Supporting Information

Bifunctional nanoporous Ni-Co-Se electrocatalyst with superaerophobic surface for the water and hydrazine oxidation

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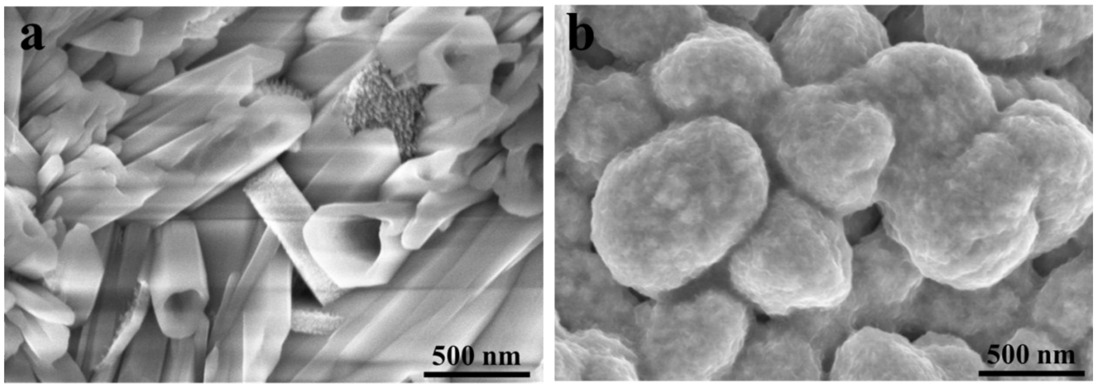

Fig. S1 SEM images of **a)** $CoSe_2$ and **b)** $NiSe_2$

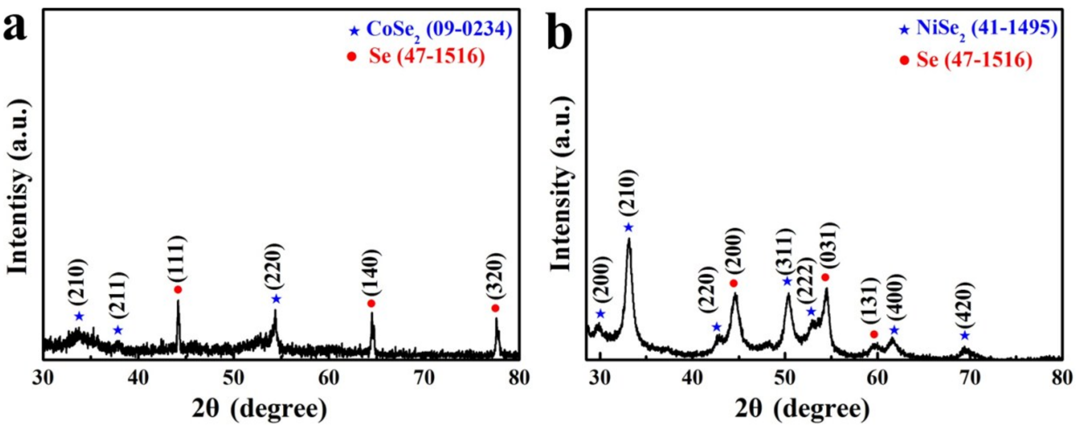

Fig. S2 XRD patterns of **a)** $CoSe_2$ and **b)** $NiSe_2$

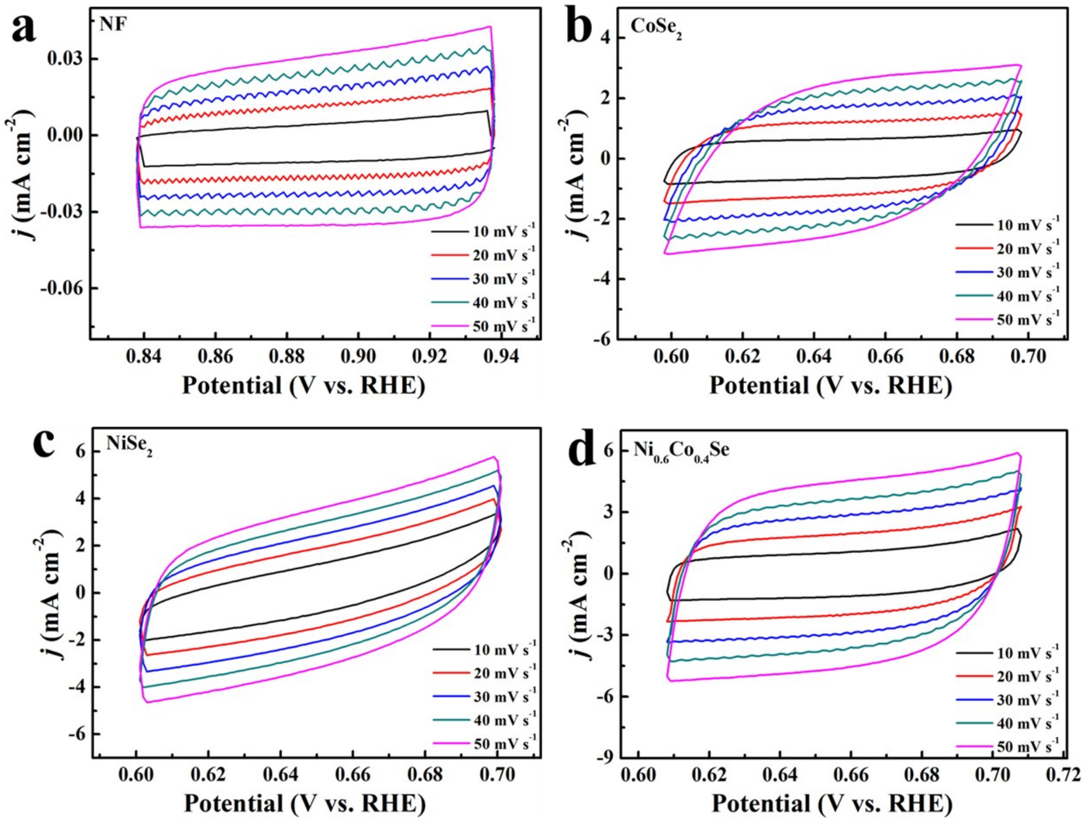

Fig. S3 CV curves of **a)** NF, **b)** $CoSe_2$, **c)** $NiSe_2$ and **d)** $Ni_{0.6}Co_{0.4}Se$ in the capacitance current range at various scan rates.

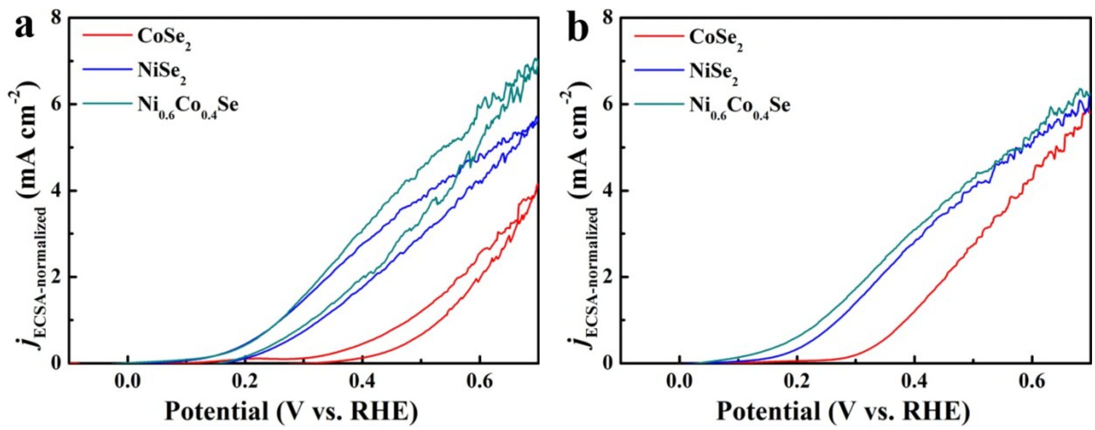

Fig. S4 a) CV plots and b) LSV plots of $CoSe_2$, $NiSe_2$ and $Ni_{0.6}Co_{0.4}Se$ after averaged by ECSA

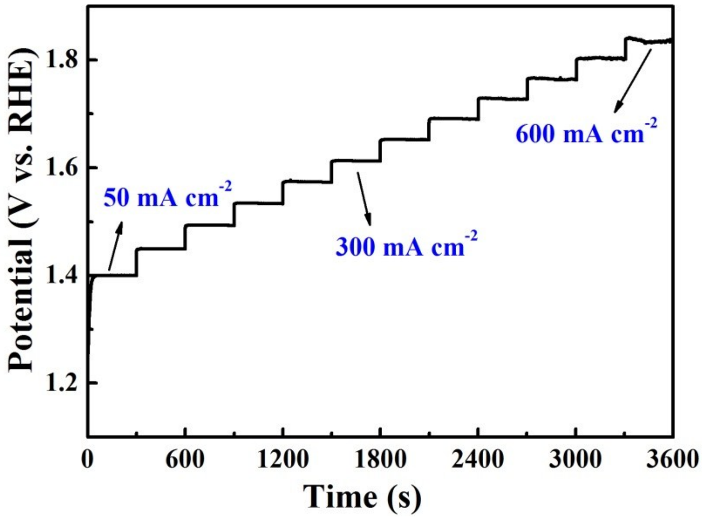

Fig. S5 Multi-current process of $Ni_{0.6}Co_{0.4}Se$ in 1.0 M KOH electrolyte.

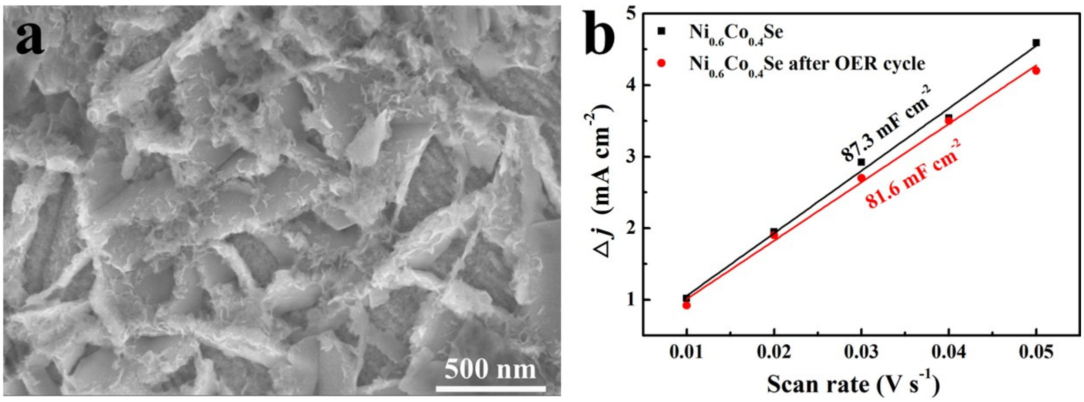

Fig. S6 a) SEM image of used $Ni_{0.6}Co_{0.4}Se$ after OER cycles in 1.0 M KOH at 10 mA cm^{-2} for 24 h, **b)** capacitive current densities of fresh and used $Ni_{0.6}Co_{0.4}Se$ after OER cycles as a function of scan rate ($\Delta j = |j_a - j_c|/2$).

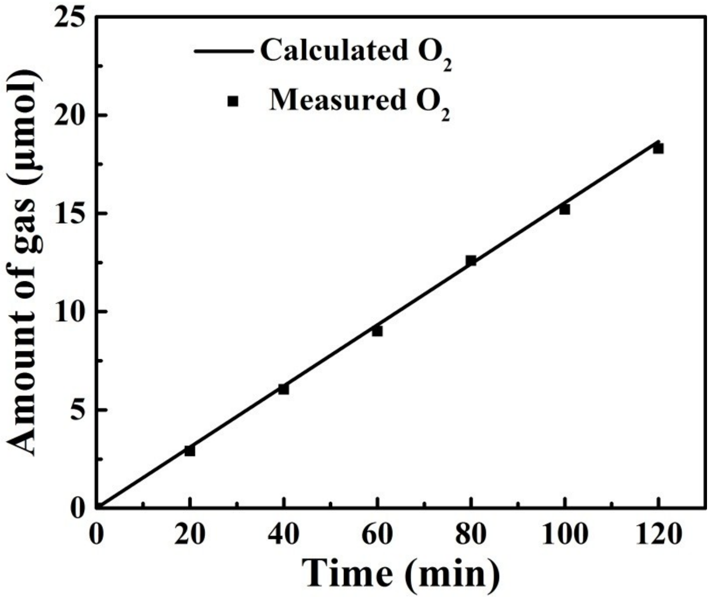

Fig. S7 Amount of experimental and theoretical O_2 evolution by $Ni_{0.6}Co_{0.4}Se$ at a constant oxidation current density of 1 mA.

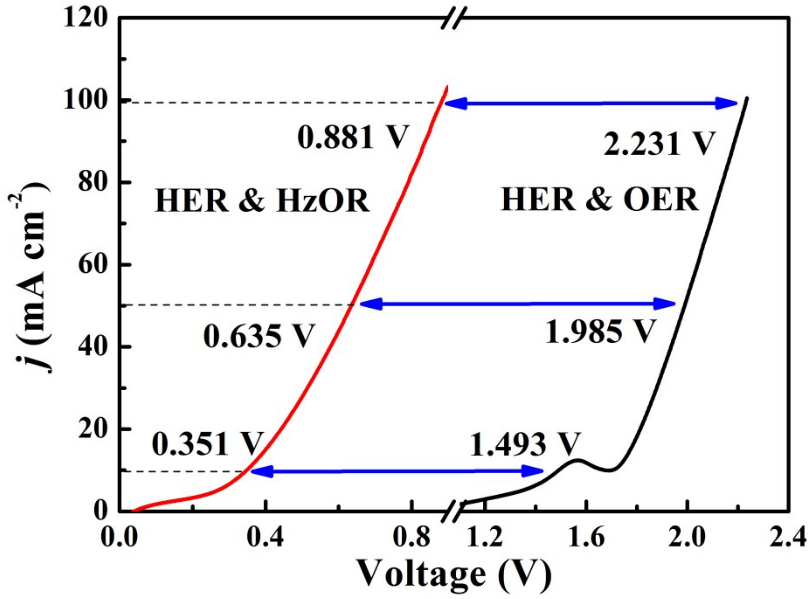

Fig. S8 Comparison of cell voltages from LSV plots of overall and hybrid water electrolysis for $Ni_{0.6}Co_{0.4}Se$ couple in two-electrode cell at a scan rate of 5 mV s^{-1}

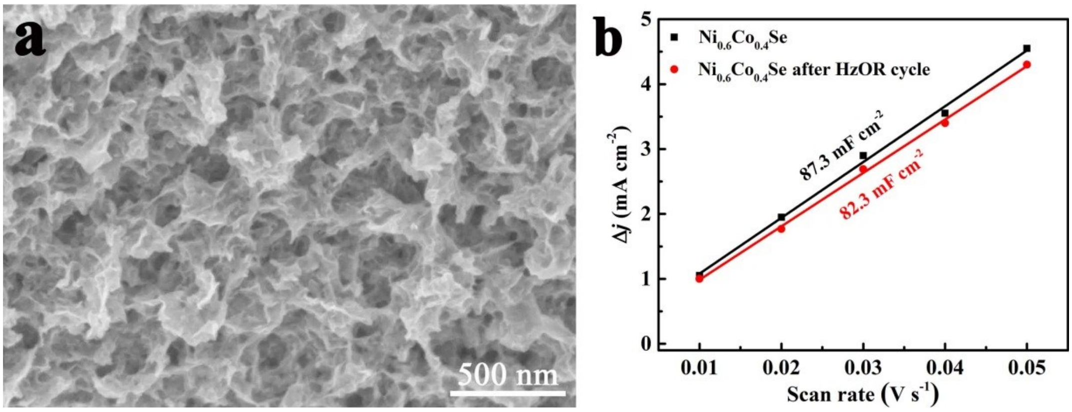

Fig. S9 a) SEM images of used $Ni_{0.6}Co_{0.4}Se$ after HzOR cycle in 1.0 M KOH with 3.0 M $N_2H_4 \cdot H_2O$ at 200 mA cm^{-2} for 20000 s, **b)** capacitive current densities of fresh and used $Ni_{0.6}Co_{0.4}Se$ after HzOR cycles as a function of scan rate ($\Delta j = |j_a - j_c|/2$).

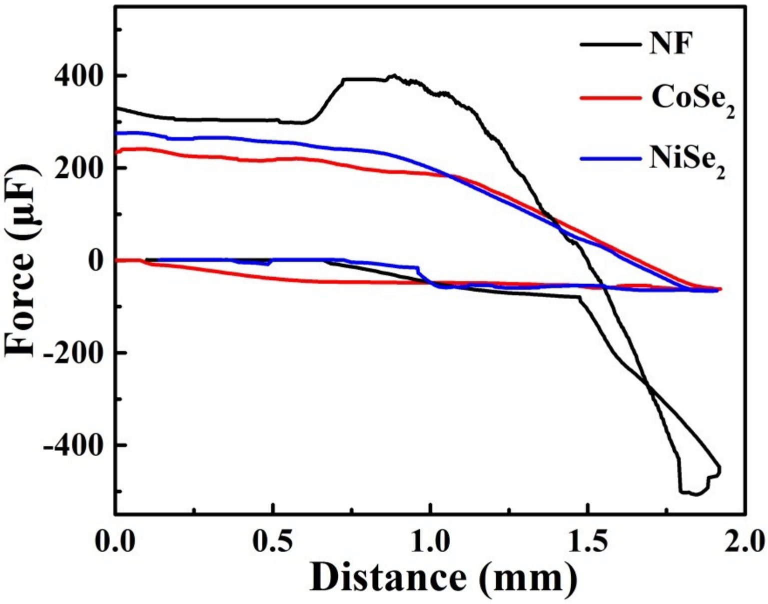

Fig. S10 a) Adhesive force measurements of the gas bubbles on NF, $CoSe_2$ and $NiSe_2$ surface

Table S1. Comparision of OER performance of $Ni_{0.6}Co_{0.4}Se$ with other non-noble metal-based electrocatalysts.

Catalysts	Current density (mA cm^{-2})	Overpotential (mV)	Tafel slope (mV dec^{-1})	Ref.
$(Ni,Co)Se_2/CC$	10	256	74	[S1]
$CoSe_2/CC$	10	297	41	[S2]
$(Ni,Co)_{0.85}Se/NF$	20	287	87	[S3]
$EG/Co_{0.85}Se/NiFe\text{-}LDH$	10	250	57	[S4]
$NiCoSe_2/NF$	10	274	61	[S5]
$Co(S_{0.22}Se_{0.78})_2/CF$	10	270	65.6	[S6]
Ni_5P_4/Ni foil	10	290	40	[S7]
$Co_3O_4@MoS_2$	10	269	58.9	[S8]
$Ni_{0.6}Co_{0.4}Se/NF$	**10**	**249**	**53**	**This work**

Table S2. Comparision of HzOR performance of $Ni_{0.6}Co_{0.4}Se$ with other non-noble metal-based electrocatalysts.

samples	electrolyte	j (mA cm^{-2})	E (V vs. RHE)	Onset Potential (V)	Ref.
$NiCoSe_2$/NF	0.5 M KOH, 0.1 M $N_2H_4 \cdot H_2O$	40	0.6	0.15	[S9]
Ni_3Se_4/NF	1.0 M KOH, 0.5 M $N_2H_4 \cdot H_2O$	75	0.4	0.15	[S10]
$CoSe_2$	1.0 M KOH, 0.1 M $N_2H_4 \cdot H_2O$	120	0.4	0.025	[S11]
NiS/NF	1.0 M KOH, 0.02 M $N_2H_4 \cdot H_2O$	125	0.4	0.1	[S12]
NiFeP/NM	1.0 M KOH, 0.5 M $N_2H_4 \cdot H_2O$	200	0.3	0.00	[S13]
$Ni_{0.6}Co_{0.4}Se$/NF	**1.0 M KOH, 0.1 M $N_2H_4 \cdot H_2O$**	**300**	**0.4**	**0.025**	**This work**

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