ceramatec®
ADVANCED MATERIALS & ELECTROCHEMICAL TECHNOLOGIES

Lanthanum Gallate Electrolyte for Intermediate Temperature SOFCs

SBIR-Phase II

Ceramatec, Inc.

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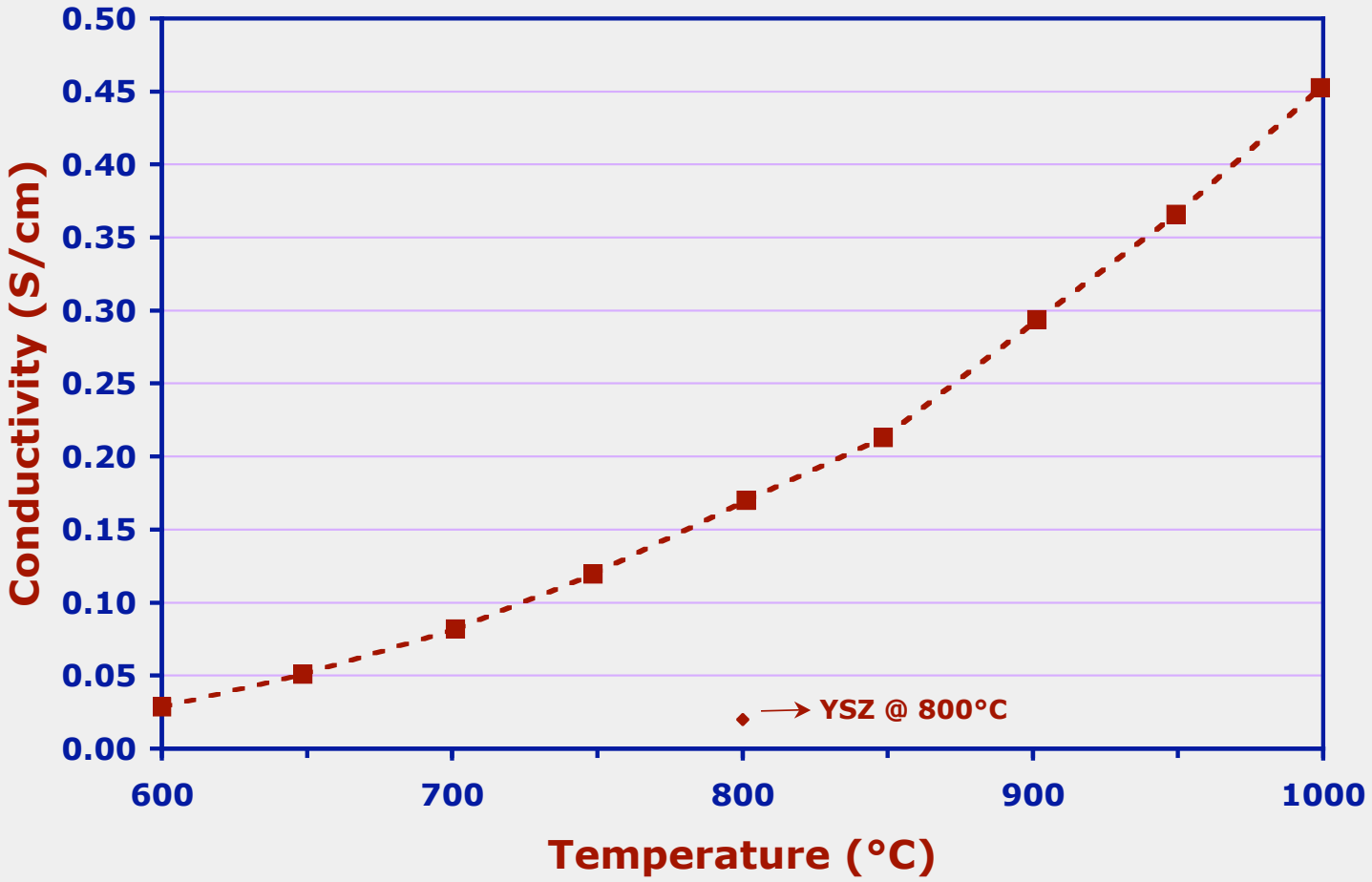
Outline

- Comparison of intermediate temperature electrolyte options
- Lanthanum Gallate
  - Technical Hurdles
  - Electrode Strategy
- Button Cell Performance
  - Thick and Thin Electrolyte
  - Long-term Performance
- Test plan

Current SOFC Electrolytes

System	Electrolyte Issues	Anode Material and Issues	Cathode Material and Issues	General Comments
Zirconia	Low conductivity 0.1 S/cm at 1000°C 0.02 S/cm at 800°C	Ni-zirconia Ni coarsening	$La(Sr)MnO_3$ zirconate formation at the interface	Demonstrated No electronic leak current 1000°C Operation typical; very thin electrolyte allows 800°C operation; lower than 800°C not practical yet
Ceria	High conductivity (0.1 S/cm @800°C)	Ni-ceria	$La(Sr)CoO_3$ CTE mismatch	Electronic short Differential expansion from air to fuel side
La gallate	High conductivity (0.1 S/cm @800°C)	Ni-ceria Formation of La-Ni-O insulating phases	$La(Sr)CoO_3$ CTE mismatch	No electronic leak current CTE similar to zirconia Long term cell stability is an issue material cost

LSGM Conductivity



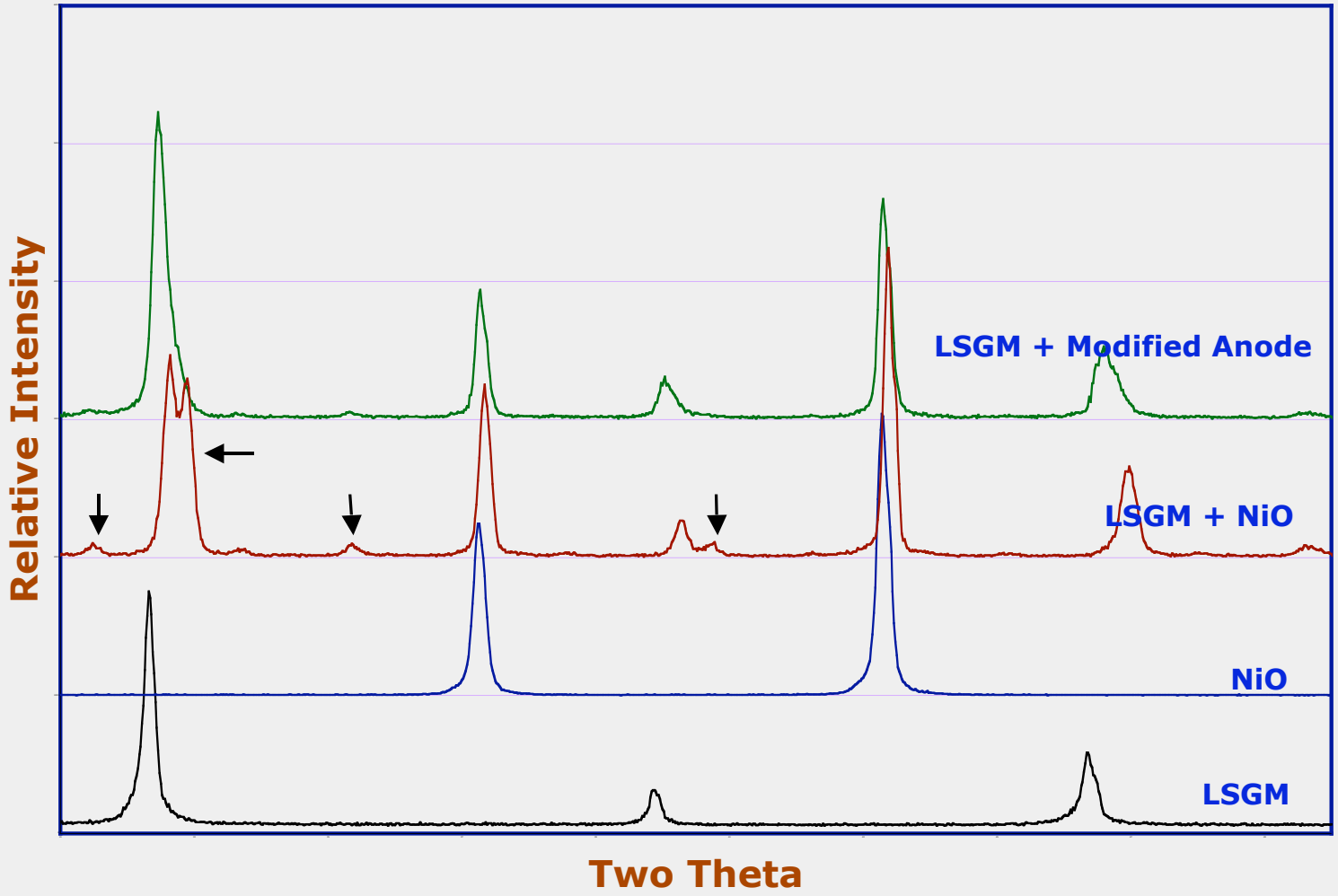
- Ionic conductivity at 750°C ~ zirconia at 1000°C

Materials Challenge

Present Anode: Ni-Ceria or Ni-LSGM

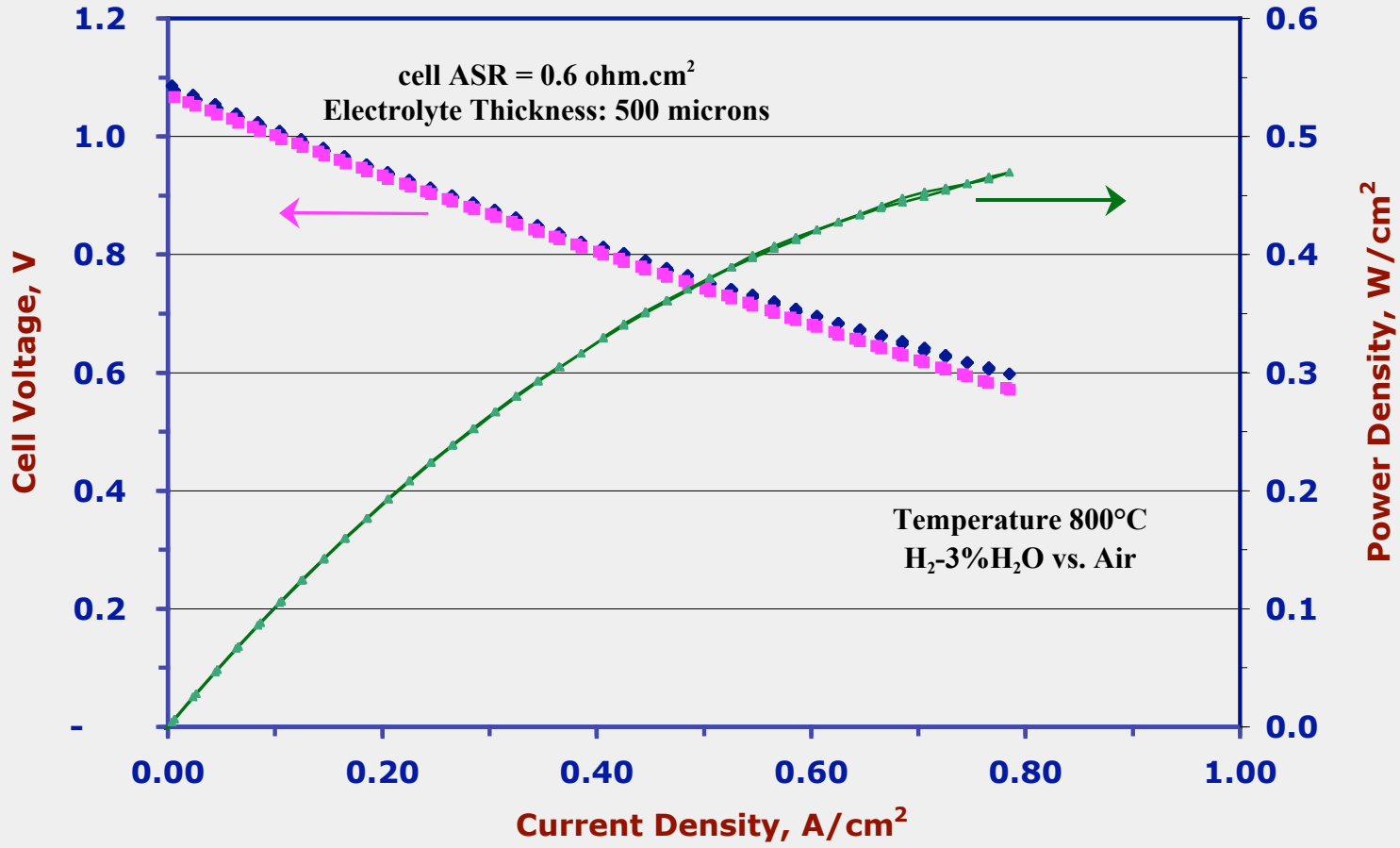
- Objective:
  - Eliminate or reduce reaction between La (in electrolyte) and Ni (in anode)
- Approach:
  - Additive to the anode that will reduce the reaction
  - Verify using powder reactivity studies

XRD - Powder Reaction Study (1350°C)



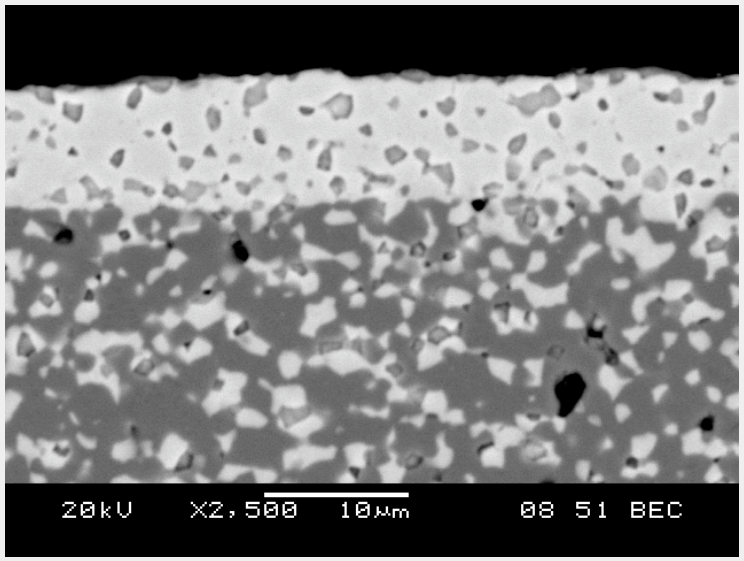
- Modified anode - significant reduction in second phase

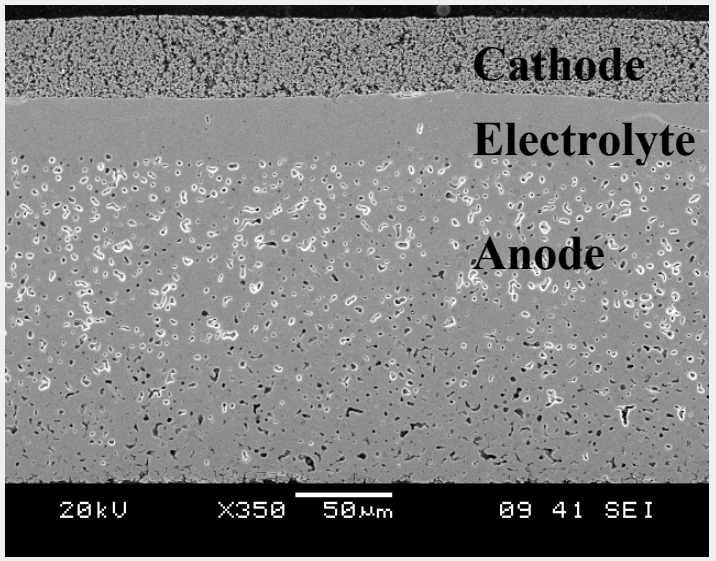
Button Cell Performance - Thick Electrolyte



- > 1 V OCV indicating good ionic transference number
- ASR 0.6 ohm.cm^2 with newer electrodes and 500 micron electrolyte

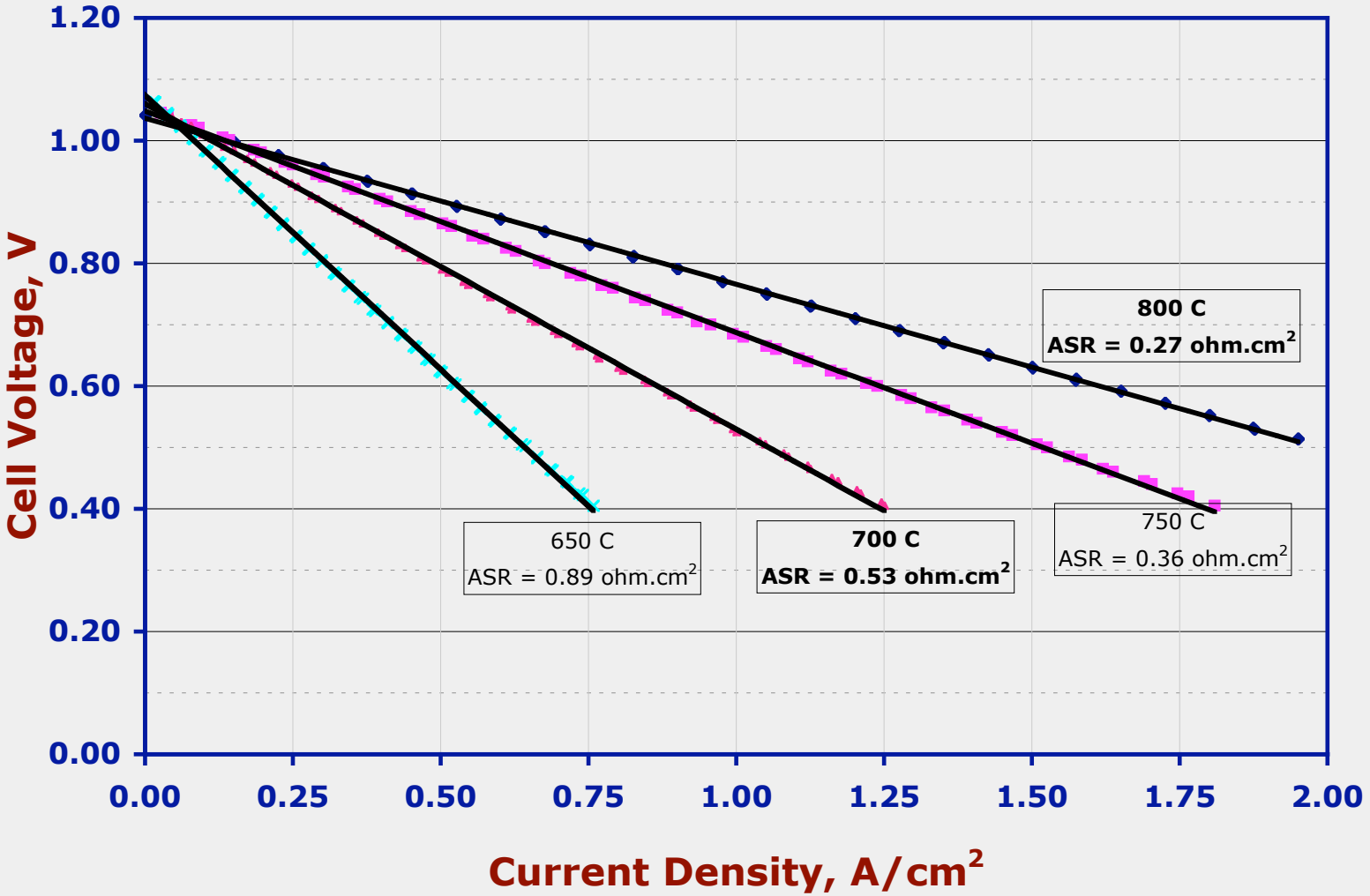
Bi-layer Fabrication





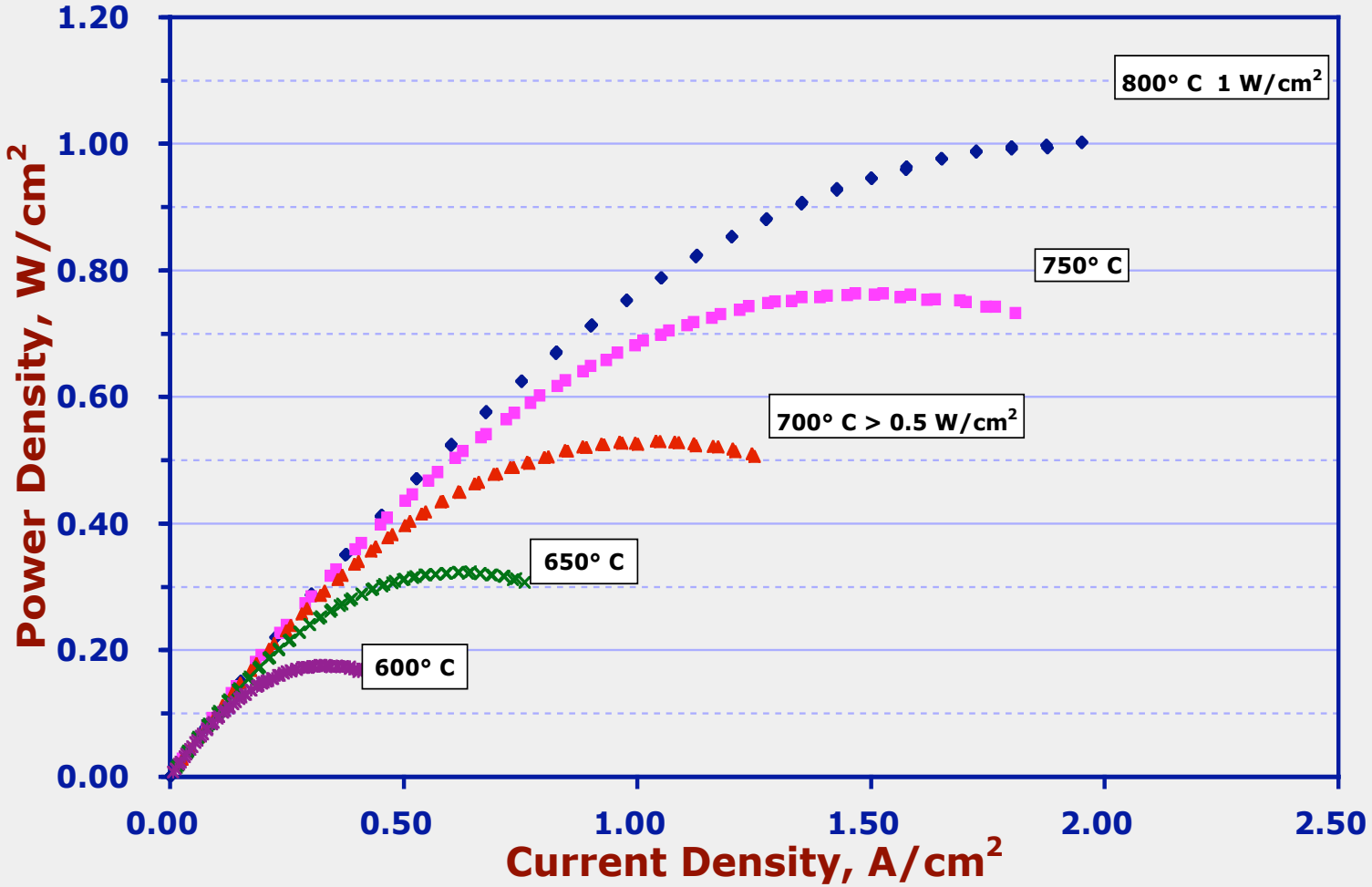
- Initial Trial
  - Challenge: Nickel diffusion
- Recent Trial
  - ~30 micron Electrolyte
  - Challenge: Anode Porosity

Thin LSGM Performance



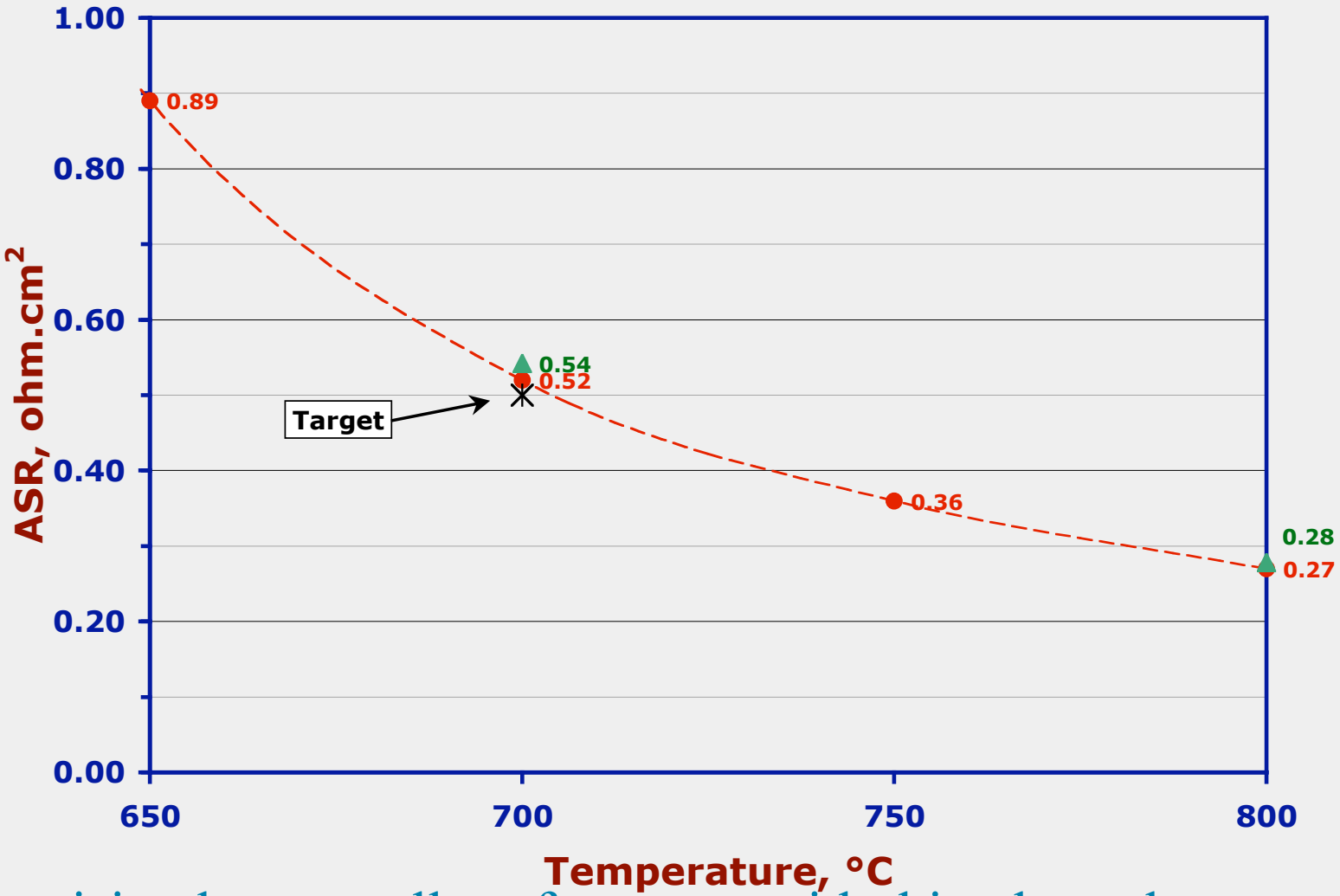
- ASR at 700°C with thin supported LSGM: ~ 0.5 ohm.cm^2

Power Density - Thin LSGM



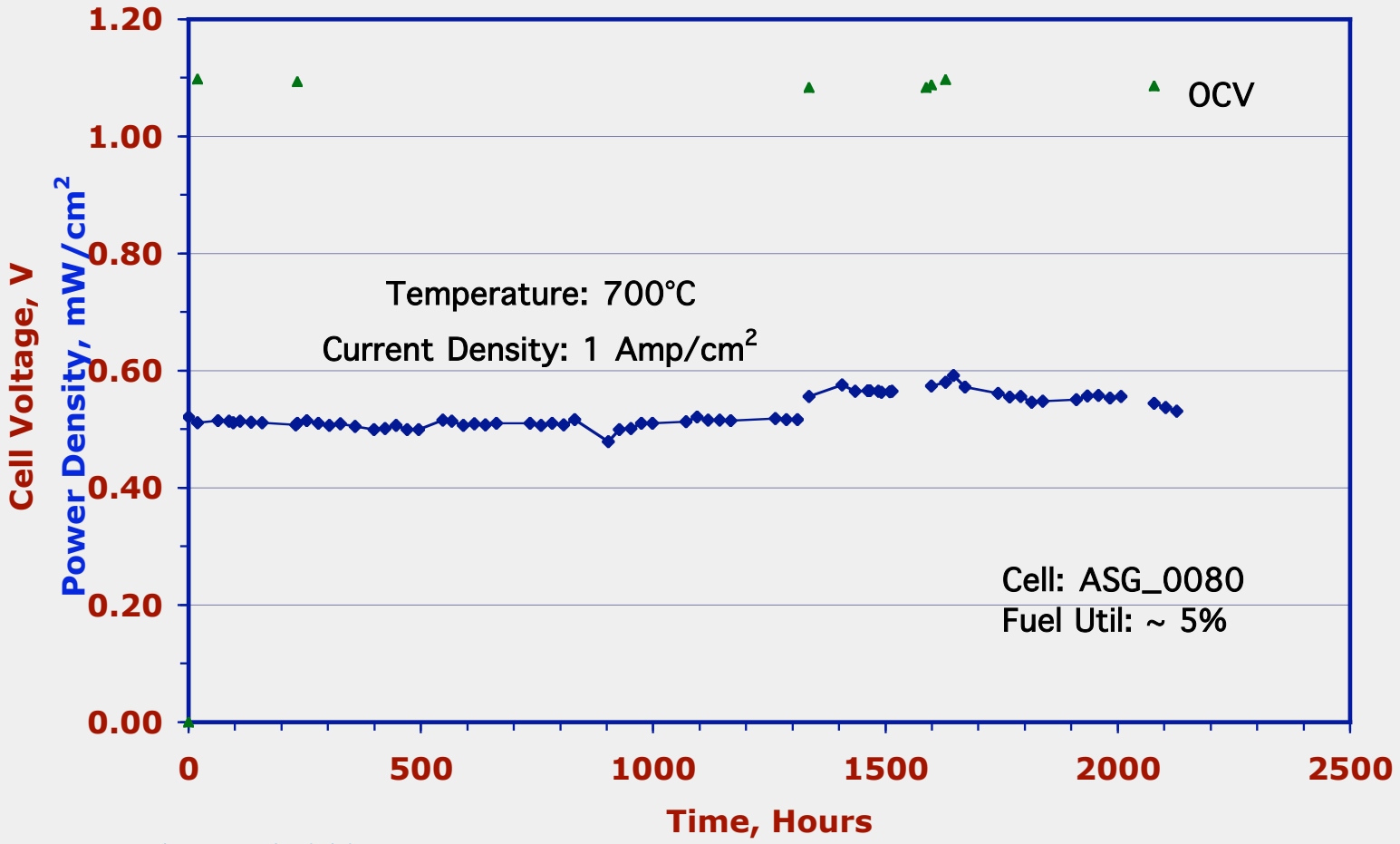
- 500 mW/cm^2 at 700°C

LSGM Button Cell Performance



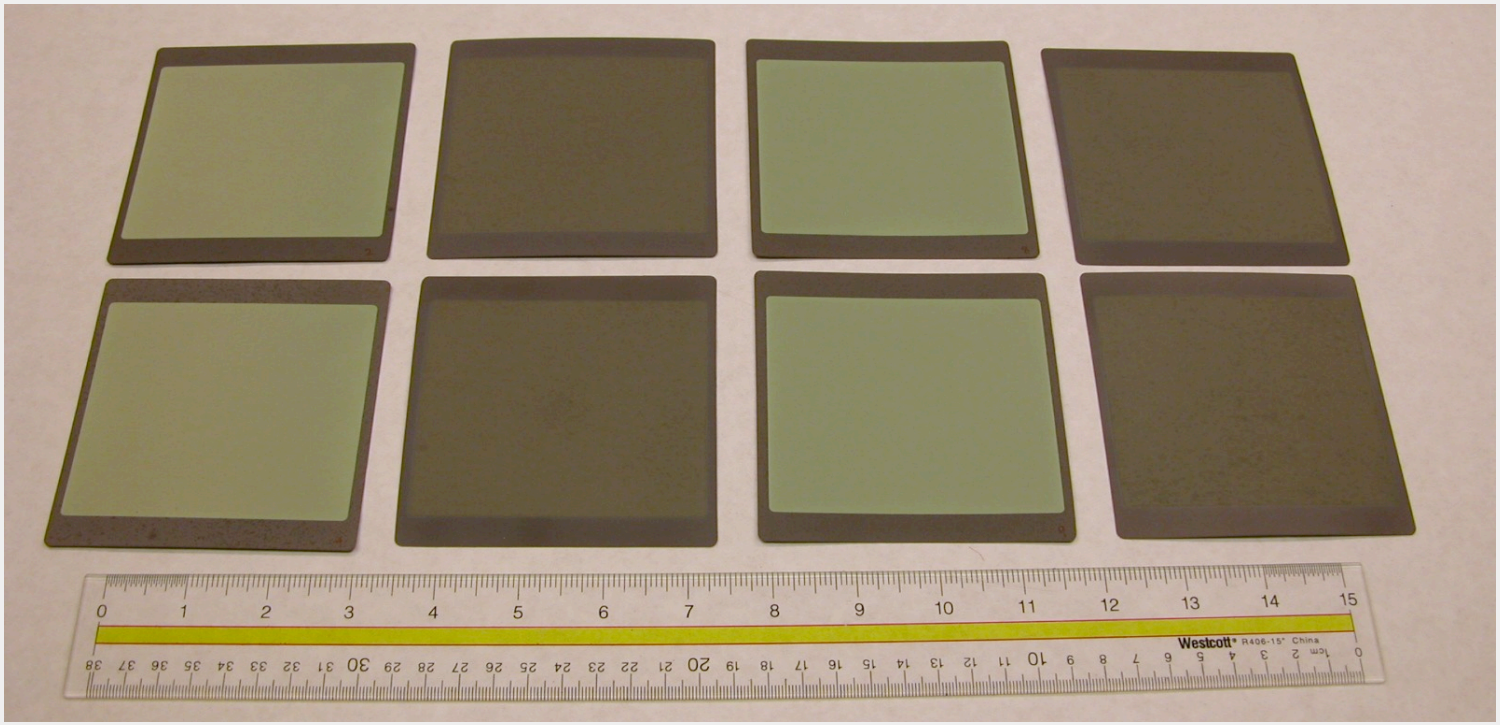
- Promising button cell performance with thin electrolyte

Power Degradation



- Good stability at 700°C

Cell Scale-up



- Tape cast development to fabricate 10 x 10 cm cells

Summary

- LSGM is a promising electrolyte for intermediate temperature operation
- Reactivity with anode was addressed
  - Anode composition with the promise of bi-layer compatibility developed
- Supported thin cells show good performance
- Fabrication changes needed for anode porosity modification
- Process development in progress for 10x10 cm cells
- Stack tests planned for Q4'03