## **Electronic Supplementary Information**

*In-Situ* Preparation of La<sub>1.2</sub>Sr<sub>0.8</sub>Mn<sub>0.4</sub>Fe<sub>0.6</sub>O<sub>4</sub> Ruddlesden-Popper Phase with Exsolved Fe Nanoparticles as Anode for SOFC

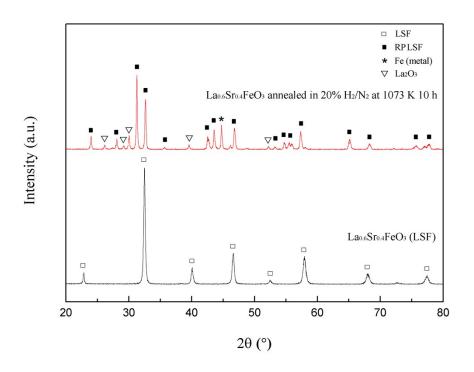
Yong Sik Chung, <sup>a</sup> Taewook Kim, <sup>a</sup> Tae Ho Shin, <sup>\*b</sup> Heechul Yoon, <sup>a</sup> Seongmin Park, <sup>a</sup> Nigel Mark Sammes, <sup>a</sup> Won Bae Kim, <sup>a</sup> Jong Shik Chung <sup>\*a</sup>

- <sup>a.</sup> Department of Chemical Engineering, Pohang University of Science and Technology (POSTECH), 77 Chungam-Ro Pohang 37673, Republic of Korea
- b. Korea Institute of Ceramic Engineering and Technology (KICET), 101 Soho-RO Jinju-si 52851, Republic of Korea

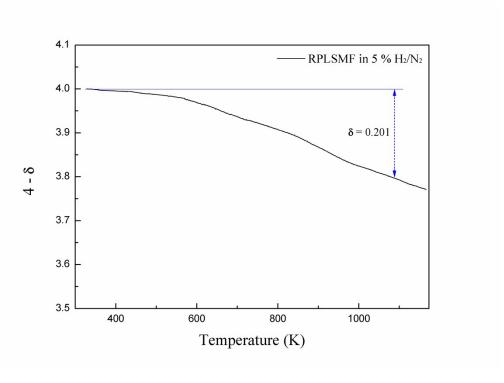
\*E-mail: jsc@postech.ac.kr (J. S. Chung) / ths@kicet.re.kr

## **Contents**

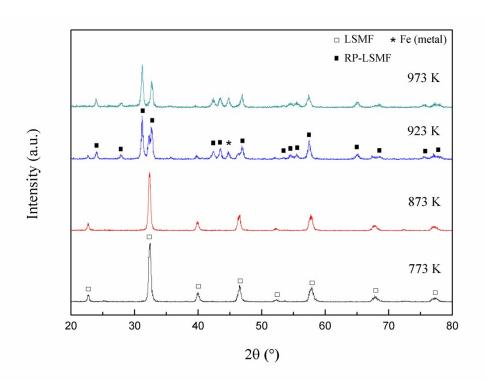
- Figure S1. XRD Pattern of the fresh  $La_{0.6}Sr_{0.4}FeO_3$  (LSF) and its phase stability in reducing condition of 20 %  $H_2/N_2$  at 1073 K for 10 h
- Figure S2. Oxygen nonstoichiometry of pre-reduced RPLSMF against temperature in 5 %  $\rm H_2/N_2$  atmosphere.
- Figure S3. XRD Patterns of the LSMF perovskite exposed to reducing condition of 20 %  $H_2/N_2$  at different temperatures (773 973 K)
- **Figure S4.** Power density change of a single cell with RPLSMF and RPLSMF/GDC composite anode containing Fe nanoparticles, in H<sub>2</sub> at 1073 K under constant voltage of 0.7 V
- **Figure S5.** XRD pattern of the fresh  $La_{0.6}Sr_{0.4}Mn_{0.6}Fe_{0.4}O_3$  (LSMF64) and its phase stability in reducing condition of 20 %  $H_2/N_2$  at 1073 K for 10 h



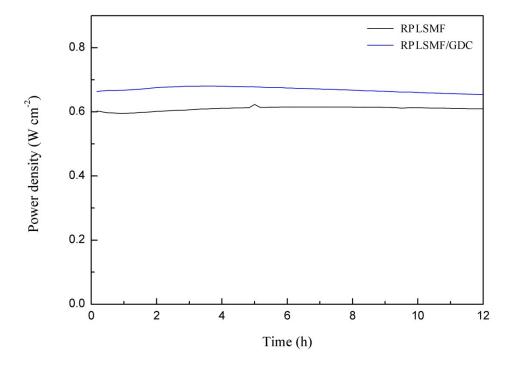
 $\label{eq:Figure S1.} XRD \ Pattern \ of the fresh \ La_{0.6}Sr_{0.4}FeO_3 \ (LSF) \ and its phase stability in reducing condition of 20 \% \ H_2/N_2 \ at 1073 \ K \ for 10 \ h$ 



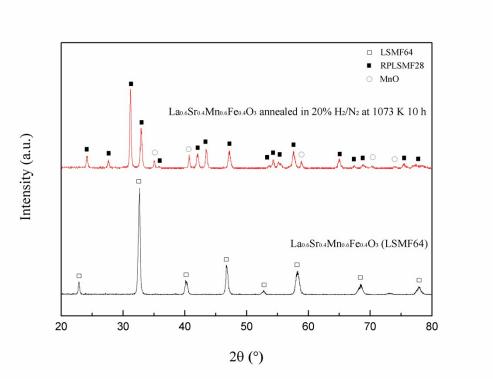
**Figure S2.** Oxygen nonstoichiometry of pre-reduced RPLSMF against temperature in  $5 \% H_2/N_2$  atmosphere.



**Figure S3.** XRD Patterns of the LSMF perovskite exposed to reducing condition of 20 %  $H_2/N_2$  at different temperatures (773 – 973 K)



**Figure S4.** Power density change of a single cell with RPLSMF and RPLSMF/GDC composite anode containing Fe nanoparticles, in H<sub>2</sub> at 1073 K under constant voltage of 0.7 V



 $\begin{tabular}{ll} \textbf{Figure S5.} & XRD \ pattern \ of the fresh $La_{0.6}Sr_{0.4}Mn_{0.6}Fe_{0.4}O_3$ (LSMF64) and its phase stability in reducing condition of 20 % $H_2/N_2$ at 1073 K for 10 h \\ \end{tabular}$