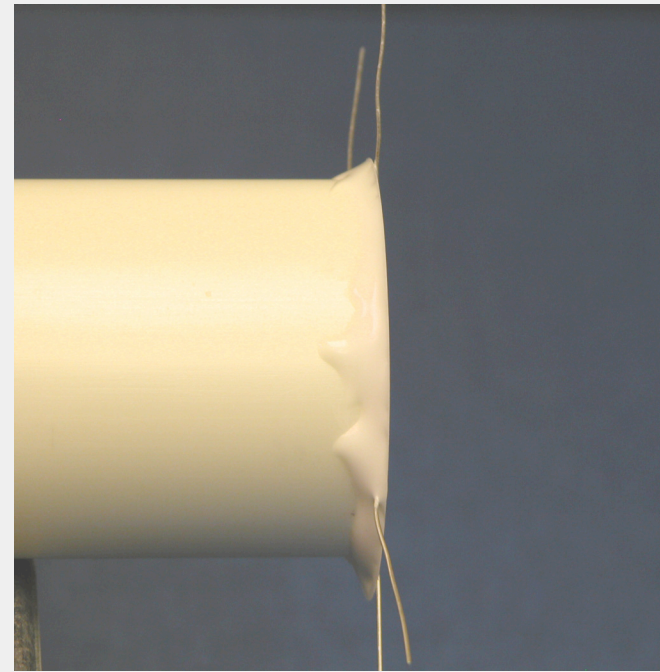
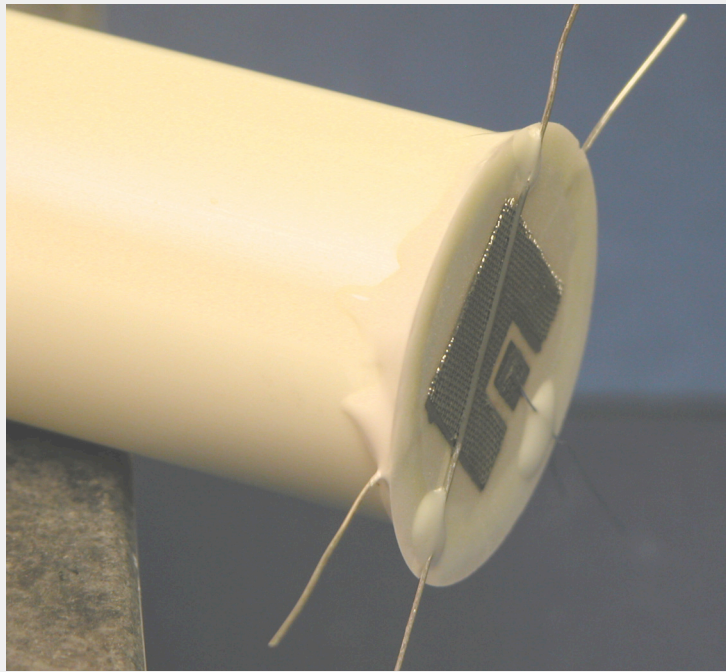
28 January 05

Seal Test Results



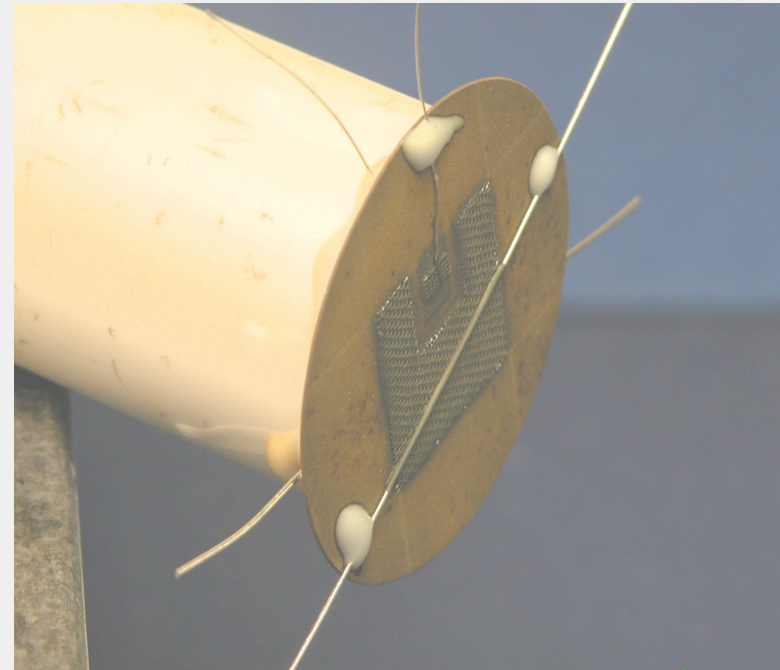
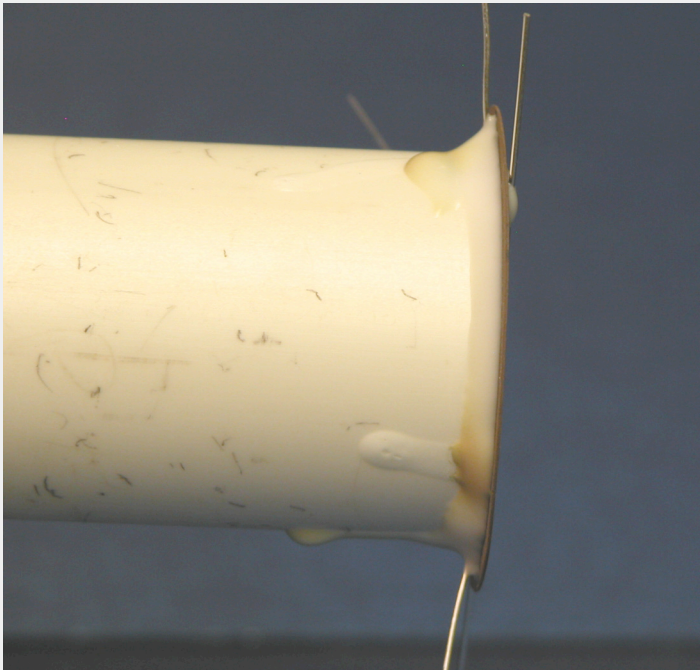
- **Pressure decay test at pressure differential (~ 5 psi)**
 - Monitored for 1 to 2 hours at RT and 800°C; five thermal cycles
 - Stable both at room temperature and 800°C

Button Cell Test



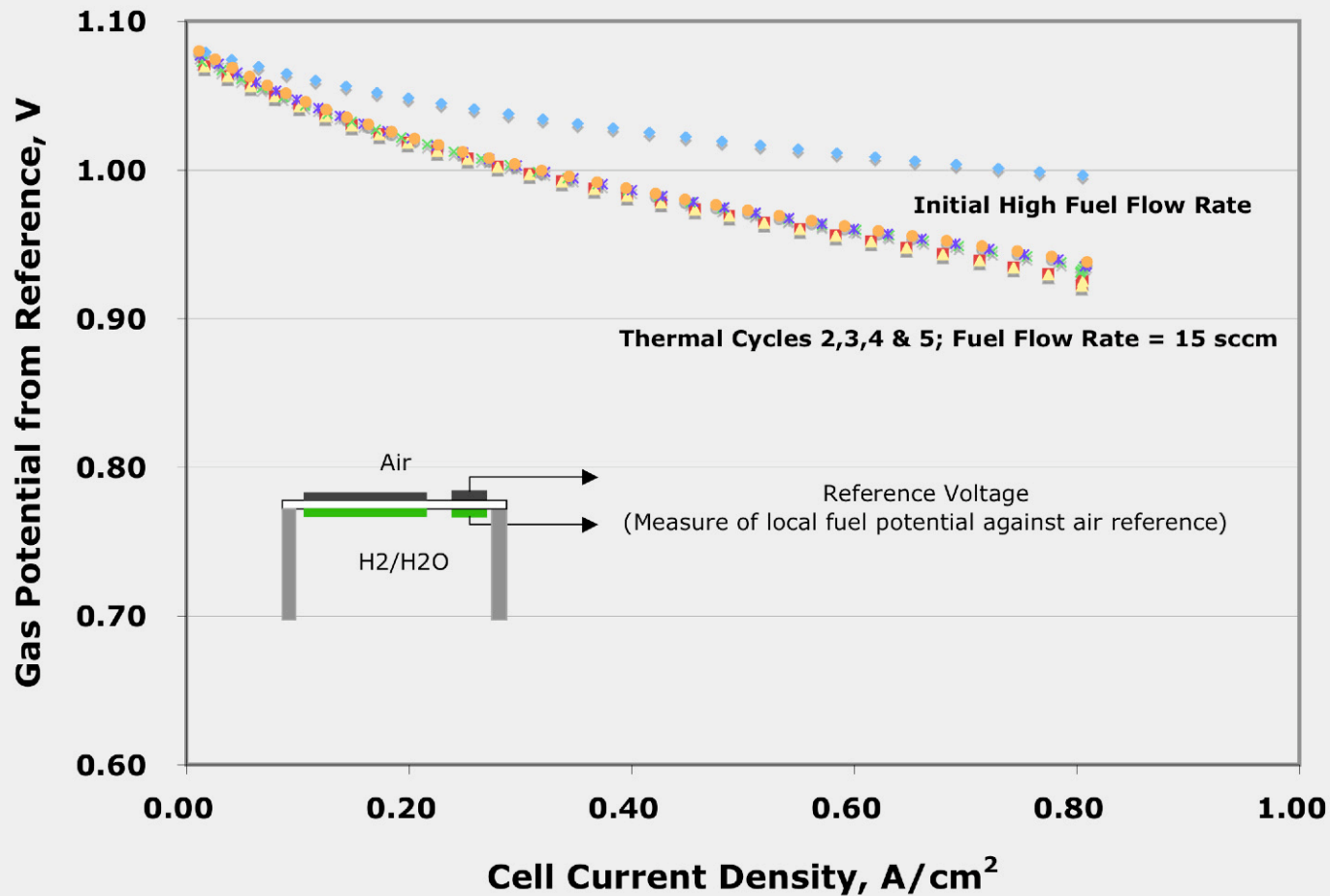
- **Zirconia electrolyte cell on Zirconia tube**
(B20008 seal)

Button Cell Test



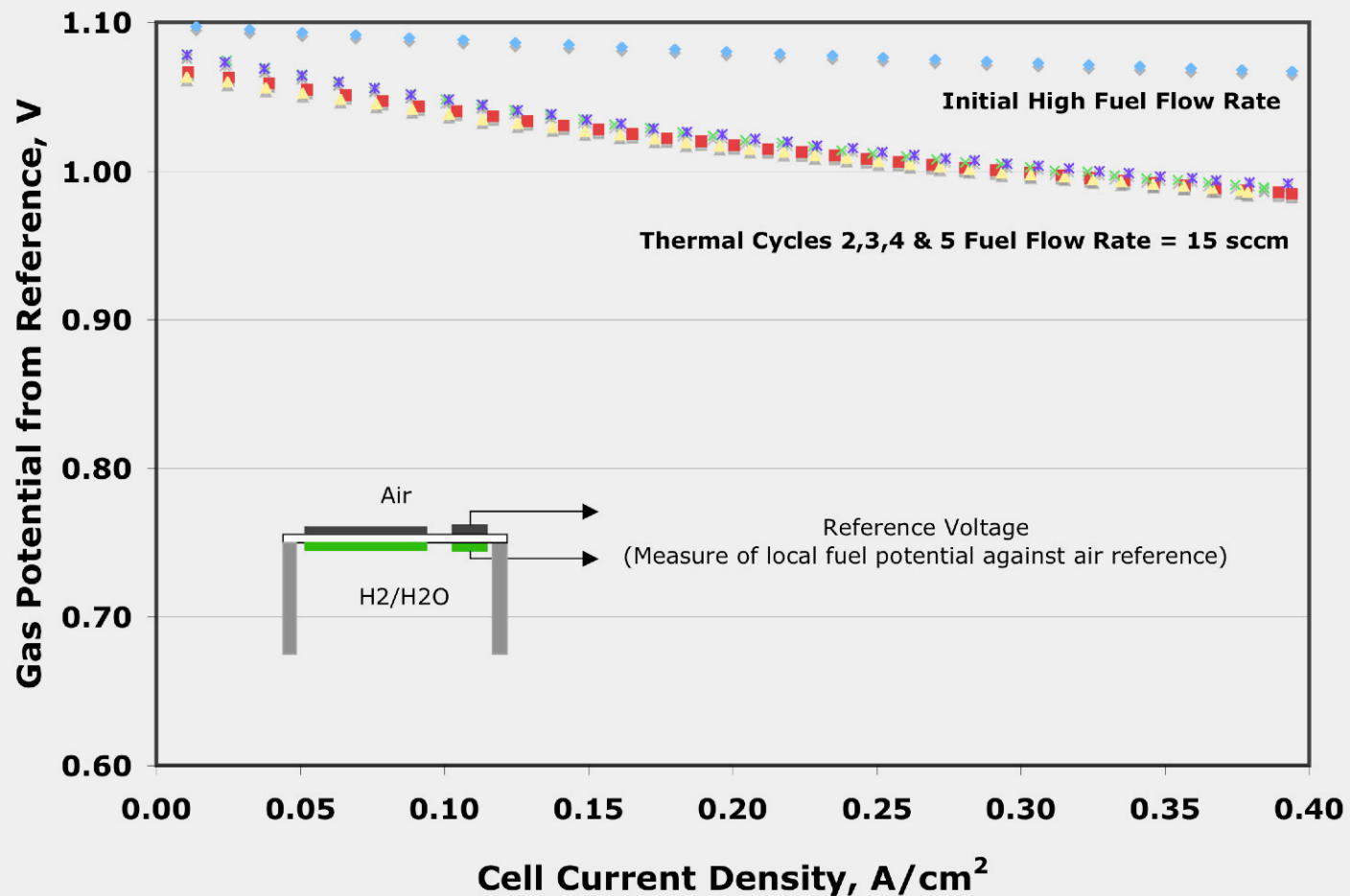
- Gallate electrolyte cell on Zirconia tube
(B20008 seal)

Zirconia Button Cell: Reference Voltage with Thermal Cycles



- **Zirconia:** Low fuel flow rate, unchanged gas potential with thermal cycles

Gallate Button Cell: Reference Voltage with thermal cycles



- **Gallate:** Low fuel flow rate, unchanged gas potential with thermal cycles

Summary

- **New composite glass seal material developed**
 - Flexibility in CTE, flow
 - Through modification to crystalline phase
 - Ratio of crystalline to vitreous phase
 - Promising results from seal tests
 - Pressure test (RT and 800°C) of zirconia to stainless
 - Button cell tests of zirconia - zirconia and gallate - zirconia
 - Five thermal cycles
 - Reactivity & Seal tests with perovskite materials (hydrogen and mixed oxygen-electron conductors) planned