Morphology Control of LSCF Powders and Reliable Lab-scale Evaluation for Enhanced SOFCs Electrode Performance

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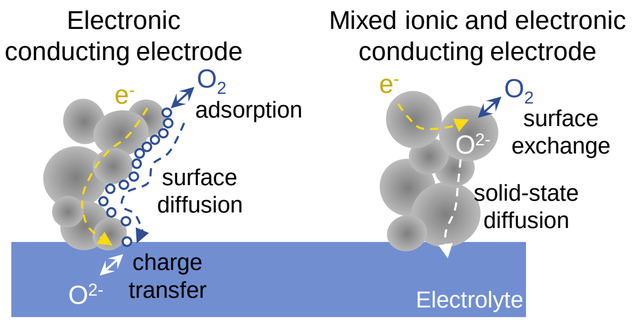
Motivation

- Understanding & optimizing electrochemically active zone in solid oxide cells electrodes are indispensable to maximize performance.
- The relative role and hierarchy of materials properties and electrode structure corresponding to cell/stack performance reliability need to be identified.



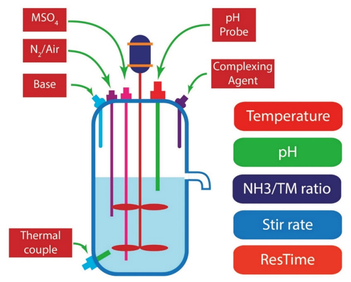
Particle Engineering
- Morphology
- Chemistry
- Scalability

Electrode Microstructure
- Porosity
- Surface area
- Connectivity

Enhanced Performance
- Cost-effectiveness
- Reliability

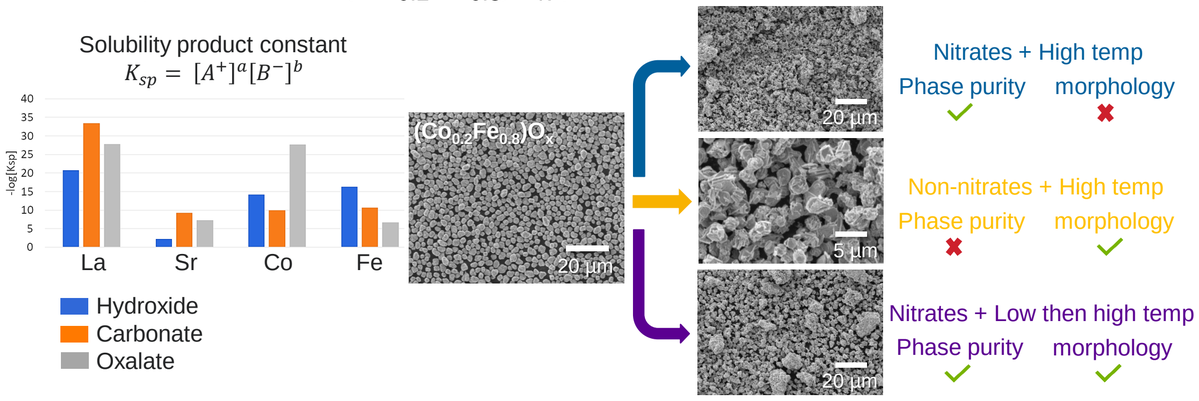
Cost-Effective Powder Synthesis with Morphology / Chemistry Control

- Mass-producible powder synthesis via co-precipitation using continuous stirred tank reactor (CSTR) - well established in battery industry.



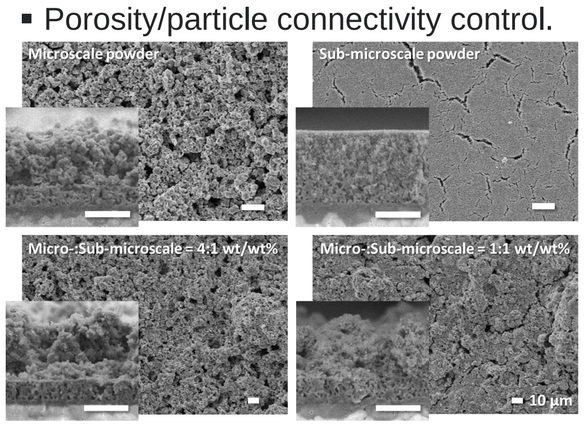
CSTR units at Argonne Nat. Lab.

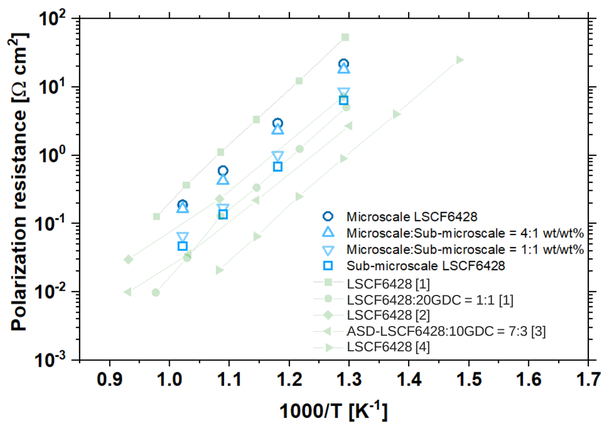
- LSCF powder from $(Co_{0.2}Fe_{0.8})O_x$ precursor.



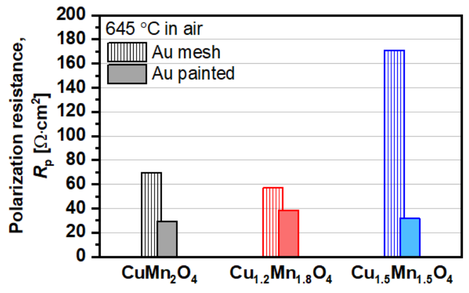
Toward Enhanced Performance

- Porosity/particle connectivity control.

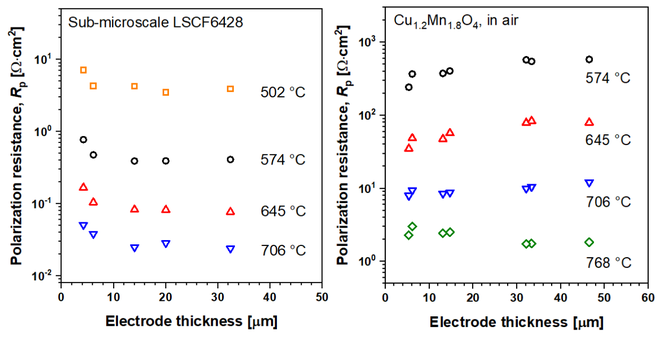




- Chemistry/Current collection control.

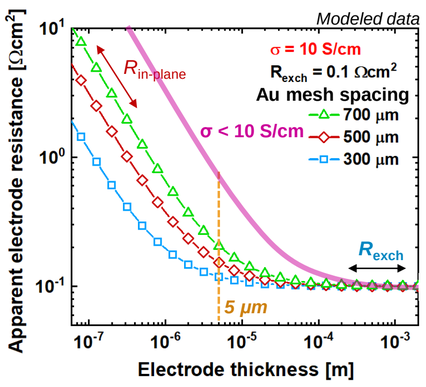


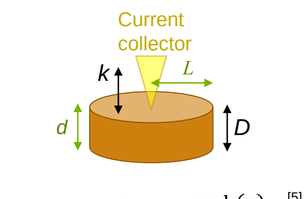
- Electrode thickness control.



Reliable Lab-scale Evaluation

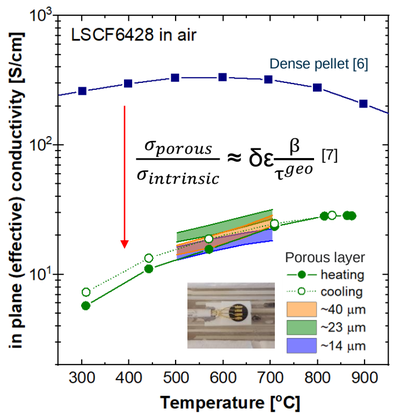
- Proper combination of mesh spacing and porous electrode thickness is required to ensure reliable R_{exch} determination.



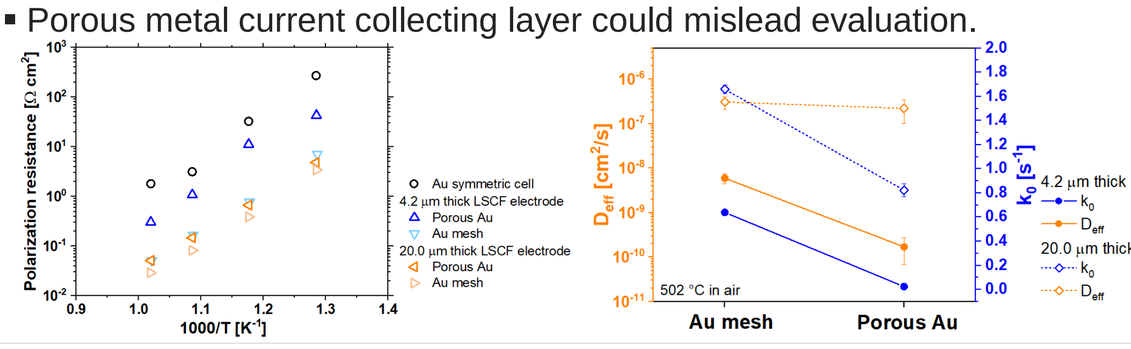


$$R_{appt} = \frac{\rho}{2\pi \cdot d} \cdot \frac{\cosh(z)}{\cosh(z) - 1} \quad [5]$$

$$z = L\sqrt{\frac{\rho}{d \cdot R_{exch}}}$$



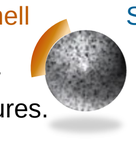
- Porous metal current collecting layer could mislead evaluation.



Potential Extension

- Tailored electrode architecture to alleviate oxygen partial pressure build-up at SOEC air electrode.
- Targeted synthesis of core-shell structured powder for SOFC/SOEC interconnect coating.

Reactive element oxides shell
- Enhanced adhesion
- Enhanced sinterability for lower processing temperatures.



Spinel oxides core
- Bi-modal size distribution for better packing density
- Maximized electrical conductivity

Argonne's Capabilities

- Fundamental materials studies to cell/stack development for SOFC technology.
- Cutting-edge facilities and scientific tools for in-depth research at the materials level that drives technological breakthroughs.
  - Advanced Photon Source (APS)*
  - Materials Engineering Research Facility (MERF)
  - High-Throughput Research Laboratory (HTRL)
  - Argonne Leadership Computing Facility (ALCF)*
  - Center for Nanoscale Materials (CNM)*
  - Electrochemical Analysis and Diagnosis Lab (EADL) and Post-Test Facility

* DOE User Facilities

Acknowledgement & References

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  - Joseph Stoffa, SOFC project manager
  - Debalina Dasgupta, SOFC project manager
  - Shailesh Vora, Technology Manager, SOFC Program.

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