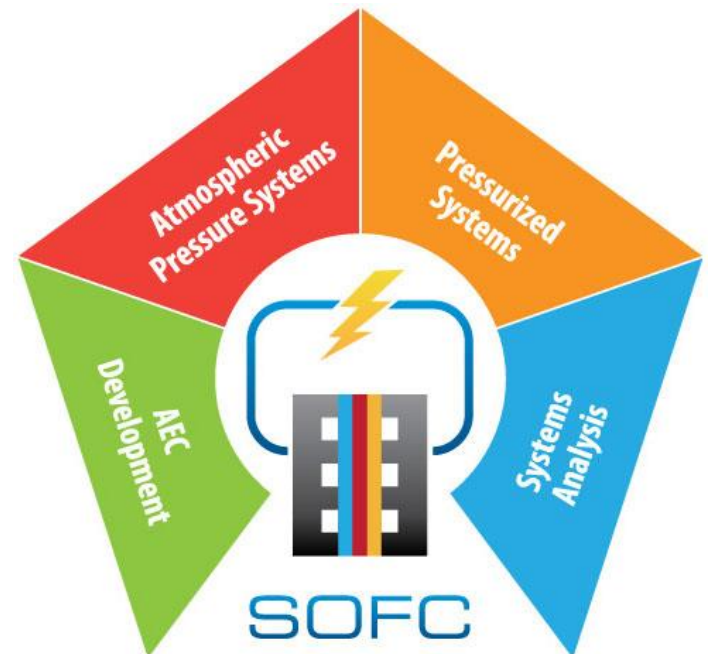


Explore the Role of Interlayer Chemistry on the Cathode Performance and Performance Stability

PI: Xiao-Dong Zhou

Department of Chemical Engineering
University of Louisiana at Lafayette
Lafayette, LA 70503
Email: zhou@louisiana.edu

PM: Jason Montgomery



Outline

1. Technical and Scientific Background

Necessity and relevance

2. Project Objectives

Role of the interlayer on cathode durability

Theoretical analysis

3. Technical Approaches

Experimental and theoretical modeling

4. Project Budget and Period

Cost share, equipment

5. Project Management Plans

Investigators and risk analysis

A Long-Lasting Challenge in SOFC Electrode Development

How to achieve high-performance and highly durable electrode?

In terms of the technological development

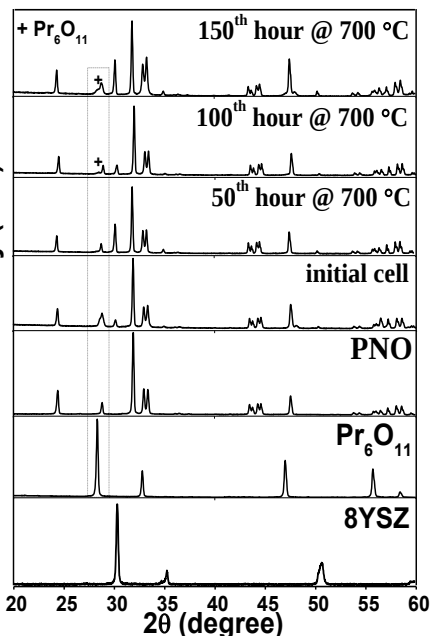
What is the mechanism that underlies the strong correlation between activity and stability?

In terms of the scientific advance

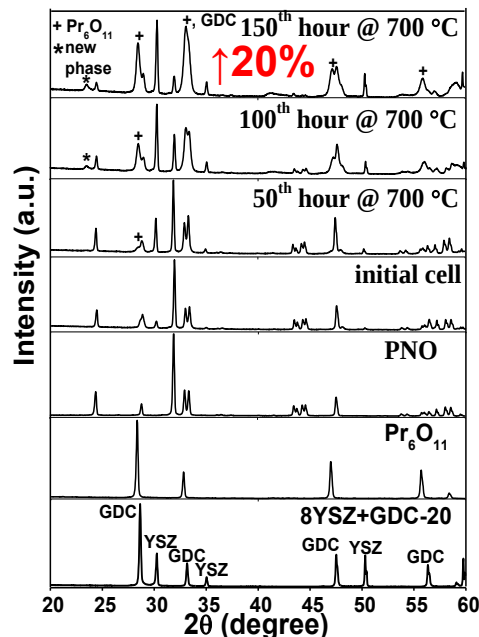
Role of Interlayer on the Phase Evolution?

PNO

interlayer absent

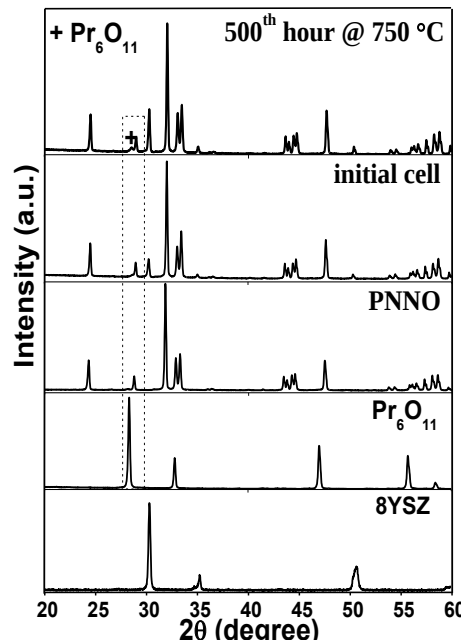


GDC-20

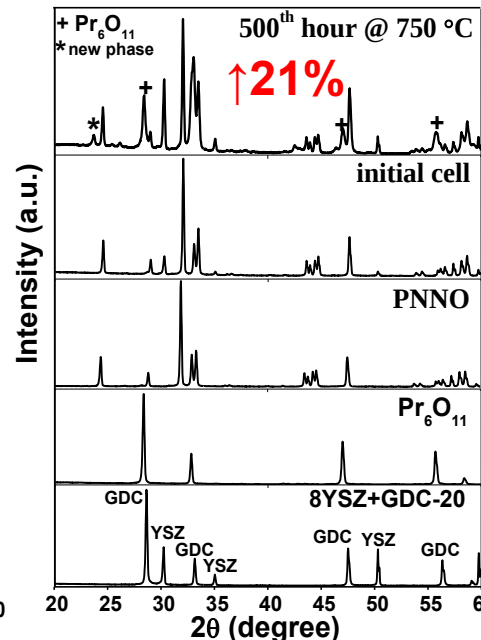


PNNO50-50

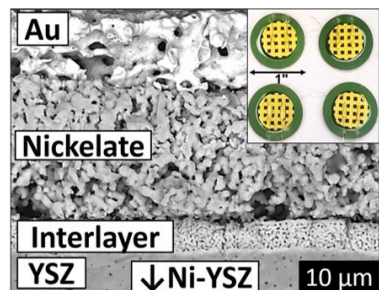
interlayer absent



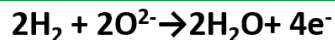
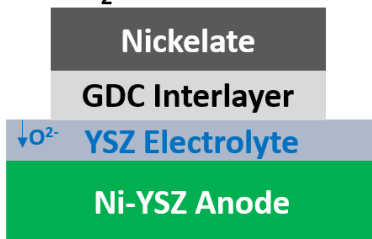
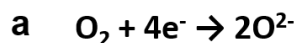
GDC-20



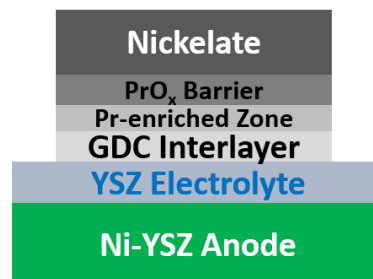
Standard



GDC cells



Thin PrO_x Film



PrO_x -GDC cells

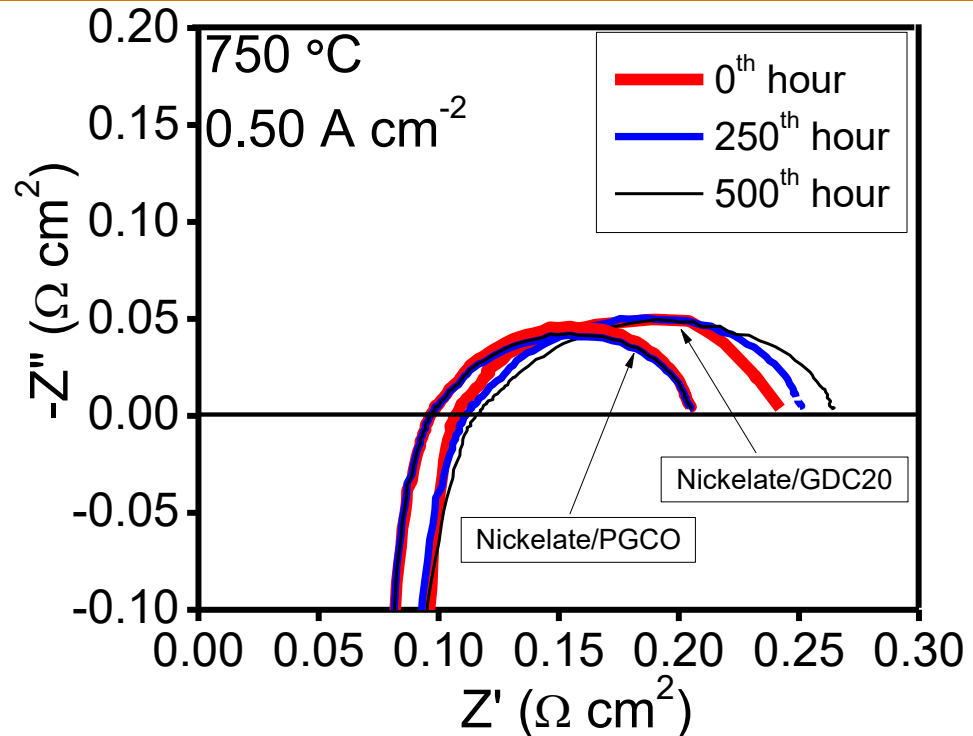
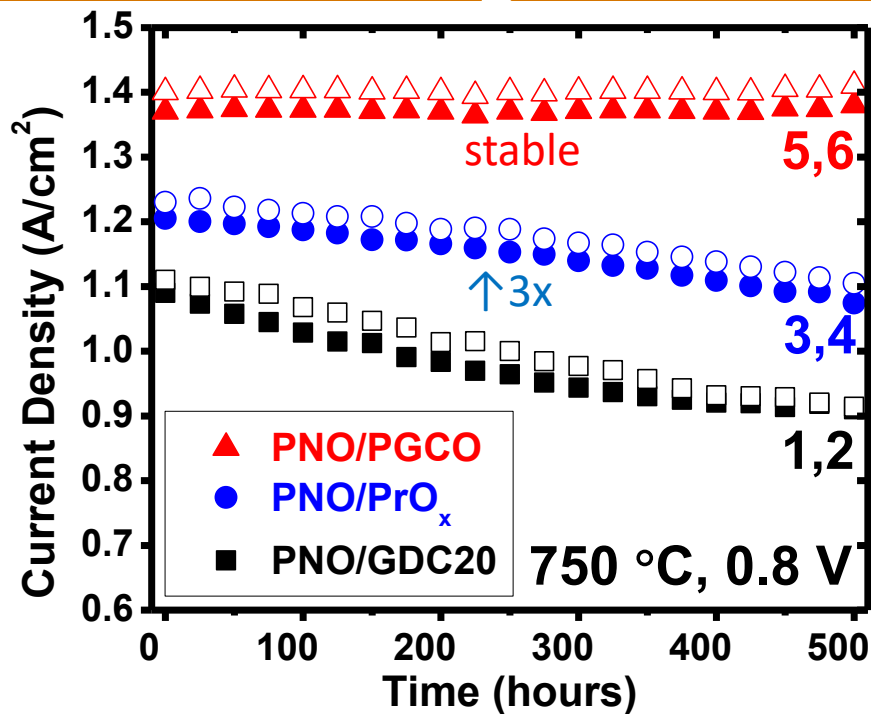
New Chemistry



PGCO cells

PGCO: $Pr_{0.5}Gd_{0.5}CeO_{2-x}$

Performance Stability vs. Interlayer Chemistry



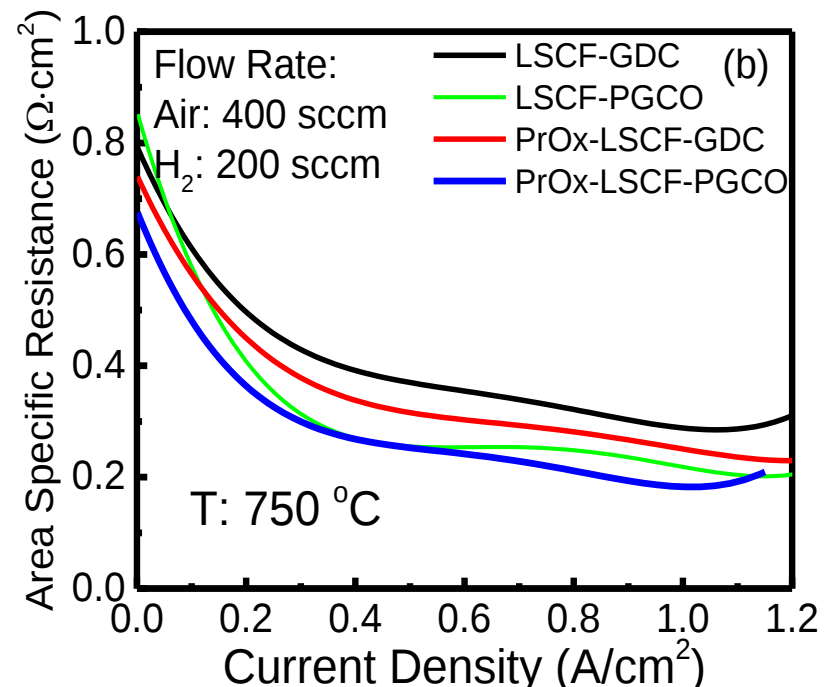
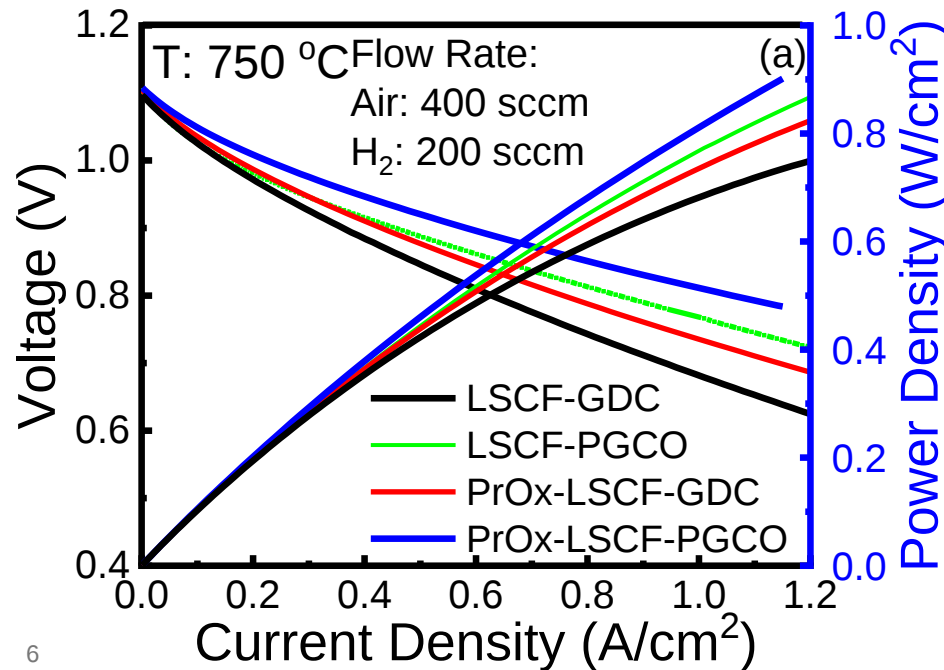
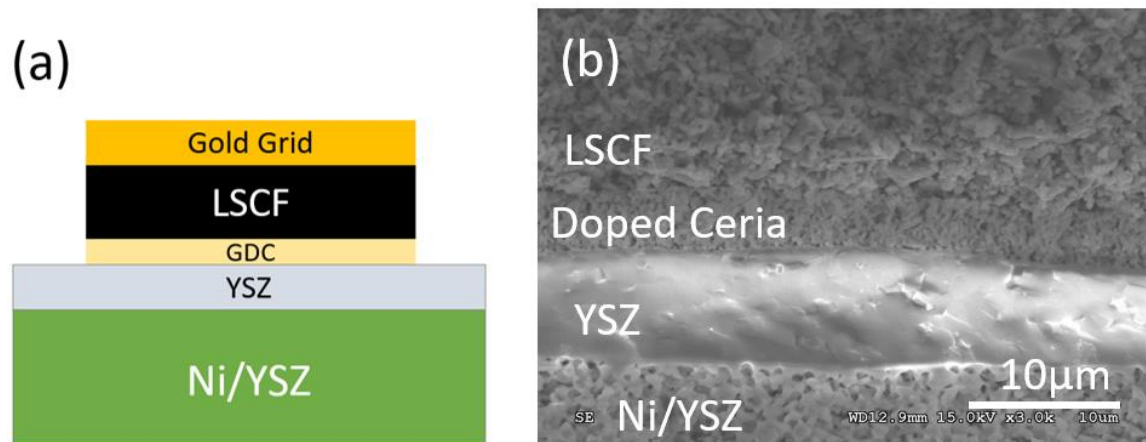
Points to take:

- Multiple cells for each condition for both PNO and PNNO electrodes
- 3x reduced performance degradation in PNO/ PrO_x cells.
- Stable operation was measured on multiple sets of cells and cathode compositions with the PGCO interlayer.
- Reduced R_{pol} ($\uparrow\text{MIEC} \rightarrow \uparrow\sigma_e$) due to extended rxn. zone.
- Reduced R_{ohm} ($\downarrow R_{\text{gb}}$ with $[\text{Pr}]\uparrow$)¹

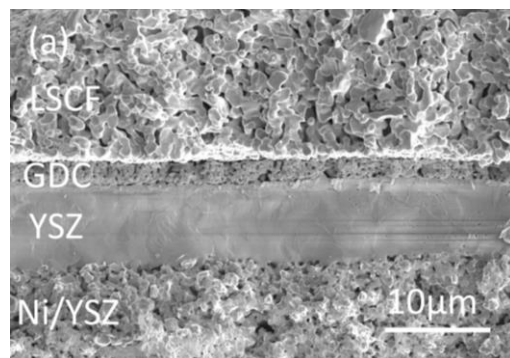
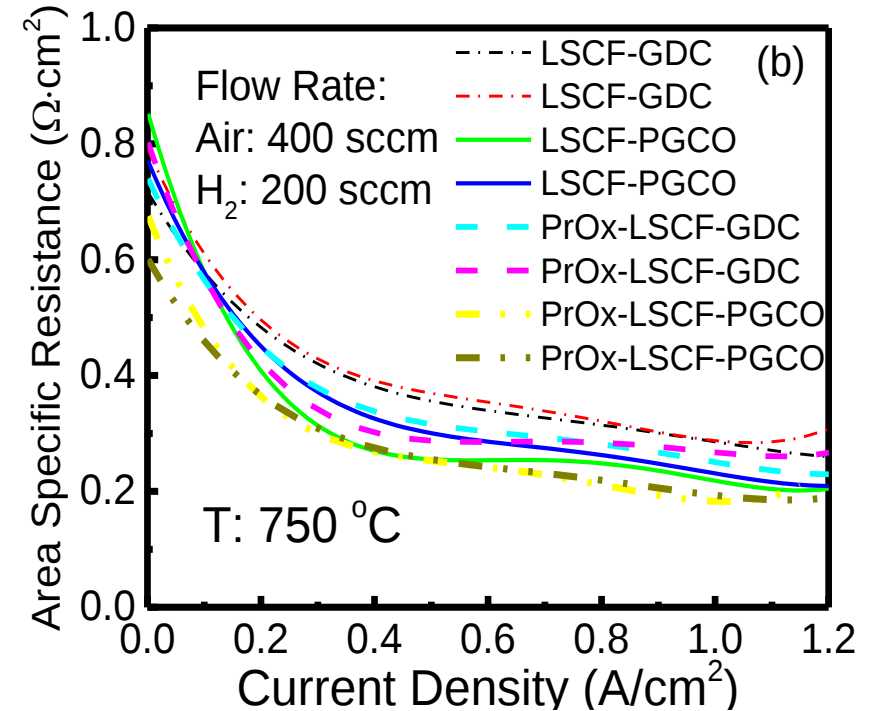
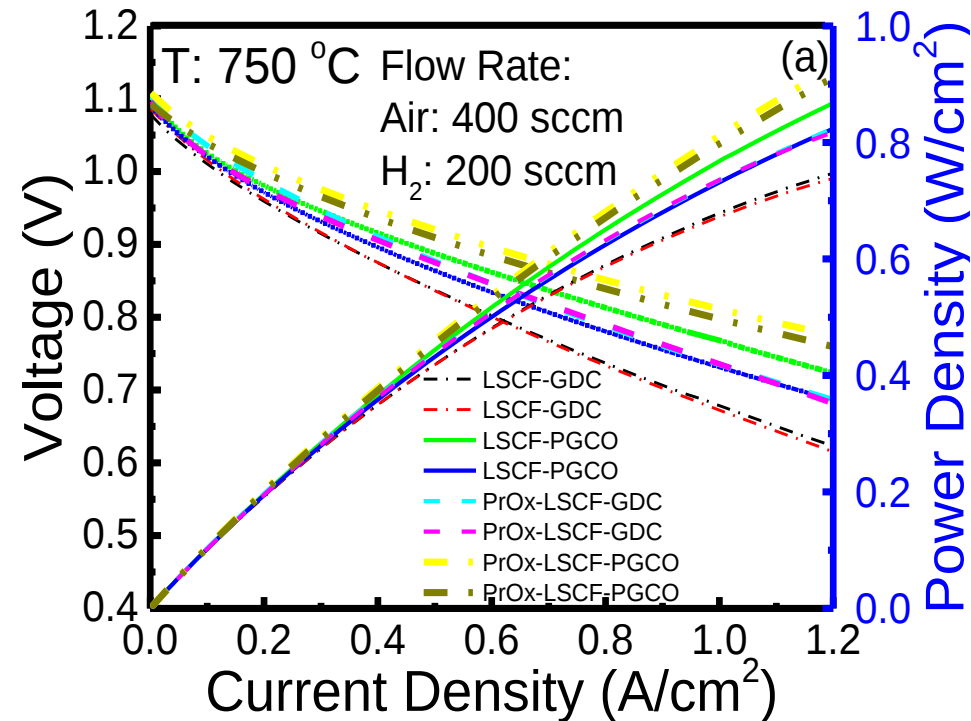
Summarized ASR vs. GDC cells.

ASR	Ohmic	Electrode	Total
PrOx-GDC 500^{th} hour	7%↓	22%↓	15%↓
PGCO 500^{th} hour	16%↓	28%↓	22%↓

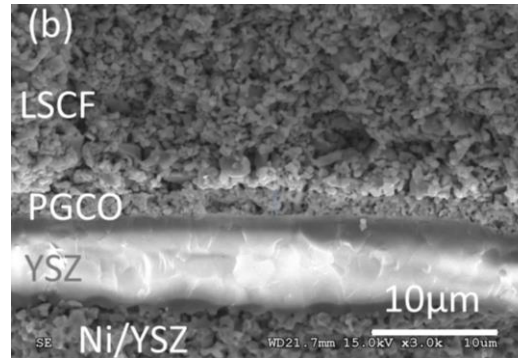
Cell Performance vs. Interlayer Chemistry – LSCF Cathode



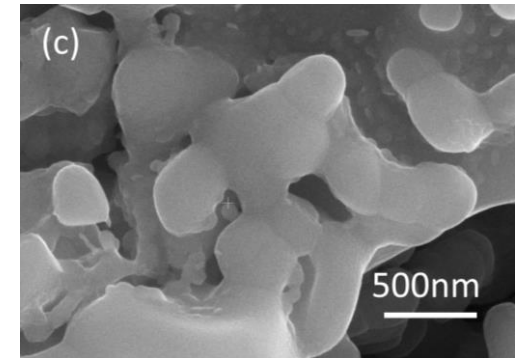
Performance Stability vs. Interlayer Chemistry – LSCF Cathode



LSCF-GDC Cell

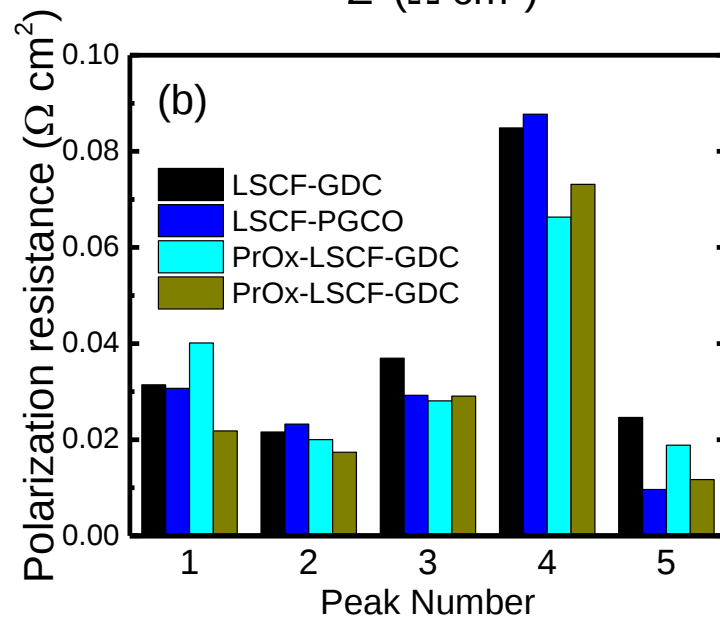
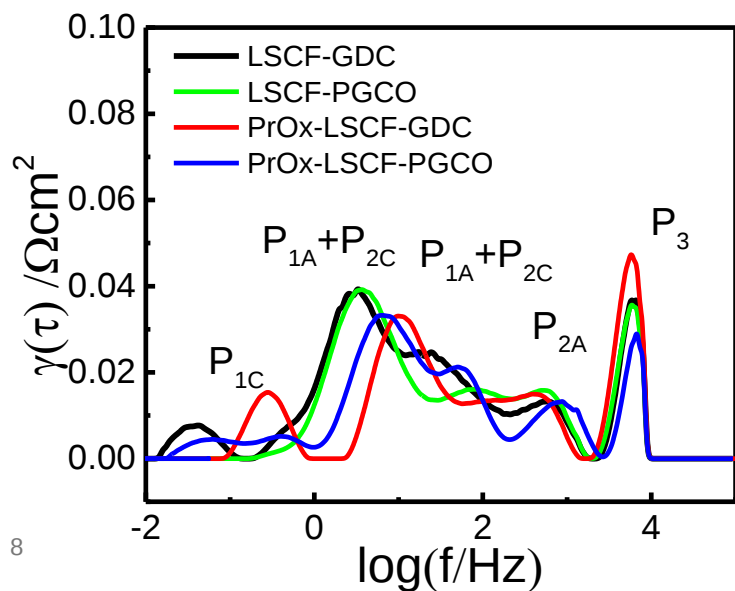
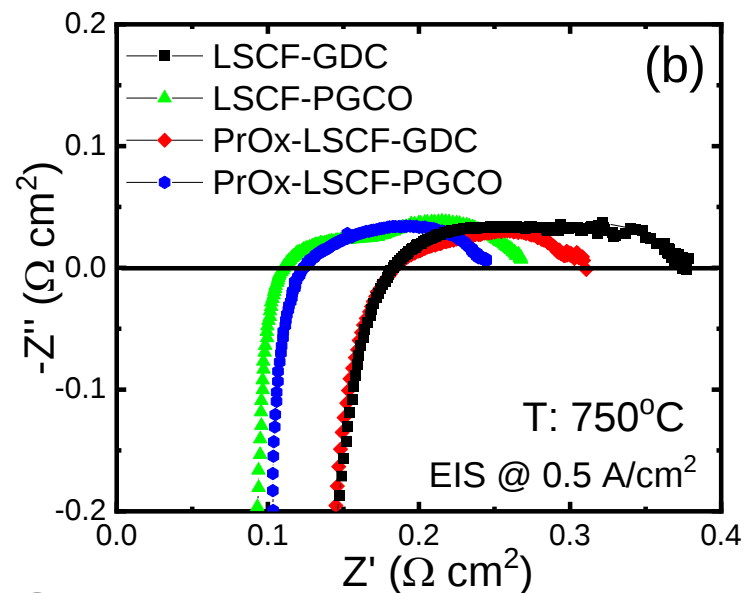
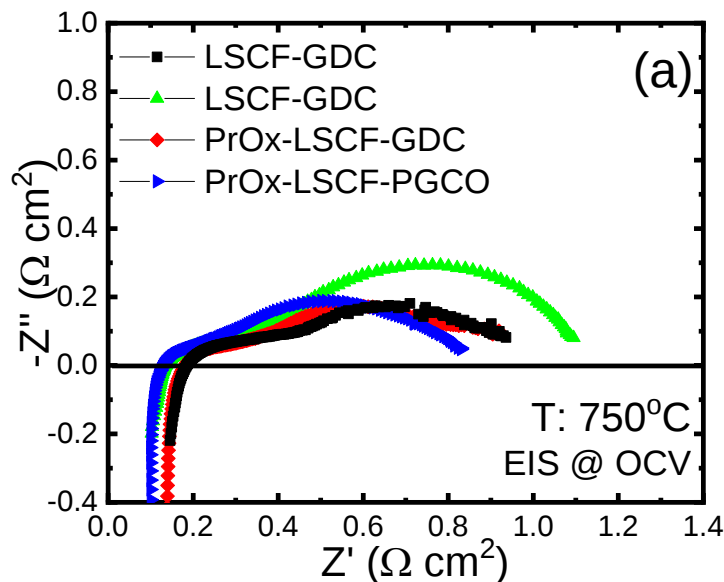


LSCF-PGCO Cell

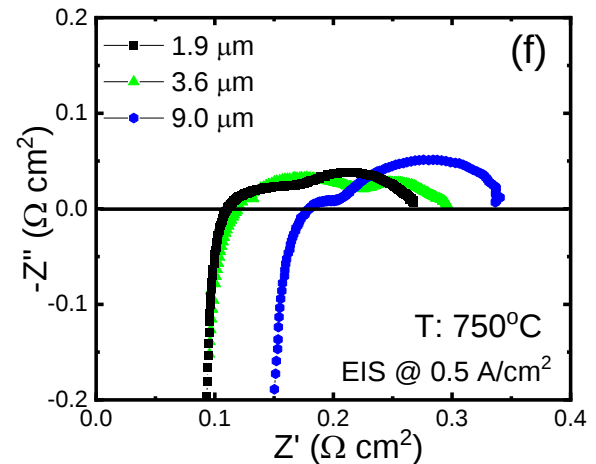
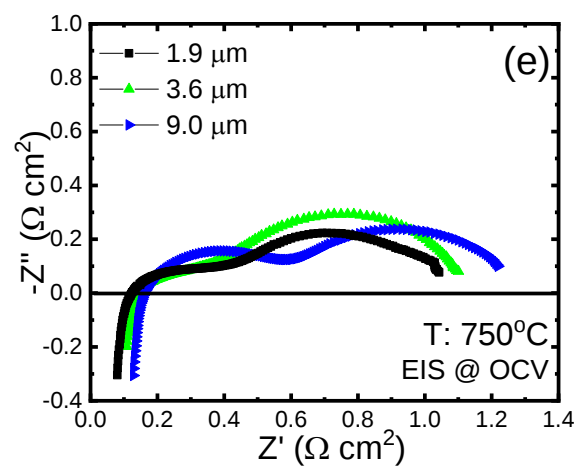
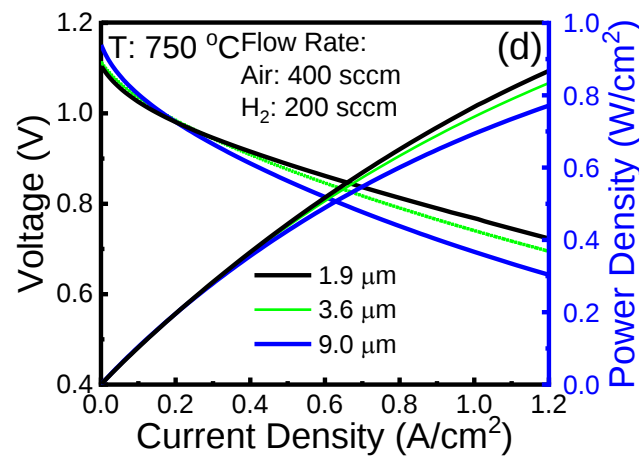
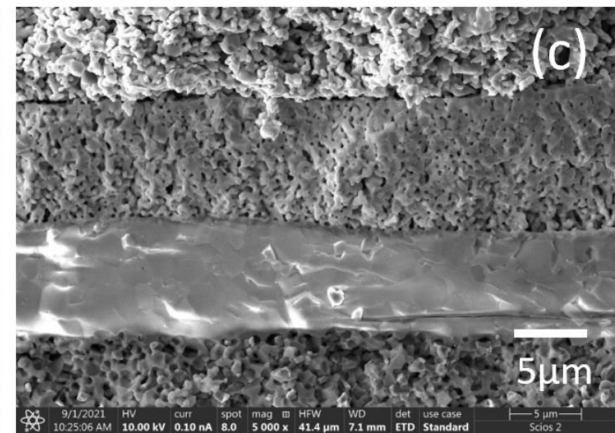
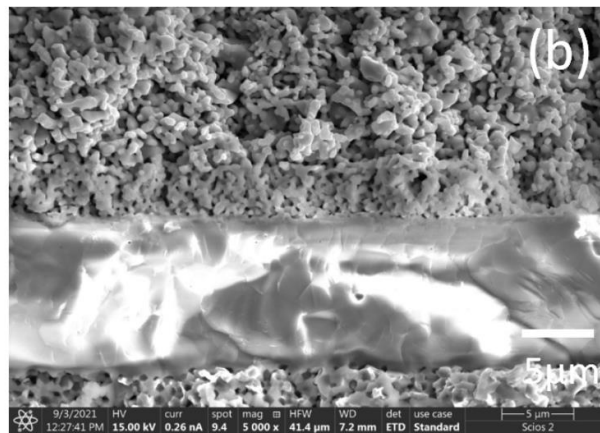
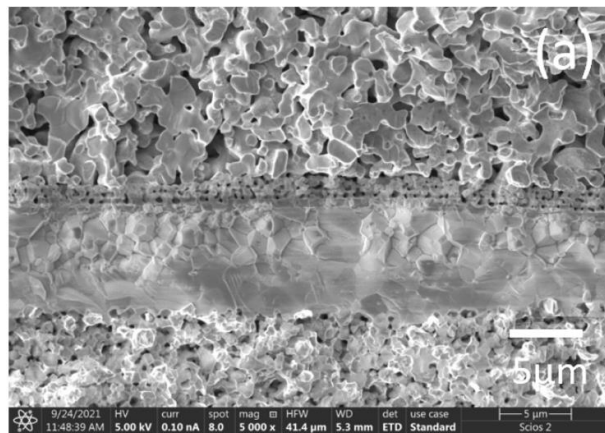


Infiltrated LSCF

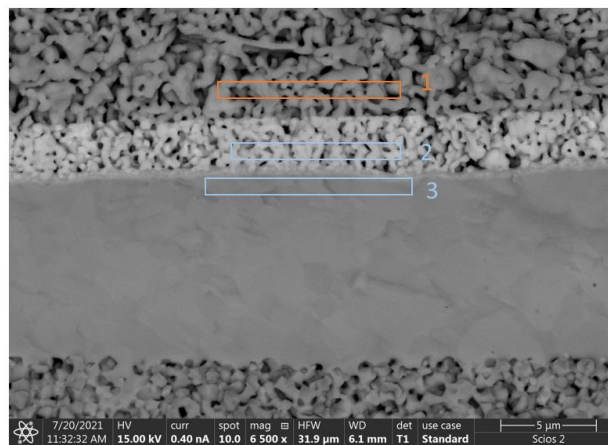
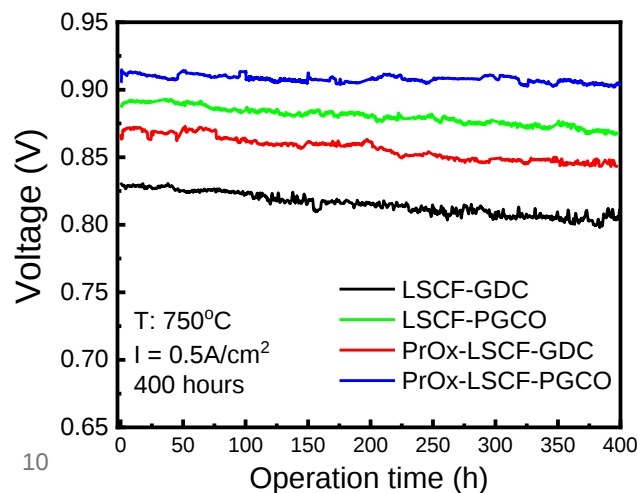
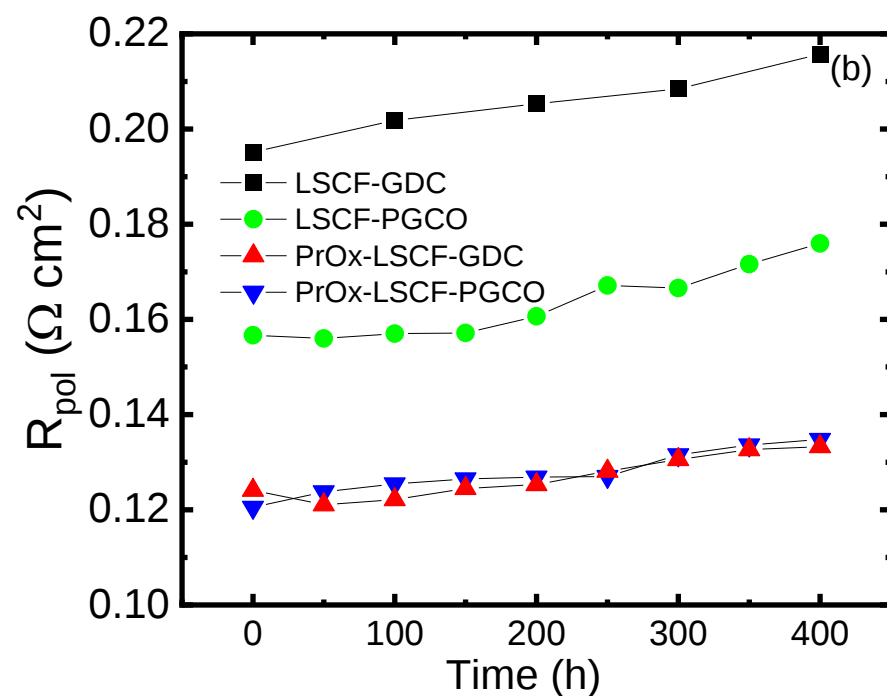
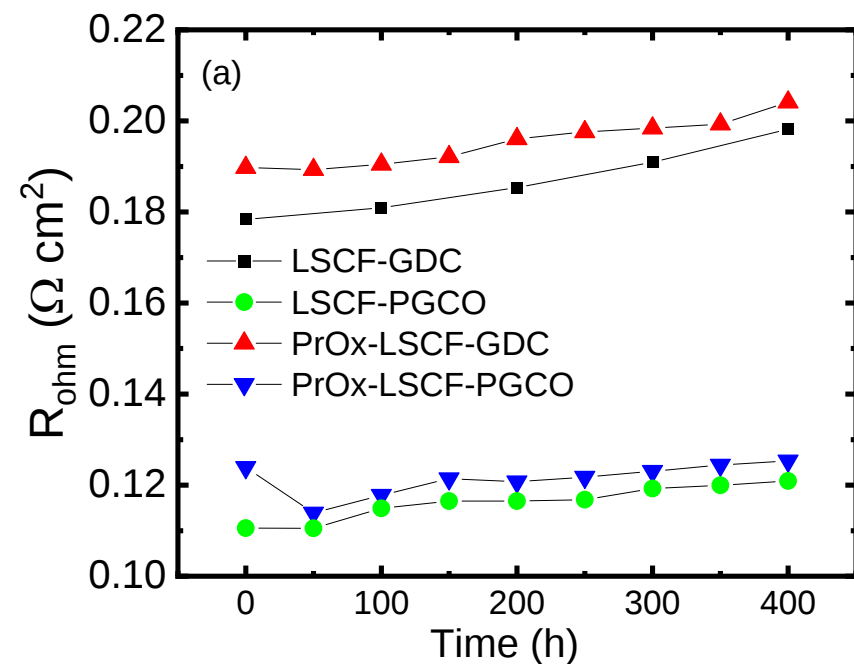
Impedance Analysis – LSCF Cathode



SEM Image and Cell Performance with Various Thickness of PGCO

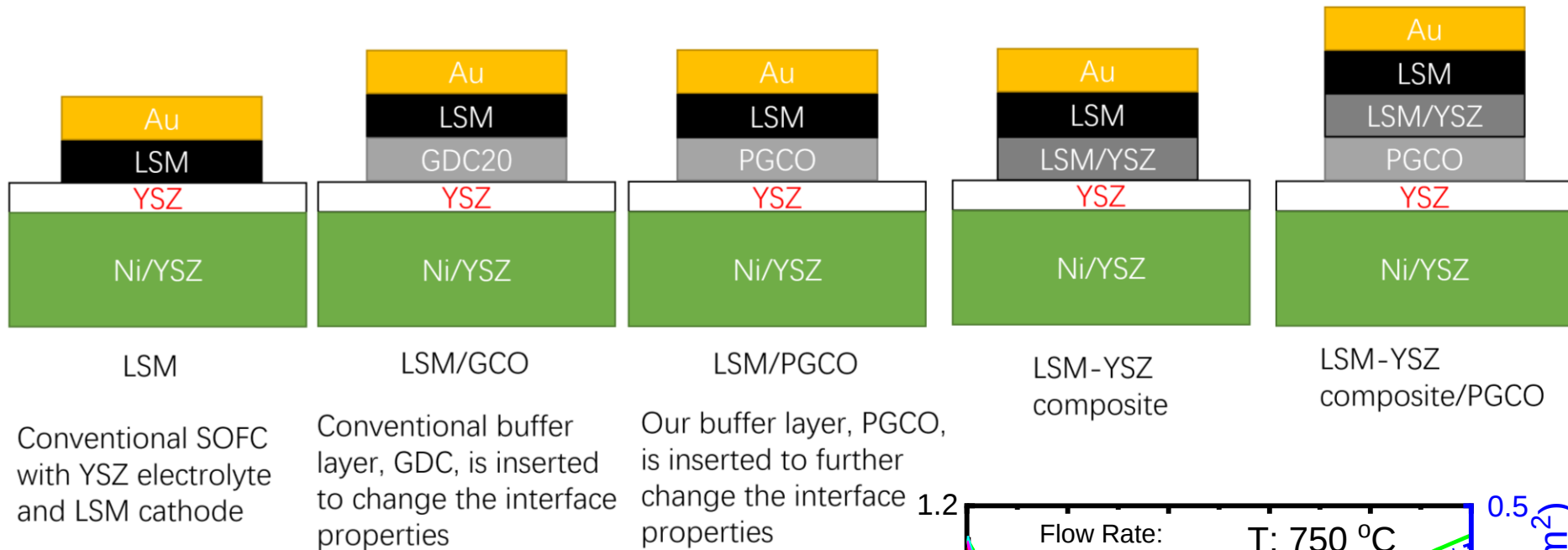


Performance Stability – LSCF Cathode

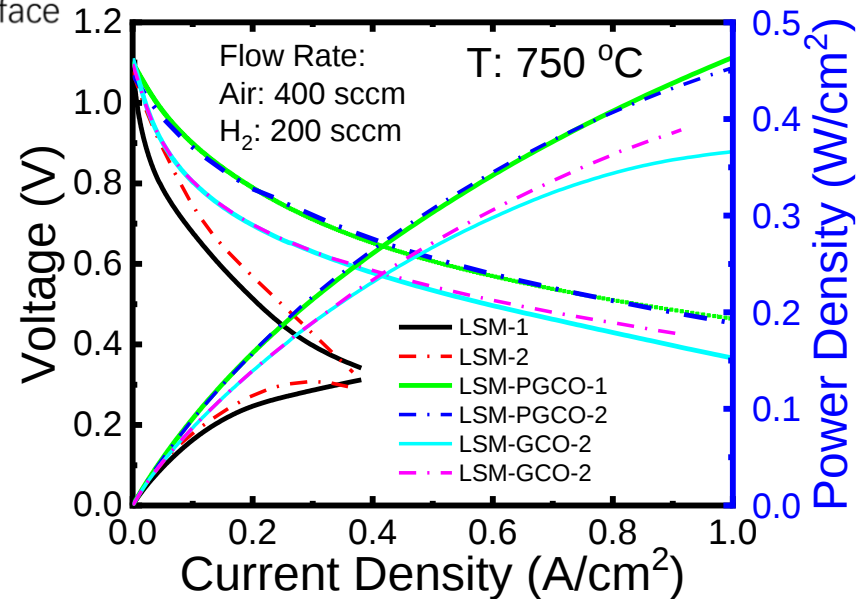


Elements	LSCF	PGCO	YSZ
Pr atom%	0	3.72	0
Gd atom%	0	4.64	0
Ce atom%	0	25.73	0
La atom%	12.29	0	0
Sr atom%	8.65	0.74	0
Co atom%	6.13	0	0
Fe atom%	22.07	0	0
Y atom%	0	0	5.31
Zr atom%	0	0.72	29.33

Cell Architecture – LSM Cathode



- Doped ceria buffer layer is needed for the SOFC with LSM cathode. This work measure the performance difference with different LSM/electrolyte interface to further illustrate the relation between cell performance and cathode/electrolyte interface properties
- An LSM electrode shows low performance at 750 °C
- With PGCO interlayer, the power density is increased, comparing with the use of GDC electrode.



Project Budget and Period

	Type	Budget	Activities	Period
DOE	Cash	\$499,999	Development of stable and active cathodes	08/02/18 – 03/30/22
UL Cost Share	Cash at UL	\$121,583	1. Graduate Student Fellow 2. Equipment	08/02/18 – 03/30/22
	In-kind at UL	\$3,417	1. Indirect cost of cash cost share	08/02/18 – 03/30/22
Total	\$624,000; Cost share percentage: 20% (cash% = 19.5%)			

Investigators and Risk Analysis

Program Managers:

Jason Montgomery, NETL, 626 Cochrans Mill Road, Pittsburg, PA15236

Personnel at University of South Carolina

Xiao-Dong Zhou	Principal Investigator
Ram Submaraniam	Co-PI
Tom Pesacreta	HRTEM specialist at UL
Lily Ann Hume	FIB/SEM specialist
Yudong Wang	Graduate student
Alex Tucker	Undergraduate student
Chris Gros	Undergraduate student
Austin Schilling	Undergraduate student

Risks:

Risk #1: Correlation between modeling and experimental evaluations

Risk #2: The effect of porosity of the interlayer on cathode durability

Risk #3: Cathode materials in reducing conditions

Explore the Role of Interlayer Chemistry on the Cathode Performance and Performance Stability

PI: Xiao-Dong Zhou

Department of Chemical Engineering
University of Louisiana at Lafayette
Lafayette, LA 70503
Email: zhou@louisiana.edu

PM: Jason Montgomery

