

# Electronic Supplementary Material

## Highly conductive and cost-effective quaternary $(\text{Yb}_2\text{O}_3)_x(\text{Sc}_2\text{O}_3)_{0.10-x}(\text{CeO}_2)_{0.01}(\text{ZrO}_2)_{0.89}$ ( $x = 0.04\text{--}0.10$ ) electrolytes for efficient and durable solid oxide fuel cells

Zhiyi Chen<sup>1,2\*</sup>, Fujun Liang<sup>1\*</sup>, Jiongyuan Huang<sup>1</sup>, Changgen Lin<sup>1</sup>, Jiaqi Qian<sup>1</sup>, Na Ai<sup>3</sup>,  
Chengzhi Guan<sup>4</sup>, Kongfa Chen (✉)<sup>1</sup>, Jiujun Zhang (✉)<sup>5</sup>

1 College of Materials Science and Engineering, Fuzhou University, Fuzhou 350108, China

2 College of Chemical Engineering, Fuzhou University, Fuzhou 350108, China

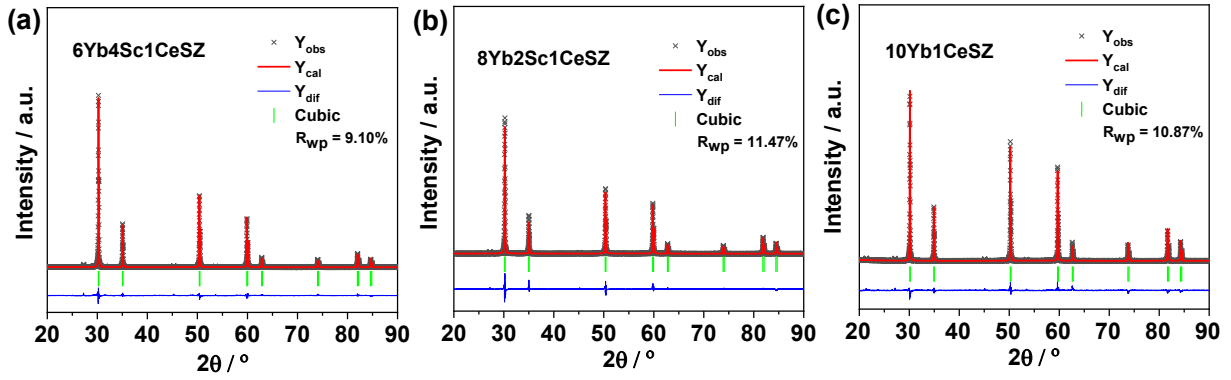
3 Fujian College Association Instrumental Analysis Center, Fuzhou University, Fuzhou 350108, China

4 Department of Hydrogen Technique, Shanghai Institute of Applied Physics, Chinese Academy of  
Sciences, Shanghai 201800, China

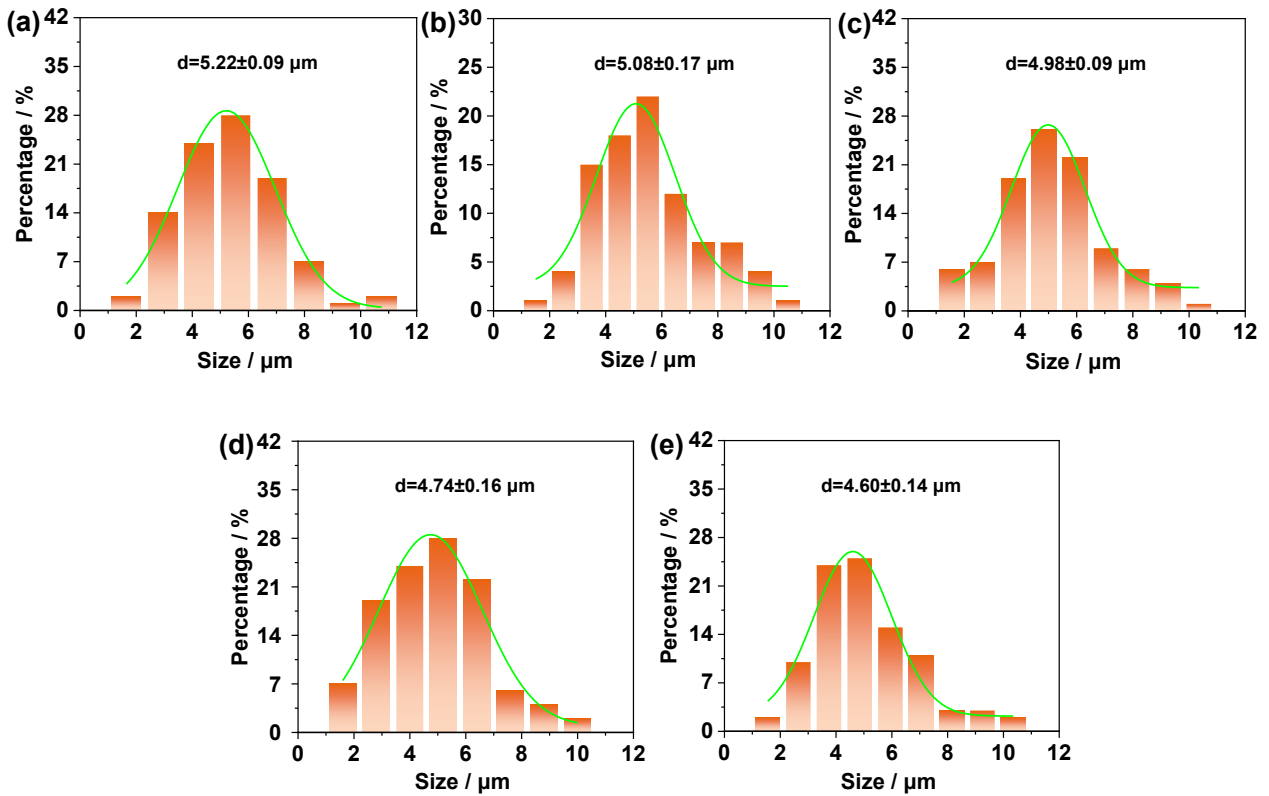
5 Fujian Engineering Research Center of High Energy Batteries and New Energy Equipment & Systems,  
College of Materials Science and Engineering, Fuzhou University, Fuzhou 350108, China

E-mail: kongfa.chen@fzu.edu.cn (Chen K); jiujun.zhang@i.shu.edu.cn (Zhang J)

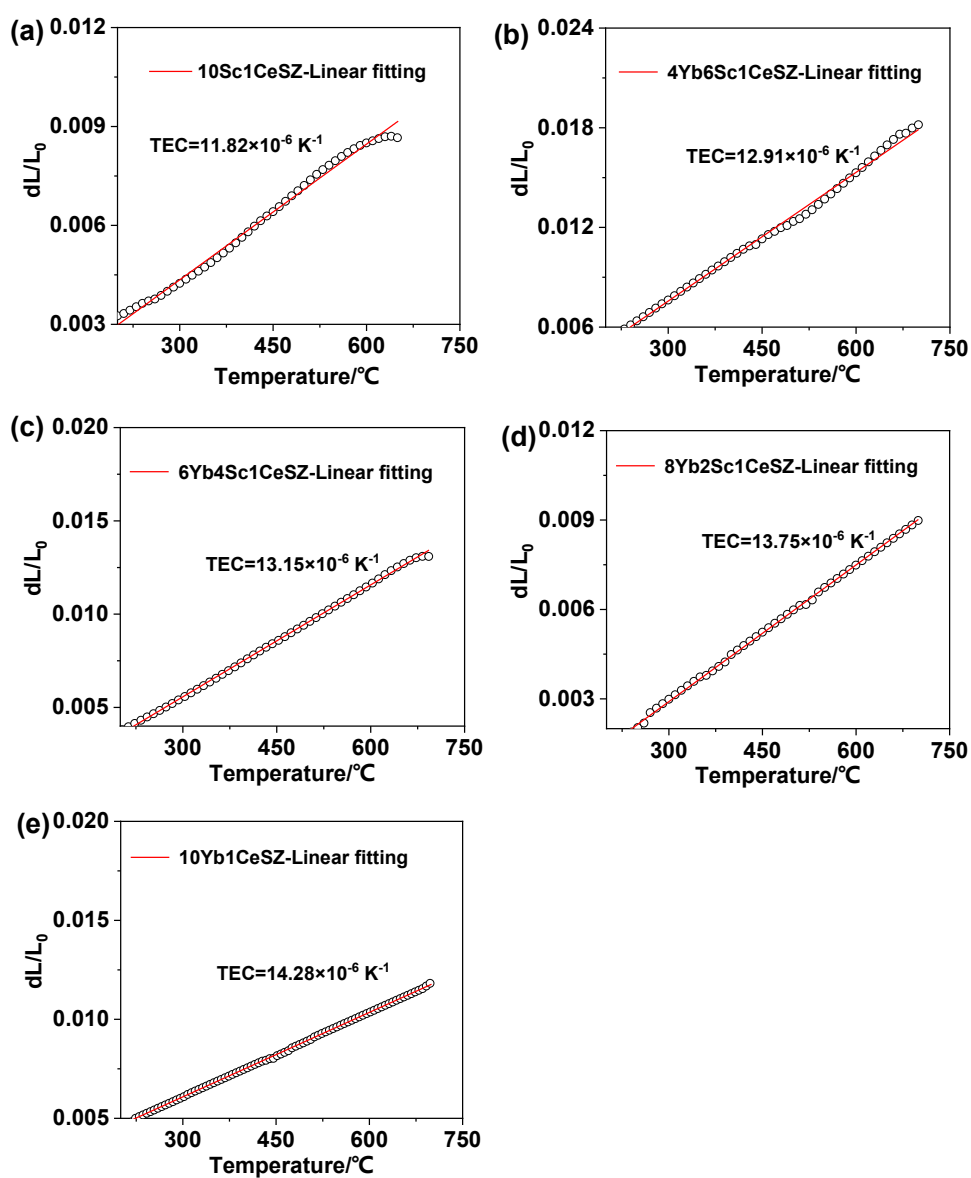
\* These authors contributed equally to this work.



**Fig. S1.** XRD refinement analysis of sintered electrolyte discs with different  $\text{Yb}_2\text{O}_3$  amounts: (a) 6 mol%, (b) 8 mol%, and (c) 10 mol%  $\text{Yb}_2\text{O}_3$ .



**Fig. S2.** Histograms of average grain size on the surface of electrolyte discs with different  $\text{Yb}_2\text{O}_3$  amounts: (a) 0 mol%, (b) 4 mol%, (c) 6 mol%, (d) 8 mol%, and (e) 10 mol%.



**Fig. S3.** TEC curves of electrolytes with different  $\text{Yb}_2\text{O}_3$  amounts: (a) 0 mol%, (b) 4 mol%, (c) 6 mol%, (d) 8 mol%, and (e) 10 mol%.