

Extended Duration (1000 h) In-situ XRD of Operating LSCF Cathodes

John S. Hardy, Jared W. Templeton, and Jeffry W. Stevenson



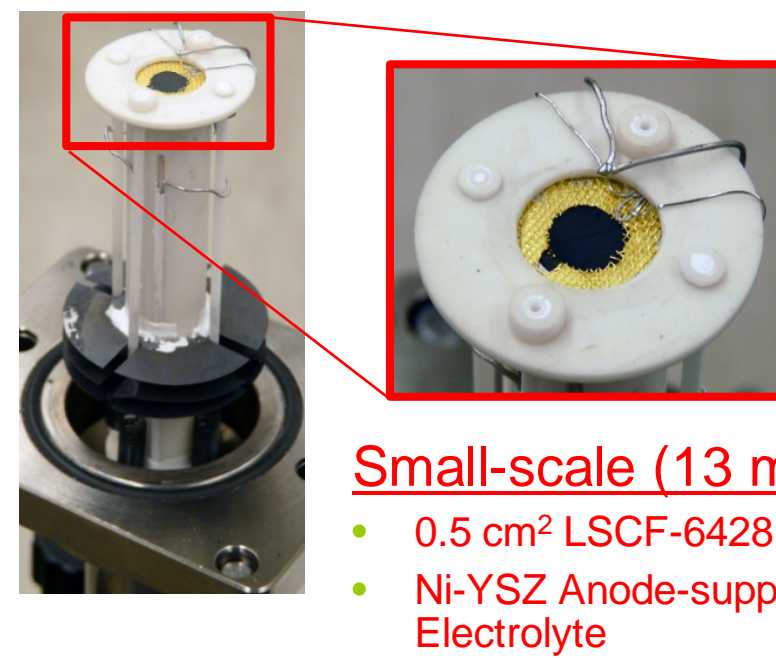
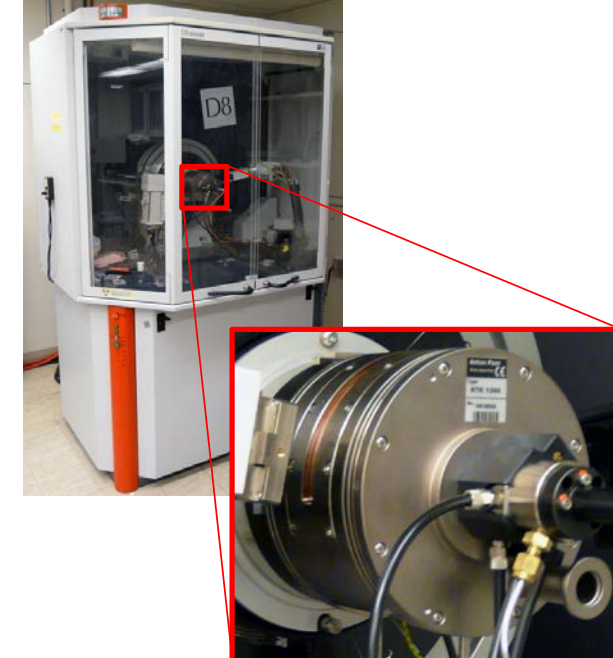
Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965

New SOFC Research Capability was Developed at PNNL In-situ XRD of Anode-supported SOFCs during Operation

Bruker D8 Advance XRD...

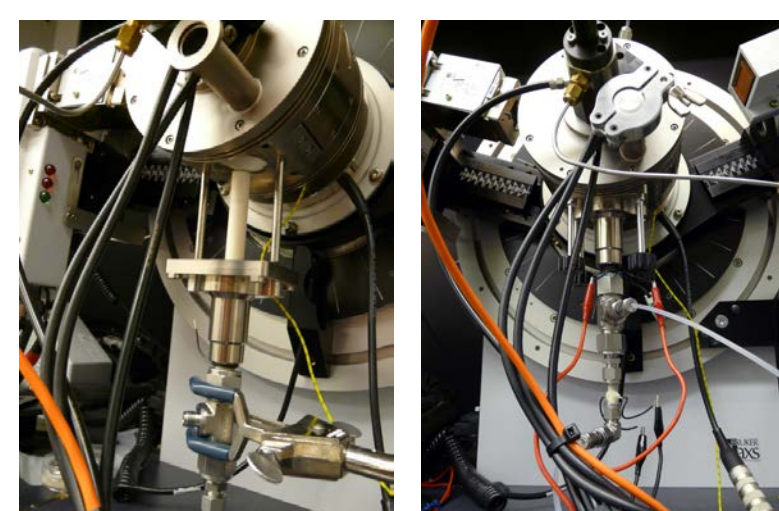
XRD-compatible SOFC Test Fixture



Small-scale (13 mm dia) button cell

- 0.5 cm² LSCF-6428 Cathode on SDC Interlayer
- Ni-YSZ Anode-supported ~10µm YSZ Electrolyte

...with Anton Parr HTK 1200 Heating Chamber



Experimental Parameters for ~1000 hour tests

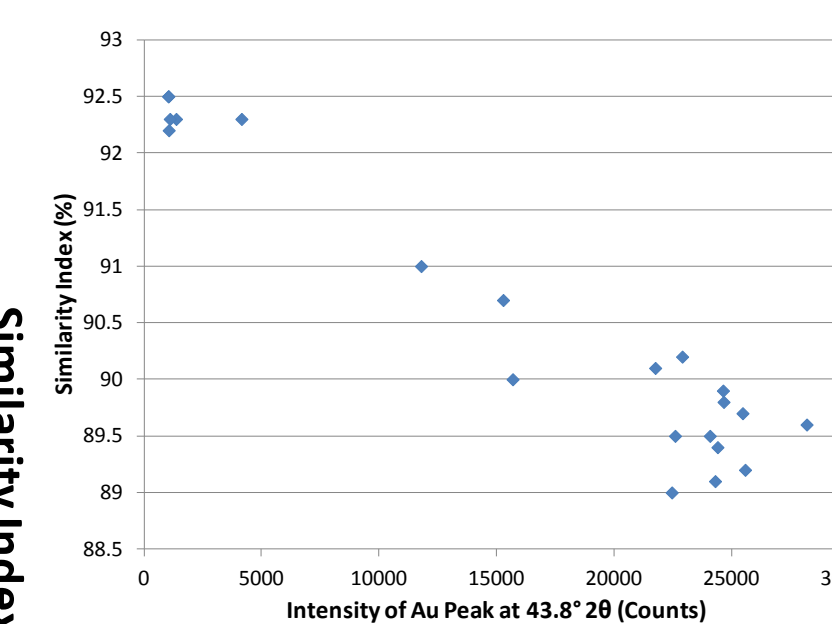
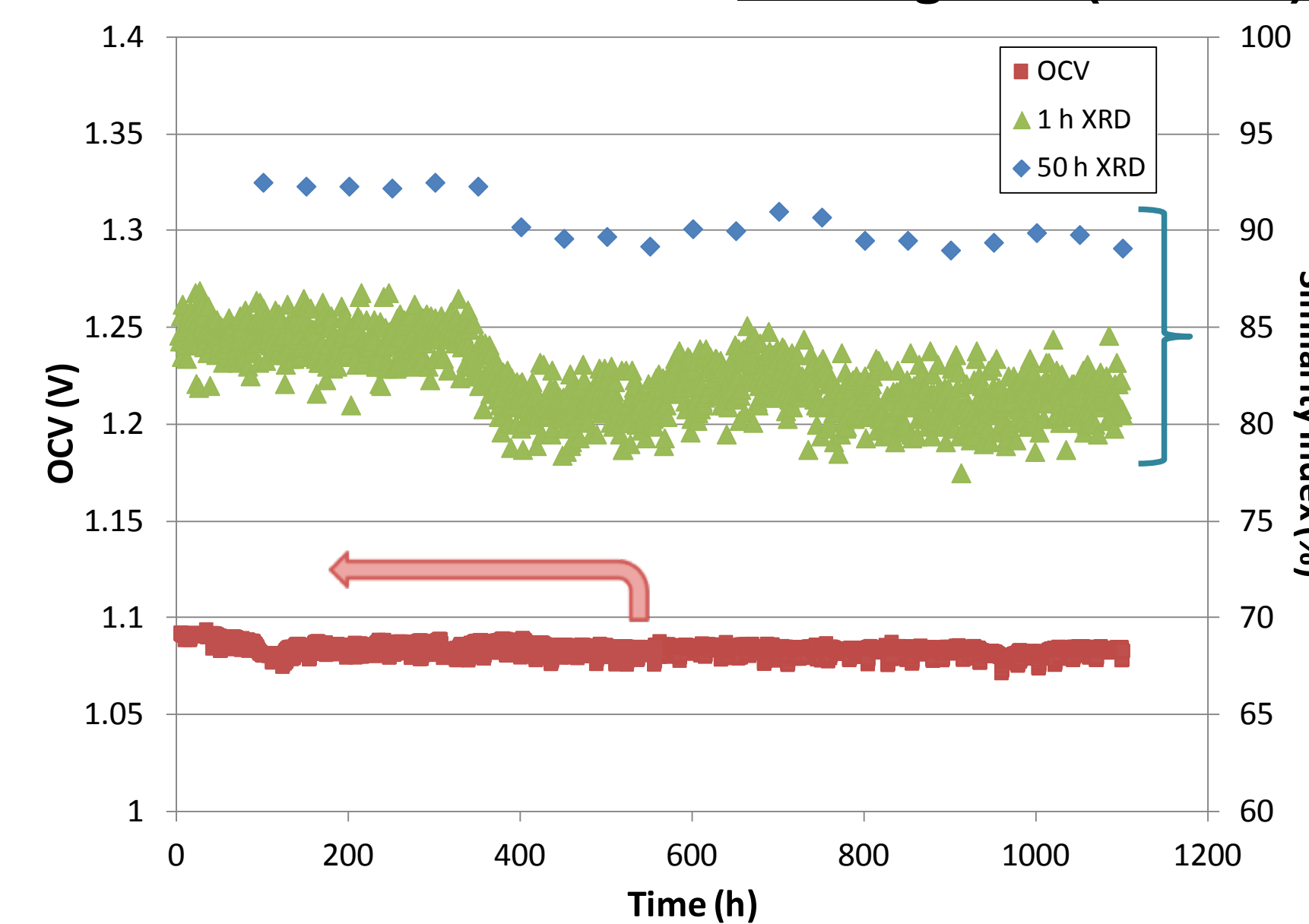
Cell Tests

- Operating Cell: Constant Current simulating 800 mV
- Resting Cell: OCV
- Feed Gas: Flowing air and moist H₂
- Temperature: 750°C

XRD

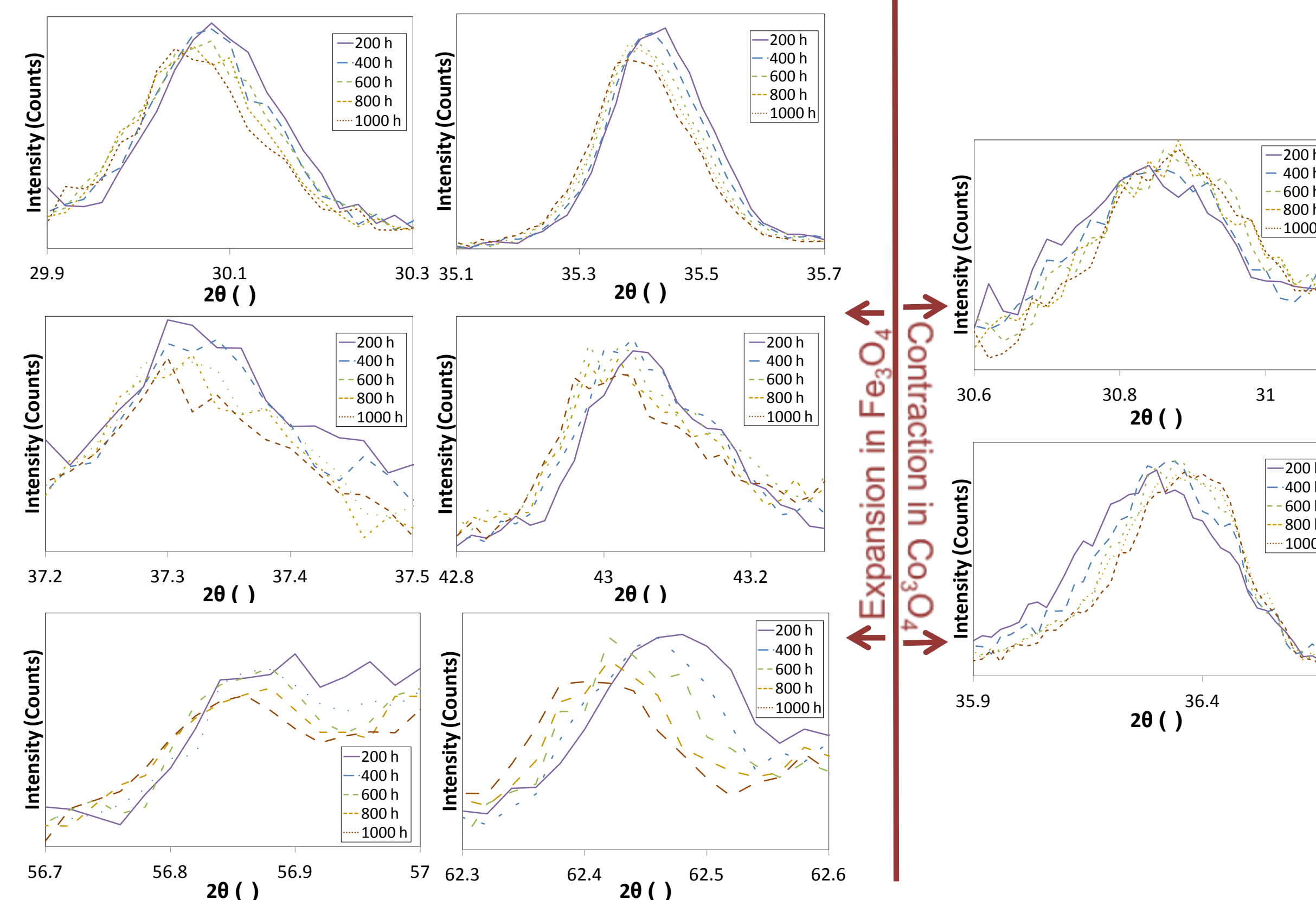
- Repeated 1 hour scans
- 2θ Range: 25 - 85°
- Step Size: 0.02°
- Time/Step: 1.1 seconds

Resting Cell (at OCV)

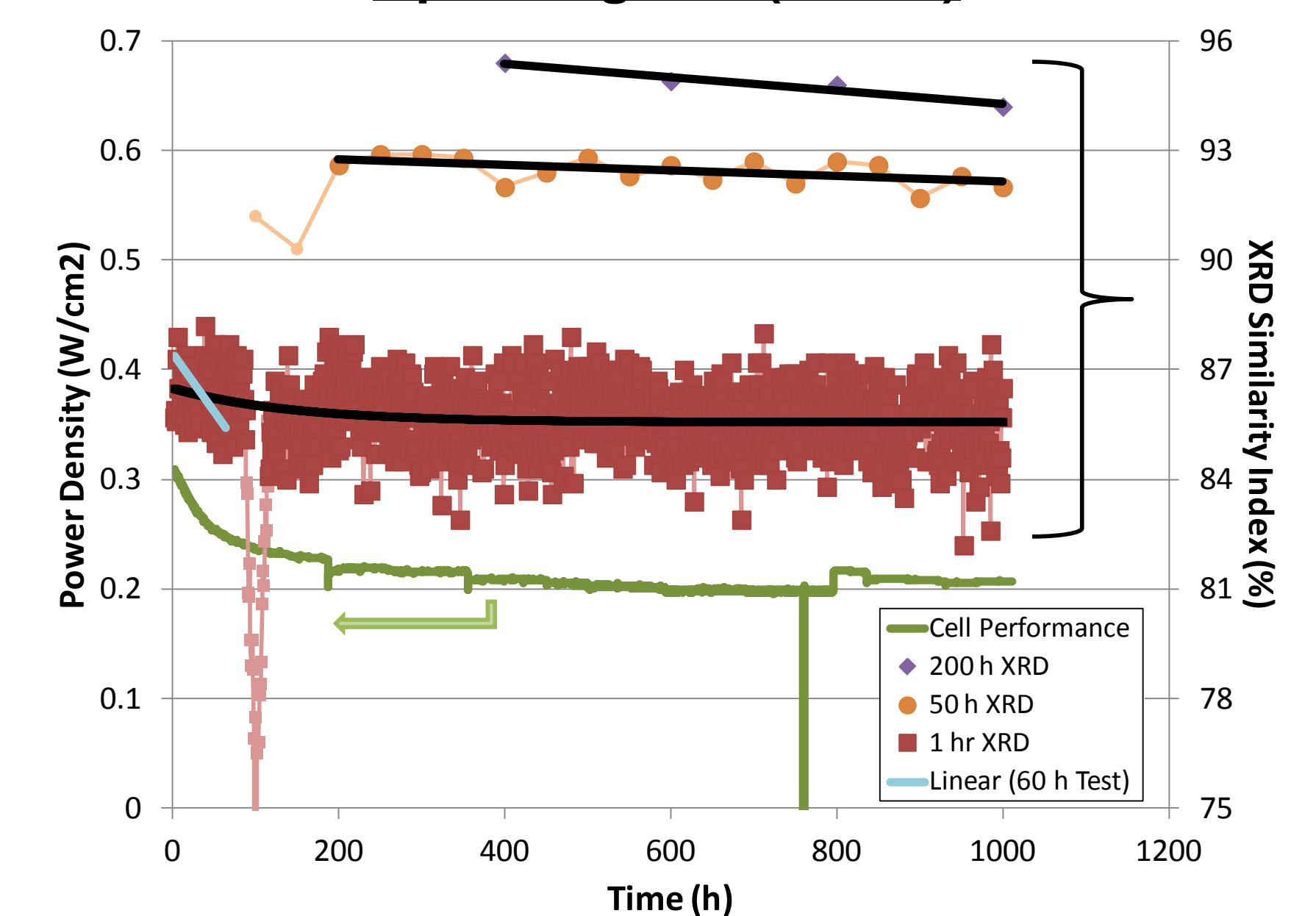


Changes in SI were due to changes in peak intensity of the Au current collector

- No significant changes detected in LSCF peaks over time
- Secondary phases of Fe₃O₄ and Co₃O₄ exhibited peak shifts
 - Lattice parameters were diverging from one another



Operating Cell (~0.8 V)



- SI of 1 hour patterns followed exponentially decaying trend
 - Power density also follows exponentially decaying trend
- Inspection of XRD patterns did not identify the specific changes responsible for the decrease in SI.

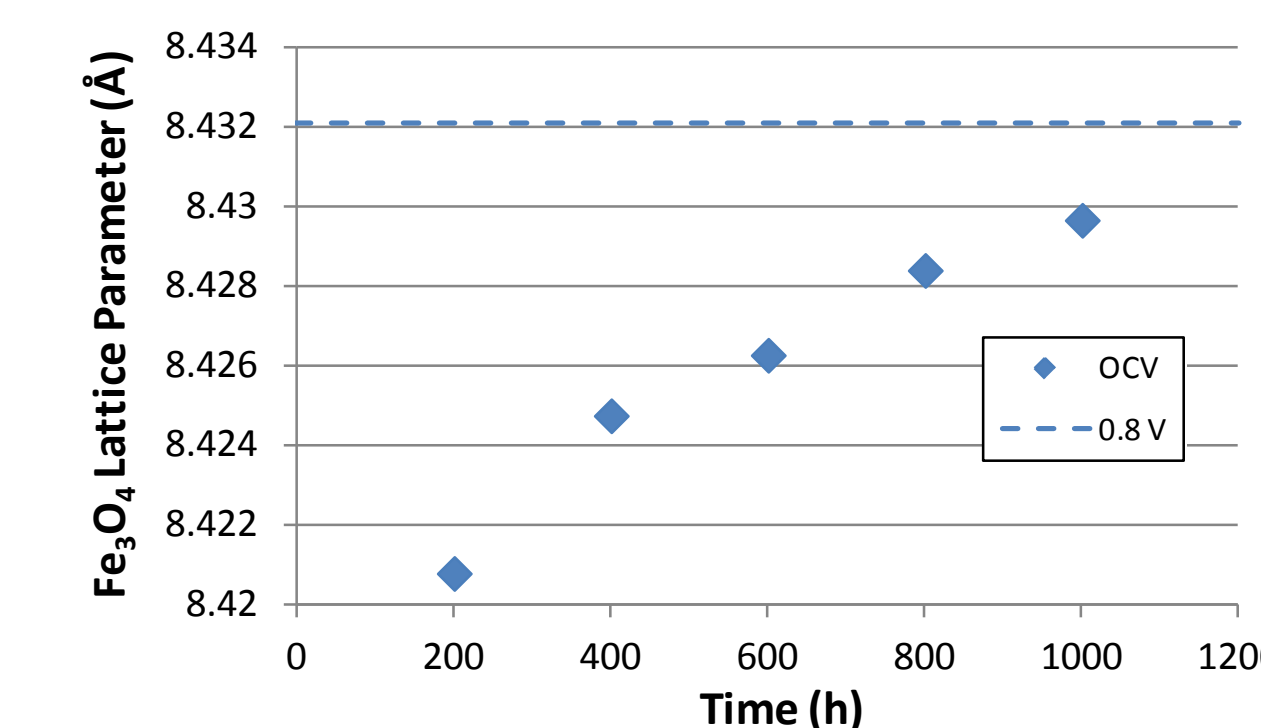
Comparison of Resting vs Operating Cells

Cathode Composition
OCV Operating

	OCV	Operating
LSCF	97 wt%	91 wt%
LaCoO ₃	<2 wt%	<2 wt%
Fe ₃ O ₄	<2 wt%	7 wt%
Co ₃ O ₄	<2 wt%	---

Summing 1000 hours of XRD scans made it possible to resolve trace phases

- LSCF lattice of operating cathode was larger than that of the resting cathode
- A shoulder peak was present on the low angle side of LSCF peaks of operating cathode, suggesting the presence of a second perovskite composition



- Fe₃O₄ lattice parameter was larger and constant in the operating cathode.
- It expanded over time in the resting cathode.