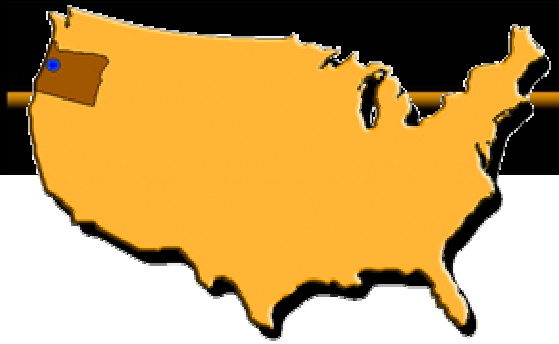

Albany Research Center

Solutions that make the Nation's energy systems safe, efficient and secure

METALLIC ALLOYS FOR SOFC

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SECA Core Technology Program Review
Sacramento, California
February 19-20, 2003

ARC Program

Program scheduled to begin in FY2004

- Funding level $2 million
  - Proposed in President's FY2004 budget.
  - DOE-FE via AMP Program at ARC.
- Support SECA program via metallic alloy development for SOFC.
  - Metal interconnects
  - BOP

Technical Approach (Summary)

- Melt a matrix of 10 lb experimental heats. Fabricate to sheet form.
- Agree on screening test regime to evaluate experimental compositions.
- Melt 80 to 100 lb ingot(s) of candidate alloy(s) and fabricate to sheet for evaluation (available to SECA cooperators).

Technical Approach

- Metallic Alloys
  - Ni-, Fe-, Co-base superalloys
  - Cr- base alloys
  - Stainless steels
- Matrix of 10 lb (4.5 kg) experimental heats of modified commercial compositions will be melted & rolled to sheet form
  - Ferritic stainless steel (interconnect)

Technical Approach

- Devise with cooperating SECA laboratories appropriate experimental matrices.
- Agree on screening tests.
- Relate screening test results to film morphology.

Metallic Interconnect Requirements

- High temperature oxidation/corrosion
- CTE match (rigid seals)
- Thermodynamic stability
- Chemical compatibility (sealing glasses)
- Electrical conductivity – bulk resistance and scale resistance
- Stack design

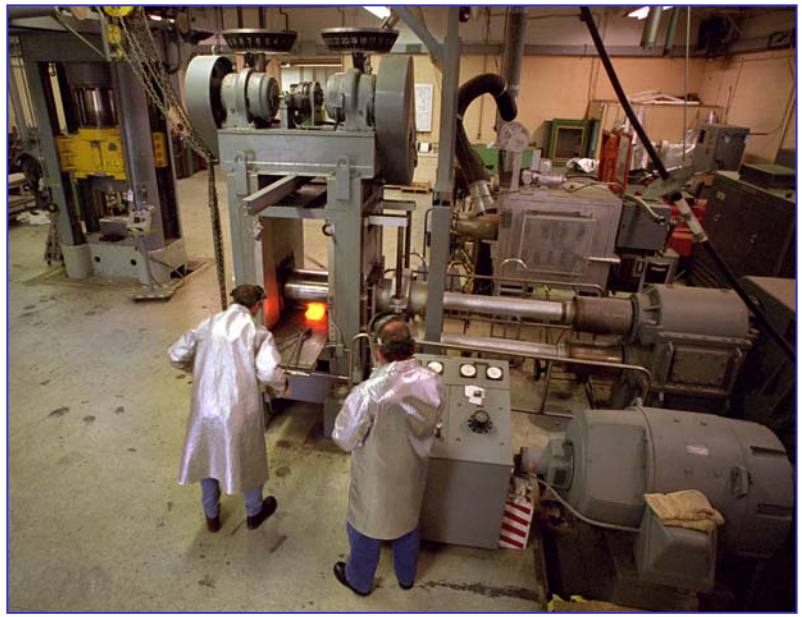
Technical Approach

- Produce 100 lb (45 kg) heats of candidate alloy(s)
- Reduce ingots to sheet form for evaluation
- Alloy(s) available to SECA cooperators.

ARC CAPABILITIES

Alloy Production

- Vacuum induction melt 5 or 50 kg charges.
- Forge and roll (2 and 4 high) into plate/sheet



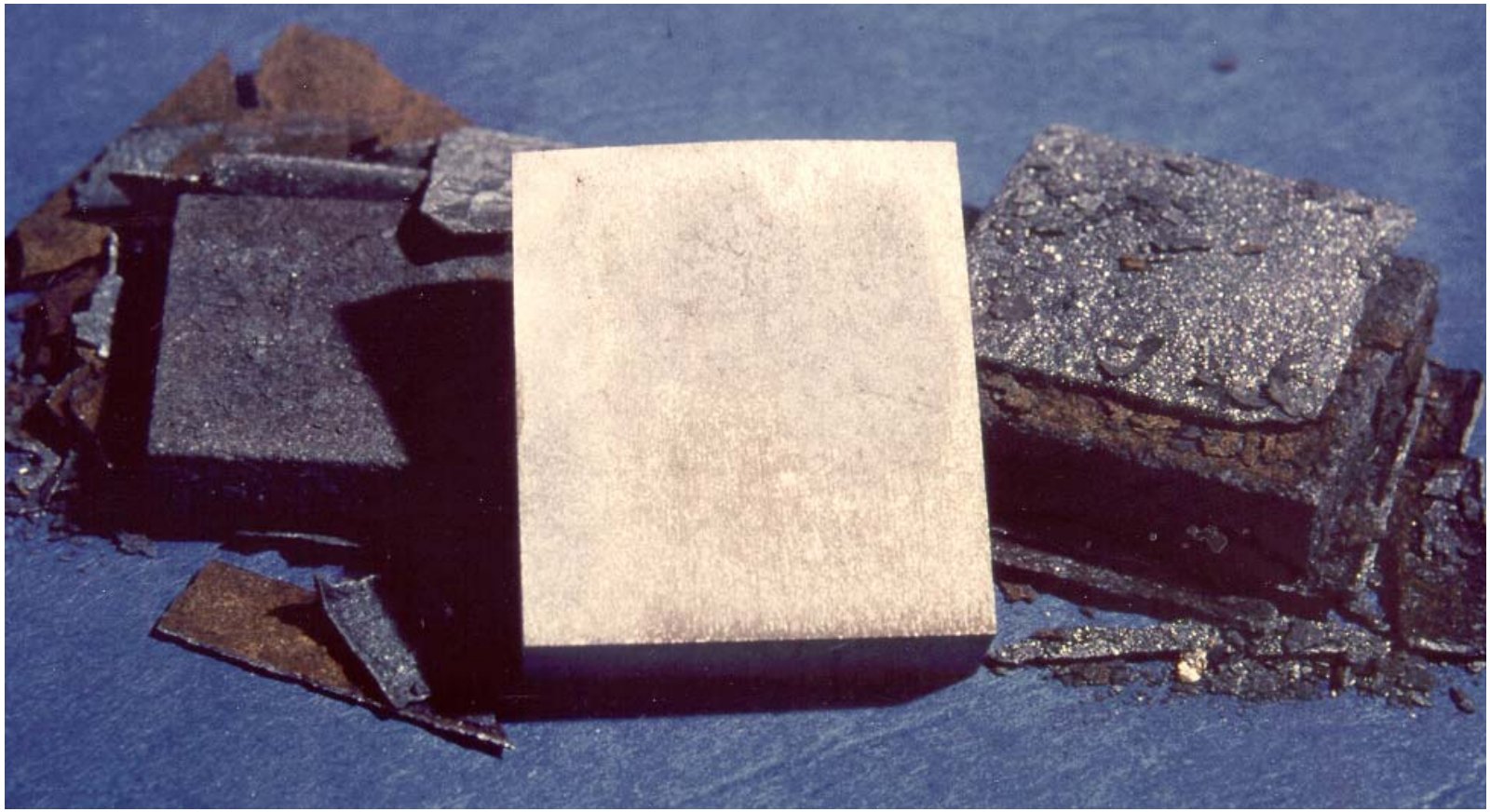
Ingot Capabilities

Rolling Capabilities

Oxidation/Corrosion Resistant Alloys Development at ARC

- Extensive research on minor alloying elements to improve oxidation and corrosion resistance.
  - Chromium substitution in stainless steels (1980's)
  - Minor alloy additions to improve oxidation/corrosion resistance in near commercial compositions of stainless steels

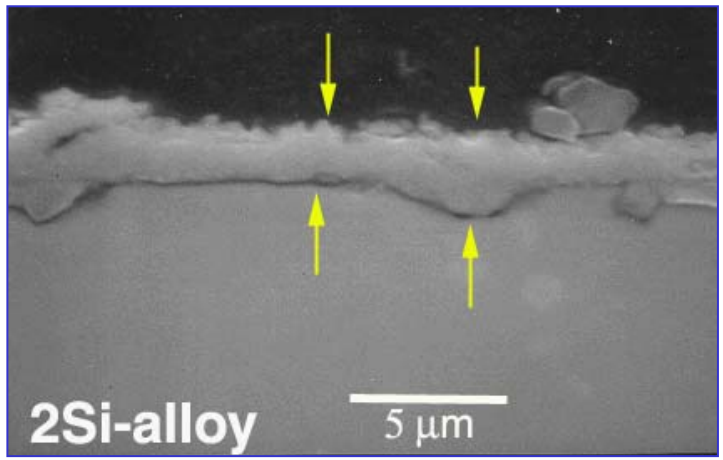
Oxidation Resistant Alloy Development

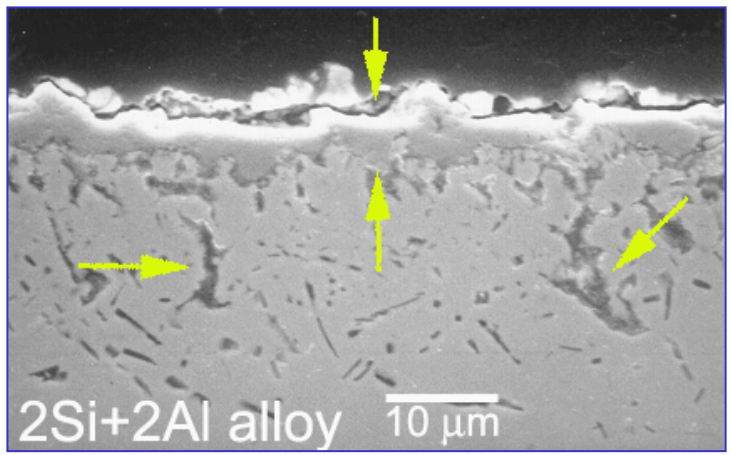


Oxide Scale Morphology Analysis

alloy	oxide feature	thickness (penetration)
2Si	film	2-5 □m
3Si-1Al	film	5-7 □m
	internal	15-25 □m
2Si-2Al	film	7-15 □m
	internal	25-30 □m

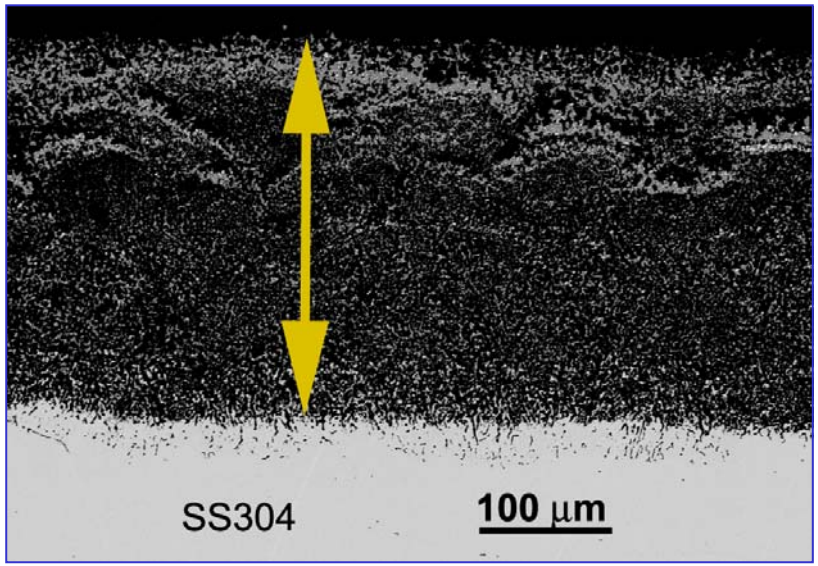
Oxidation at 800°C

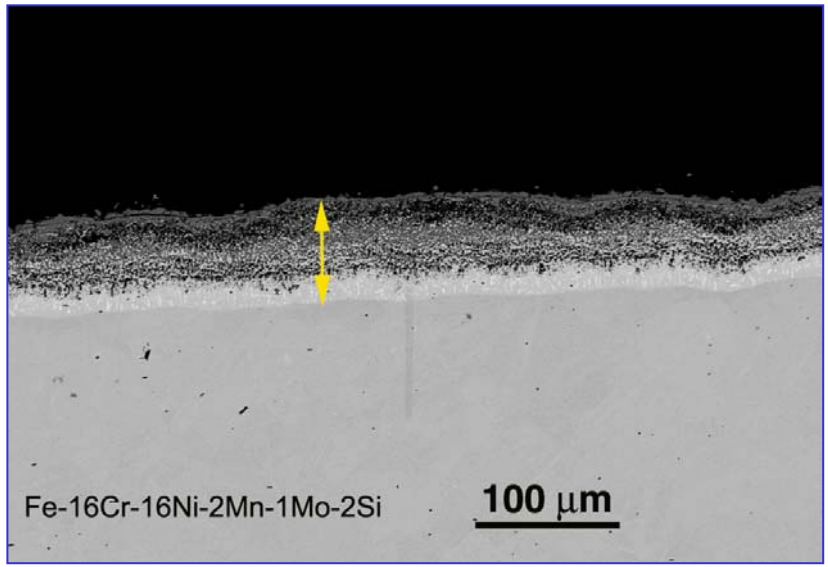




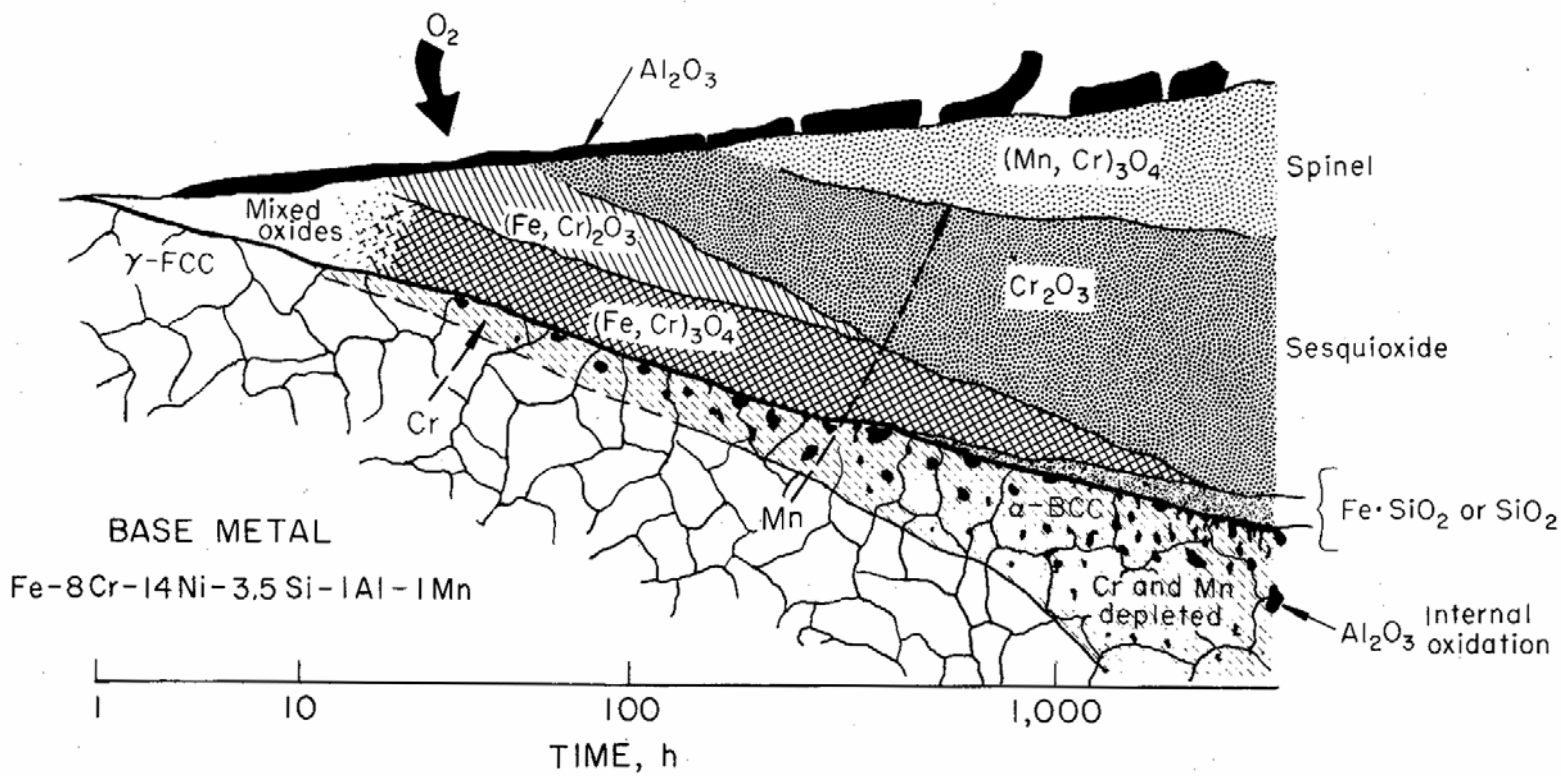
Preliminary Sulfidation Testing

exposure to 1 pct. H_2S at 700°C for 360 hrs





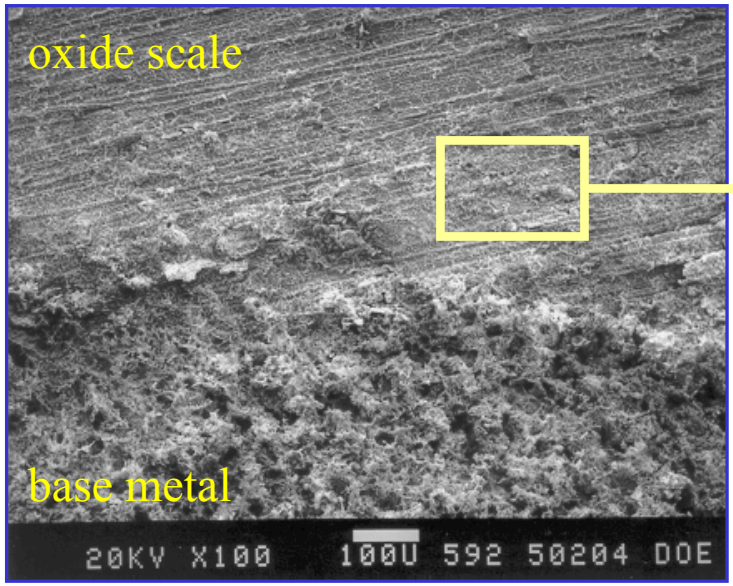
Time Profile of the Oxidation Process (800°C)

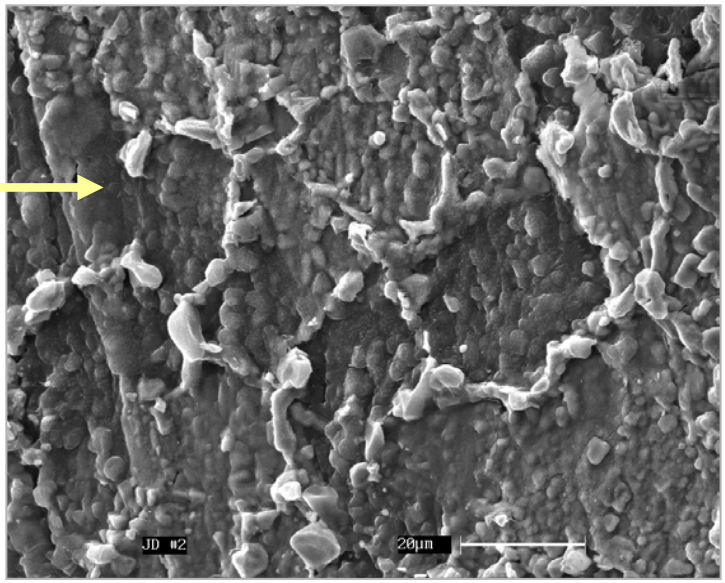


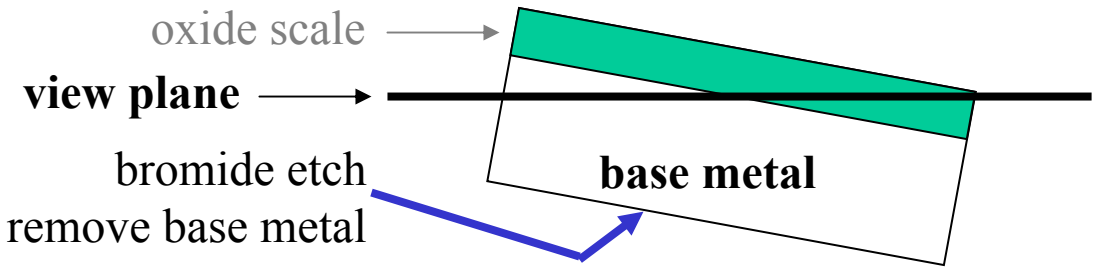
J.S. Dunning, J.M. Oh, and J.C. Rawers, in ***Alternative Alloys for Environmental Resistance,*** TMS, 1987.

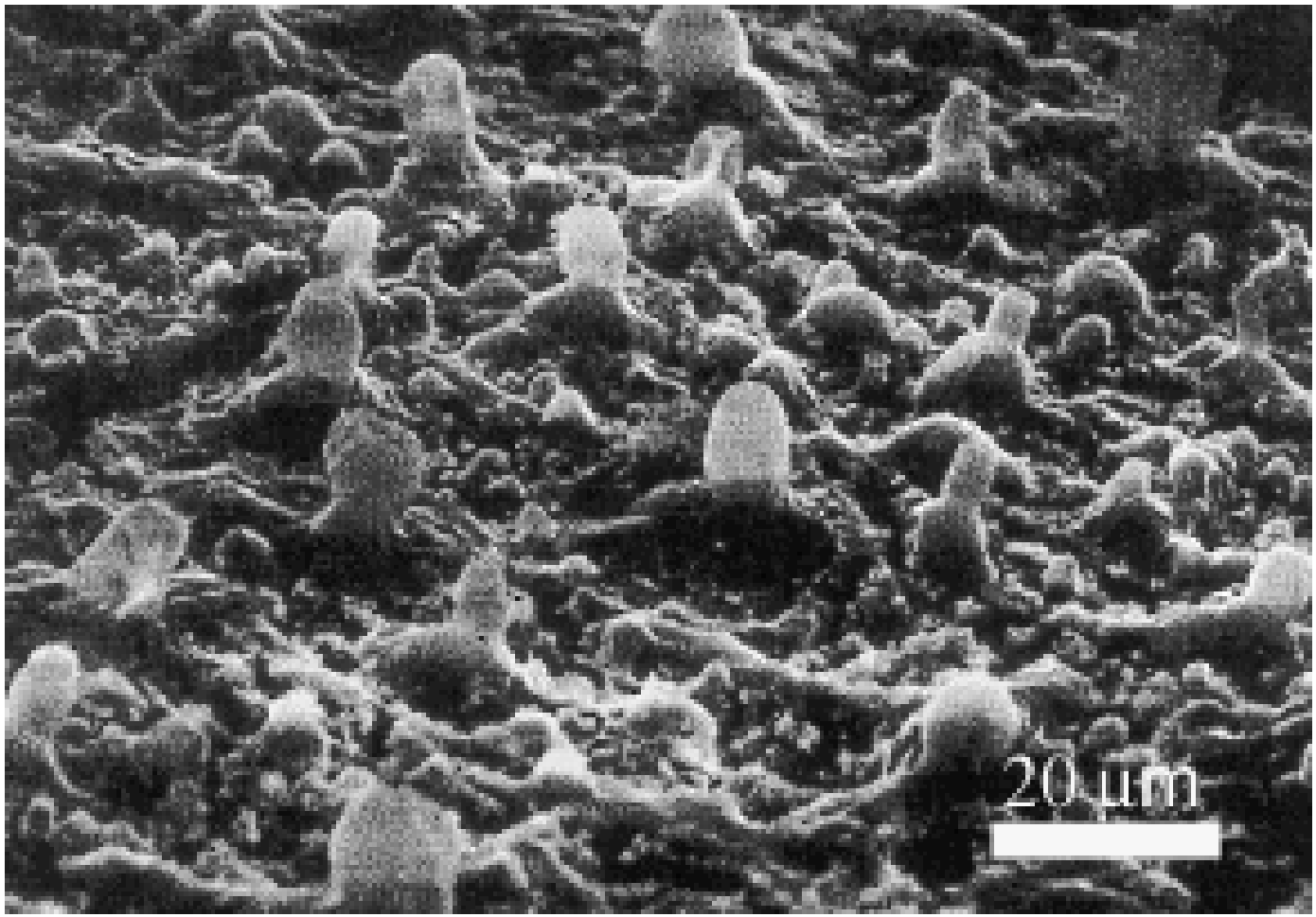
Oxide Scale-Base Metal

2Si alloy exposed at 800°C





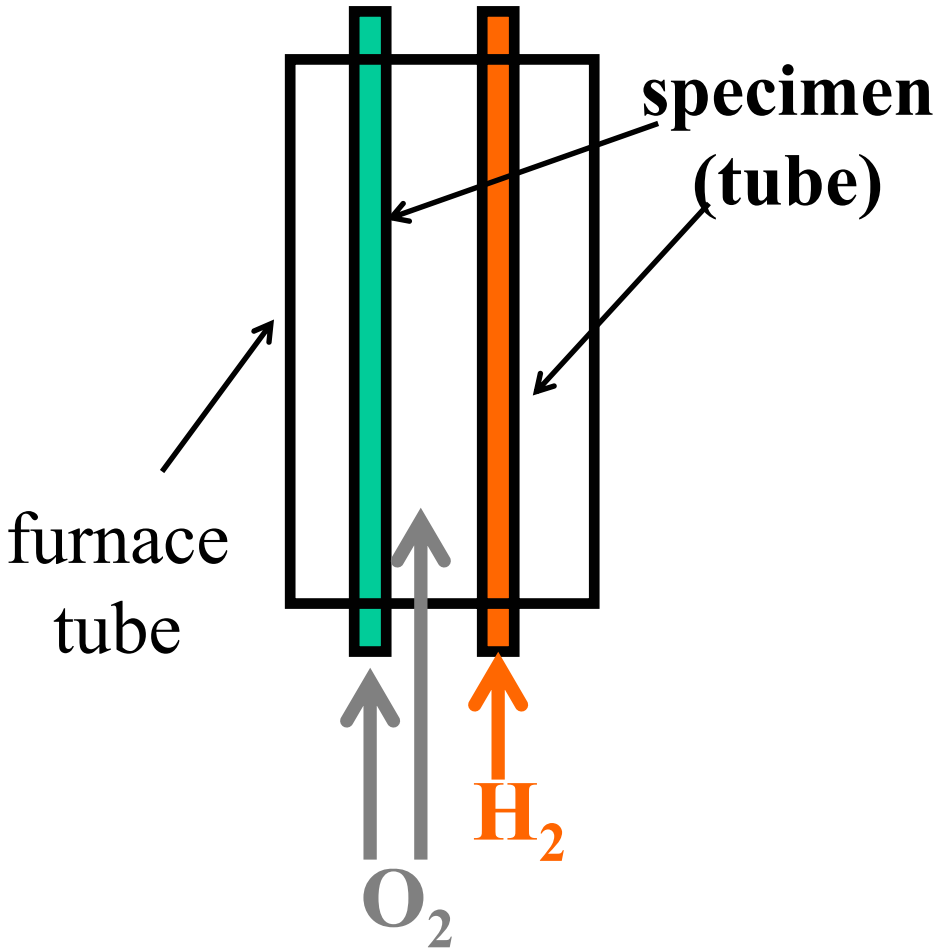



20 µm

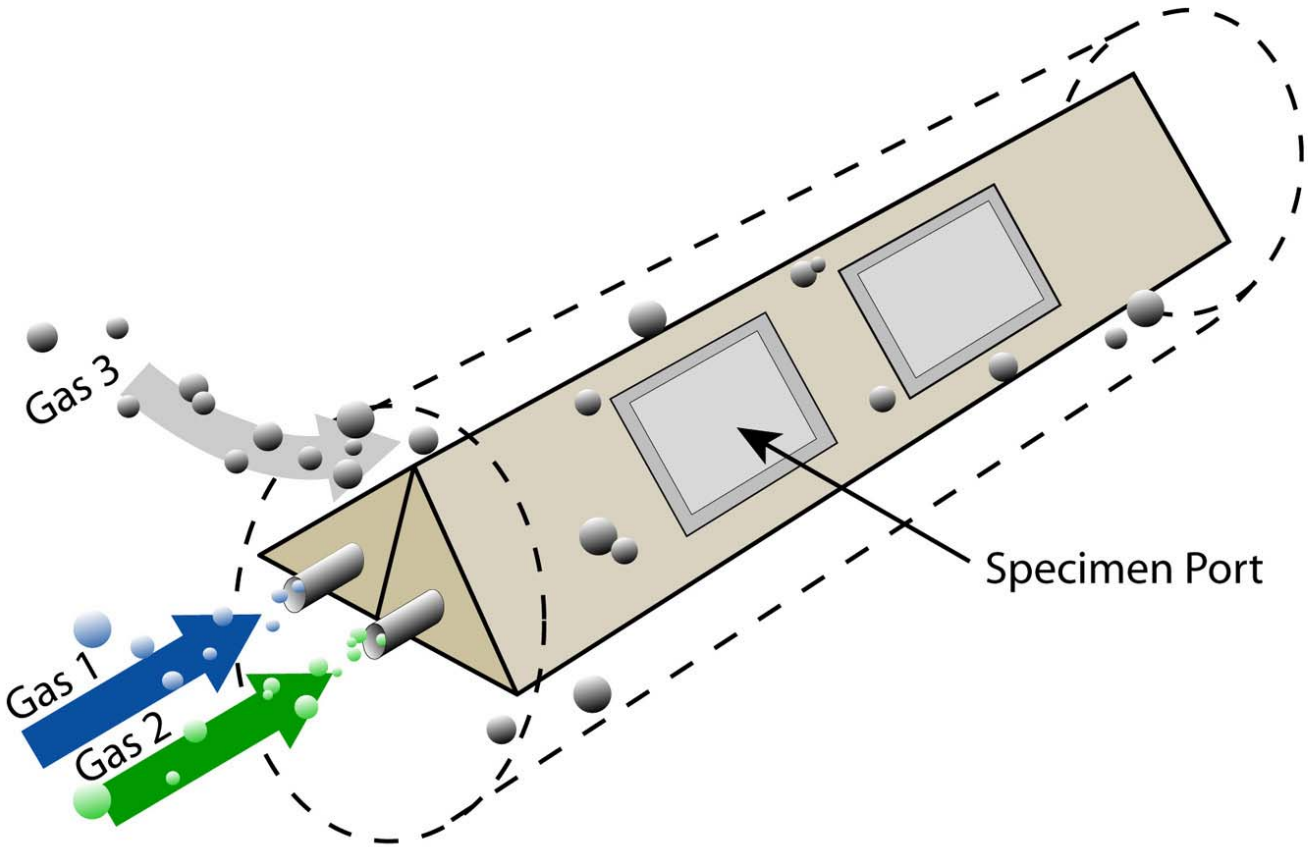
High Temperature Gaseous Corrosion Facility

N_2, **O_2**, **CO_2**, **CO**
HCl, H_2S, **H_2**, CH_4,
SO_2, **Steam**
(simulate real SOFC environments)

Dual Environment Test Setup



Dual Environment Test Setup multiple sheet specimens



Planned Activities

- Plan alloy matrix for interconnects **(FY-03)**
  - input from SECA program
- Melt (10 lb ingots) and fabricate test matrix of alloys **(FY-03)**
- Test and evaluate matrix alloys **(FY03-FY04)**
- Melt (100 lb ingot) and fabricate candidate alloy(s) **(FY04)**
- Provide test material to cooperating SECA laboratories. **(End of FY-04)**