Electronic Supplementary Information

Hydrothermal synthesis of ternary $MoS_{2x}Se_{2(1-x)}$ nanosheets for electrocatalytic hydrogen evolution

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Supplementary Figures and Tables

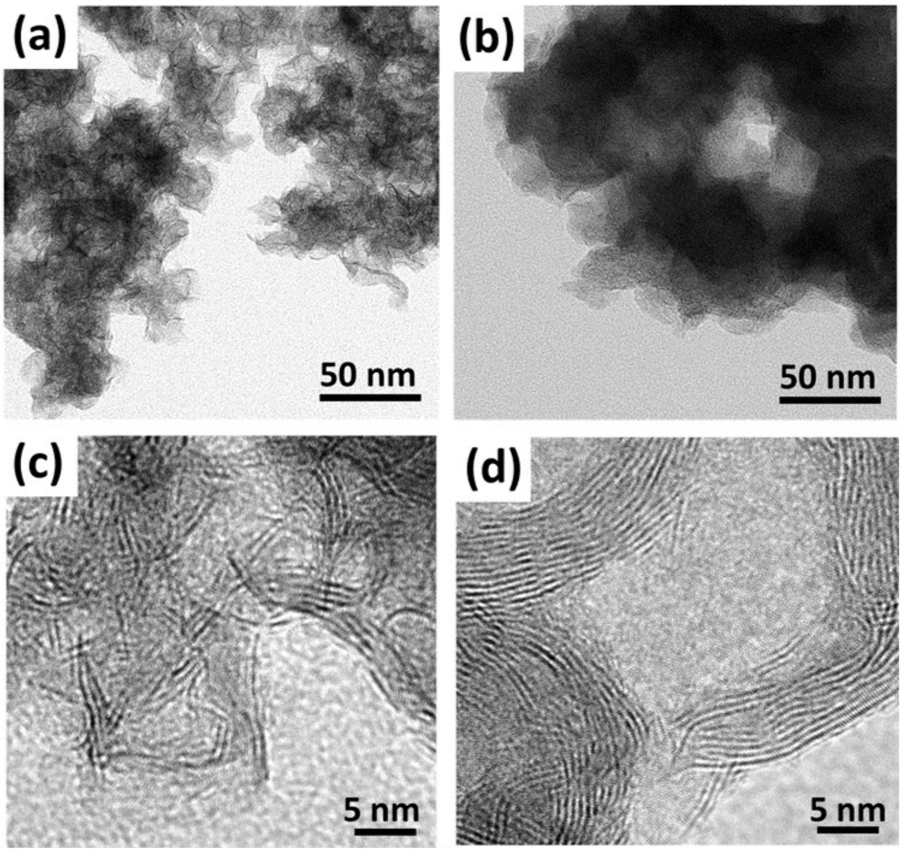

Fig. S1 (a) TEM and (b) HRTEM images of $MoSe_2$, (c) TEM and (d) HRTEM images of MoS_2.

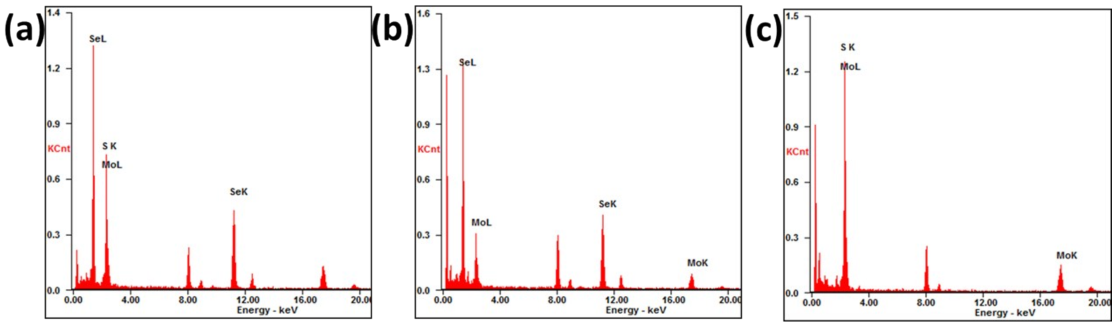

Fig. S2 EDX spectra of the (a) $MoS_{2x}Se_{2(1-x)}$ (b) $MoSe_2$ and (c) MoS_2.

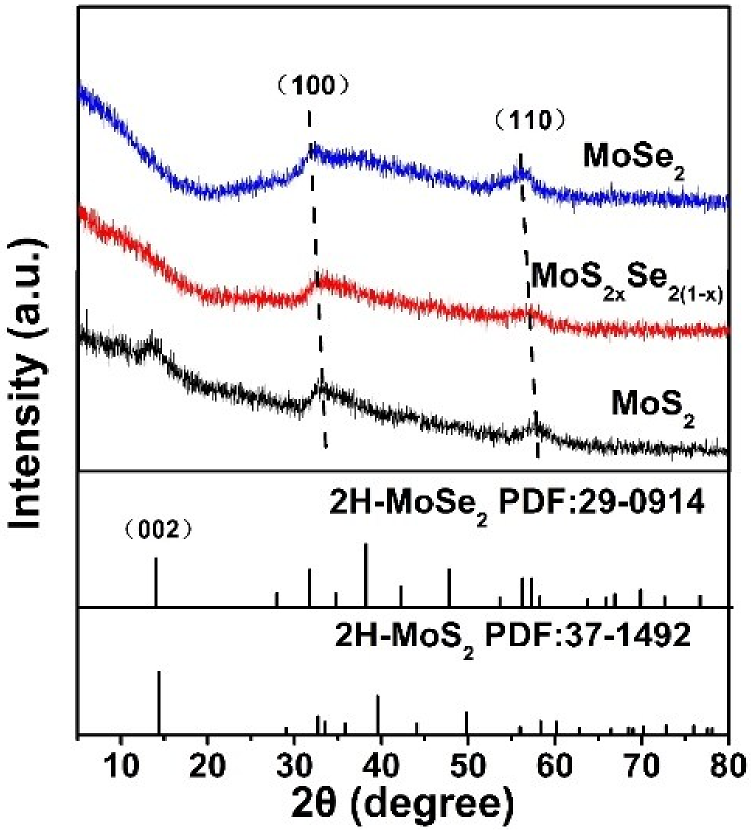

Fig. S3 XRD patterns of $MoS_{2x}Se_{2(1-x)}$, $MoSe_2$ and MoS_2.

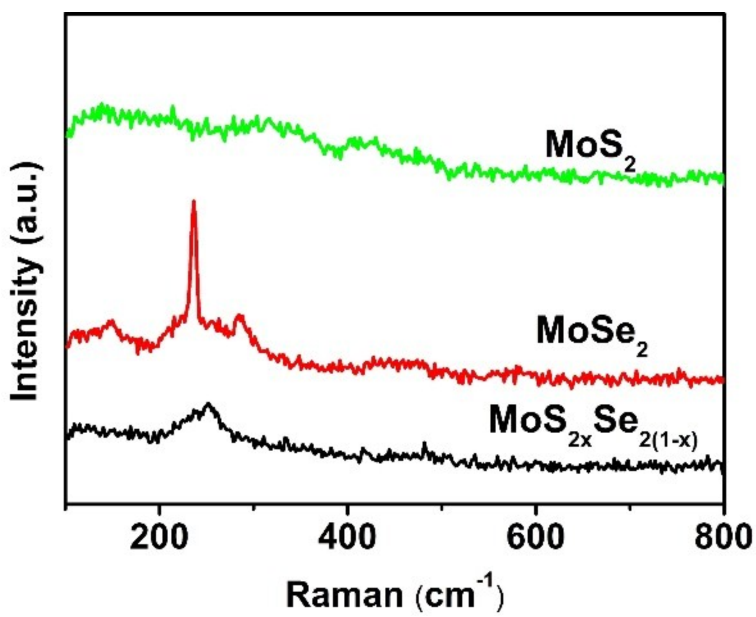

Fig. S4 Raman spectra of $MoS_{2x}Se_{2(1-x)}$, $MoSe_2$ and MoS_2.

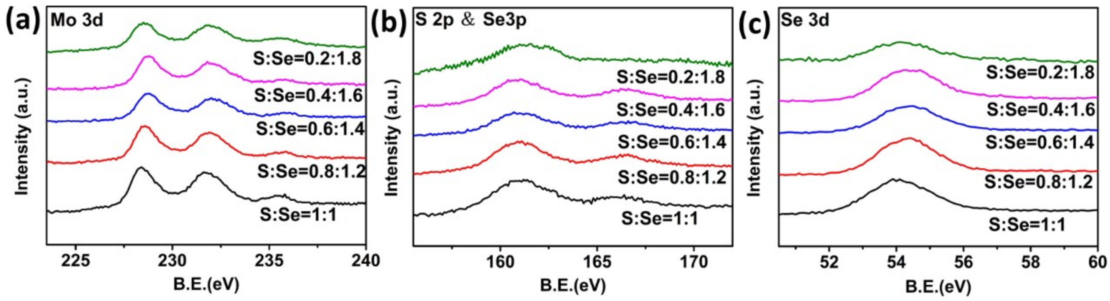

Fig. S5 High resolution XPS spectra of (a) Mo 3d, (b) S 2p and Se 3p, and (c) Se 3d regions of of the five $MoS_{2x}Se_{2(1-x)}$ samples.

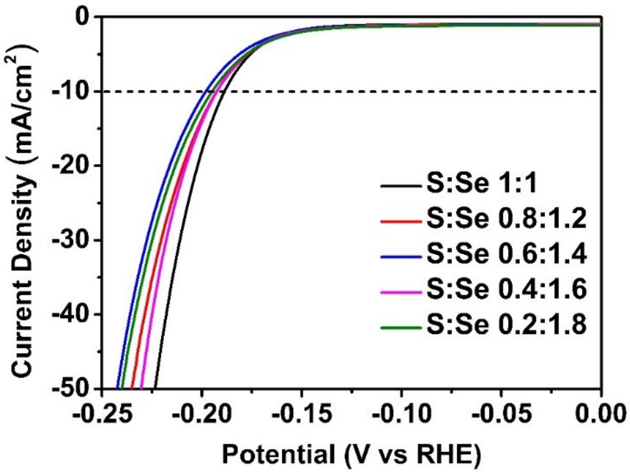

Fig. S6 Linear sweep voltammetry curves (after *iR* correction) of five $MoS_{2x}Se_{2(1-x)}$ products prepared from different molar ratios of S and Se (the total amount of S and Se powder was 2 mmol).

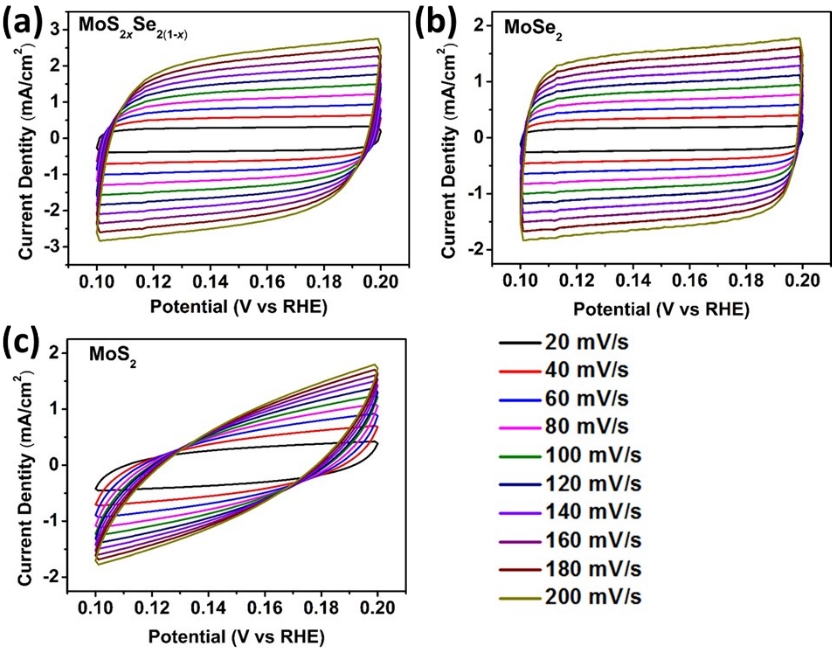

Fig. S7 Cyclic voltammetry curves of $MoS_{2x}Se_{2(1-x)}$, $MoSe_2$ and MoS_2 under different scan rate, in the region of 0.1-0.2 V vs. RHE. These data were used to present the plots showing the extraction of the C_{dl} as shown in Fig. 4(c) in the main text.

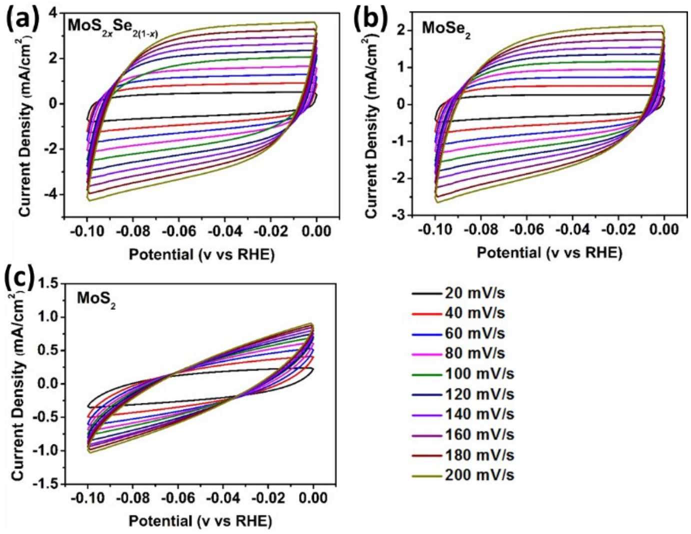

Fig. S8 Cyclic voltammetry curves of $MoS_{2x}Se_{2(1\text{-}x)}$, $MoSe_2$ and MoS_2 under different scan rates in the range of 0 ~ -0.1 V vs. RHE.

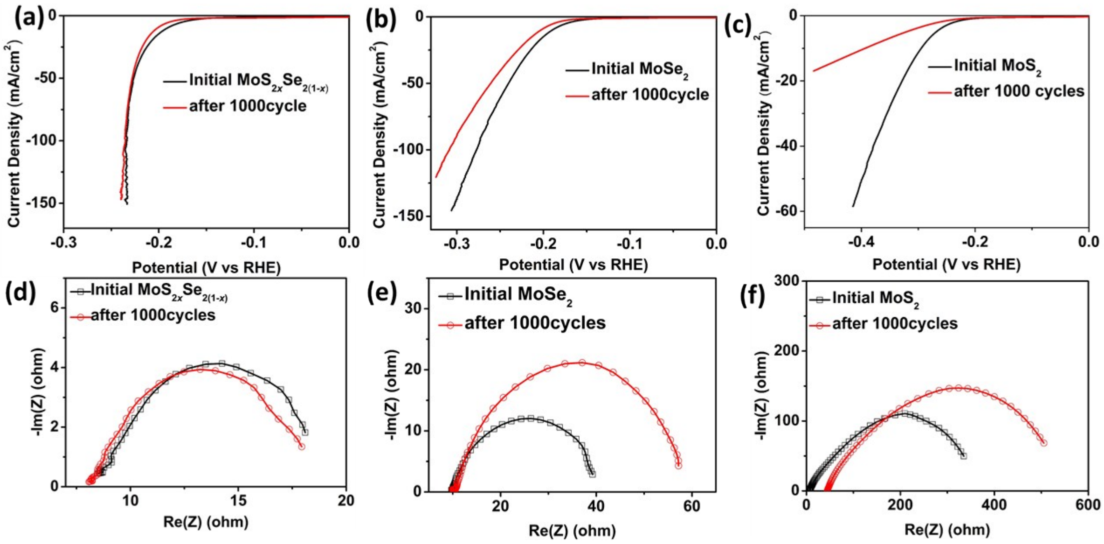

Fig. S9 Stability tests of the as-prepared materials. Polarization curves before and after 1000 cycles of (a) $MoS_{2x}Se_{2(1\text{-}x)}$, (b) $MoSe_2$ and (c) MoS_2; Electrochemical impedance spectroscopy (EIS) Nyquist plots for before and after 1000 cycles of (a) $MoS_{2x}Se_{2(1\text{-}x)}$, (b) $MoSe_2$ and (c) MoS_2.

Table S1 A brief survey of $MoS_{2x}Se_{2(1-x)}$, $MoSe_2$ and MoS_2 HER electrocatalysts reported in literature.

Catalyst	η/mV (at -10 mA cm^{-2})	Tafel slope (mV dec^{-1})	Ref
$MoS_{2x}Se_{2(1-x)}$ nanosheets	188	43	this work
$MoSe_2$ nanosheets	221	58	this work
MoS_2 nanosheets	268	68	this work
$MoS_{2x}Se_{2(1-x)}$ Nanotubes	219	55	1
Se-doped MoS_2 nanosheet	-	55	2
3D $MoS_{2(1-x)}Se_{2x}$/CF	183	55.5	3
Ultrathin $MoS_{2(1-x)}Se_{2x}$ nanoflakes	164±2	48±2	4
few-layer alloys of $MoS_{2(1-x)}Se_{2x}$	-	56	5
$MoS_{2(1-x)}Se_{2x}$	141	67	6
monolayered $MoS_{2(1-x)}Se_{2x}$	273	119	7
MoSSe/rGO	153	51	8
$MoS_{2(1-x)}Se_{2x}$ nanobelts	-	65	9
Se–MoS_2/CC	127	63	10
Active-site-rich MoS_2	220	53.5	11
Oxygen-incorporated MoS_2 nanosheets	-	55	12
2H c-MoS_2	191	64	13
a few layer MoS_2 nanodots	-	61	14
mesoporous MoS_2/Co foam	156	74	15
MoS_2/Graphene	110	67.4	16
Ultra-thin and porous $MoSe_2$ nanosheets	150	80	17
$MoSe_2$/carbon fiber paper	250	59.8	18
Mo-rich $MoSe_2$ nanosheets	-	98	19
$MoSe_2$/graphene	-	69	20
$MoSe_2$/graphene	195	67	21

Table S2 Summary of the *x* value from XPS analyses for the five $MoS_{2x}Se_{2(1-x)}$ samples using different molar ratios of S and Se in the hydrothermal synthesis.

molar ratio of S and Se	*x* value of $MoS_{2x}Se_{2(1-x)}$
1:1	0.68
0.8:1.2	0.65
0.6:1.4	0.66
0.4:1.6	0.65
0.2:1.8	0.62

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