Supporting Information for

Gold atom-decorated $CoSe_2$ nanobelts with engineered active sites for enhanced oxygen evolution

Xu Zhao,[a] Pengfei Gao,[a] Yu Yan,[a] Xingqi Li,[a] Yulin Xing,[a] Hongliang Li,[a] Zhenmeng Peng,[b,*] Jinlong Yang[a] and Jie Zeng[a,*]

[a]Hefei National Laboratory for Physical Sciences at the Microscale, Key Laboratory of Strongly-Coupled Quantum Matter Physics of Chinese Academy of Sciences, Department of Chemical Physics, University of Science and Technology of China, Hefei, Anhui 230026, P. R. China

[b]Department of Chemical and Biomolecular Engineering, University of Akron, Akron, Ohio 44325, United States

*Correspondence and requests for materials should be addressed to J.Z. (email: zengj@ustc.edu.cn) and Z. P. (email: zpeng@uakron.edu)

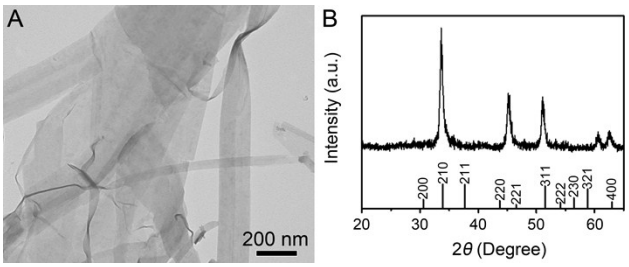

Figure S1. (A) TEM image of lamellar $CoSe_2$ nanobelts. (B) XRD pattern of $CoSe_2$ nanobelts. The standard patterns for pure $CoSe_2$ (JCPDS No.09-234) are attached at the bottom for comparison.

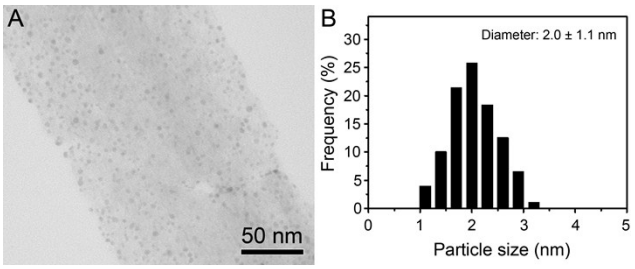

Figure S2. (A) TEM image of Au_N-$CoSe_2$ nanobelts. (B) The corresponding histogram of particle size distribution of Au nanoparticles.

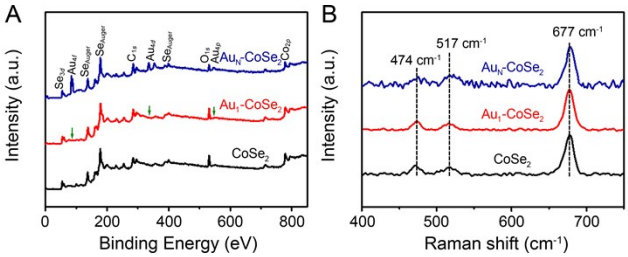

Figure S3. (A) XPS survey spectra of Au_N-$CoSe_2$, Au_1-$CoSe_2$, and $CoSe_2$ nanobelts. (B) Raman spectra of Au_N-$CoSe_2$, Au_1-$CoSe_2$, and $CoSe_2$ nanobelts.

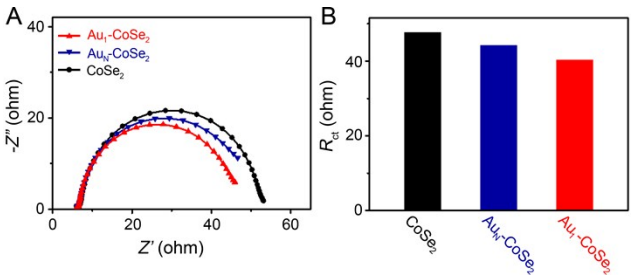

Figure S4. (A) Nyquist plots of Au_1-$CoSe_2$, Au_N-$CoSe_2$ and $CoSe_2$ nanobelts obtained at 1.4 V versus reversible hydrogen electrode (RHE). (B) Comparison of the charge transfer resistance (R_{ct}) for different catalysts.

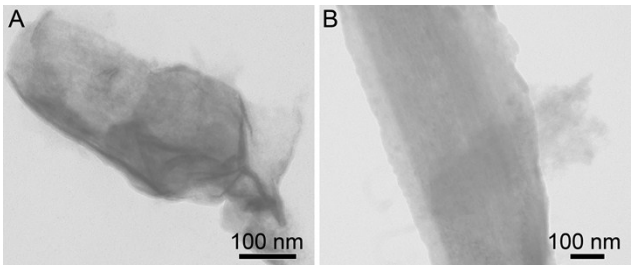

Figure S5. TEM images of (A) 0.05%Au_1-$CoSe_2$, (B) 0.02%Au_1-$CoSe_2$ nanobelts.

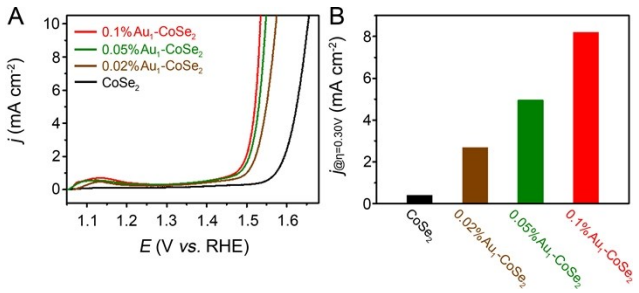

Figure S6. Electrocatalytic properties of Au_1-$CoSe_2$ with different Au contents (0.02%, 0.05% and 0.1%) and the pure $CoSe_2$ nanobelts. (A) iR-corrected polarization curves recorded in O_2-saturated 0.1 M KOH solution with a scan rate of 5 mV/s. (B) Corresponding current densities at the overpotential of 0.30 V.

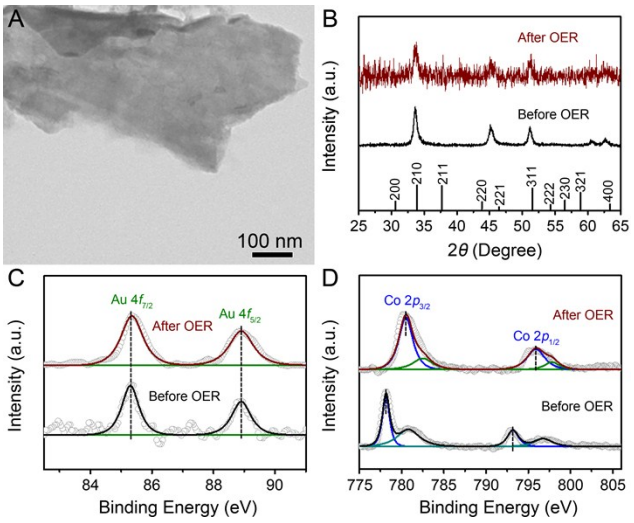

Figure S7. (A) TEM image of Au_1-$CoSe_2$ nanobelts after the stability test. (B) XRD patterns of Au_1-$CoSe_2$ nanobelts before and after the stability OER test. The standard patterns for pure $CoSe_2$ (JCPDS No.09-234) are shown at the bottom for comparison. (C) Au 4*f* XPS and (D) Co 2*p* XPS spectra of Au_1-$CoSe_2$ nanobelts before and after the stability OER test.

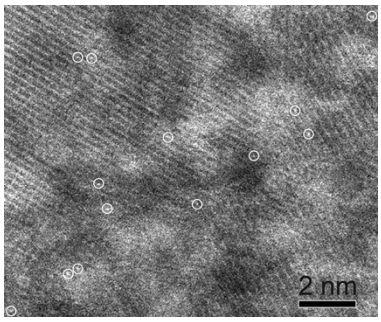

Figure S8. HAADF-STEM image of Au_1-$CoSe_2$ nanobelts after the stability test. Isolated Au atoms marked in white circles are uniformly dispersed on the nanobelts.

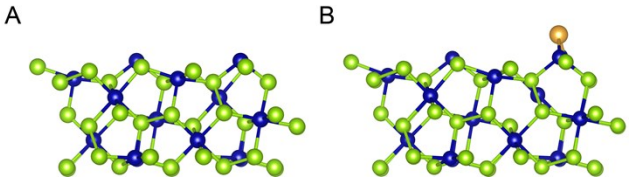

Figure S9. The models of (A) pure $CoSe_2$ and (B) Au_1-$CoSe_2$. Orange, blue and green spheres represent Au, Co, and Se atoms, respectively.

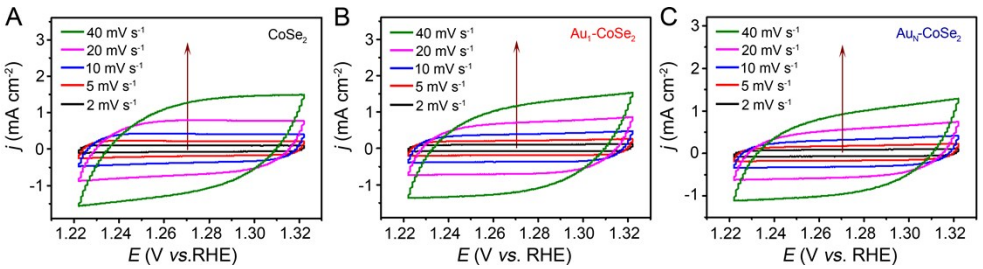

Figure S10. Typical cyclic voltammetry curves of (A) $CoSe_2$, (B) Au_1-$CoSe_2$ and (C) Au_N-$CoSe_2$ nanobelts in 0.1 M KOH solution with different scan rates.

Table S1. OER activities of various Co-based electrocatalysts in alkaline solution.

Material	Electrolyte	η@10 mA cm^{-2} (mV)	j@300 mV (mA cm^{-2})	Tafel slope (mV dec^{-1})	Reference
Au_1-$CoSe_2$	0.1M KOH	303	8.20	42	This work
Co_2B-500	0.1M KOH	380	~1.59	45	S1
$CoCr_2O_4$/CNS-700	0.1M KOH	365	~4	58.2	S2
Co Phyllosilicate	1M KOH	364	~1.36	60	S3
$NiCo_2O$	0.1M KOH	362	~1.54	64.4	S4
Co_3S_4/NCNTs	0.1M KOH	430	/	70	S5
CoMnP	1M KOH	330	~3.33	61	S6
NiCoP/C	1M KOH	330	~6.66	96	S7
Co_9S_8/S-C-800	1M KOH	339	~4.62	64	S8
Co_3S_4	0.1M KOH	355	~2	48	S9

References

[1] J. Masa, P. Weide, D. Peeters, I. Sinev, W. Xia, Z. Y. Sun, C. Somsen, M. Muhler, W. Schuhmann, *Adv. Energy Mater.* 2016, ***6***, 1502313.

[2] M. Al-Mamun, X. T. Su, H. M. Zhang, H. J. Yin, P. Liu, H. G. Yang, D. Wang, Z. Y. Tang, Y. Wang, H. J. Zhao, *Small.* 2016, ***12***, 2866.

[3] J. S. Kim, I. Park, E.-S. Jeong, K. Jin, W. M. Seong, G. Yoon, H. Kim, B. Kim, K. T. Nam, K. Kang, *Adv. Mater.* 2017, ***29***, 1606893.

[4] C. Z. Zhu, D. Wen, S. Leubner, M. Oschatz, W. Lin, M. Holzschuh, F. Simon, S. Kaskel, A. Eychmuller, *Chem. Commun.* 2015, ***51***, 7851.

[5] H. J. Wang, Z. P. Li, G. H. Li, F. Peng, H. Yu, *Catal Today.* 2015, ***245***, 74.

[6] D. Li, H. Baydoun, C. N. Verani, S. L. Brock, *J. Am. Chem. Soc.* 2016, ***138***, 4006.

[7] P. L. He, X.-Y. Yu, X. W. Lou, *Angew. Chem. Int. Ed.* 2017, ***56***, 3897.

[8] H. Y. Qian, J. Tang, Z. L. Wang, J. Kim, J. H. Kim, S. M. Alshehri, E. Yanmaz, X. Wang, Y. Yamauchi, *Chem. Eur. J.* 2016, ***22***, 18259.

[9] Y. W. Liu, C. Xiao, M. J. Lyu, Y. Lin, W. Z. Cai, P. C. Huang, W. Tong, Y. M. Zou, Y. Xie, *Angew. Chem. Int. Ed.* 2015, ***54***, 11231.