

Electronic Supplementary Information (ESI)

Template synthesis of CoSe₂/Co₃Se₄ nanotubes: tuning the crystal structures for photovoltaics and hydrogen evolution in alkaline medium

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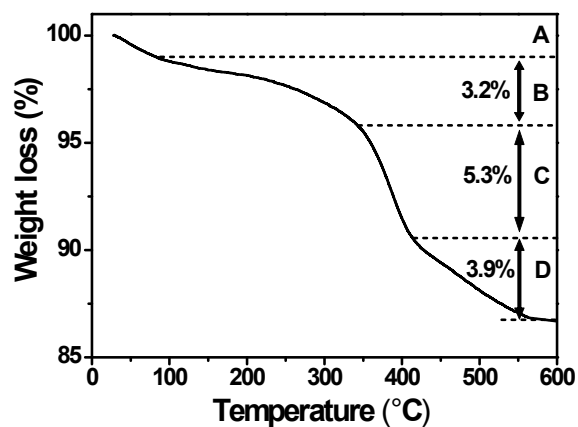


Fig. S1 Thermogravimetric curve of Co₃Se₄ NTs samples. This TGA has four distinct stage of weight losses. The first weight loss stage (A stage) ended at ~85 °C, stemming from evaporation of trace water. The second weight loss (B stage) at the temperature ranging from 85 to 340 °C was attributed to the Co₃Se₄ reacting with Se to form o-CoSe₂. The third weight loss (C stage) at the temperature ranging from 340 to 410 °C may be associated with the evaporation of Se. Following this, the o-CoSe₂ converted to c-CoSe₂ accompanying with the evaporation of Se at the temperature ranging from 410 to 600 °C (D stage).

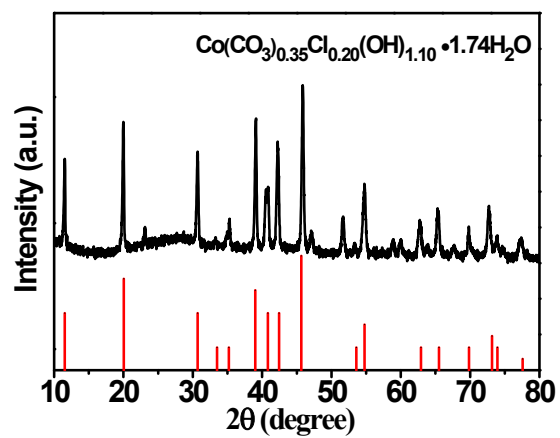


Fig. S2 XRD patterns of the $\text{Co}(\text{CO}_3)_{0.35}\text{Cl}_{0.20}(\text{OH})_{1.10} \cdot 1.74\text{H}_2\text{O}$ sample.

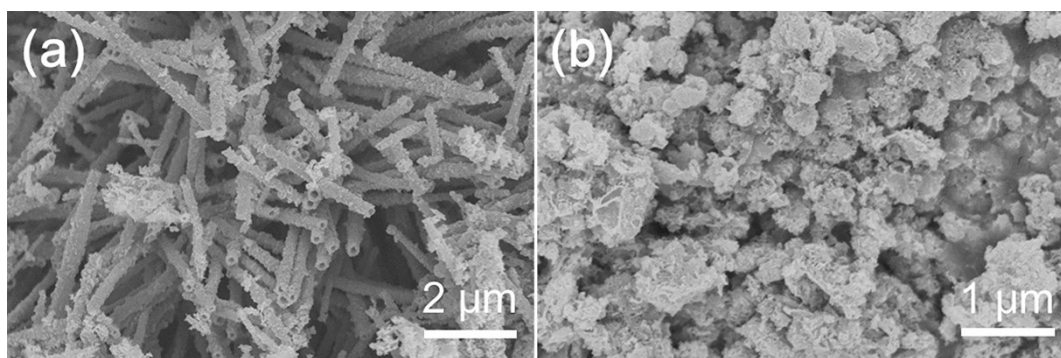


Fig. S3 SEM images of the (a) α - CoSe_2 and (b) Co_3Se_4 NPs.

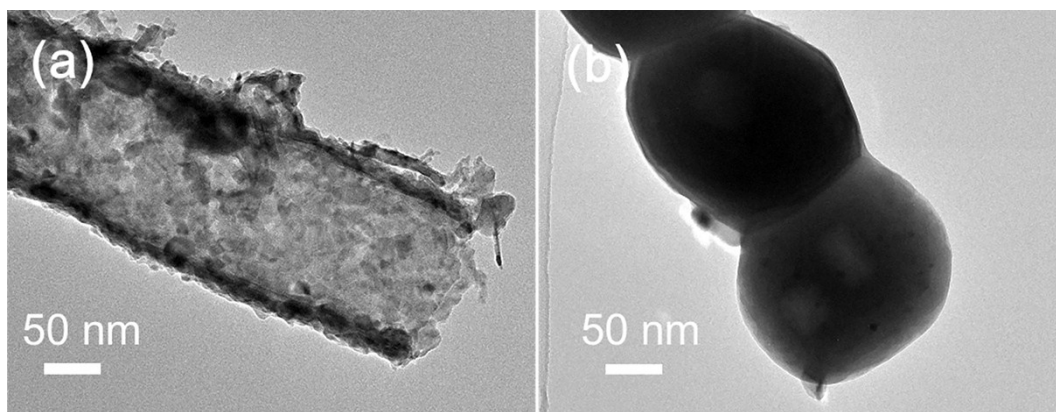


Fig. S4 TEM images of the (a) o-CoSe₂ and (b) c-CoSe₂.

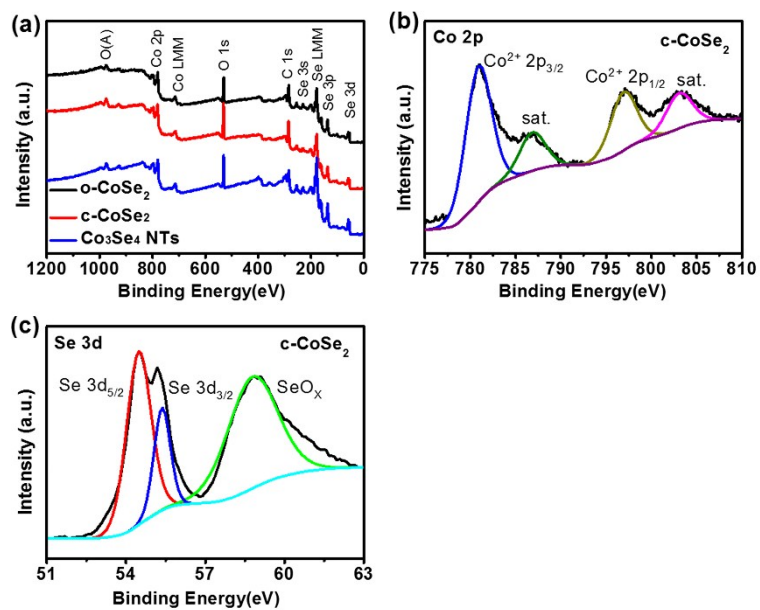


Fig. S5 (a) The survey spectrum of o-CoSe₂, c-CoSe₂ and Co₃Se₄ NTs. (b) Co 2p XPS spectra of c-CoSe₂. (c) Se 3d XPS spectra of c-CoSe₂.

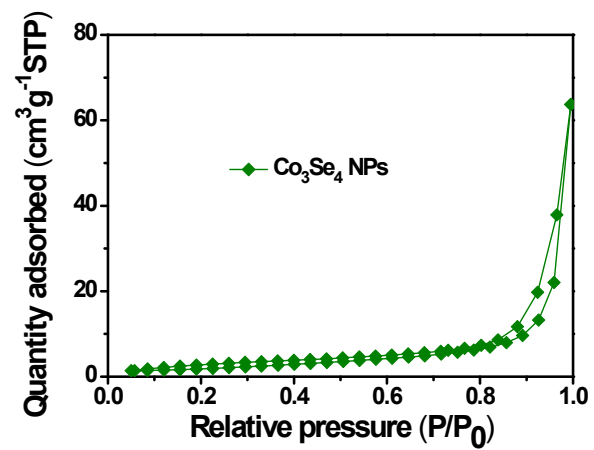


Fig. S6 N₂ adsorption-desorption isotherm of Co₃Se₄ NPs.

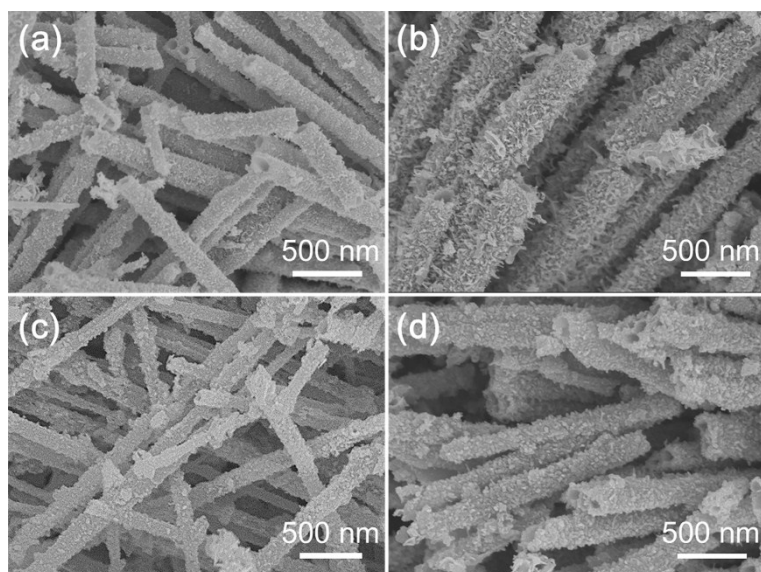


Fig. S7 (a) and (b) SEM images of Co_3Se_4 after the DSSC and HER tests, respectively. (c) and (d) SEM images of o-CoSe_2 after the DSSC and HER tests, respectively.

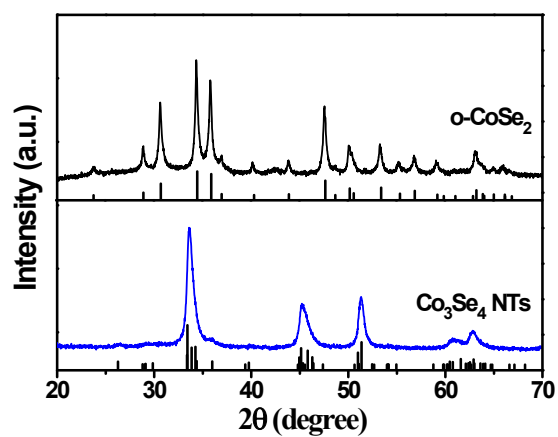


Fig. S8 XRD patterns of the Co₃Se₄ NTs and o-CoSe₂ after the HER stability test in 1.0 M KOH.

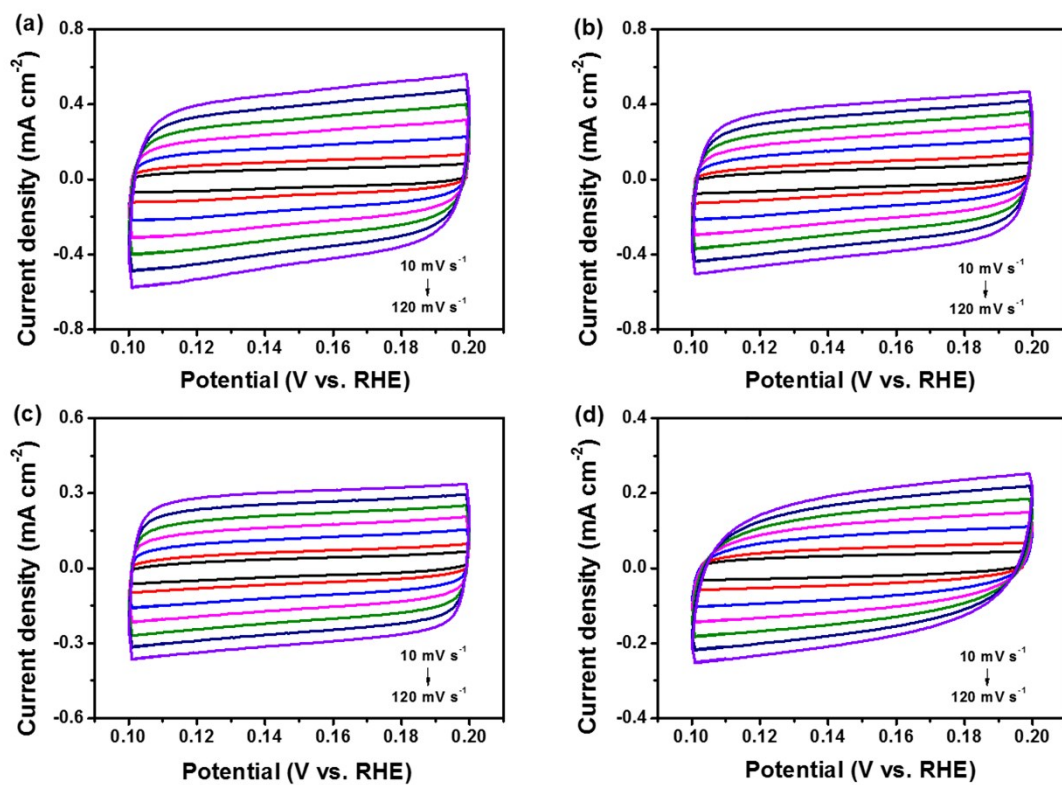


Fig. S9 Cyclic voltammograms of (a) *o*-CoSe₂, (b) *c*-CoSe₂, (c) Co₃Se₄ NTs and (d) Co₃Se₄ NPs at different scan rates (10, 20, 40, 60, 80, 100 and 120 mV s⁻¹) in 1.0 M KOH.

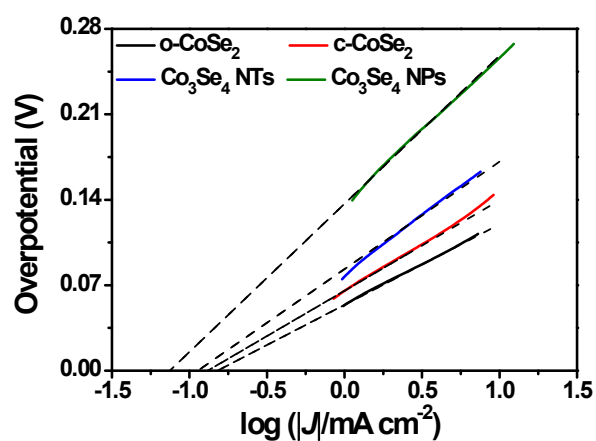


Fig. S10 Calculation of exchange current density of o-CoSe₂, c-CoSe₂, Co₃Se₄ NTs and Co₃Se₄ NPs.

The exchange current density (J_0) was calculated using extrapolation methods. When the overpotential value is 0, the $\log(J)$ values for o-CoSe₂, c-CoSe₂, Co₃Se₄ NTs and Co₃Se₄ NPs are -0.83 , -0.89 , -0.96 and -1.12 , respectively. Based on Tafel equations, J_0 values for o-CoSe₂, c-CoSe₂, Co₃Se₄ NTs and Co₃Se₄ NPs were calculated to be 0.15 , 0.13 , 0.11 and 0.08 mA cm⁻², respectively.

Table S1 Comparison of HER performance in alkaline medium for as-obtained samples with other non-noble metal-based catalysts.

Catalysts	Onset potential (mV)	η_{10} (mV)	Tafel slope (mV decade ⁻¹)	References
Ni ₂ P nanoparticles	100	225	100	1
Ni-Co-P-300	—	150	60.6	2
CoP nanowire arrays	80	209	129	3
Co@N-C	—	210	108	4
Ni ₅ P ₄ films	—	150	53	5
CoO _x /CN	85	232	114	6
NiP ₂ nanosheet arrays	74	102	65	7
WN nanorod arrays	—	285	170	8
MoB	140	225	59	9
Co-Ni-B	—	133	121	10
CoS ₂ pyramids	—	244	133	11
CoSe ₂ /CF	—	95	52	12
o-CoSe ₂	54	124	65.9	This work

References

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