Supporting Information

Modulating heterointerfaces of tungsten incorporated CoSe/Co_3O_4 as highly efficient electrocatalyst for overall water splitting

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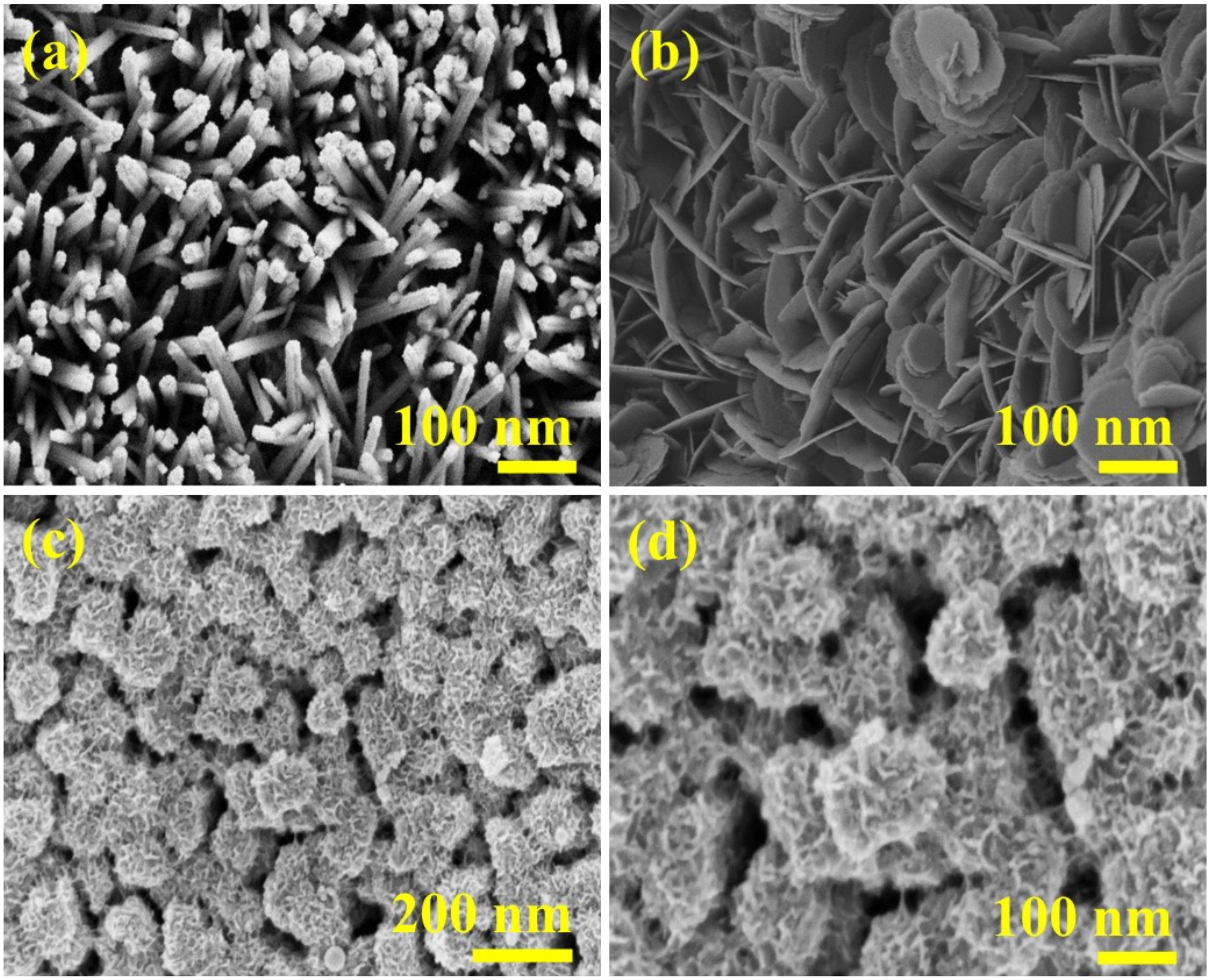

Fig. S1. SEM images (a) Pure Co LDH (b) Pure W LDH (c) Low and (d) high magnification of as-synthesized WCo LDH nanostructure.

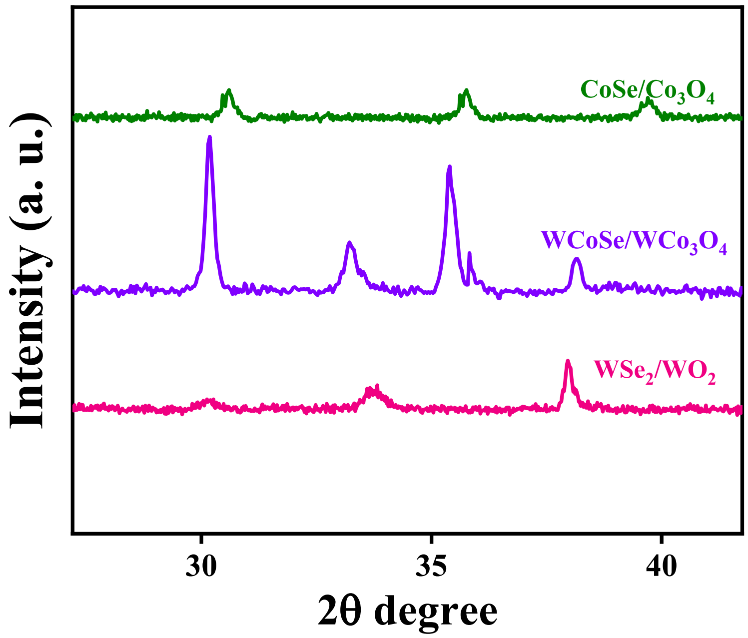

Fig. S2. XRD pattern zoomed version of $WCoSe/WCo_3O_4$ heterostructure.

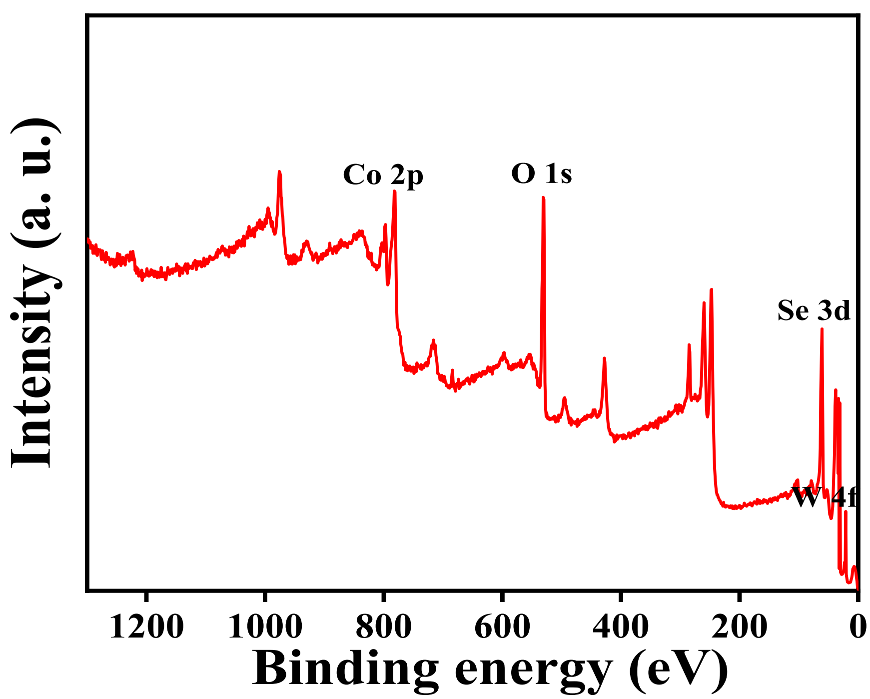

Fig. S3. XPS full spectra indicates that the elements presence of W, Co, O, and Se in the $WCoSe/WCo_3O_4$ heterostructure.

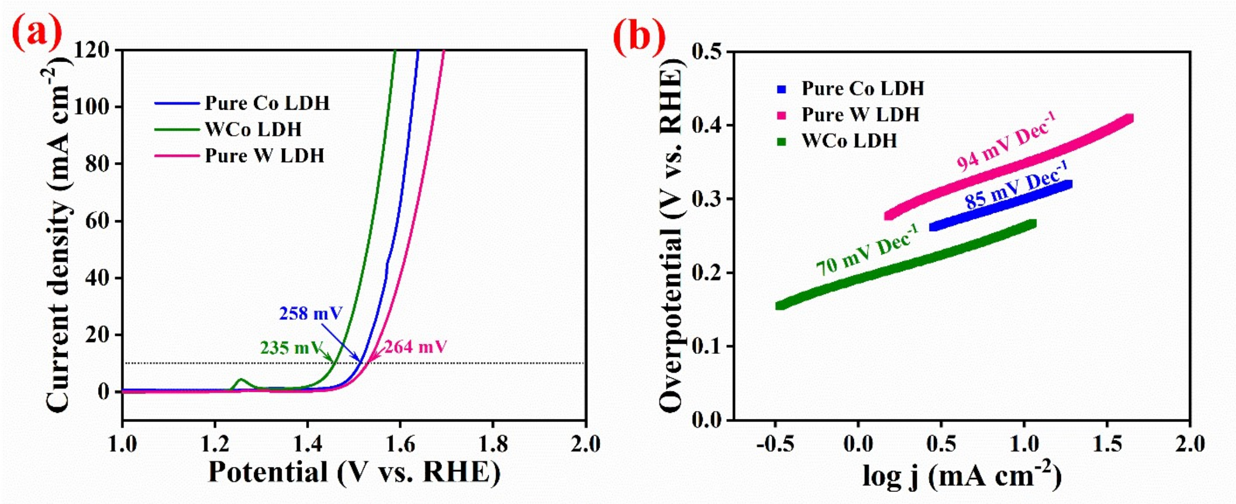

Fig. S4. (a) LSV performance and (b) Tafel slopes of precursors for OER.

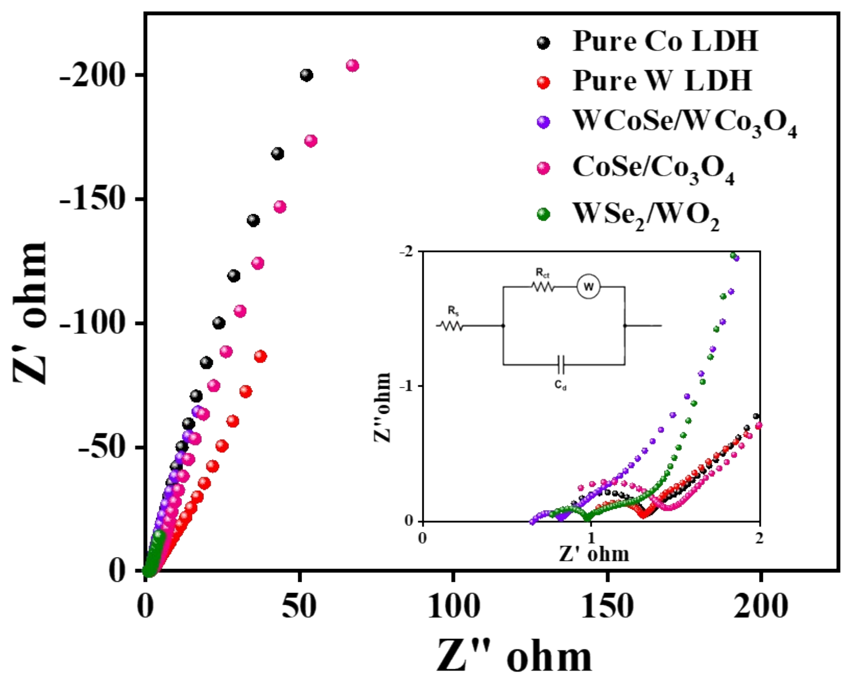

Fig. S5. EIS of as prepared electrocatalysts for OER activities.

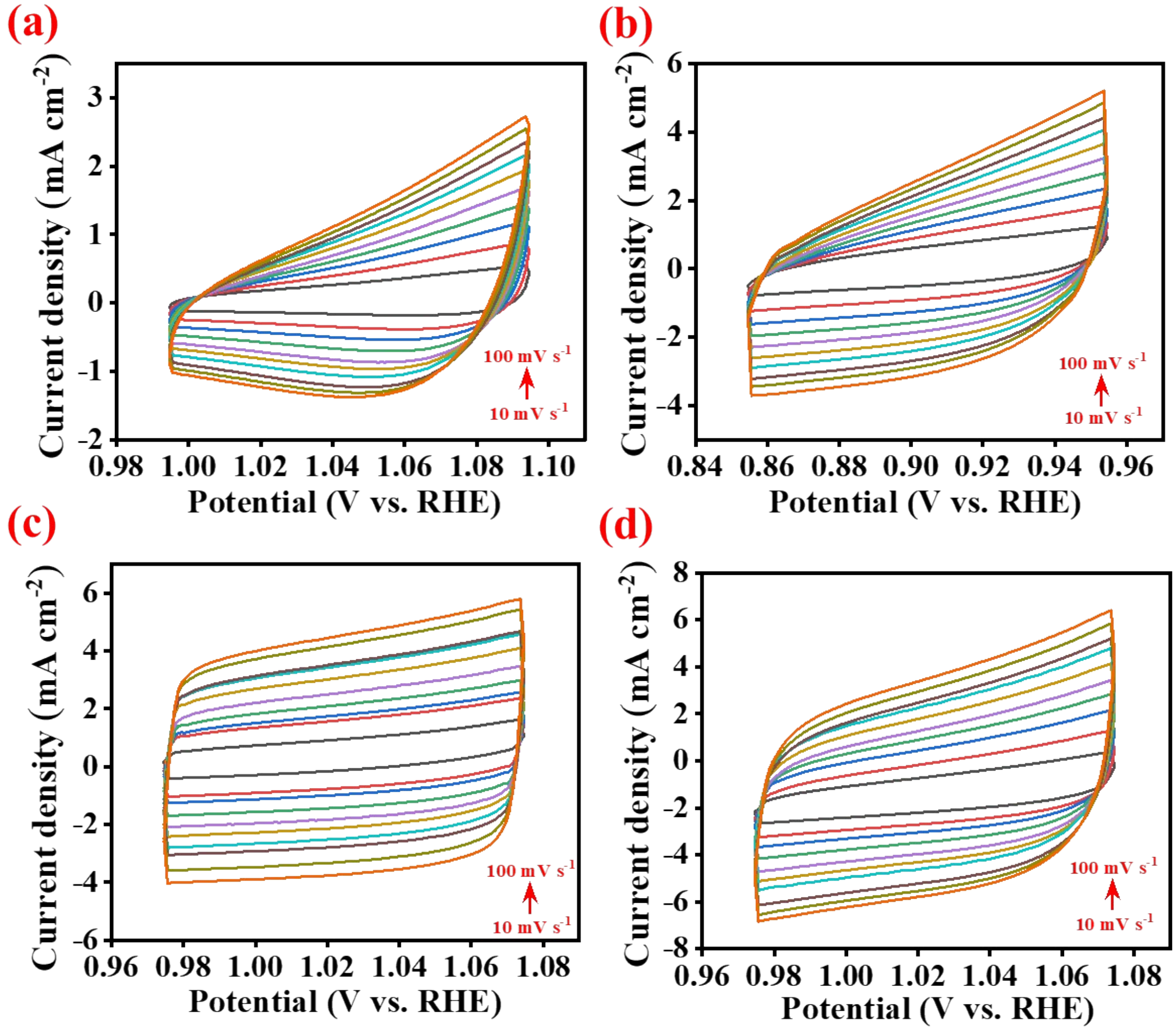

Fig. S6. CV curves of OER catalysts with varying scan rates from 10 to 100 mV s^{-1} (a) WSe_2/WO_2, (b) $CoSe/Co_3O_4$ (c) RuO_2 and (d) $WCoSe/WCo_3O_4$ HS electrocatalysts.

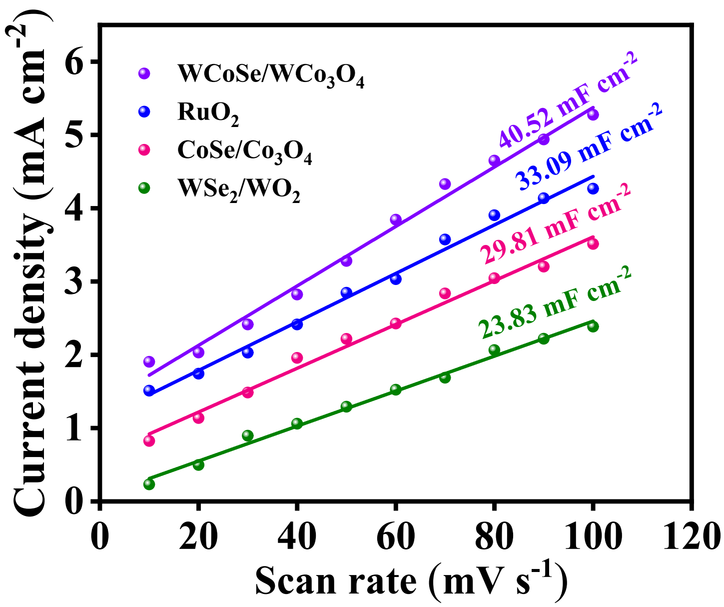

Fig. S7. ECSA for $WCoSe/WCo_3O_4$ HS and other comparative electrocatalysts during OER process.

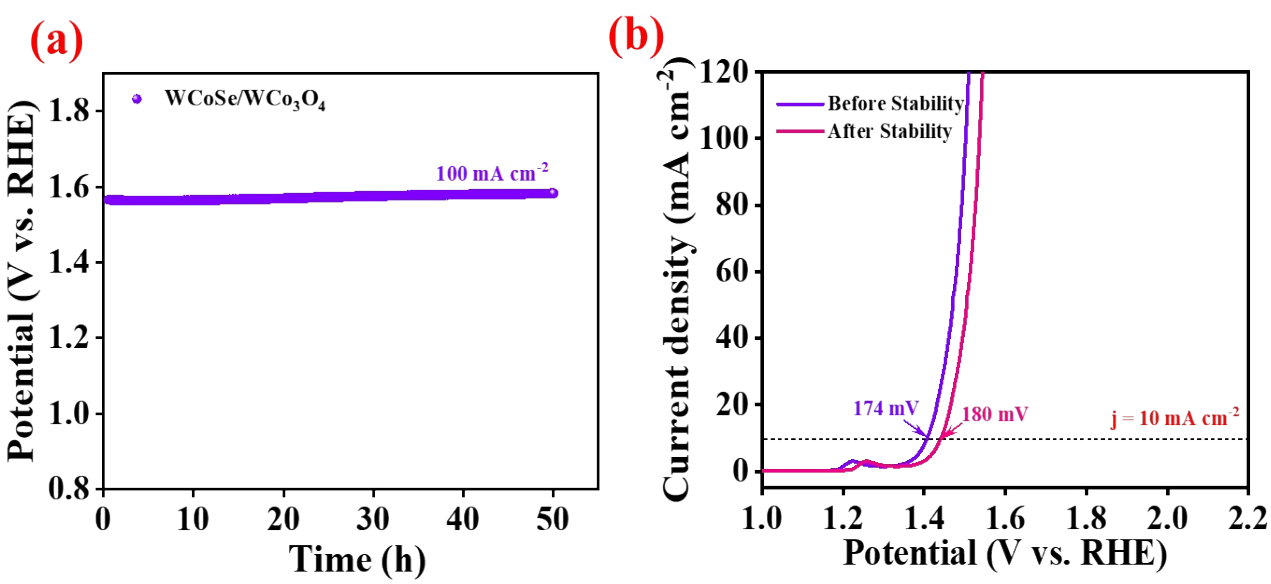

Fig. S8. (a) Long term stability of $WCoSe/WCo_3O_4$ HS electrocatalyst at current density of 100 mA cm^{-2} for 50 h towards OER activities and (b) LSV curves of $WCoSe/WCo_3O_4$ HS electrocatalyst after long term stability.

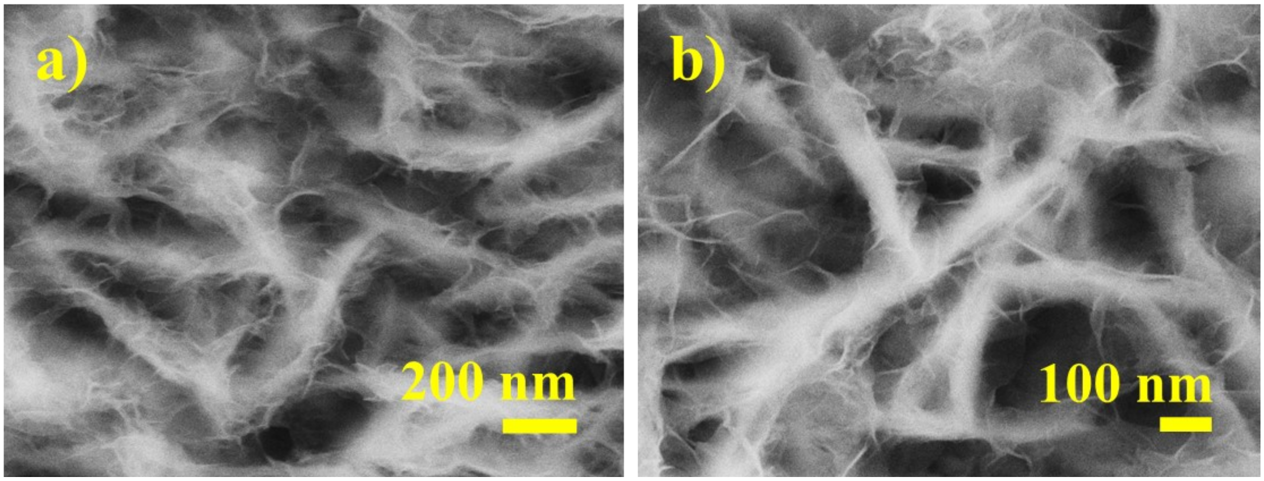

Fig. S9. a) Low and b) high magnification SEM of WCoSe/WCo_3O_4 after OER stability performance.

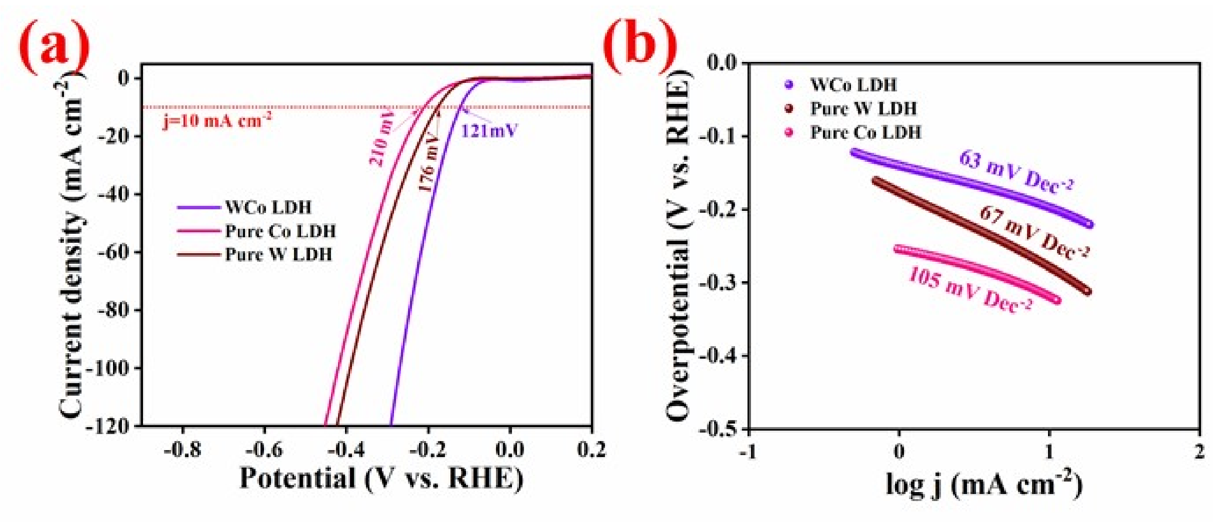

Fig. S10. (a)LSV performance and (b) Tafel slopes of precursors for HER.

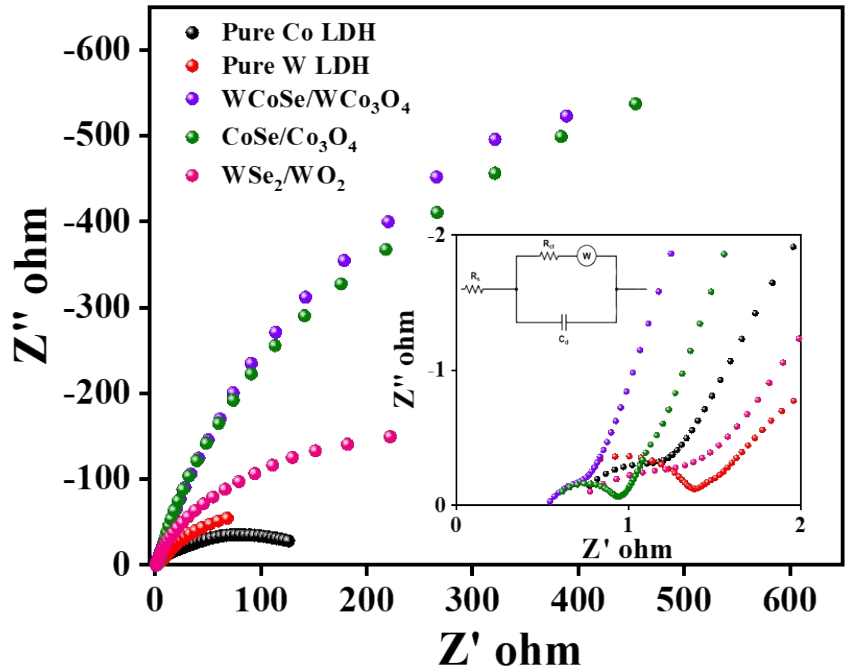

Fig. S11. EIS of as-prepared electrocatalysts for HER performance.

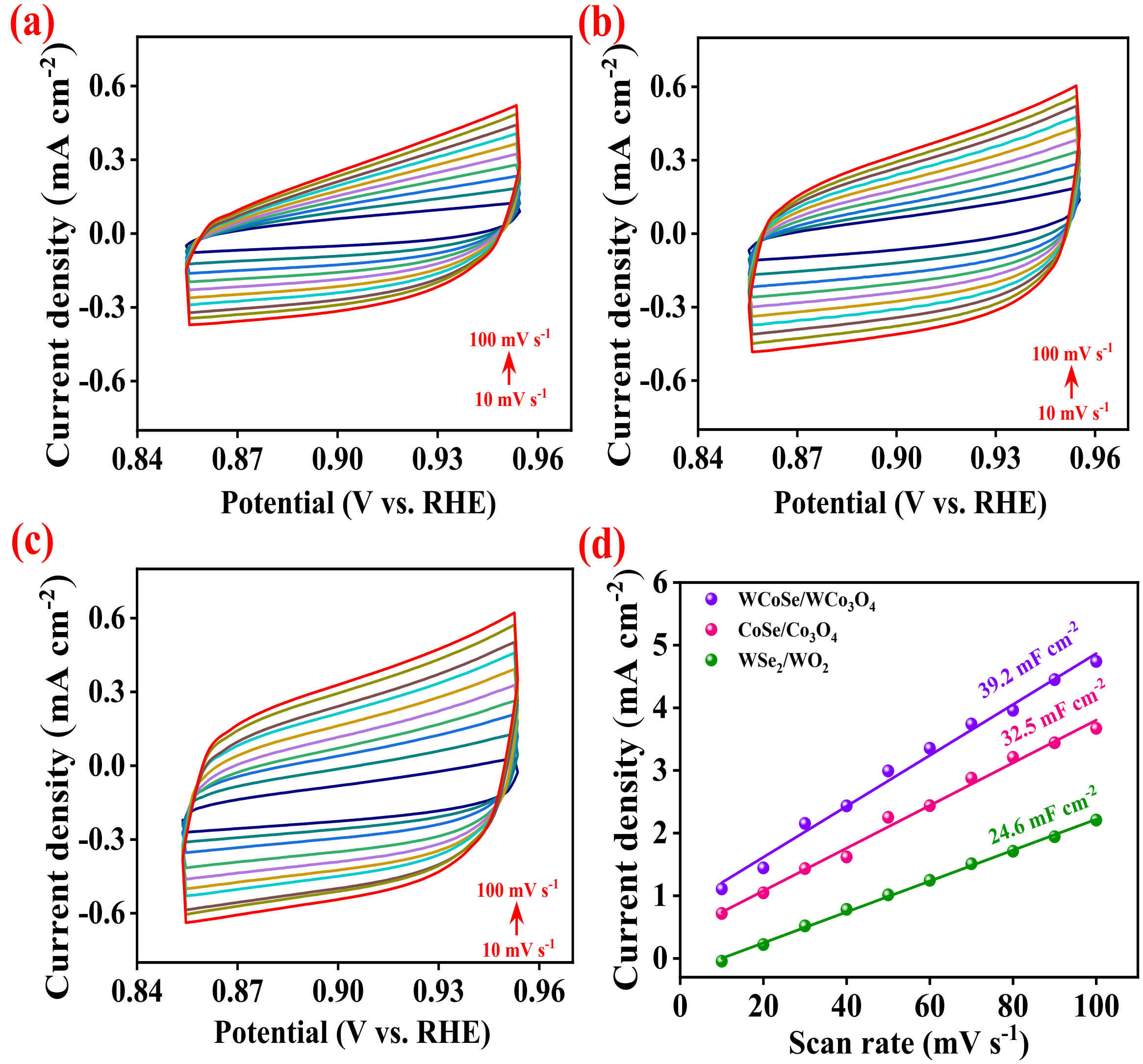

Fig. S12. CV curves of HER catalysts with varying scan rates from 10 to 100 mV s^{-1} (a) WSe_2/WO_2, (b) $CoSe/Co_3O_4$ and (c) $WCoSe/WCo_3O_4$ heterostructure electrocatalysts. (f) ECSA for $WCoSe/WCo_3O_4$ heterostructure and other comparative electrocatalysts during HER process.

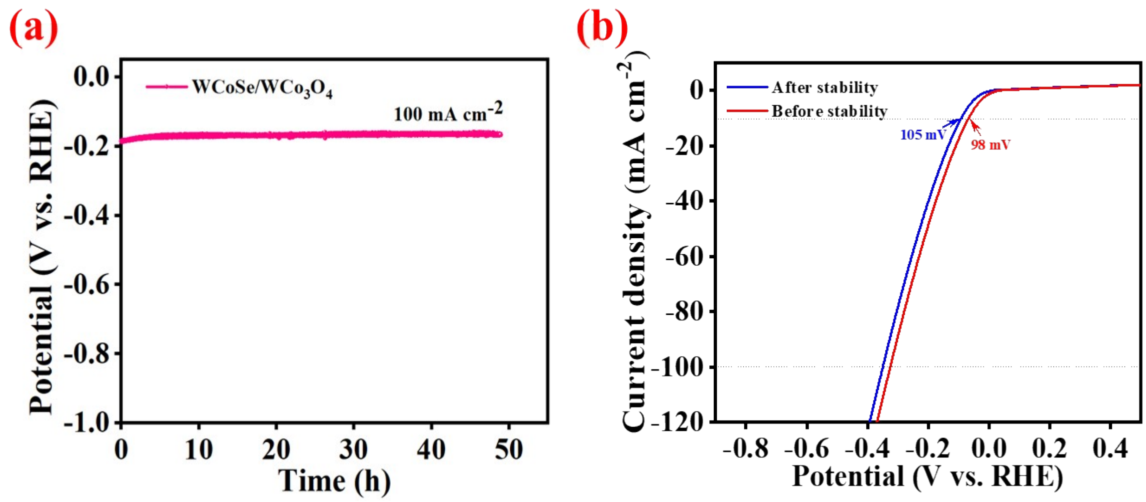

Fig. S13. The HER stability performance: a) chronopotentiometric response after 50 h and b) LSV curves of OER performance after long term stability of 50 h for $WCoSe/WCo_3O_4$ HS electrocatalyst.

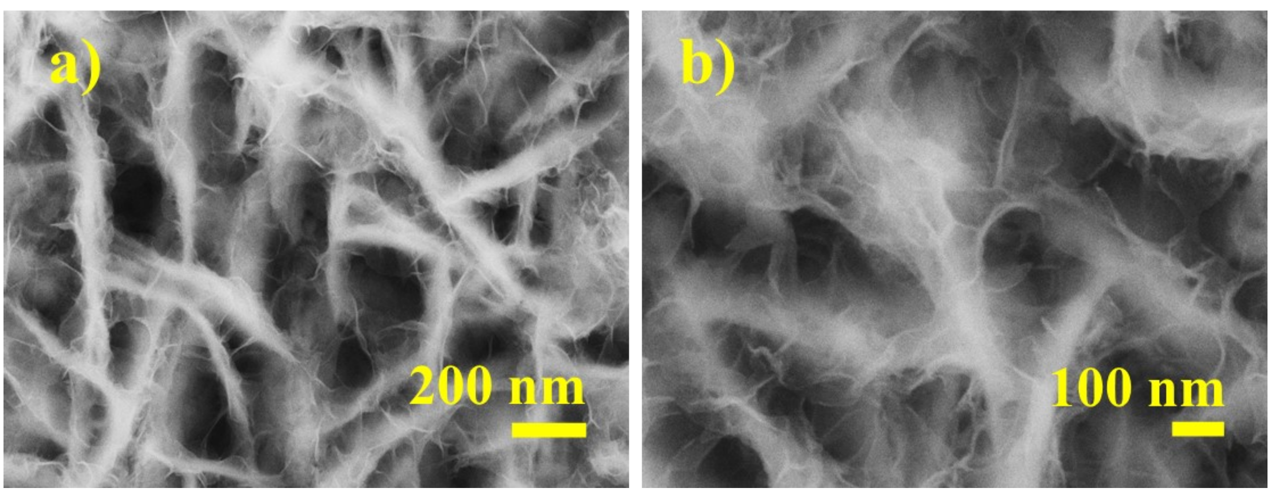

Fig. S14. a) Low and b) high magnification SEM of $WCoSe/WCo_3O_4$ heterostructure after HER performance.

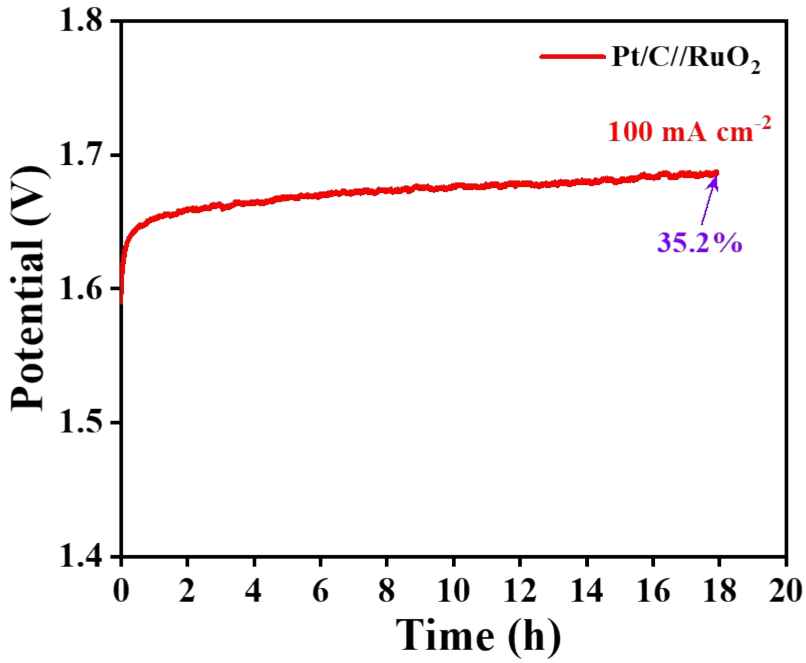

Fig. S15. Long term stability of Pt/C||RuO_2 device.

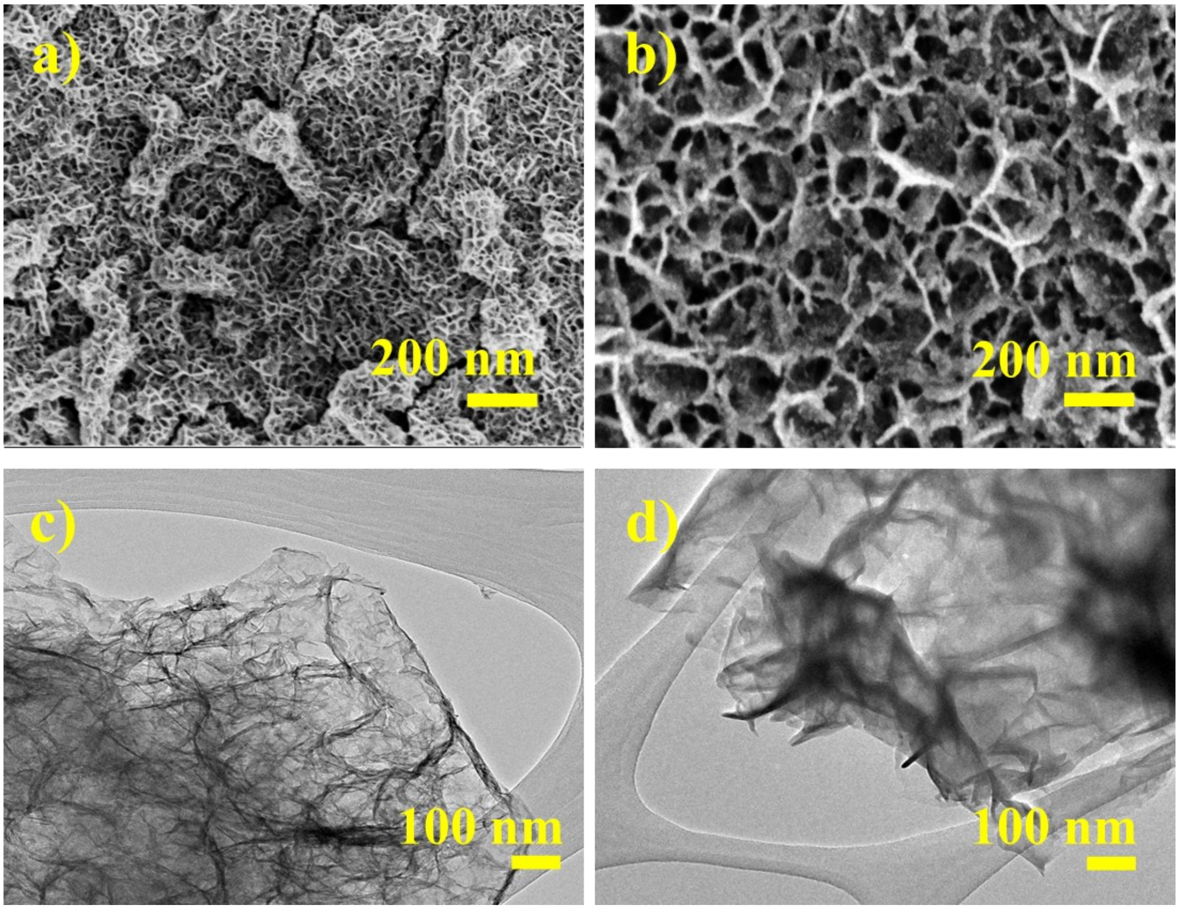

Fig. S16. SEM and TEM after overall water splitting of WCoSe/WCo_3O_4||WCoSe/WCo_3O_4 bifunctional device.

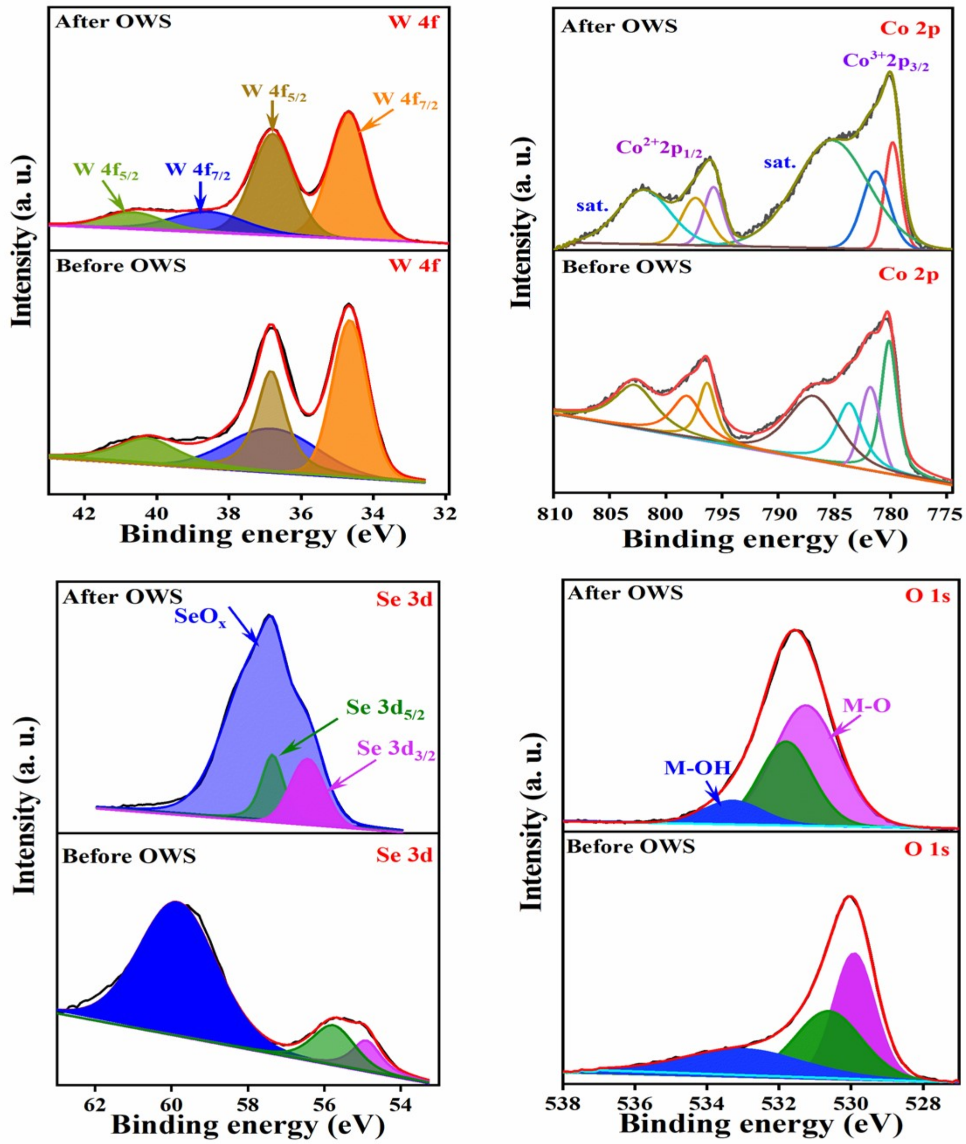

Fig. S17. XPS after overall water splitting device.

Table S1. Comparison of OER performance with previous reported state-of-the-art OER catalysts.

OER catalysts	Electrolytes	Current density (J)	Overpotential (mV)	Tafel (mV dec^{-1})	References
WCoSe/WCo_3O_4	1.0 M KOH	10 mA cm^{-2}	175	62	This work
Mn $(Fe_{0.3}Ni_{0.7})O_x$	1.0 M KOH	10 mA cm^{-2}	262	-	1
$FeNi_3$@NC	1.0 M KOH	10 mA cm^{-2}	277	77	2
meso-NPC/Co_2NiO_x	1.0 M KOH	10 mA cm^{-2}	330	54	3
FeNi2S4 NPs/CB	1.0 M KOH	10 mA cm^{-2}	405	126	4
Co_2P/CoNPC	1.0 M KOH	10 mA cm^{-2}	326	72.6	5
Re/ReS2-7H/CC	1.0 M KOH	10 mA cm^{-2}	290	-	6
CoP-B1	1.0 M KOH	10 mA cm^{-2}	297	58.1	7
Fe_3O_4/CoO CNTs	1.0 M KOH	10 mA cm^{-2}	270	59	8
Ni10-CoPi	1.0 M KOH	10 mA cm^{-2}	320	44.5	9
W_2N/WC	1.0 M KOH	10 mA cm^{-2}	320	122.8	10

Table S2. Comparison of HER performance with previous reported state-of-the-art HER catalysts.

HER catalysts	Electrolytes	Current density (J)	Overpotential (mV)	Tafel (mV dec^{-1})	References
$WCoSe/WCo_3O_4$	1.0 M KOH	10 mA cm^{-2}	98	72	This work
CFeNiP	1.0 M NaOH	10 mA cm^{-2}	132	58	11
NiRu-LDH	1.0 M KOH	10 mA cm^{-2}	165	107	12
$CoMoO_4 \cdot nH_2O/CF$	1.0 M KOH	10 mA cm^{-2}	-	134	13
Te/FeNiOOH-NCs	1.0 M KOH	10 mA cm^{-2}	167	93	14
$Ni/Mo_6Ni_6C@C$	1.0 M KOH	10 mA cm^{-2}	101	88	15
MoS_2/MoN-8	1.0 M KOH	10 mA cm^{-2}	132	98	16
Mo_2N/NF	1.0 M KOH	10 mA cm^{-2}	109.7	-	17
MoP/NPG	1.0 M KOH	10 mA cm^{-2}	126	56	18
MoP@NC	1.0 M KOH	10 mA cm^{-2}	149	55.9	19
Se-$MoS_2/CoSe_2$	1.0 M KOH	100 mA cm^{-2}	93	-	20

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