# Electronic Supplementary Information

# Constructing an Efficient Electrocatalyst for Water Oxidation: A Fe-Doped CoO/Co Catalyst Enabled by in-situ MOF Growth and Solvent-Free Strategy

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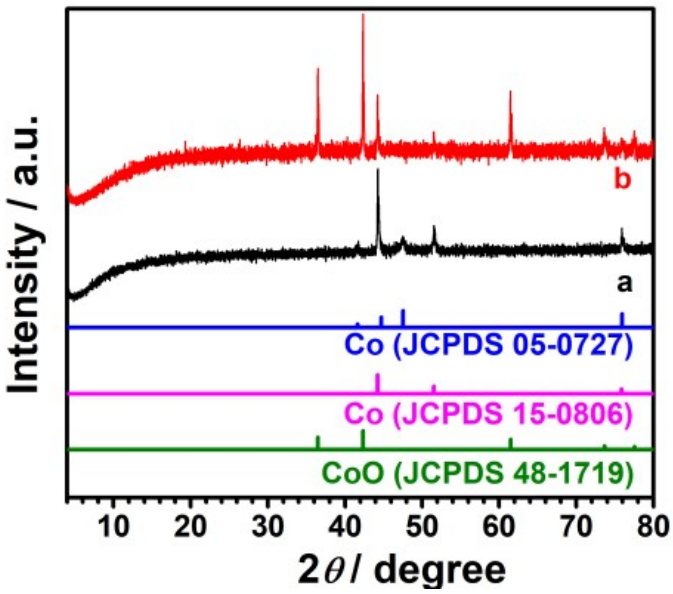


**Fig. S1.** XRD patterns of $Co(Ac)_2$ calcination (a) without and (b) with a little $Zn(Ac)_2$.

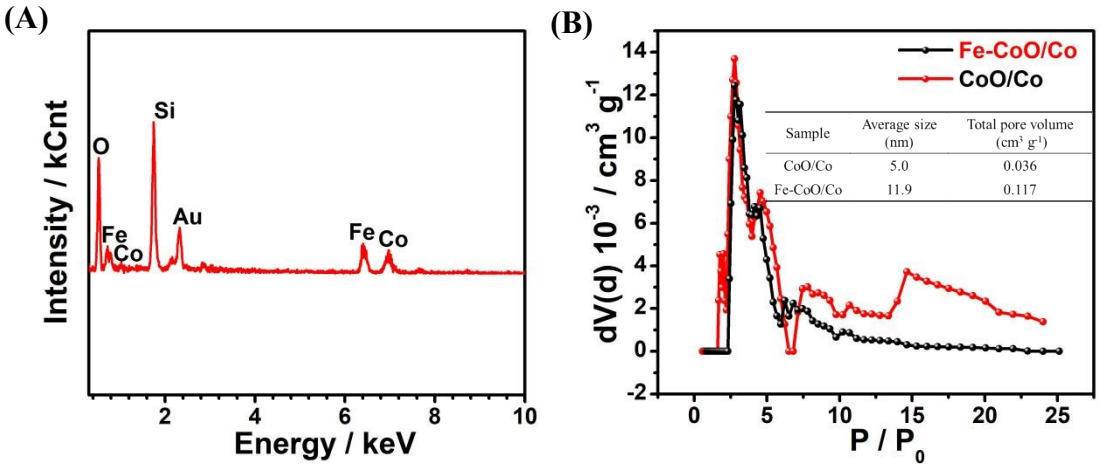


**Fig. S2.** (A) EDS of Fe-CoO/Co and (B) pore size distribution of CoO/Co and Fe-CoO/Co.

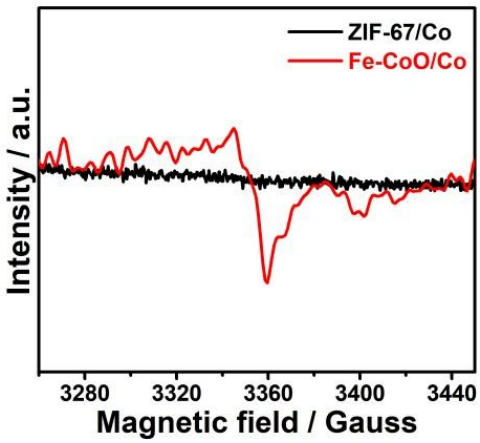


**Fig. S3.** EPR characterization of ZIF-67/Co and Fe-CoO/Co.

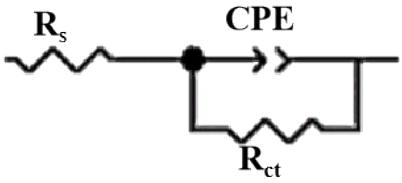


**Fig. S4.** The equivalent circuit model.

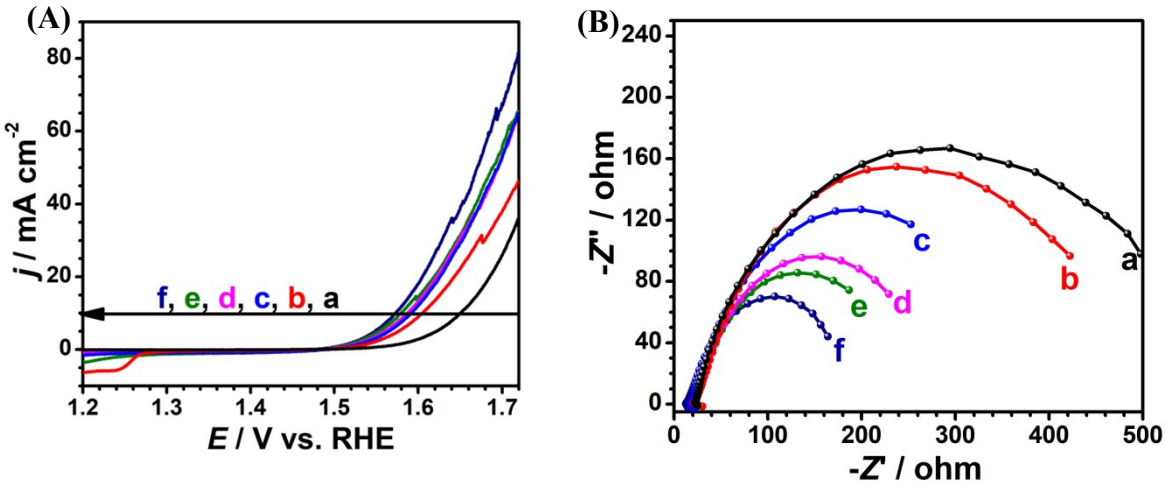


**Fig. S5.** (A) Liner scan curves and (B) EIS for Ni-CoO/Co with different atom ratios of Ni/Co (a: 0/1, b: 0.33, c: 0.5, d: 3.0, e: 2.0 and f: 1.0).

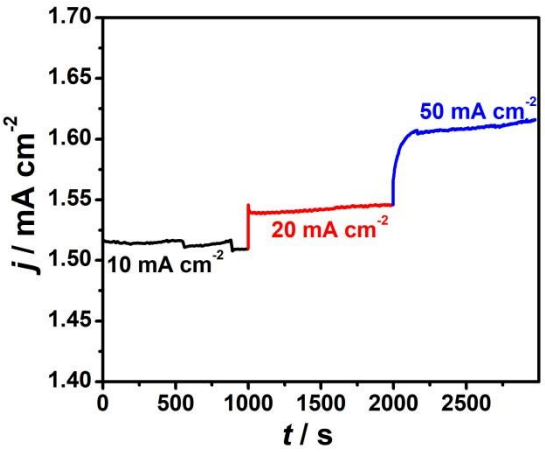


**Fig. S6.** Chronopotentiometric curves for Fe-CoO/Co at 10, 20 and 50 mA cm$^{-2}$.

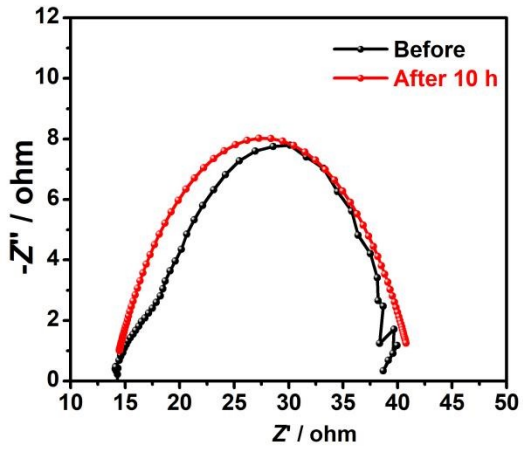


**Fig. S7.** EIS after 10 h stability test for the optimized Fe-CoO/Co.

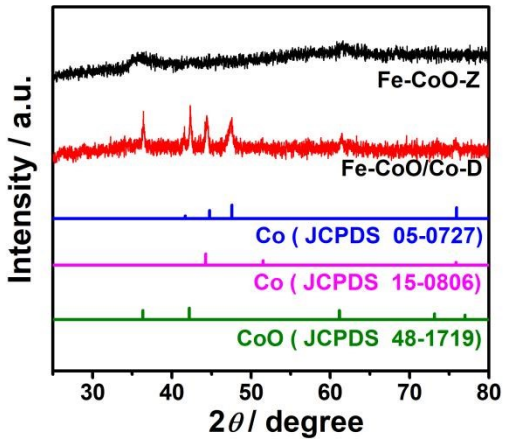


**Fig. S8.** XRD patterns of (A) Fe-CoO-Z and Fe-CoO/Co-D.

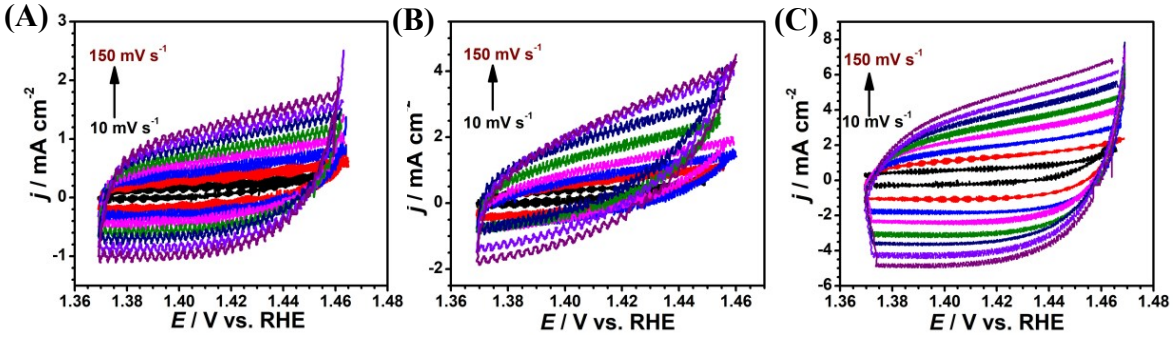


**Fig. S9.** CV curves of (A) Fe-CoO-Z, (B) Fe-CoO/Co-D and Fe-CoO/Co

**Table S1** The results of element analysis for CoO/Co and Fe-CoO/Co

| Sample | C (wt%) | N (wt%) |
|---|---|---|
| CoO/Co | 0.14 | / |
| Fe-CoO/Co | 0.18 | / |

**Table S2** The ICP-OES results for Fig. 4A

| Element | a | b | c | d | e | f |
|---|---|---|---|---|---|---|
| Co (at%) | 41.05 | 33.19 | 27.4 | 23.65 | 13.68 | 10.26 |
| Fe (at%) | 0 | 7.76 | 9.61 | 16.46 | 23.36 | 28.82 |

**Table S3** The fitted element values of equivalent circuit for Fig. 4B

| No. | Fe/Co (actual ratio) | $R_s$ / Ω | CPE | | $R_{ct}$ / Ω |
|---|---|---|---|---|---|
| | | | $Q$ /$10^{-4}$ S $s^n$ | $n$ | |
| a | 0/1 | 22.5 | 10.3 | 0.77 | 522.8 |
| b | 0.23 | 18.0 | 43.2 | 0.72 | 80.5 |
| c | 0.35 | 20.5 | 43.5 | 0.70 | 61.7 |
| d | 0.7 | 20.2 | 46.5 | 0.78 | 40.2 |
| e | 1.7 | 16.3 | 51.3 | 0.74 | 23.6 |
| f | 2.7 | 20.3 | 48.3 | 0.76 | 33.1 |

**Table S4** The fitted element values of equivalent circuit for Fig. S5B

| No. | Ni/Co (feeding ratio) | $R_s$ / Ω | CPE | | $R_{ct}$ / Ω |
|---|---|---|---|---|---|
| | | | $Q$ /$10^{-4}$ S $s^n$ | $n$ | |
| a | 0/1 | 22.5 | 10.3 | 0.77 | 522.8 |
| b | 0.33 | 19.0 | 20.2 | 0.79 | 465.7 |
| c | 0.5 | 19.1 | 30.2 | 0.78 | 365.7 |
| d | 3.0 | 19.3 | 39.0 | 0.76 | 262.0 |
| e | 2.0 | 22.1 | 39.2 | 0.80 | 260.0 |
| f | 1.0 | 18.4 | 42.2 | 0.78 | 190.4 |

**Table S5** Comparison of OER performance of Co-MOF-based electrocatalysts

| Catalyst | Electrolyte | Substrate | Overpotential at 10 mA/cm$^{-2}$ (mV) | Ref. |
|---|---|---|---|---|
| $Fe_1Co_1$-P/C | 1 M KOH | GC | 360 | 1 |
| $(Fe(II)_1Fe(III)1)_{0.6}$/NMOF-Co | 1 M KOH | GC | 330 | 2 |
| Fe-doped $Co_3O_4$ | 1 M KOH | GC | 318 | 3 |
| CoFe-MOF-OH | 1 M KOH | GC | 310 | 4 |
| $Co_3O_4$/Co-Fe oxide | 1 M KOH | GC | 297 | 5 |
| $Fe(OH)_3$@Co-MOF-74 | 1 M KOH | CP | 294 | 6 |
| $A_{2.7}B$-MOF-$FeCo_{1.6}$ | 1 M KOH | GC | 288 | 7 |
| **Fe-CoO/Co** | **1 M KOH** | **GC** | **276** | **This work** |

$A_{2.7}B$ = terephthalic (A) and 2-aminoterephthalic ligands (B)

**Table S6** The fitted element values of equivalent circuit for Fig. 5C

| No. | Sample | $R_s$ / Ω | CPE | | $R_{ct}$ / Ω |
|---|---|---|---|---|---|
| | | | $Q$ /$10^{-4}$ S $s^n$ | $n$ | |
| 1 | Fe-Co/CoO | 16.3 | 51.3 | 0.74 | 23.6 |
| 2 | Ni-Co/CoO | 18.4 | 42.2 | 0.78 | 190.4 |
| 3 | $IrO_2$/C | 17.6 | 31.8 | 0.91 | 307 |

**Table S7** The fitted element values of equivalent circuit for Fig. 7B

| No. | Sample | $R_s$ / Ω | CPE | | $R_{ct}$ / Ω |
|---|---|---|---|---|---|
| | | | $Q$ /$10^{-4}$ S $s^n$ | $n$ | |
| 1 | Fe-CoO-Z | 27.2 | 31.5 | 0.74 | 317 |
| 2 | Fe-CoO/Co-D | 28.9 | 41.9 | 0.76 | 90.6 |
| 3 | Fe-CoO/Co | 16.3 | 51.3 | 0.74 | 23.6 |

## References


1. W. Hong, M. Kitta and Q. Xu, *Small Methods*, 2018, **2,** 1800214.
2. M. Zhao, T. Guo, W. Qian, Z. Wang, X. Zhao, L. Wen and D. He, *Chem. Eng. J.*, 2021, **422,** 130055.
3. K. Min, M. Hwang, S. E. Shim, D. Lim and S.-H. Baeck, *Chem. Eng. J.*, 2021, **424,** 130400.
4. Z. Zou, T. Wang, X. Zhao, W. Jiang, H. Pan, D. Gao and C. Xu, *ACS Catal.*, 2019, **9**, 7356-7364.
5. X. Wang, L. Yu, B. Y. Guan, S. Song and X. Lou, *Adv. Mater.*, 2018, **30,** 1801211.
6. Z. Gao, Z. W. Yu, F. Q. Liu, C. Yang, Y. Yuan, Y. Yu and F. Luo, *ChemSusChem*, 2019, **12**, 4623-4628.
7. Z. Xue, Y. Li, Y. Zhang, W. Geng, B. Jia, J. Tang, S. Bao, H. Wang, Y. Fan, Z. Wei, Z. Zhang, Z. Ke, G. Li and C.-Y. Su, *Adv. Energy Mater.*, 2018, **8,** 1801564.