Supplementary information

Tailoring tantalum doping into perovskite ferrite to obtain highly active and stable anode for solid oxide fuel cells

Jingwei Li[a*], Zhaoming Fu[b†], Bo Wei[a*], Chaoxiang Su[a], Xing Yue[a], Zhe Lü[a*]

[a]School of Physics, Harbin Institute of Technology, Harbin 150001, P.R. China.

[b]School of Physics, Henan Normal University, Xinxiang 453007, P.R. China.

[†]These authors contributed equally to this work: Jingwei Li, Zhaoming Fu.

Corresponding authors: 16b911015@stu.hit.edu.cn (Jingwei Li); bowei@hit.edu.cn (Bo Wei); lvzhe@hit.edu.cn (Zhe Lü)

Supplementary figures

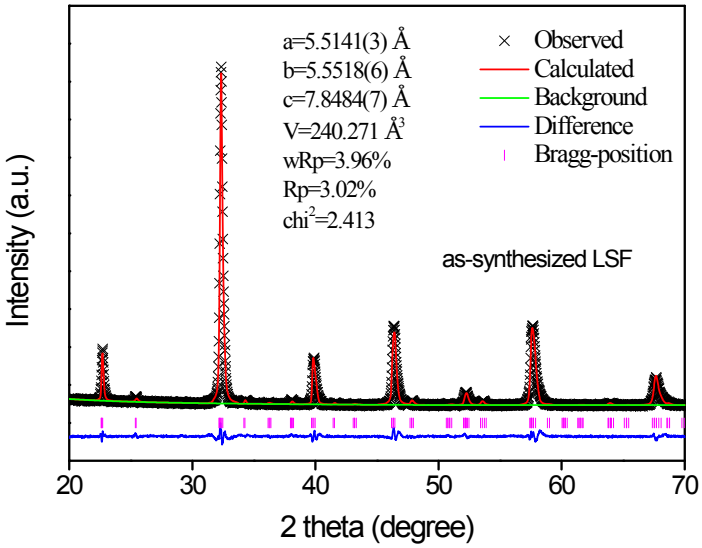


Fig. S1. XRD Rietveld refinement of as-synthesized $La_{0.8}Sr_{0.2}FeO_{3-\delta}$ (LSF) powder conducted by GSAS software.

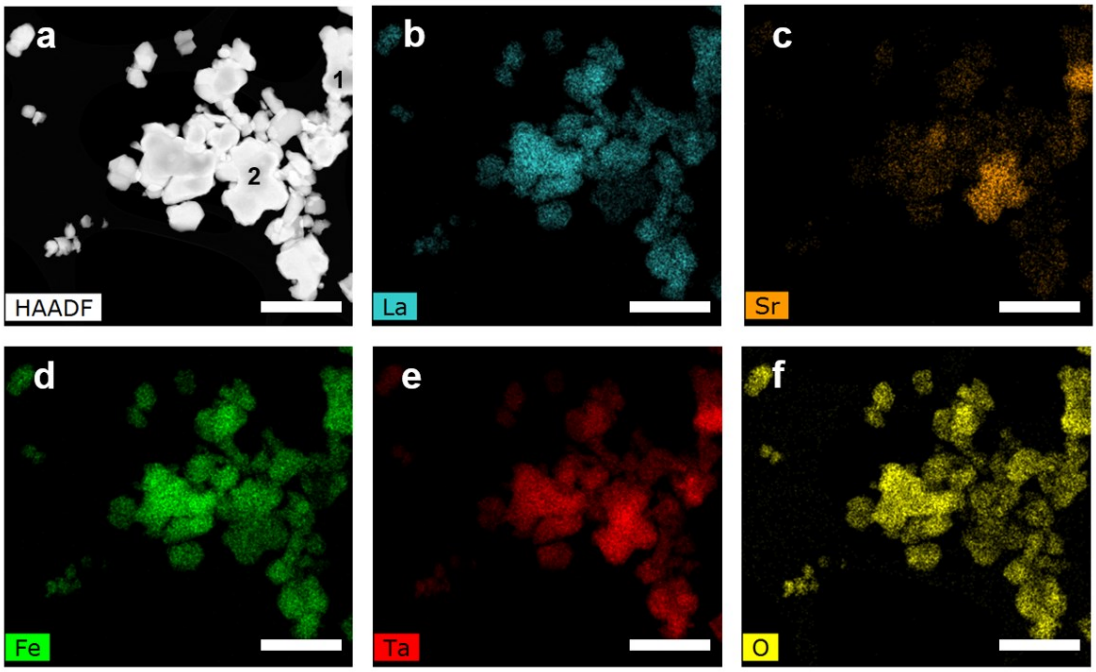
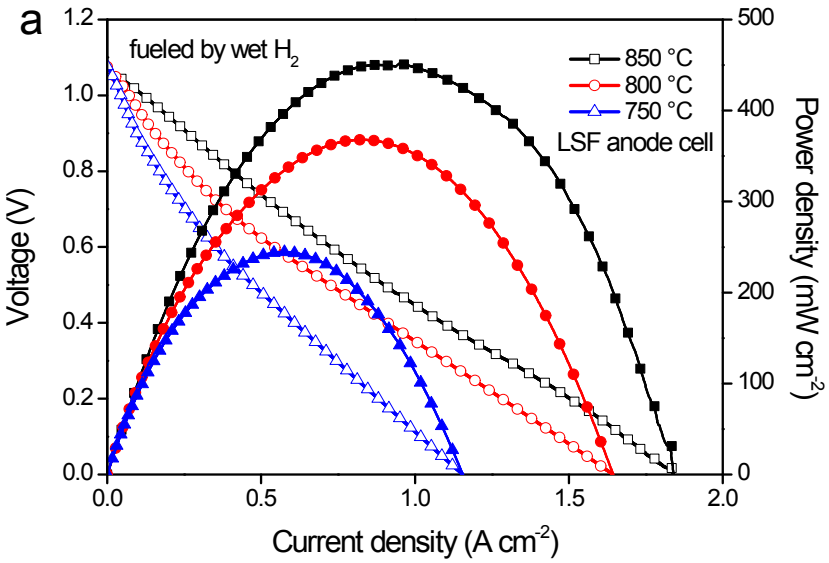
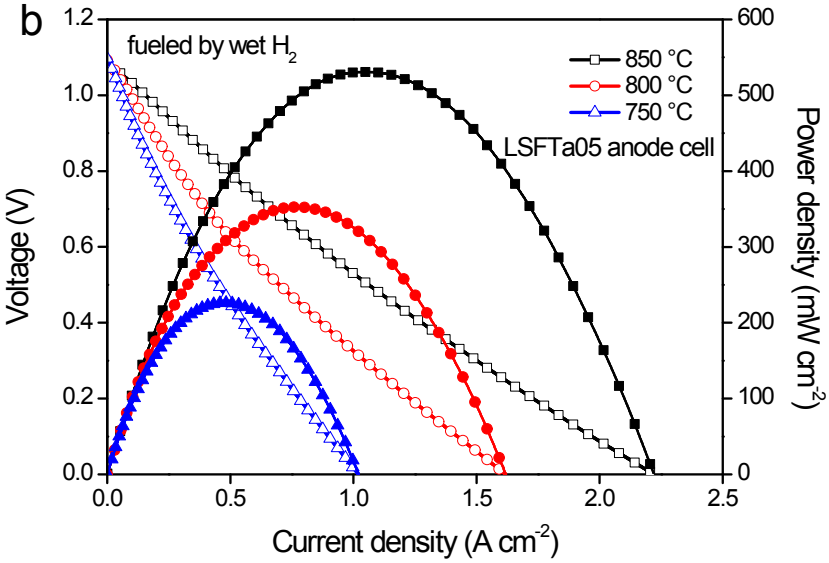


Fig. S2. EDS elemental mapping of as-prepared LSFTa05 particles. (a) HAADF image, (b) La, (c) Sr, (d) Fe, (e) Ta, (f) O. Scale bar is 100 nm.


a
fueled by wet H2
850 °C
800 °C
750 °C
LSF anode cell
Voltage (V)
Power density (mW cm-2)
Current density (A cm-2)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
100
200
300
400
500
0.0
0.5
1.0
1.5
2.0


b
fueled by wet H2
850 °C
800 °C
750 °C
LSFTa05 anode cell
Voltage (V)
Power density (mW cm-2)
Current density (A cm-2)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
100
200
300
400
500
600
0.0
0.5
1.0
1.5
2.0
2.5

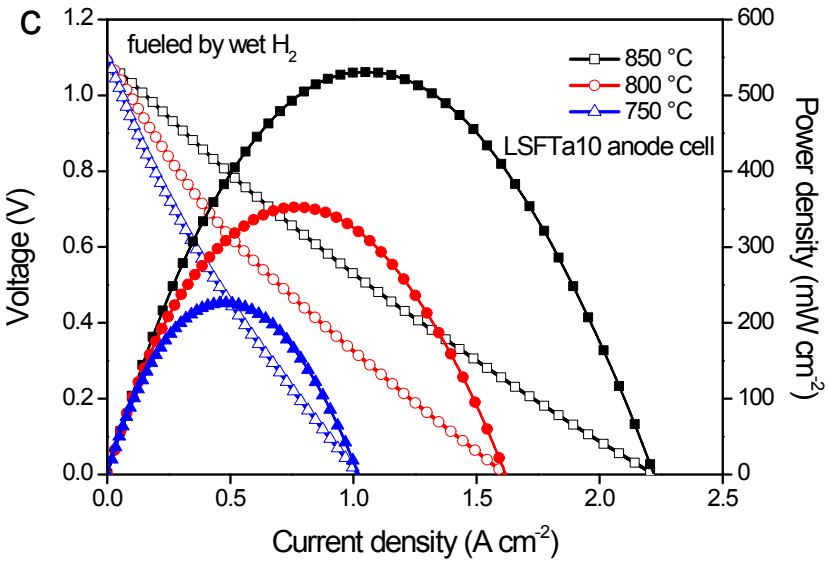


Fig. S3. *V-I* polarization curves and the corresponding power densities of (a) LSF anode cell, (b) LSFTa05 anode cell and (c) LSFTa10 anode cell fuel by wet hydrogen at the beginning of the test.

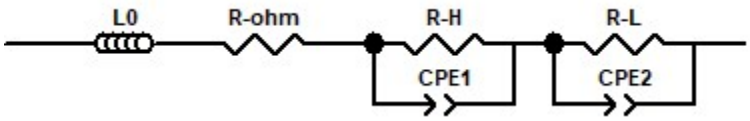


Fig. S4. An equivalent circuit model for electrochemical impedance spectra fitting.

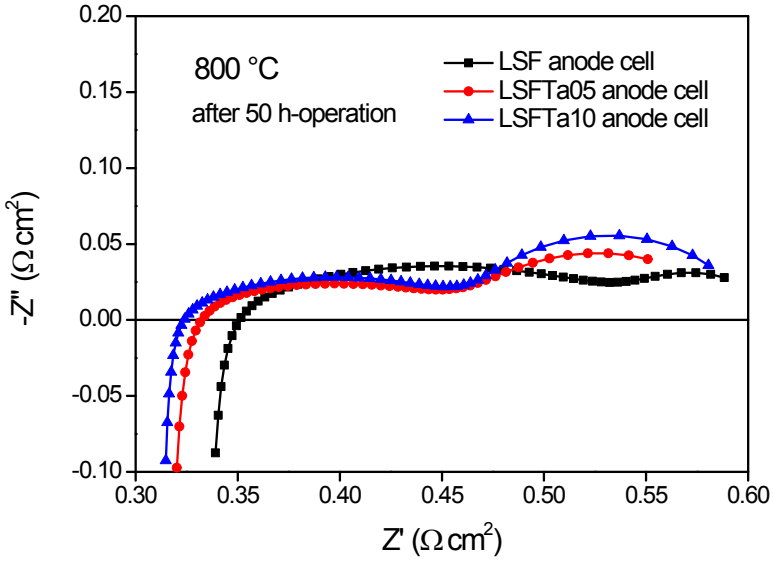


Fig. S5 AC impedance spectra of LSF, LSFTa05 and LSFTa10 anode cells after discharging in wet H_2 at 800 ^oC for 50 h.

Table S1. Temperature dependence of initial maximum power densities of the three anode cells fueled by wet hydrogen.

MPD (mW cm^{-2})	LSF anode cell	LSFTa05 anode cell	LSFTa10 anode cell
850 ^{o}C	450.2	530.9	488.4
800 ^{o}C	367.9	352.6	298.4
750 ^{o}C	244.5	226.4	220.7

Table S2. Electrochemical performance of single cells we fabricated and other cells with similar configurations using hydrogen as fuel.

Anode	Electrolyte	Thickness (μm)	Cathode	T (°C)	MPD (mW cm^{-2})	R_P (Ω cm^2)	Testing time
LSFT05	ScSZ	400	LSM-ScSZ	800	441.7	0.288	50 h
LSFTa10	ScSZ	400	LSM-ScSZ	800	381.7	0.295	50 h
LSFNb[1]	ScSZ	400	LSM-ScSZ	800	241.6	1.55	100 h
LST-1[2]	YSZ	400	LSM	900	31	/	/
LST-2[3]	YSZ	500	LSM	1000	175	/	/
LSTF[4]	YSZ	400	LSTF	800	215	0.36	~40 h
LSCM[5]	YSZ	200	LSCM	900	300	0.78	Initial
SFMO[6]	LSGM-1	265	SFMO	800	500	0.51	500 h
LCFNb[7]	ScSZ	58	LSM-YSZ	800	610	0.35	Initial
PBMO[8]	LSGM-1	300	NBSCF50-GDC	800	~430	/	100 h
SMMO[9]	LSGM-2	300	SCF	800	838	/	200 h

LSFNb: $La_{0.8}Sr_{0.2}Fe_{0.9}Nb_{0.1}O_{3-\delta}$ LST-1: $La_{0.3}Sr_{0.7}TiO_{3-\delta}$ LST-2: $La_{0.4}Sr_{0.6}TiO_{3-\delta}$

LSTF: $La_{0.3}Sr_{0.7}Ti_{0.3}Fe_{0.7}O_{3-\delta}$ LSCM: $La_{0.75}Sr_{0.25}Cr_{0.5}Mn_{0.5}O_{3-\delta}$

SFMO: $Sr_2FeMoO_{6-\delta}$ LSGM-1: $La_{0.9}Sr_{0.1}Ga_{0.8}Sr_{0.2}O_{3-\delta}$ LCFNb: $La_{0.9}Ca_{0.1}Fe_{0.9}Nb_{0.1}O_{3-\delta}$

PBMO: $PrBaMn_2O_{5+\delta}$ SMMO: $Sr_2MgMoO_{6-\delta}$ LSGM-2: $La_{0.8}Sr_{0.2}Ga_{0.87}Sr_{0.13}O_{3-\delta}$

SCF: $SrCo_{0.8}Fe_{0.2}O_{3-\delta}$

References

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