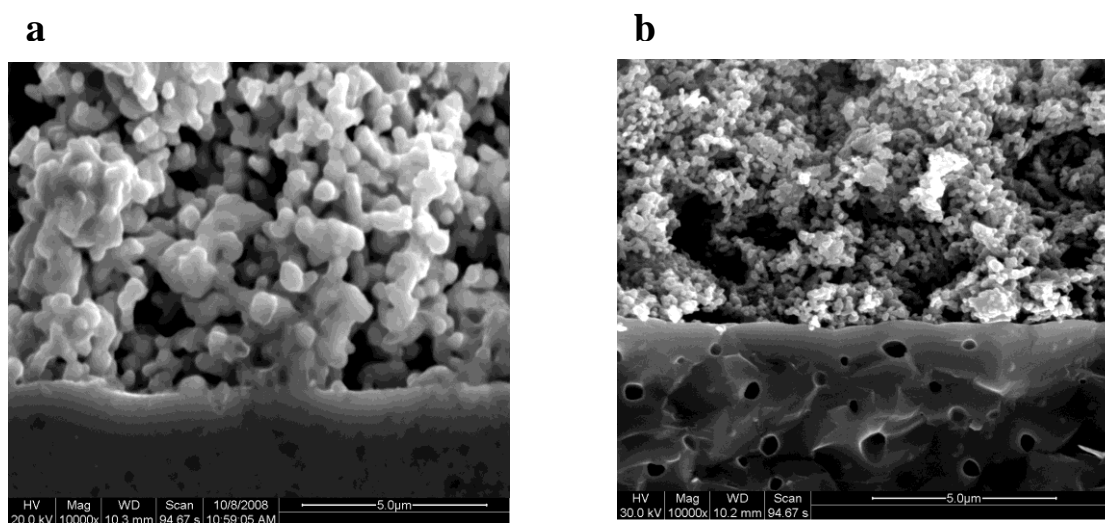


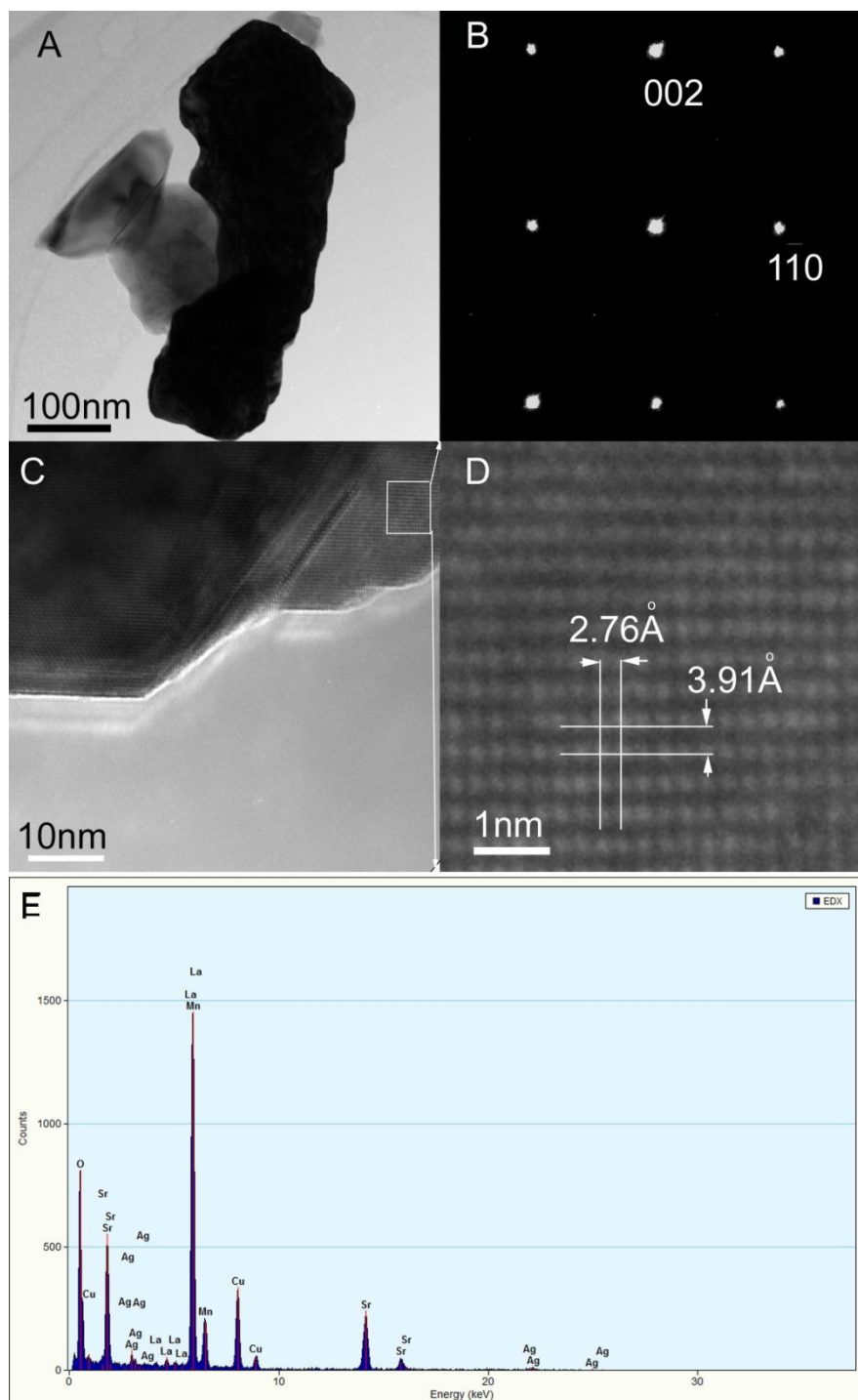
## Supplementary Information

### A new cathode for solid oxide fuel cells capable of in-situ electrochemical regeneration

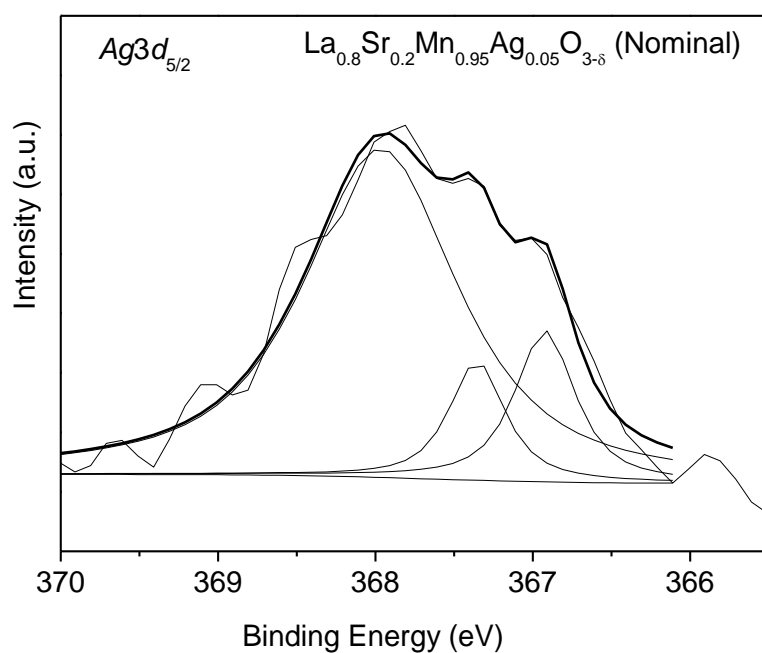
Wei Zhou<sup>a</sup>, Zongping Shao<sup>\*a</sup>, Fengli Liang<sup>b</sup>, Zhi-Gang Chen<sup>c</sup>, Zhonghua Zhu<sup>\*b</sup>, Wanqin Jin<sup>a</sup>, Nanping Xu<sup>a</sup>



**Supplementary Figure S1.** Scanning electron microscopy (SEM) images of the cross-section of the LSM electrode fired at (a) 1100 and (b) 1000 °C for 2 h in air. The electrode can not attach to the electrolyte well after firing at 1000 °C, which leads to peeling off the electrode from the electrolyte. The microscopic features of the prepared electrodes were characterized by an environmental scanning electron microscopy (ESEM, QUANTA-2000).

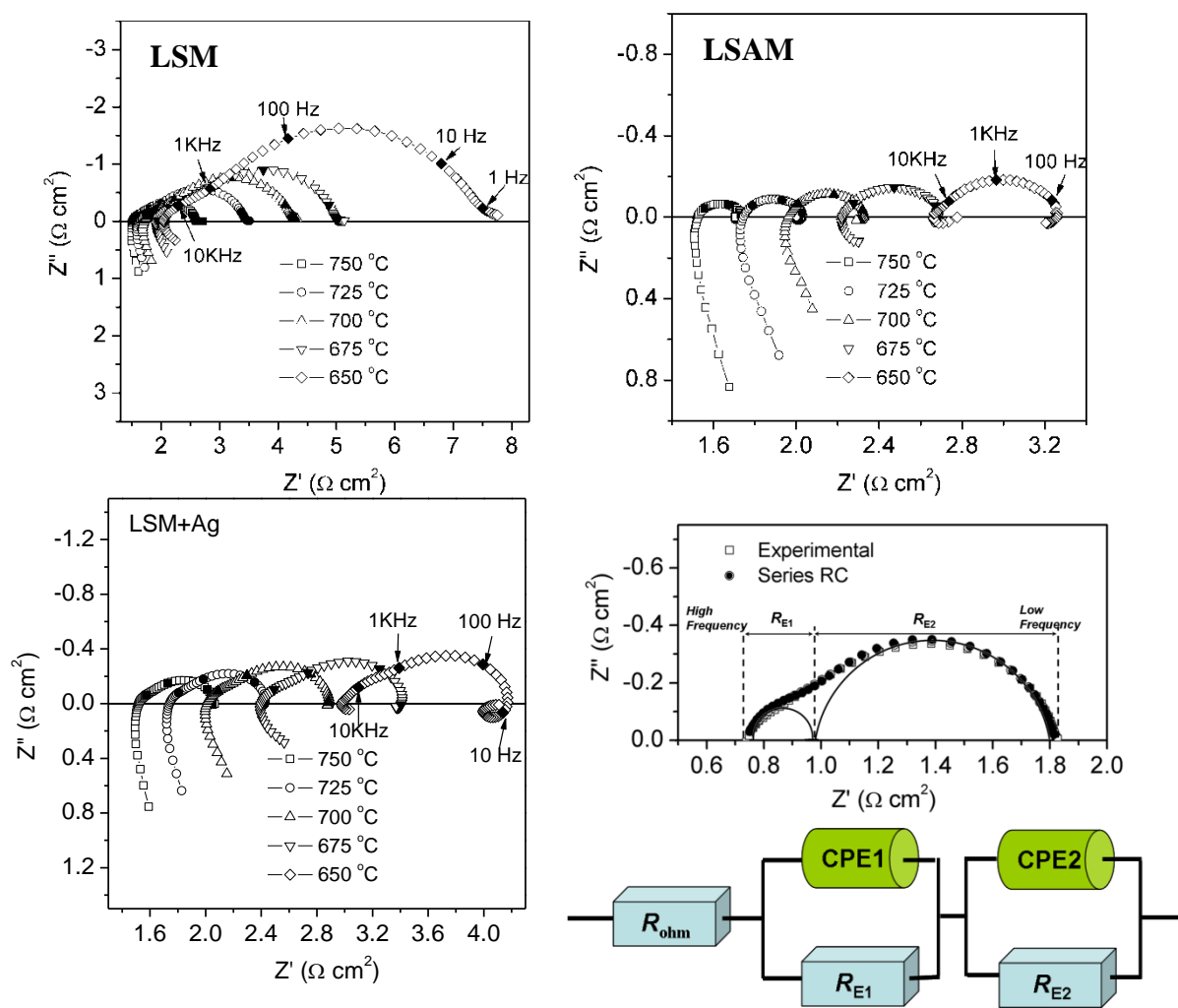


**Supplementary Figure S2.** TEM images of the fresh LSAM electrode. A) Typical TEM image of LSAM. B) The corresponding SAED image with the zone axis of [110]. C) The corresponding HRTEM image and D) high magnification HRTEM image showing atomic lattice structure with  $[200]_{d\text{-spacing}} = 2.76 \text{ \AA}$  and  $[110]_{d\text{-spacing}} = 3.91 \text{ \AA}$ . E) The EDS analysis of the particle.

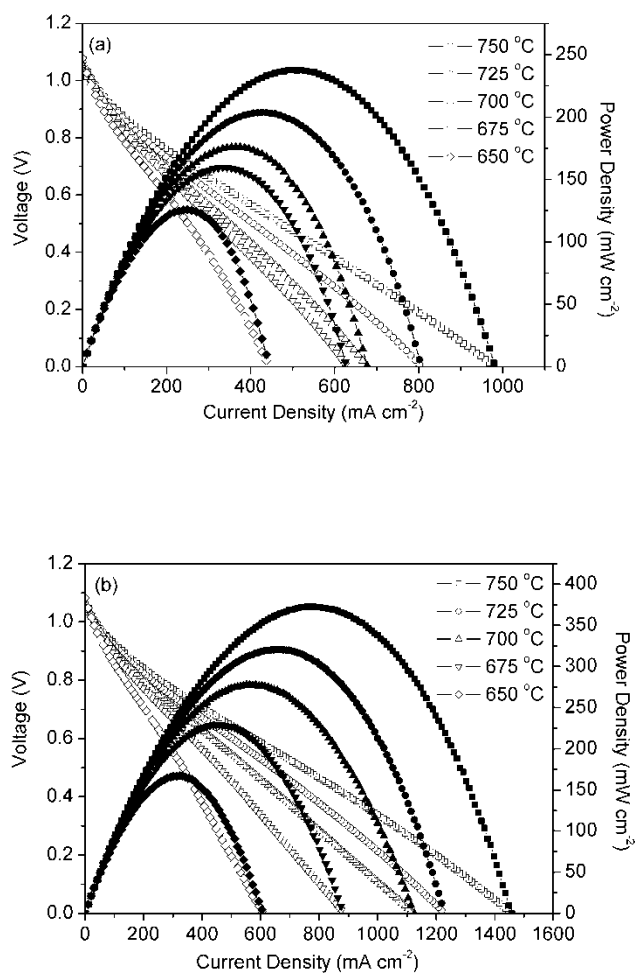


**Supplementary Figure S3.** XPS of Ag 3d<sub>5/2</sub> of synthesized nominal La<sub>0.8</sub>Sr<sub>0.2</sub>Mn<sub>0.95</sub>Ag<sub>0.05</sub>O<sub>3-δ</sub> powders calcined at 850 °C. Only a small amount of Ag goes into the B-site of perovskite lattice (366.9 eV), which is very similar with the value of the additional peak detected in anodic polarized LSAM. Most of Ag is metallic (368.0 eV), while the slight silver can also go into the A-site of the perovskite lattice (367.4 eV).

## Electrochemical Impedance Spectroscopy



**Supplementary Figure S4.** Impedance responses of LSM, LSM+Ag and LSAM cathode measure at various temperatures under open circuit voltage in air. Fitting of Series RC equivalent circuits to experimental data for LSM cathode at 750 °C.



**Supplementary Figure S5** *I-V* and *I-P* curves for fuel cell based on a 45  $\mu\text{m}$ -thick YSZ electrolyte utilizing (a) LSM and (b) Ag-impregnated LSM as cathode

**Table S1.** High-temperature oxygen nonstoichiometry ( $\delta$ ) and mean valence ( $n$ ) of Mn of the powders.

Temperature ( $^{\circ}\text{C}$ )	LSAM		$\text{La}_{0.8}\text{Sr}_{0.2}\text{MnO}_{3-\delta}$	
	$\delta$	$n$	$\delta$	$N$
800	0.0092	3.272	0.0371	3.266

The oxygen nonstoichiometry and mean valence of Mn of the LSAM and  $\text{La}_{0.8}\text{Sr}_{0.2}\text{MnO}_{3-\delta}$  powders were evaluated by iodometry as described in Ref [2]. The samples with the weight of 0.10 g were dissolved in HCl ( $6.0 \text{ mol l}^{-1}$ ) under an inert gas atmosphere in order to prevent the oxidation of I<sup>-</sup> ions by air, and then the solution was titrated by standard thiosulfate solution. Introduction of Ag in A-sublattice of LSM increases the average valences of Mn ions. The same trend was also observed in  $\text{La}_{0.7}\text{Sr}_{0.3-x}\text{Ag}_x\text{MnO}_{3-\delta}$  reported by W. Cheikh-Rouhou Koubaa et al. [3].

#### References

- [1] G. Schiller, K. Bolwin, W. Schnurnberger, *Thin Solid Film*, 174 (1989) 85
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- [3] W. Cheikh-Rouhou Koubaa, M. Koubaa, A. Cheikhrouhou, *J. Alloys Compd.* 453 (2008) 42.