Ruddlesden-Popper Oxide $SrEu_2Fe_2O_7$ as Promising Symmetrical Electrodes for Pure CO_2 Electrolysis

Daoming Huan[‡a], *Lu Zhang*[‡a], *Shaowei Zhang*[a], *Nai Shi*[a], *Xinyu Li*[a], *Kang Zhu*[a], *Changrong Xia**[a], *Ranran Peng**[a], *Yalin Lu*[a]

[a] CAS Key Laboratory of Materials for Energy Conversion, Department of Materials Science and Engineering, University of Science and Technology of China, Hefei, 230026 Anhui, China.

Corresponding Author

*Changrong Xia: xiacr@ustc.edu.cn

*Ranran Peng: pengrr@ustc.edu.cn

Thermal structural stability

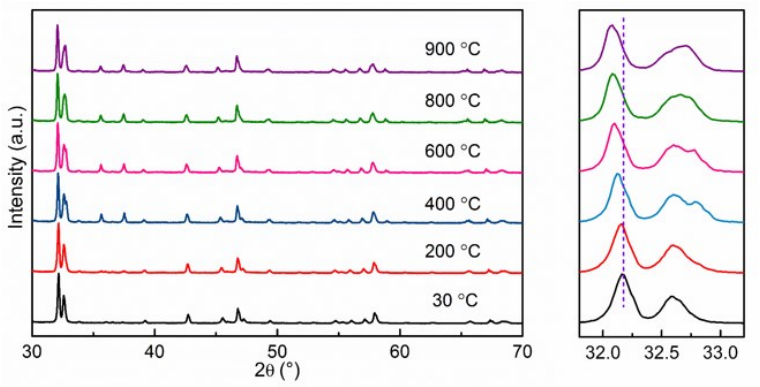

Figure S1. *In-situ* XRD patterns for SEF which are measured from 20 to 900 °C.

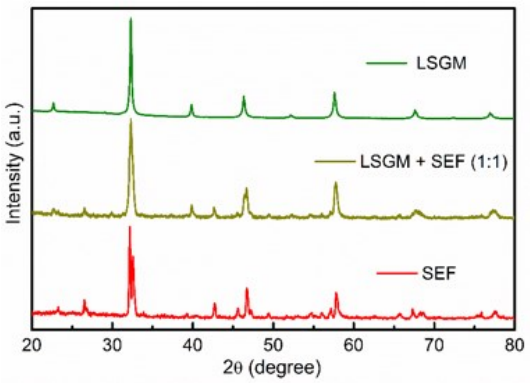

Figure S2. Chemical compatibility of LSGM-SEF (weight ratio 1:1) mixed powders calcined at 1000 °C for 2 h.

SEF rectangular bars

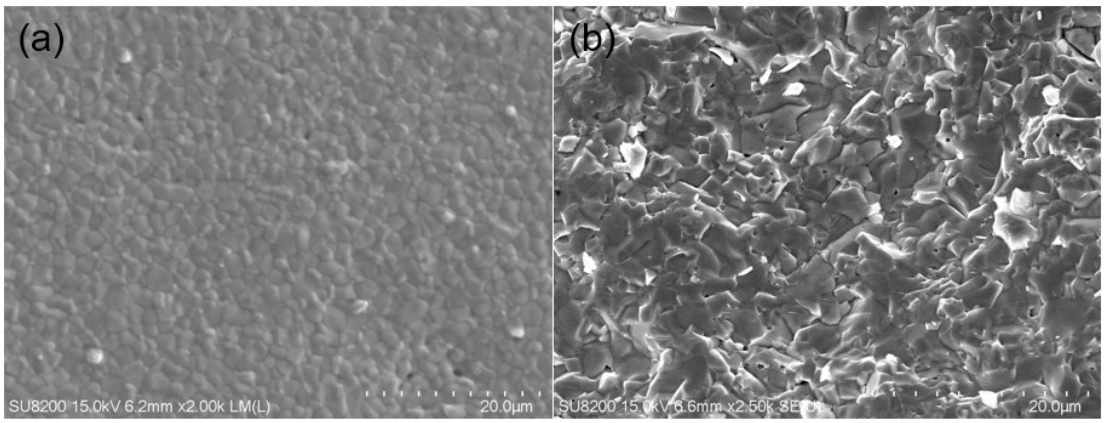

Figure S3. (a) surface and (b) cross section microstructures of SEF rectangular bars.

Oxygen nonstoichiometry

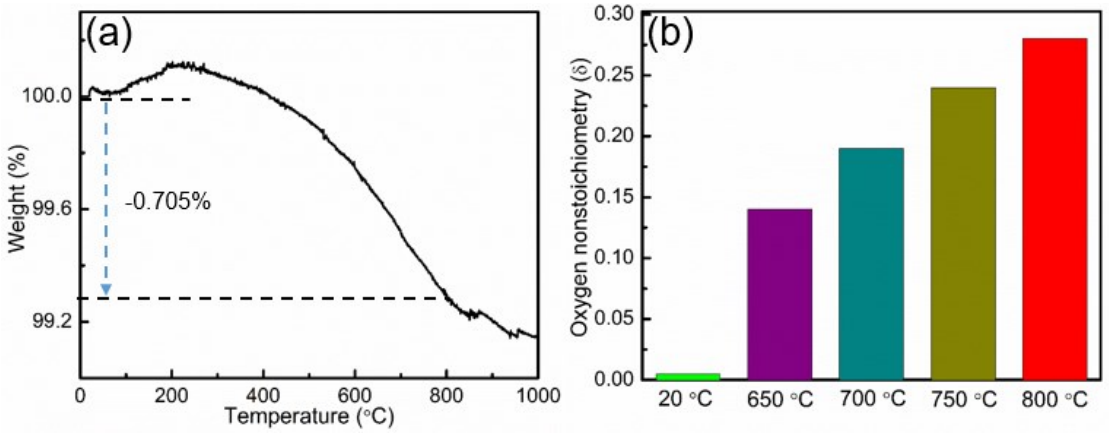

Figure S4. (a) TG analysis testing from 20 to 1000 °C and (b) compasison of oxygen nonstoichiometry (δ) at 20, 650, 700, 750 and 800 °C, respectively.

Section microstructures

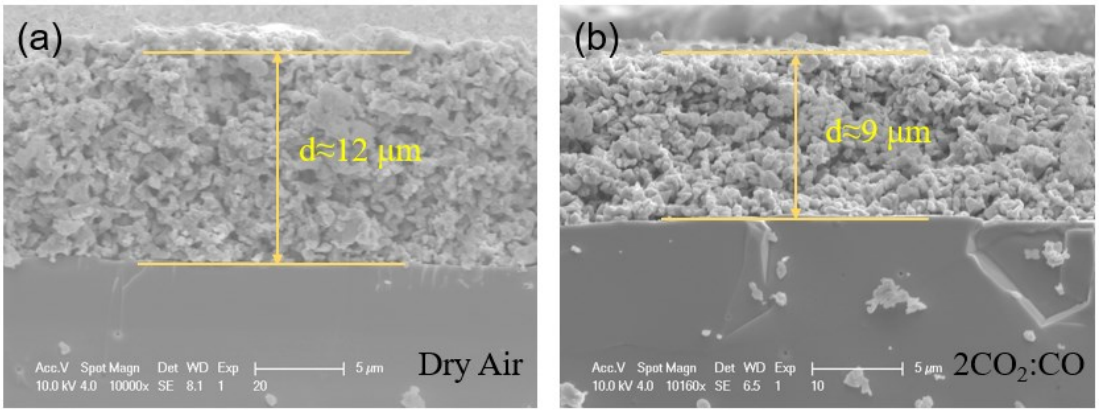

Figure S5. Section microstrcutures of SEF electrode after test in (a) dry air, and (b) CO_2-CO (2:1) atmospheres.

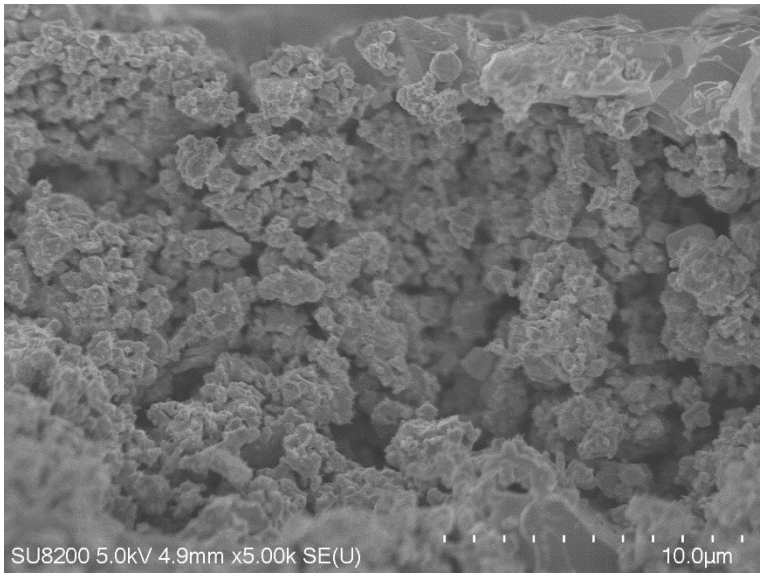

Figure S6. High resolution SEM microstructure of cathode electorde after 260 hours' long-term test.

SFM|LSGM|SFM symmetrical SOEC

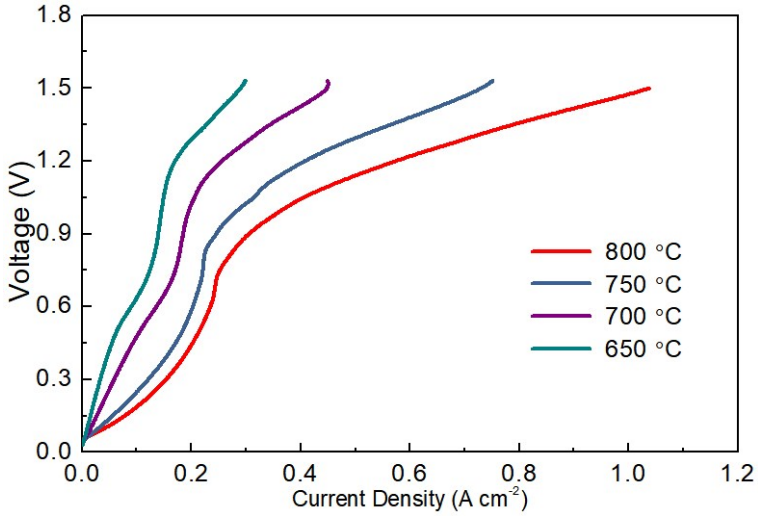

Figure S7. I-V curves of the symmetrical SOEC with configuration of SFM|LSGM|SFM applied to electrolyze pure CO_2.

Table S1. Room-temperature structural parameters of SEF powders.

Sample	a/b (Å)	c (Å)	α=β=γ	R_p (%)	R_{wp} (%)	χ^2
SEF	5.4965	19.8637	90°	2.75	3.48	2.20

Table S2. Summary of some typical symmetrical SOECs for pure CO_2 electrolysis measured at 800 °C.

Electrodes	R_p (Ωcm^2)	Current density (Acm^{-2})	V (V)	Ref.
$La_{0.3}Sr_{0.7}Fe_{0.7}Ti_{0.3}O_{3-\delta}$	0.35 @1.2V	0.28	1.5	1
$La_{0.3}Sr_{0.7}Fe_{0.7}Cr_{0.3}O_{3-\delta}$	1.33@OCV	0.32 ($9CO_2$:CO)	1.5	2
$La_{0.75}Sr_{0.25}Cr_{0.5}Mn_{0.5}O_{3-\delta}$-SDC	2.8@1.5V	0.09	1.5	3
$La_{0.6}Sr_{0.4}Fe_{0.8}Ni_{0.2}$ $O_{3-\delta}$-GDC	0.91@OCV	0.55	1.5	4
$La_{0.6}Sr_{0.4}Fe_{0.9}Mn_{0.1}O_{3-\delta}$-GDC	0.85@OCV	0.35	1.5	5
$La_{0.4}Sr_{0.6}Co_{0.2}Fe_{0.7}Nb_{0.1}O_3$-δ-GDC	0.68@OCV	0.44	1.5	6
$La_{0.6}Ca_{0.4}Fe_{0.8}Ni_{0.2}O_3$-δ-GDC	0.70@OCV	0.75	1.5	7
$La_{0.75}Sr_{0.25}Cr_{0.5}Mn_{0.5}O_{3-\delta}$-SDC-Fe	0.6@2.0V	0.25	1.5	8
$MnCo_2O_4$-GDC	1.43@OCV	0.75	1.5	9
$Sr_2Fe_{1.5}Mo_{0.5}O_{6-\delta}$	**0.85@OCV**	**1.04**	**1.5**	**This work**
$SrEu_2Fe_2O_7$	**0.27@OCV, 800**	**1.27**	**1.5**	**This work**

Reference

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