



Effect of Sr Doping on the Oxygen Reduction Reaction Kinetics of La₂NiO_{4+δ} Cathode for Solid Oxide Fuel Cells



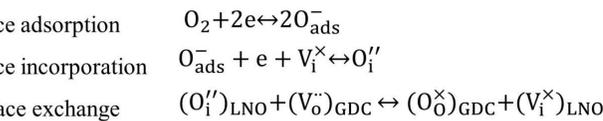
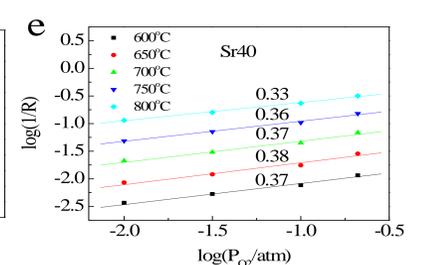
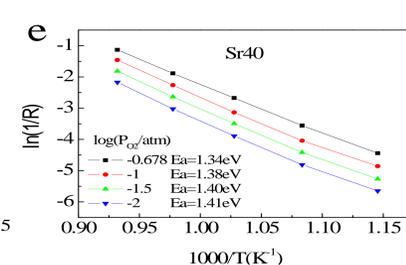
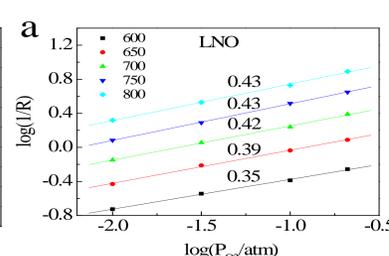
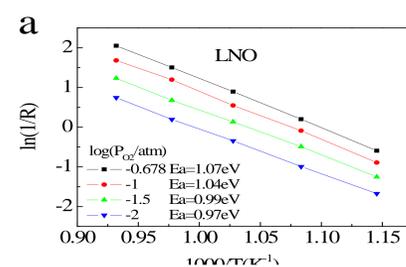
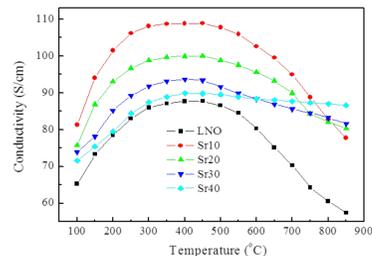
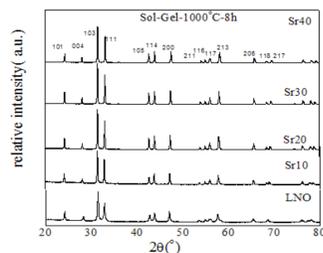
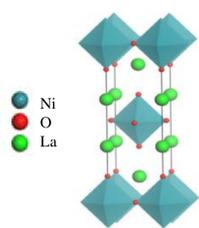
Bo Guan, Hui Zhang, Wenyuan Li, Xingbo Liu
Mechanical & Aerospace Engineering Department, West Virginia University

Overview

- Ruddlesden-Popper (RP) phase lanthanum nickelate (LNO) as cathode displays high D and k values, however, the electrical conductivity is relatively low.
- Sr is doped in the present work to enhance the electrical conductivity of LNO.
- The influence of Sr doping in the cathode performance upon Sr doping is investigated and the possible rate limiting step is proposed.

RP phase and Conductivities

- Pure RP phase specimens are synthesized using sol-gel method
- Sr doping enhances the electrical conductivity, and La_{2-x}Sr_xNiO_{4+δ} with x=0.1 shows the maximum values.



- Surface incorporation should be the rate-limiting step
- The contribution from interface exchange weighs more in Sr40, resulting in a decreased reaction order.

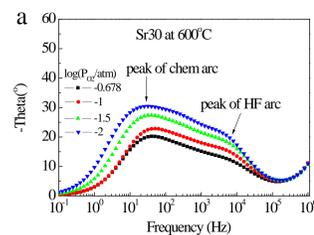
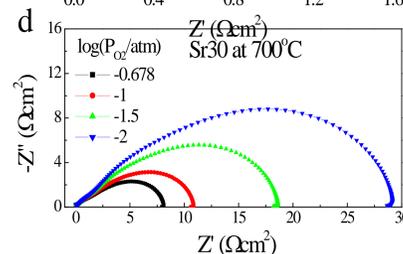
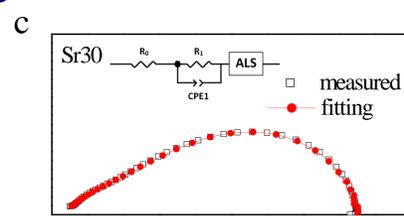
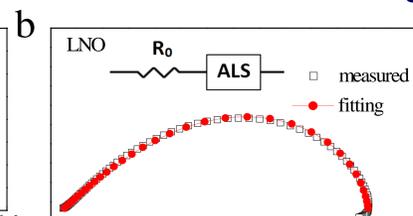
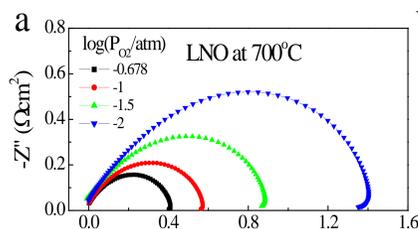
Overall performance and contributions from different parts

T=700° C	Total R _p (Ωcm ²)	O ²⁻ transfer nickelates/GDC			Chem process		
		R _{irr} (Ωcm ²)	C (mF/cm ²)	f (Hz)	R _{chem} (Ωcm ²)	C _{chem} (mF/c m ²)	α
LNO	0.41	-	-	-	0.41	14.1	0.96
Sr10	0.61	-	-	-	0.61	15.9	0.90
Sr20	1.74	-	-	-	1.74	2.1	0.80
Sr30	8.1	0.83	0.011	13000	7.3	0.20	0.90
Sr40	14.4	1.92	0.091	5400	12.5	0.15	0.88

- The best performance is obtained with the LNO cathode. The polarization resistance increases drastically with Sr doping.
- The ORR kinetics is not controlled by electrical conductivity.
- D, k mixed controlling performance.
- Small ionic conductivity after Sr doping, indicated by the occurrence of ion transfer.
- Decreased chemical capacitance after doping because of less interstitial oxygen.

Activation energy and reaction orders

EIS and ALS Model Fitting



- For LNO, half-tear shaped EIS, showing a straight line at high frequency, fitted to the ALS model.
- For Sr30, two peaks, one at ~10⁴ Hz & the other between 10~100 Hz. HF part is assigned to the ion transfer between electrolyte and the MIEC electrode.

Concluding Remarks

- The polarization performance of those cathodes was co-controlled by the oxygen surface exchange and bulk solid diffusion.
- The hyper-stoichiometric oxygen and the ionic conductivity are mainly responsible for the electrode catalytic property.

Acknowledgement

This work is sponsored by SECA Program under grant number DE-FE0009675. We appreciate the guidance and help from NETL-SECA team: Shailesh Vora (technology manager), and Briggs White & Joe Stoffa (project managers) etc.