

Electronic Supplementary Material (ESI) for Nanoscale.

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Electronic Supporting Information

MoSe₂ Nanosheets/MoO₂ Nanobelts/Carbon Nanotubes Membrane as Flexible and Multifunctional Electrodes for Full Water Splitting in Acidic Electrolyte

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Table S1. The comparison of MoSe₂-based HER electrocatalysts reported in acid electrolyte.

Catalysts	η_{onset} (mV vs. RHE)	η_{10} (mV)	Tafel slope (mV dec ⁻¹)	Reference
MoSe ₂ NSs/MoO ₂ NBs/CNTs-M (3D electrode)	□-23	97	69.4	This work
MoSe ₂ film (3D electrode)	-200	>400	105-120	Nano Lett. 2013, 13, 1341
MoSe ₂ /carbon cloth (3D electrode)	-150	220	76	Sci. Rep. 2016, 6, 22516
CNT@MoSe ₂ (powder)	-70	178	58	Nanoscale, 2015, 7, 18595
MoSe ₂ on carbon fiber paper (3D electrode)	-110	250	59.8	Nano Lett. 2013, 13, 3426
MoSe ₂ /RGO (powder)	-50	150	69	J. Mater. Chem. A, 2014, 2, 360
MoSe ₂ /carbon fiber aerogel (powder)	-104	179	62	ACS Appl. Mater. Interfaces 2016, 8, 7077
MoSe ₂ /grapheme (3D electrode)	-50	159	61	Small, 2015, 11, 414
Carbonized bacterial cellulose/MoSe ₂ (3D electrode)	-91	-	55	Small, 2017, 13, 1602866
MoSe ₂ /Mo core-shell nanoscrews MoSe ₂ /Mo core-shell nanoscrews (3D electrode)	-89	166	34.7	Adv. Mater. 2016, 28, 9831
MoSe ₂ -porous carbon fiber (powder)	-40	-	65	Adv. Mater. Interfaces 2017, 1600825

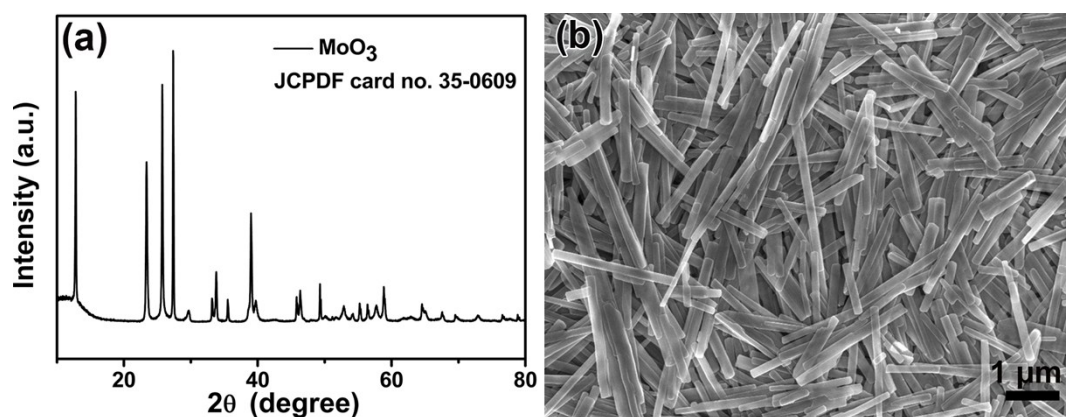


Fig. S1 XRD (a) and SEM image (b) of MoO_3 nanobelts.

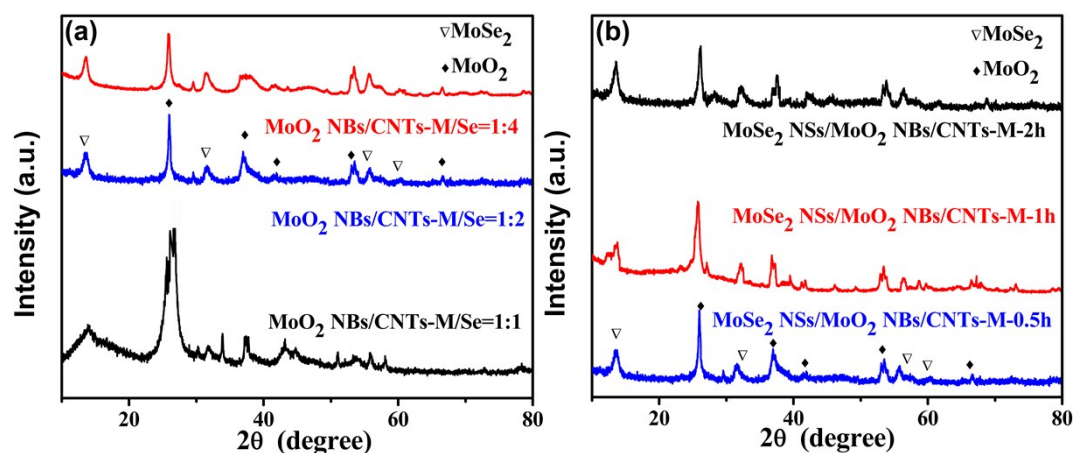


Fig. S2 XRD of MoSe_2 NSs/ MoO_2 NBs/CNTs-M obtained by changing amount of selenium (quality ratio of MoO_2 NBs/CNTs/Se-1:1 (black line), -1:2 (blue line), -1:4 and blue line (red line) (a) and holding at this quality ratio of 1:2 for various selenylation times (0.5 h, 1.0 h or 2.0 h) (b).

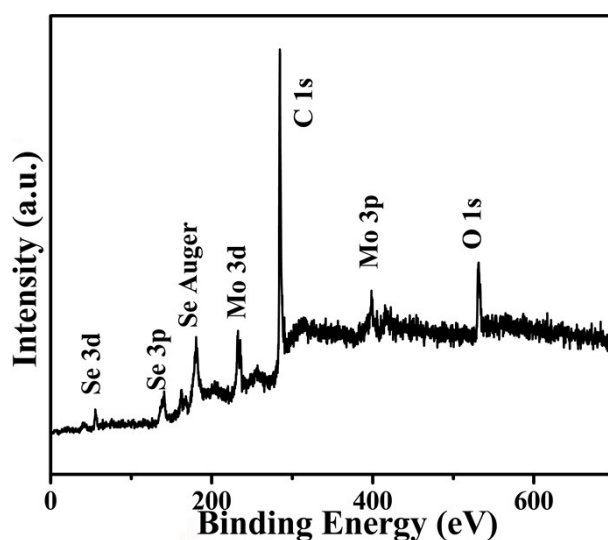


Fig. S3 The XPS survey spectra of the MoSe_2 NSs/ MoO_2 NBs/CNTs-M.

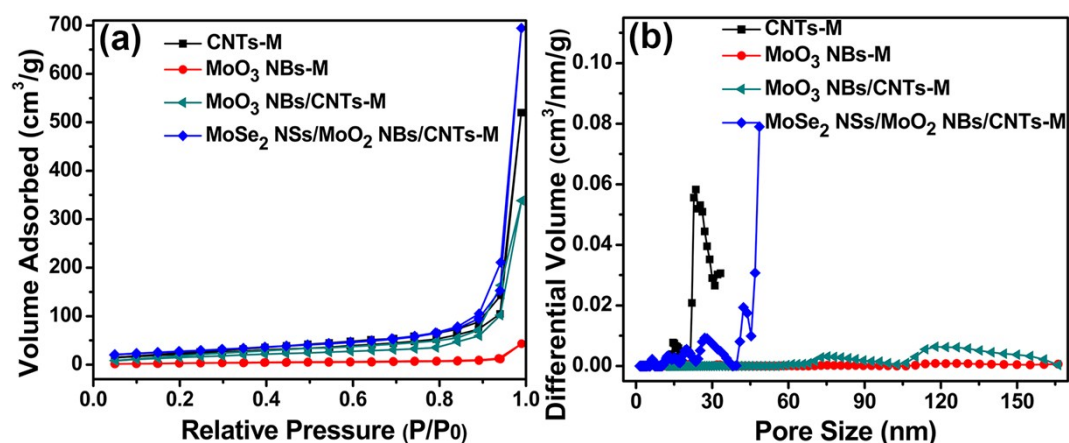


Fig. S4 (a) Nitrogen adsorption-desorption isotherm and (b) pore size distributions of CNTs-M, MoO₃ NBs-M, MoO₃ NBs/CNTs-M, and MoSe₂ NSs/MoO₂ NBs/CNTs-M.

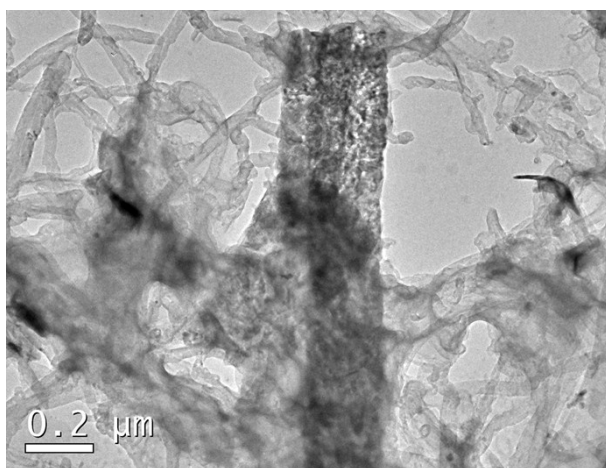


Fig. S5 TEM images of MoSe₂ NSs/MoO₂ NBs/CNTs-M.

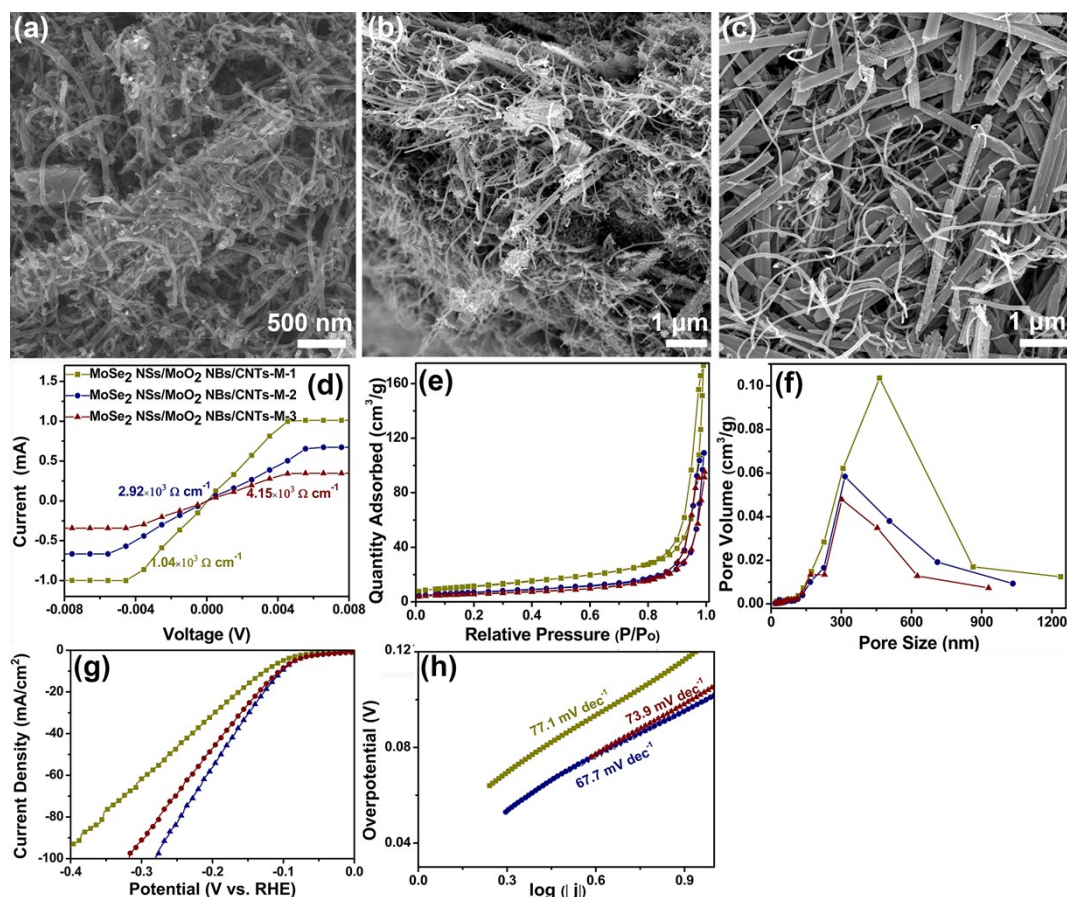


Fig. S6 SEM images of (a) MoSe₂ NSs/MoO₂ NBs/CNTs-M-1, (b) MoSe₂ NSs/MoO₂ NBs/CNTs-M-2 and (c) MoSe₂ NSs/MoO₂ NBs/CNTs-M-3. (d) Current–voltage (I–V) characteristic, (e) Nitrogen adsorption-desorption isotherm, (f) Pore size distributions, (g) LSV curves and (h) according Tafel of MoSe₂ NSs/MoO₂ NBs/CNTs membrane derived from precursors regulated by mass ratio between MoO₃ NBs and CNTs, which were 1:1(MoSe₂ NSs/MoO₂ NBs/CNTs-M-1), 5:1(MoSe₂ NSs/MoO₂ NBs/CNTs-M-2), and 15:1(MoSe₂ NSs/MoO₂ NBs/CNTs-M-3), respectively.

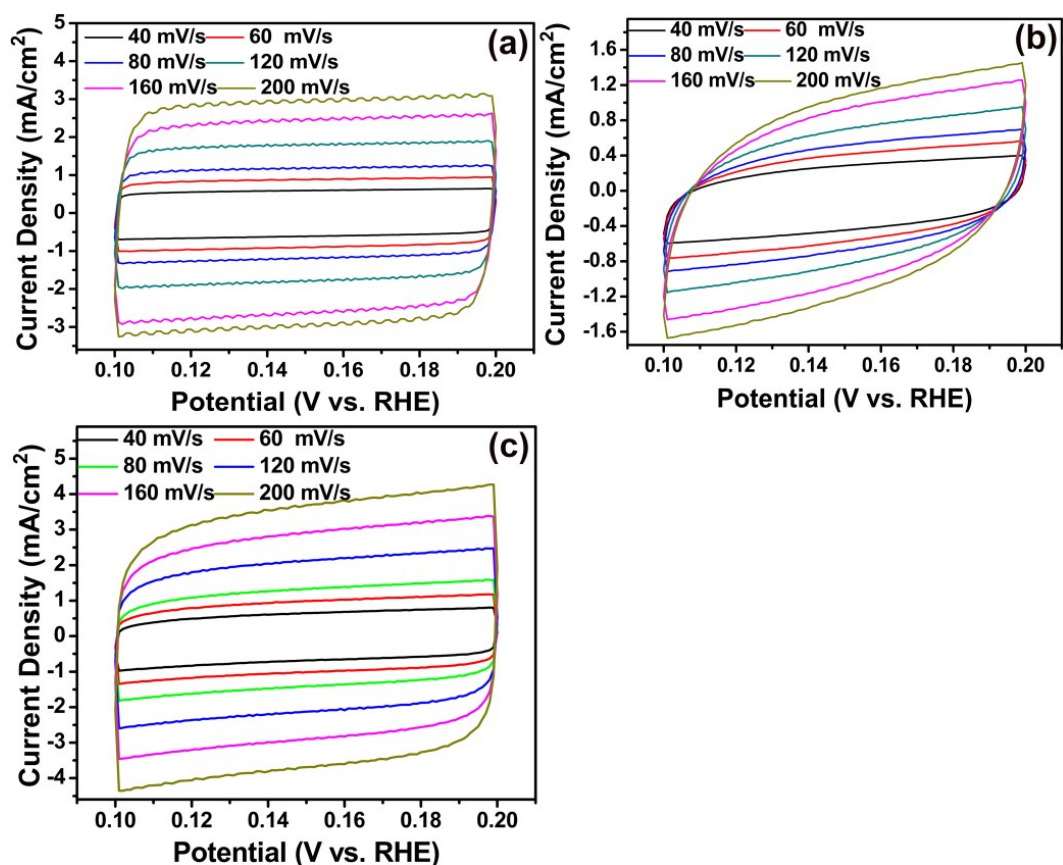


Fig. S7 The CVs curves under various scan rates of CNTs-M (a), MoSe₂ NSs/MoO₂ NBs-M (b) and MoSe₂ NSs/MoO₂ NBs/CNTs-M (c).

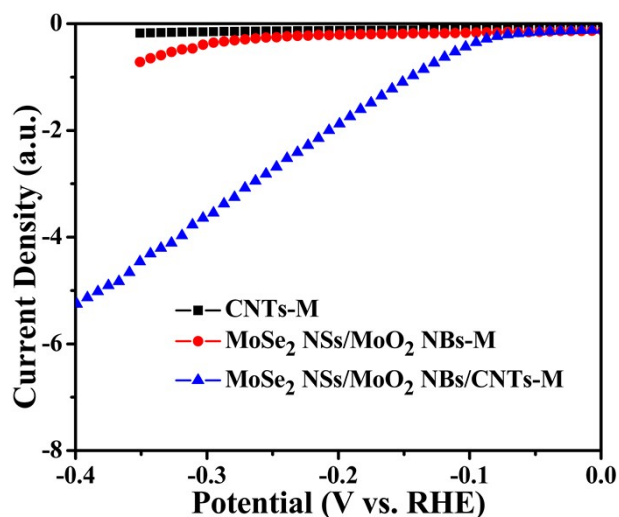


Fig. S8 Polarization curves of MoSe₂ NSs/MoO₂ NBs/CNTs-M, CNTs-M, MoSe₂ NSs/MoO₂ NBs-M. The current density (y axis) was obtained by normalizing the HER currents to the respective electrochemical surface area.

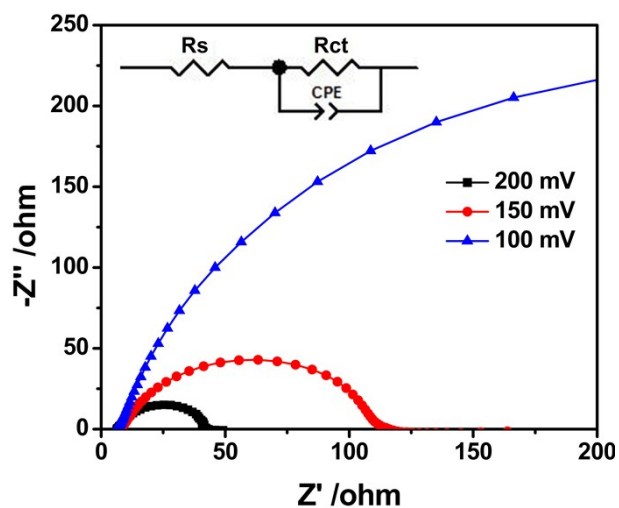


Fig. S9 Nyquist plots of MoSe₂ NSs/MoO₂ NBs/CNTs-M at various overpotentials (Inset shows equivalent circuit diagram).

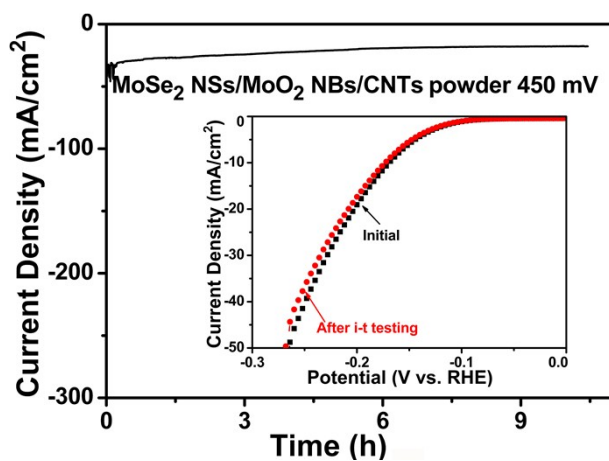


Fig. S10 Chronoamperometric response for MoSe₂ NSs/MoO₂ NBs/CNTs powder (Inset shows Polarization curves of MoSe₂ NSs/MoO₂ NBs/CNTs powder before and after i-t testing).

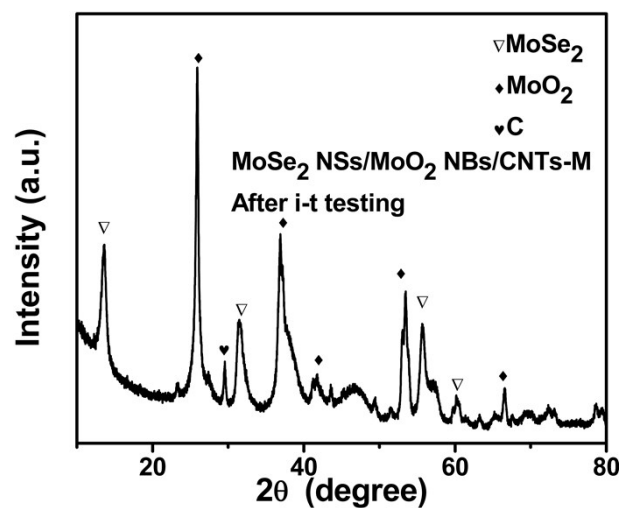


Fig. S11 The crystal structure of MoSe₂ NSs/MoO₂ NBs/CNTs-M after i-t testing.

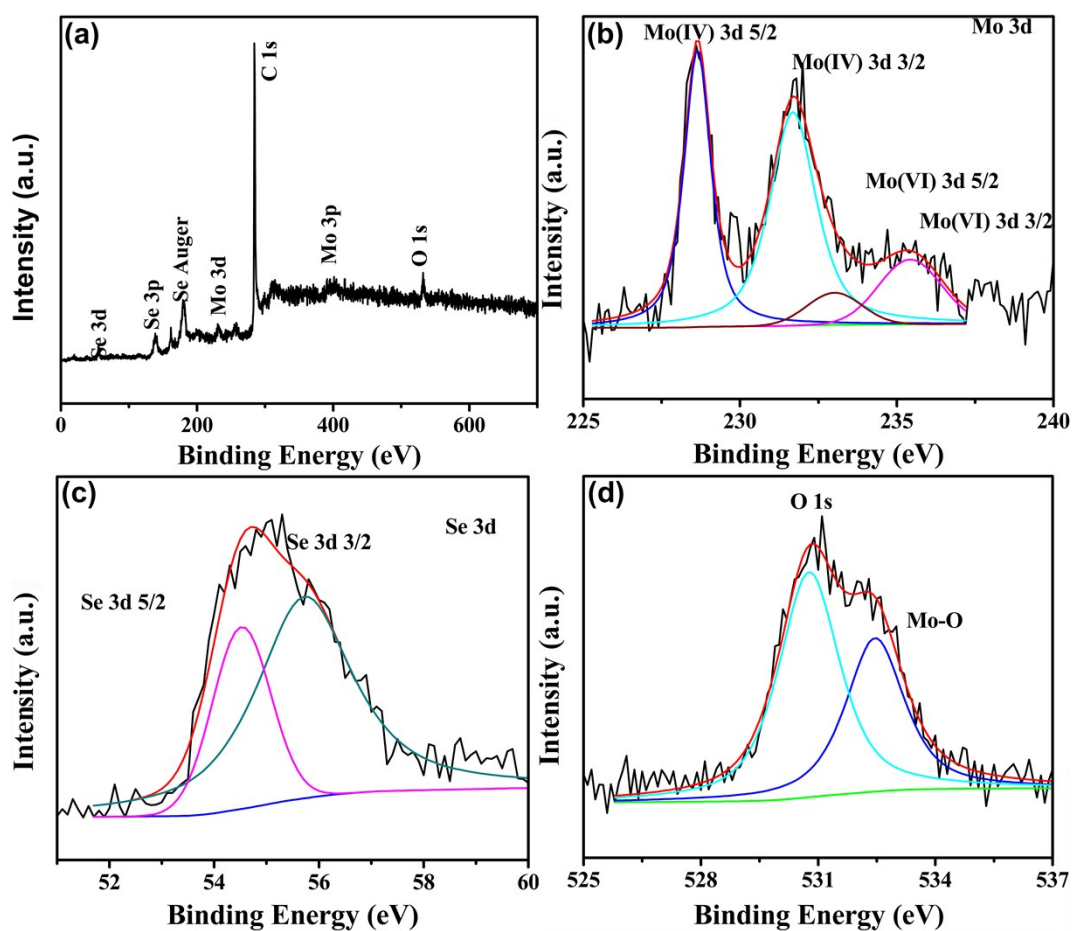


Fig. S12 The XPS of MoSe₂ NSs/MoO₂ NBs/CNTs-M after i-t testing.

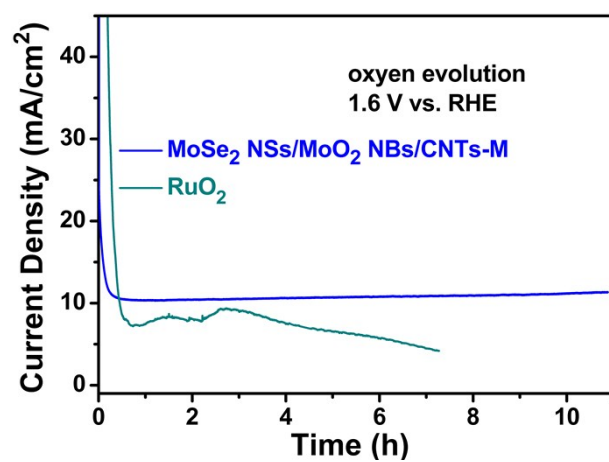


Fig. S13 Chronoamperometric records of MoSe₂ NSs/MoO₂ NBs/CNTs-M and RuO₂ in 0.5 M H₂SO₄.