

Supporting Information

Highly Promoted Electrocatalytic Activity of Spinel CoFe_2O_4 by Combination with $\text{Er}_{0.4}\text{Bi}_{1.6}\text{O}_3$ as a Bifunctional Oxygen Electrode for Reversible Solid Oxide Cells

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Table. S1, Fig. S1-S8

Table S1. Elementary ORR processes and their corresponding reaction orders

Elementary reaction		Reaction order (<i>n</i>)	Ref.
Dissociative adsorption	$O_{2(g)} \leftrightarrow 2O_{ad}$	~1	[1, 2]
Charge transfer	$O_{ad} + e^- \leftrightarrow O_{ad}^-$	~3/8	[2, 3]
Surface diffusion	$O_{ad}^- \leftrightarrow O_{TPB}^-$	~1/4	[1, 3]
Charge transfer at TPBs	$O_{TPB}^- + e^- \leftrightarrow O_{TPB}^{2-}$	~1/8	[3]
Oxygen ion incorporation	$O_{TPB}^{2-} + V_O^{\bullet\bullet} \leftrightarrow O_O^X$	~0	[1, 3]

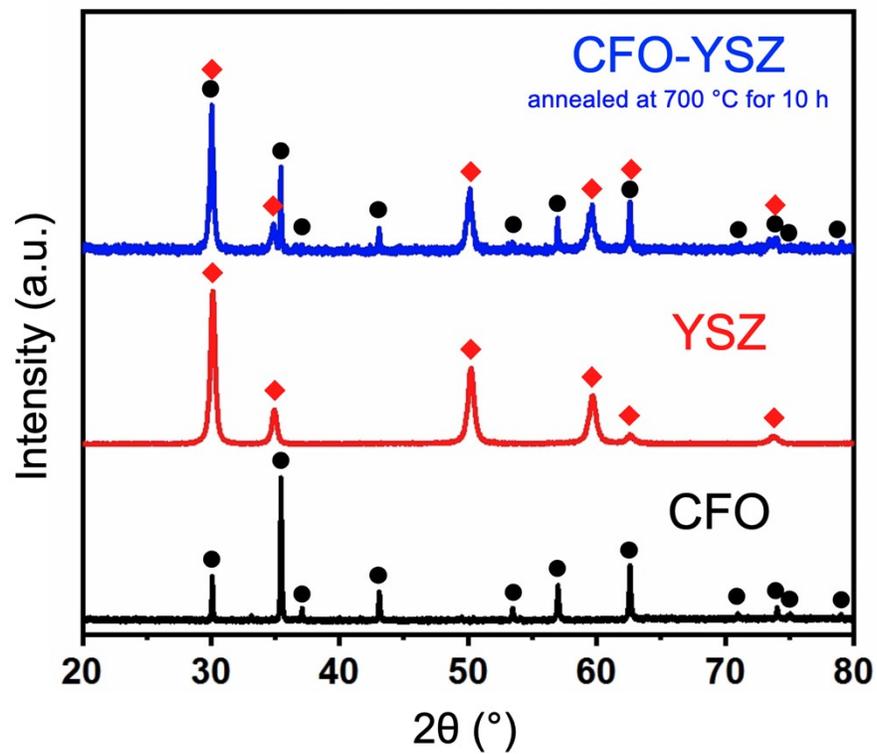


Figure. S1 XRD patterns of a mixture of the CFO and YSZ powders after heat-treatment a 700 °C for 10 h under ambient air.

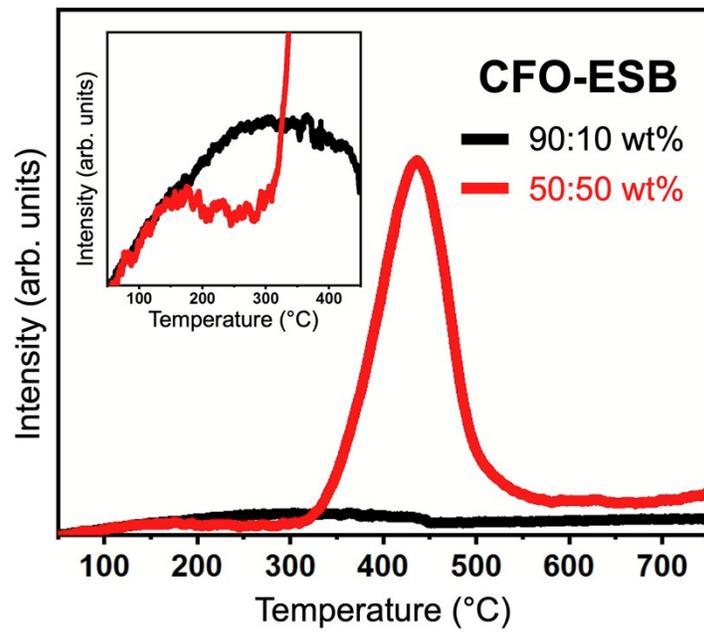


Figure. S2 Comparison of O₂-TPD profiles of CFO-ESB samples.

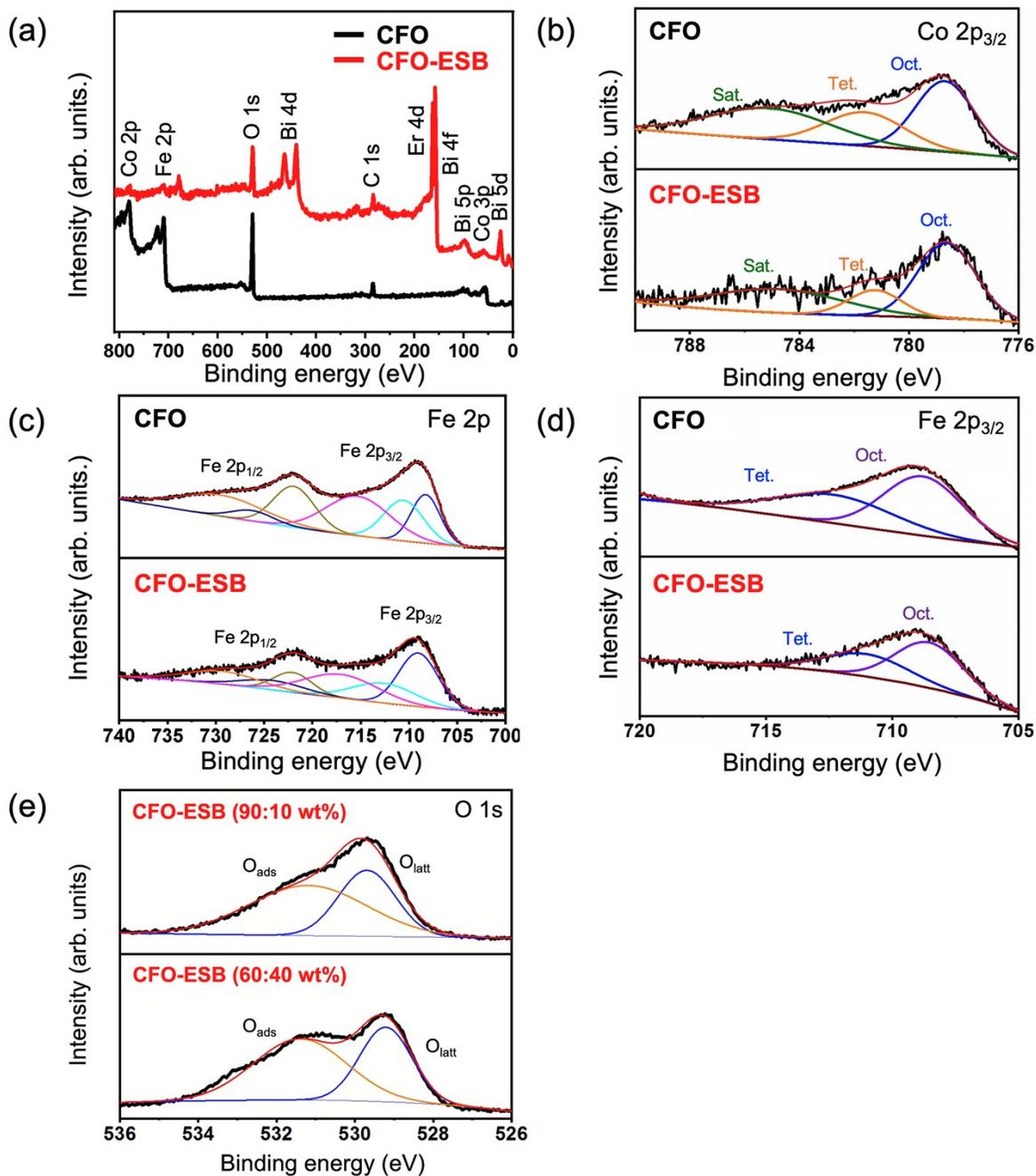


Figure. S3 (a) survey spectra, (b) Co 2p_{3/2}, (c) Fe 2p, and (d) Fe 2p_{3/2} core-level XPS spectra of CFO and CFO-ESB samples, respectively. (e) Comparison of O 1s core-level XPS spectra of CFO-ESB mixtures with different ratios.

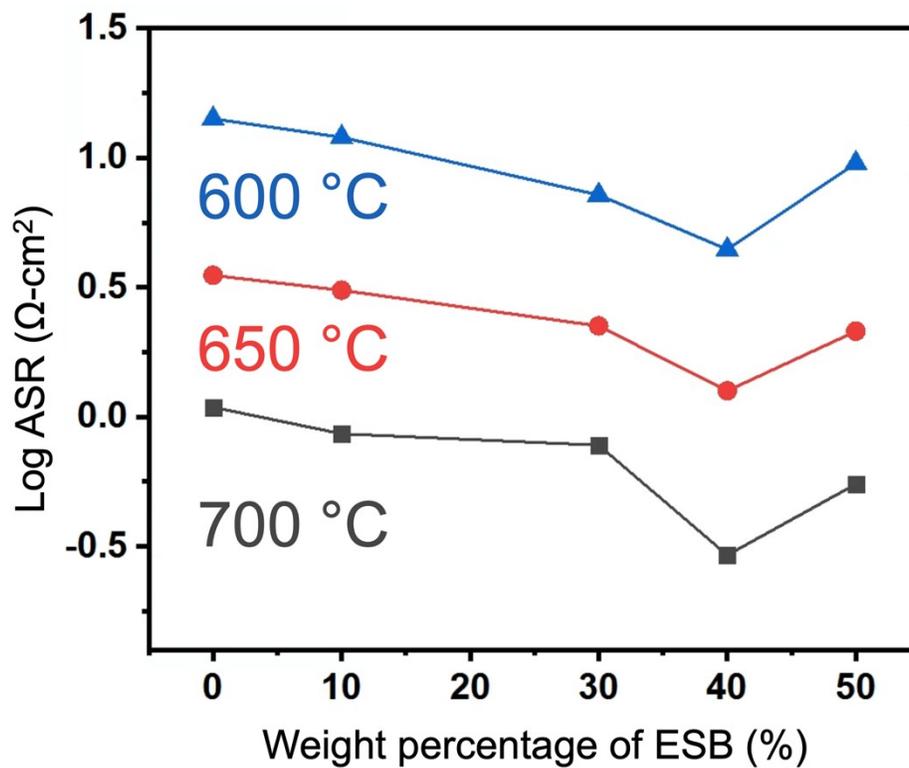


Figure. S4 Relationship between the ASR values with the weight percentage of ESB for the CFO-ESB electrode.

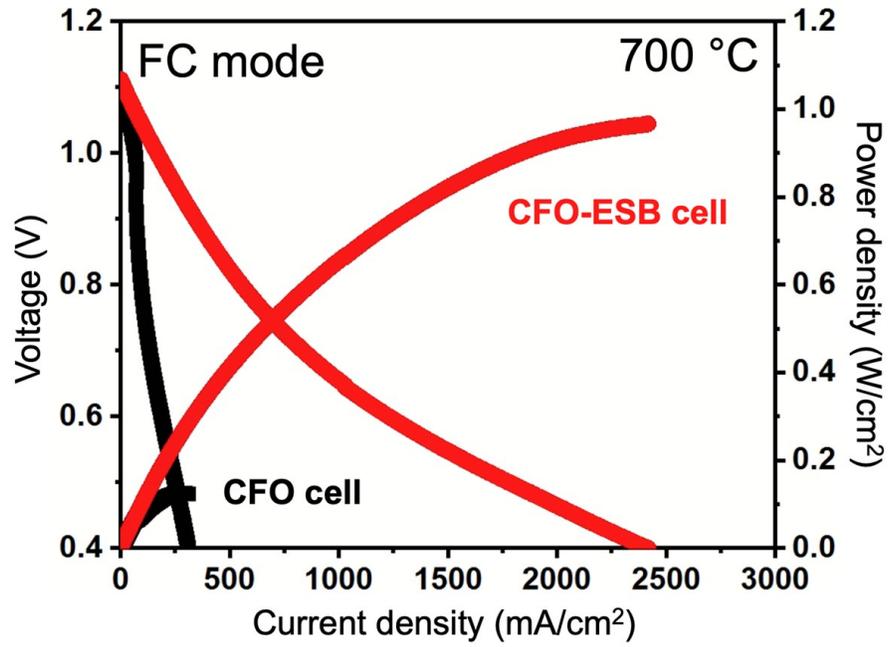


Figure. S5 Comparison of I - V - P curves of CFO and CFO-ESB cells measured at 700 °C under FC mode.

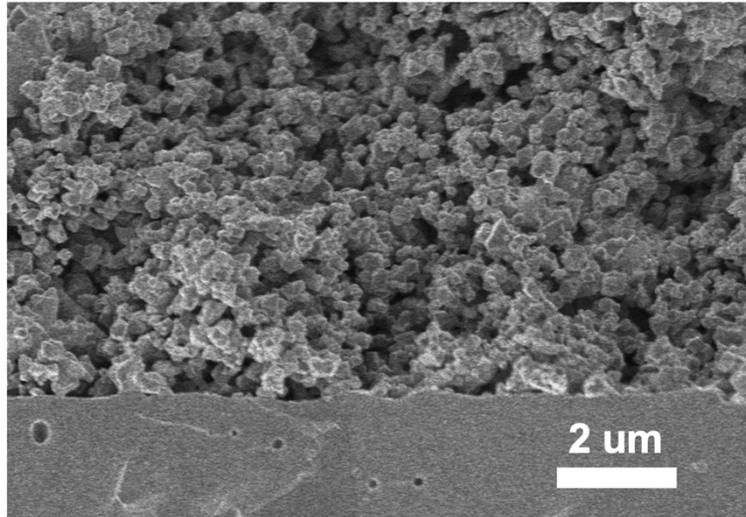


Figure. S6 A cross-sectional SEM image of the CFO-ESB cell after durability test

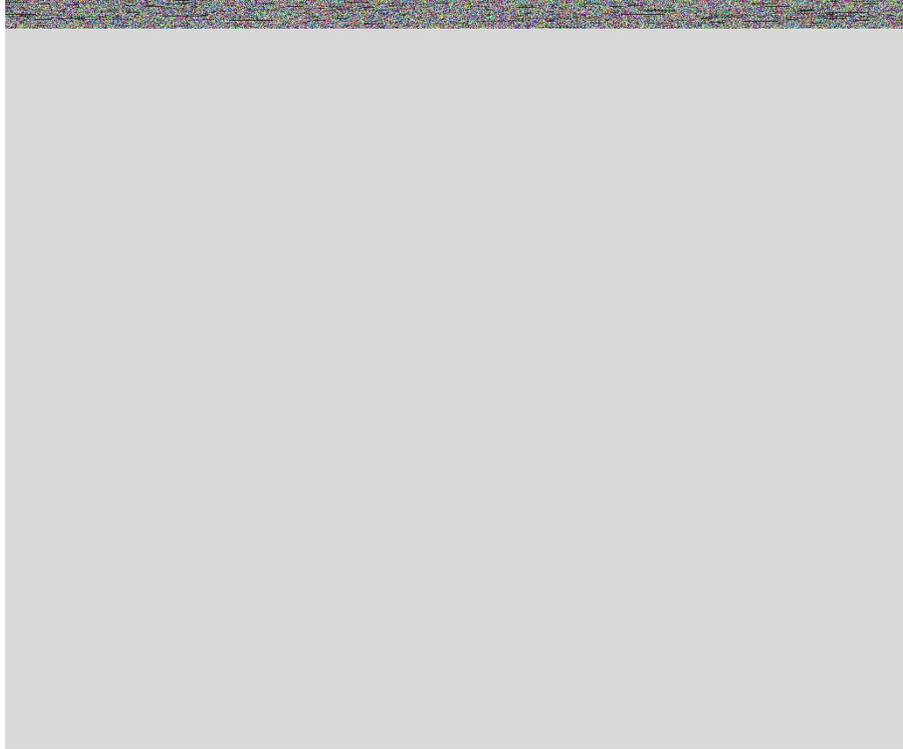


Figure. S7 Comparison of I - V curves of CFO and CFO-ESB cells measured at 700 °C under EC mode

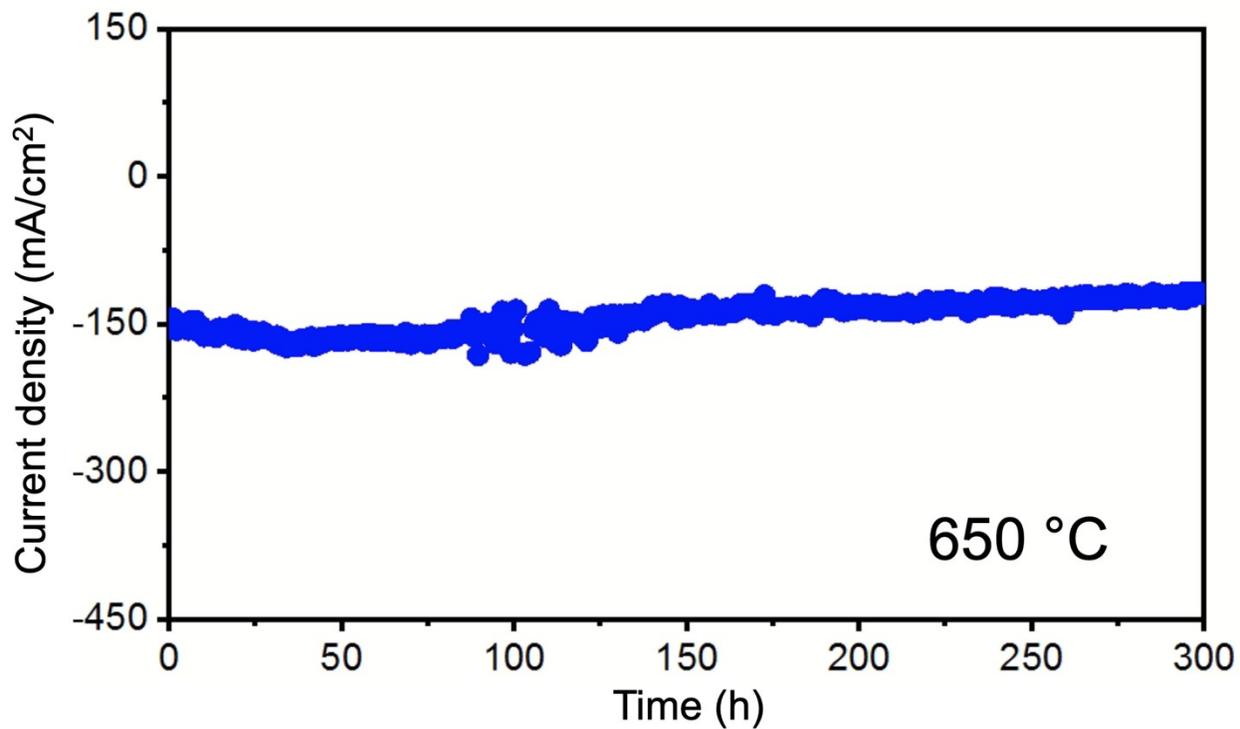


Figure. S8 Durability of CFO-ESB cell at a constant voltage of 1.3 V at 650 °C with 20% steam concentration under EC mode.

References

- [1] Kim D, Park JW, Chae MS, Jeong I, Park JH, Kim KJ, et al. An efficient and robust lanthanum strontium cobalt ferrite catalyst as a bifunctional oxygen electrode for reversible solid oxide cells. *Journal of Materials Chemistry A*. 2021;9(9):5507-21.
- [2] Thaheem I, Kim KJ, Lee JJ, Joh DW, Jeong I, Lee KT. High performance Mn_{1.3}Co_{1.3}Cu_{0.4}O₄ spinel based composite cathodes for intermediate temperature solid oxide fuel cells. *Journal of Materials Chemistry A*. 2019;7(34):19696-703.
- [3] Yun B-H, Kim KJ, Joh DW, Chae MS, Lee JJ, Kim D-w, et al. Highly active and durable double-doped bismuth oxide-based oxygen electrodes for reversible solid oxide cells at reduced temperatures. *Journal of Materials Chemistry A*. 2019;7(36):20558-66.