Supporting Information

Elemental Selenium Enables Enhanced Water Oxidation Electrocatalysis of NiFe Layered Double Hydroxides

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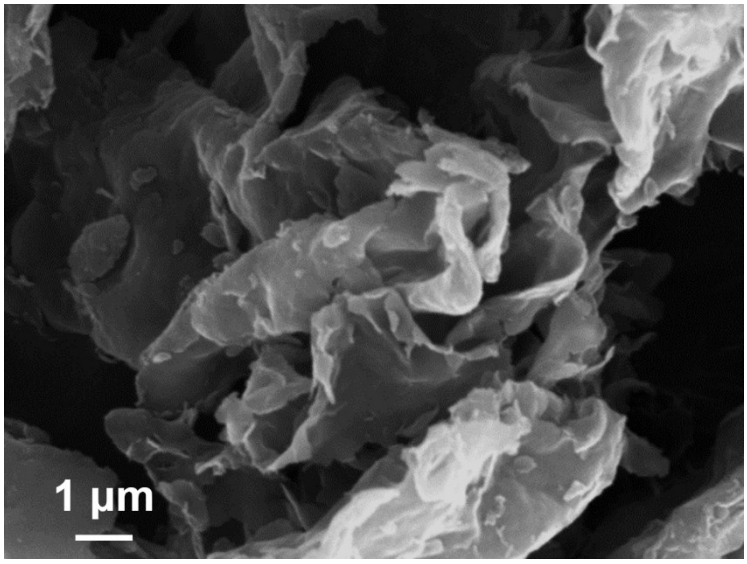

Figure S1. SEM image of $Ni_{0.8}Fe_{0.2}$-LDH.

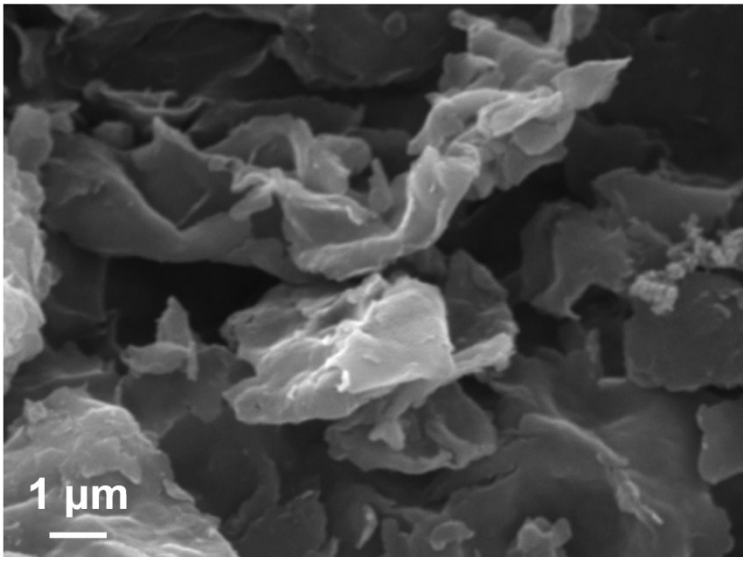

Figure S2. SEM image of $Ni_{0.8}Fe_{0.2}$-t-$Se_{0.02}$-LDH.

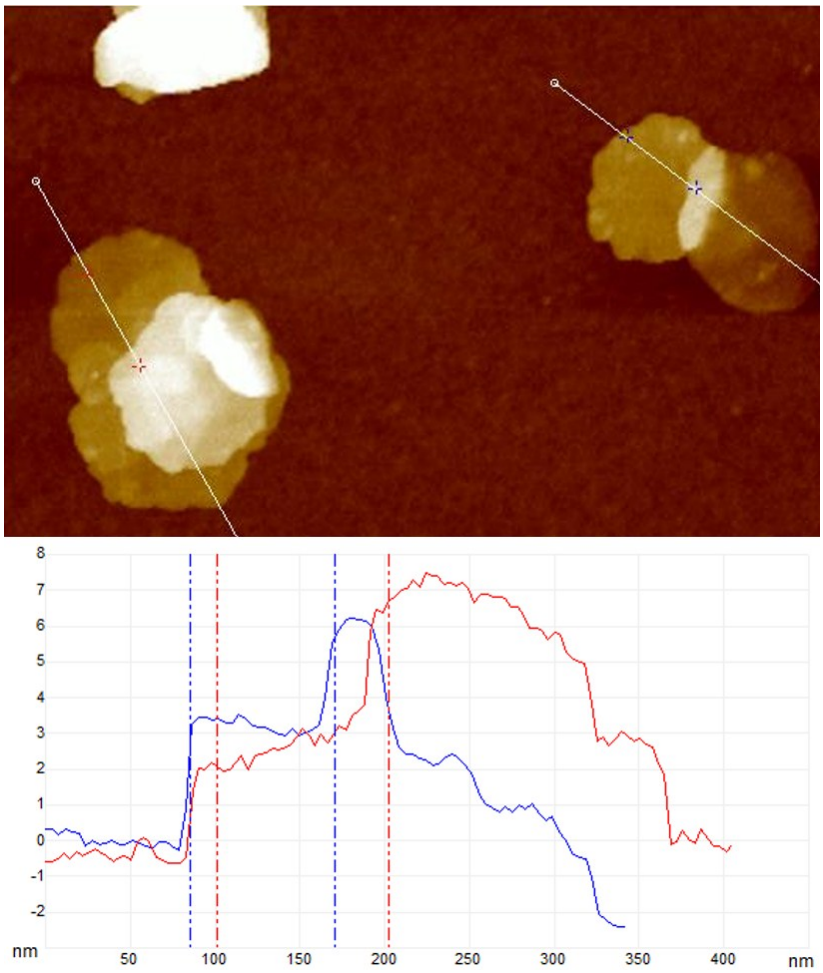

Figure S3. AFM image of $Ni_{0.8}Fe_{0.2}$-t-$Se_{0.02}$-LDH.

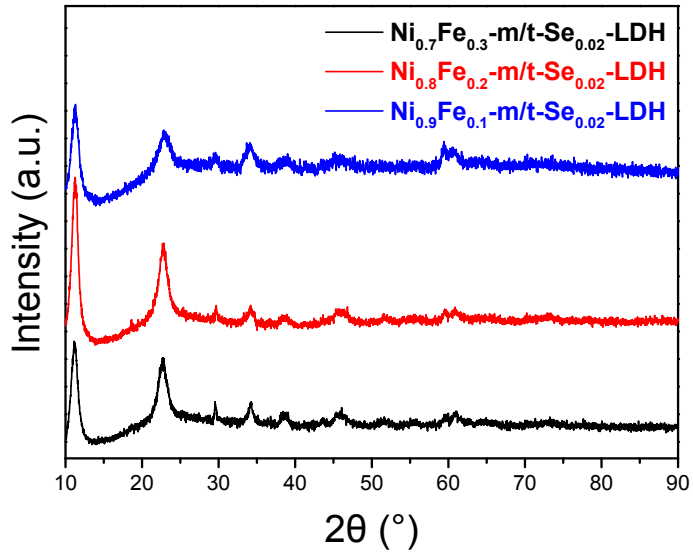

Figure S4. XRD patterns of NiFe-m/t-Se-LDH with different Ni/Fe ratios.

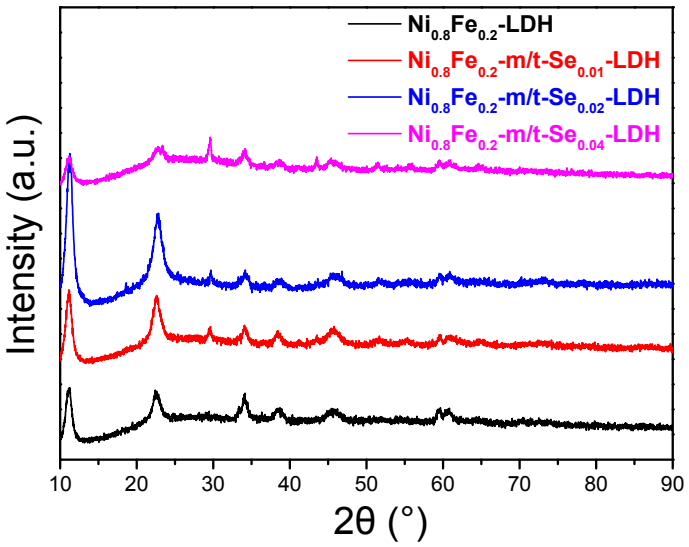

Figure S5. XRD patterns of $Ni_{0.8}Fe_{0.2}$-m/t-Se-LDH with different doping amounts of m/t-Se.

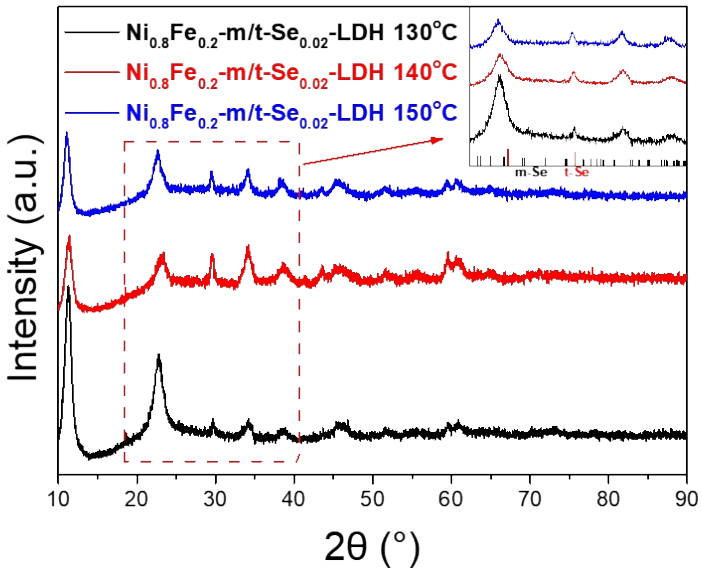

Figure S6. XRD patterns of $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH with different hydrothermal temperatures at 130°C, 140°C and 150°C; insert figure: Partial enlarged XRD patterns of $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH with different hydrothermal temperatures.

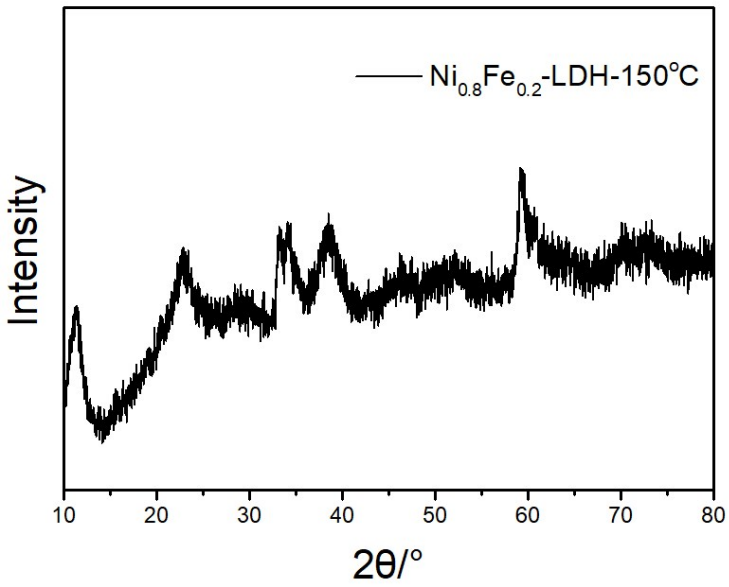

Figure S7. XRD pattern of $Ni_{0.8}Fe_{0.2}$-LDH with the hydrothermal temperature of 150 °C.

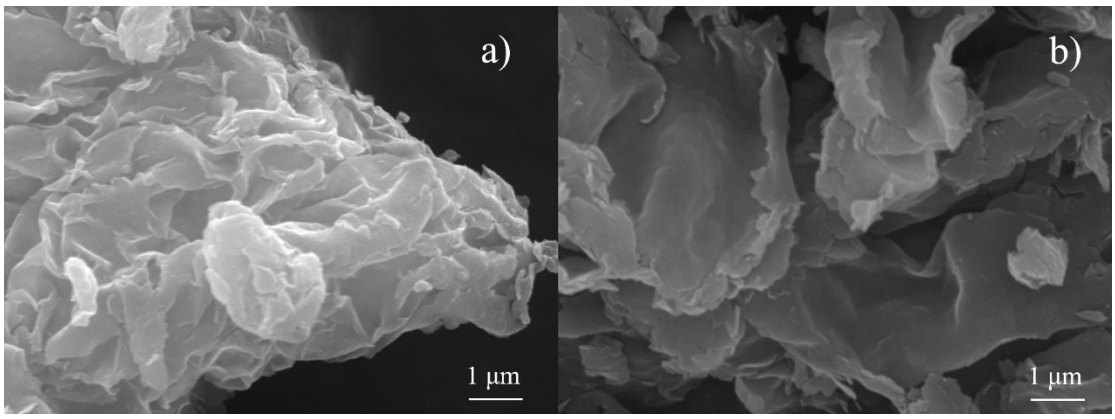

Figure S8. SEM images of (a) $Ni_{0.8}Fe_{0.2}$-LDH and (b) $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH with the hydrothermal temperature of 150 °C.

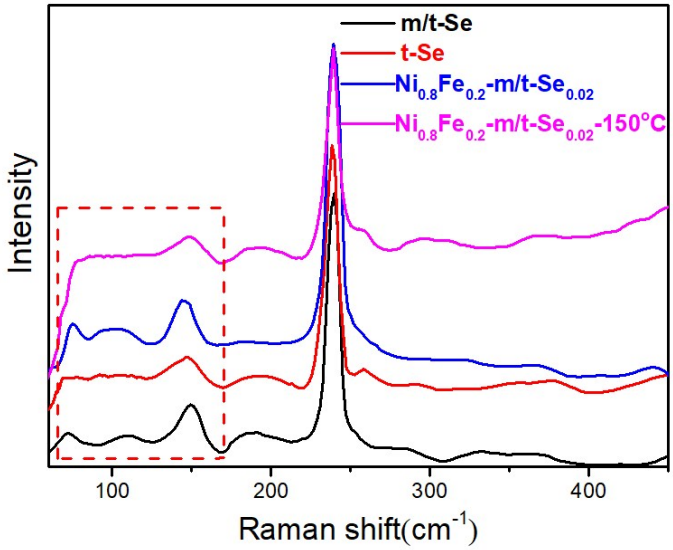

Figure S9. Raman spectra of m/t-Se(black line), t-Se(red line), $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH(blue line) and $Ni_{0.8}Fe_{0.2}$-t-$Se_{0.02}$-LDH(pink line).

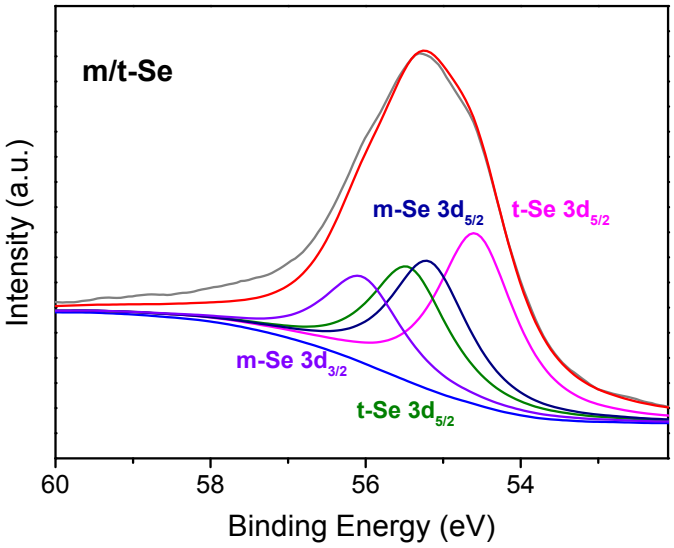

Figure S10. High-resolution Se 3d XPS spectrum of m/t-Se.

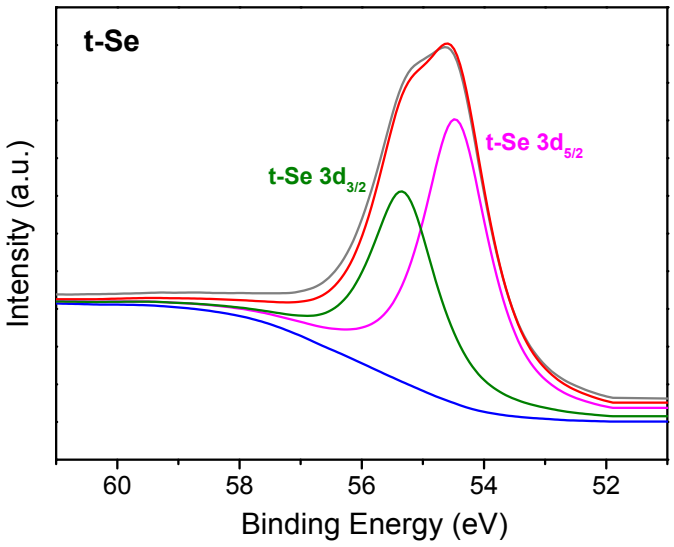

Figure S11. High-resolution Se 3d XPS spectrum of t-Se.

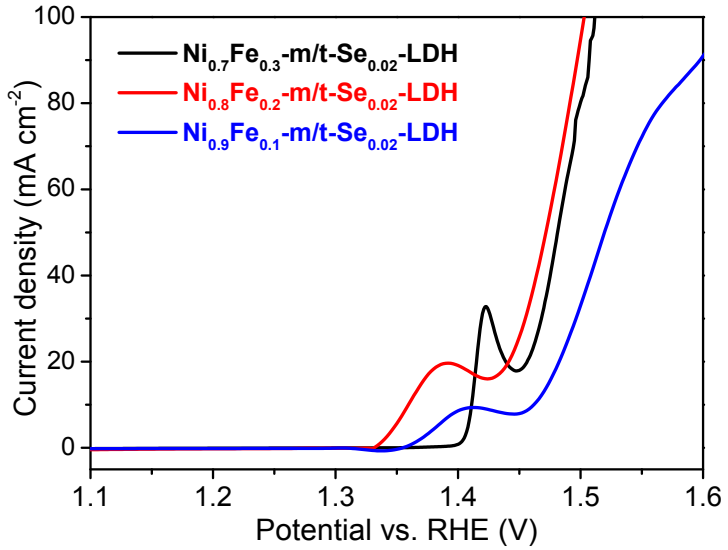

Figure S12. OER polarization curves of NiFe-m/t-Se-LDH catalysts with different Ni/Fe ratios.

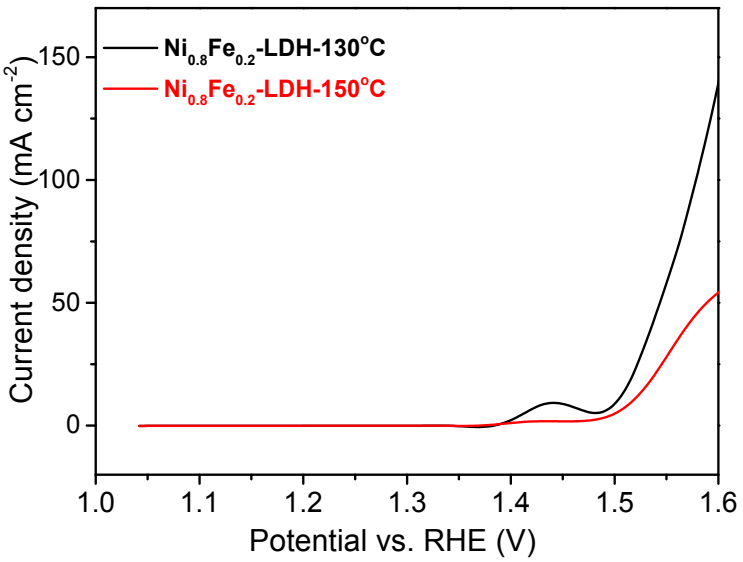

Figure S13. OER polarization curves of NiFe-LDH catalysts with different synthesis temperatures.

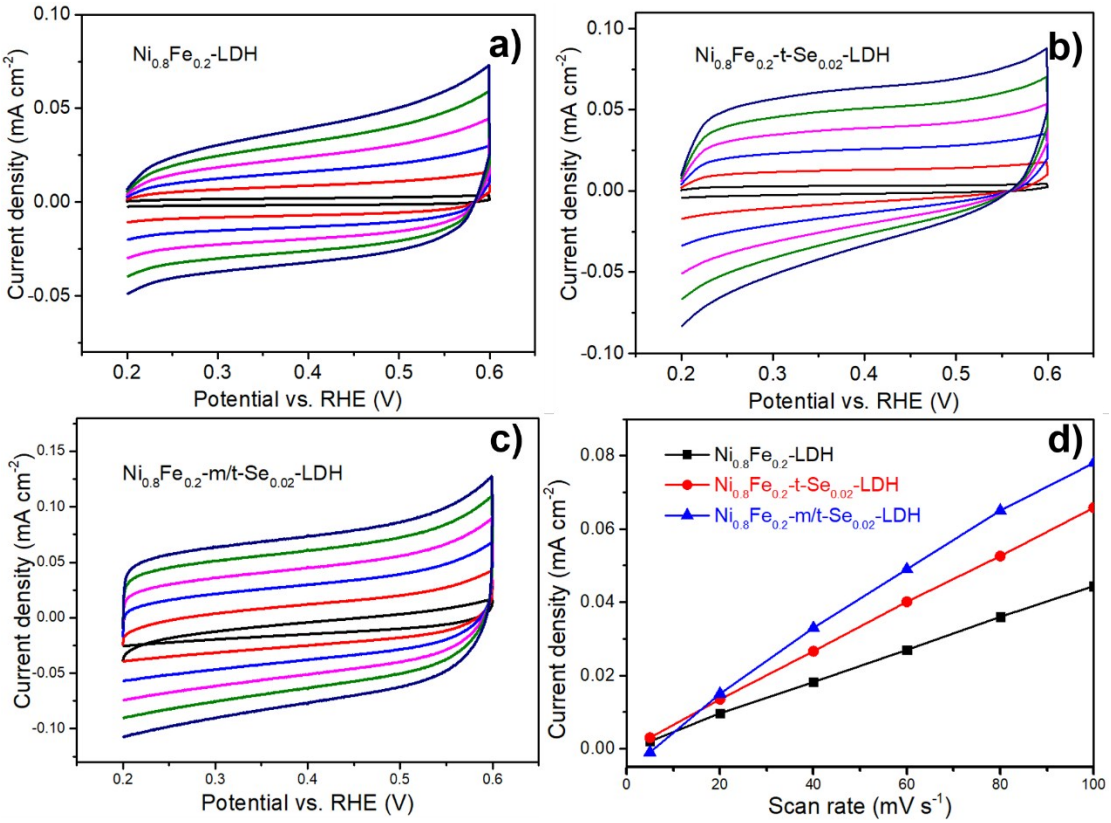

Figure S14. Non-Faradaic cyclic voltammograms of (a) $Ni_{0.8}Fe_{0.2}$ -$Se_{0.02}$-LDH, (b) $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH, and (c) $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH in 1.0 M KOH electrolyte at scan rate of 5, 20, 40, 60, 80, and 100 mV/s. (d) Anodic and cathodic current densities at 0.45 V versus the scan rate.

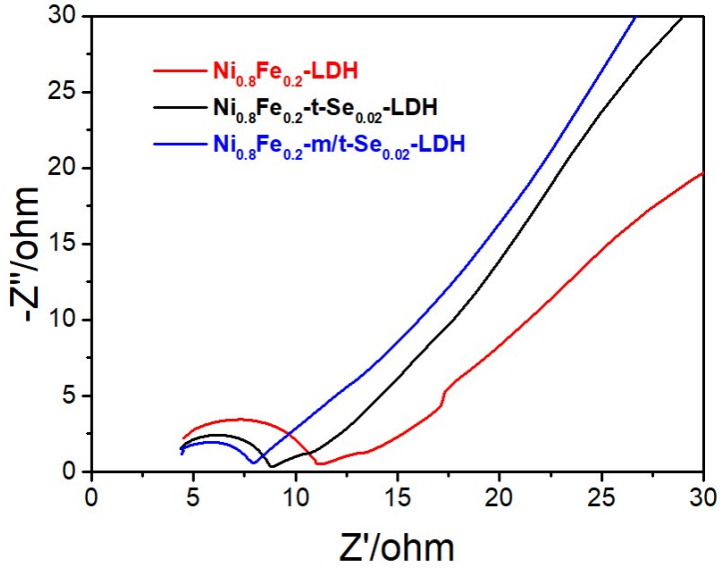

Figure S15. EIS plots of $Ni_{0.8}Fe_{0.2}$-LDH, $Ni_{0.8}Fe_{0.2}$-t-$Se_{0.02}$-LDH, and $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH

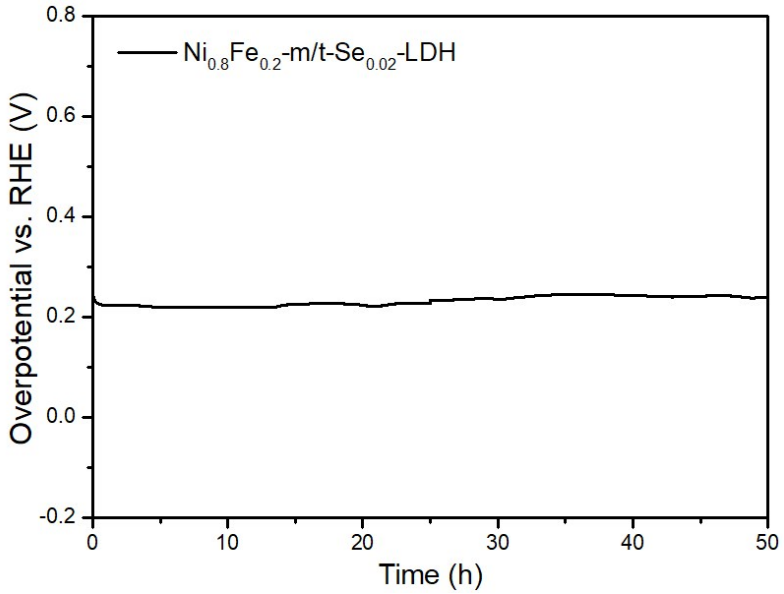

Figure S16. Chronopotentiometric curve for $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH in 1.0 M KOH electrolyte for 50 h.

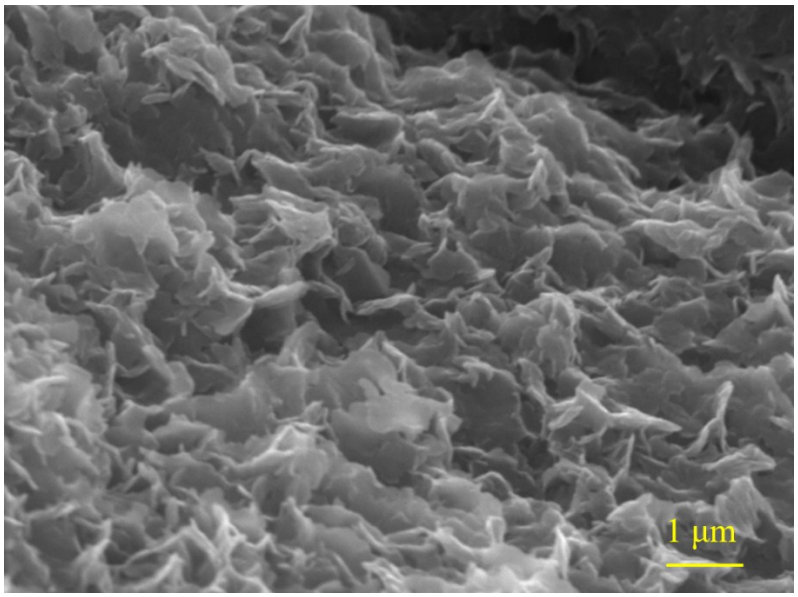

Figure S17. SEM image of $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.22}$-LDH after OER measurement.

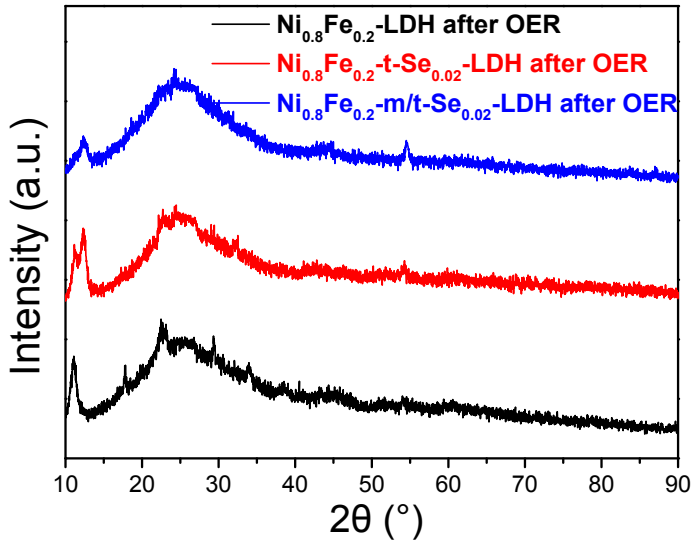

Figure S18. XRD patterns of the studied catalysts after OER measurement

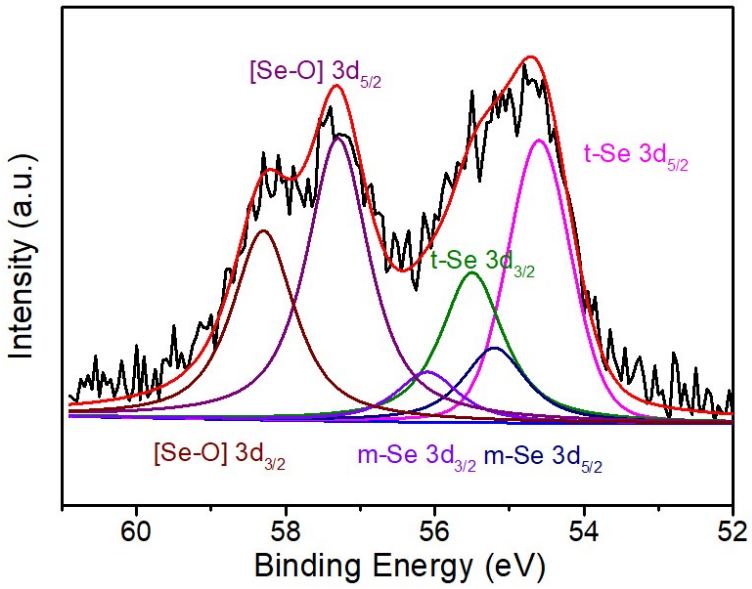

Figure S19. High-resolution Se 3d XPS spectrum of $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.22}$-LDH after OER measurement

Figure S20. The photograph of electrochemical overall water splitting cell ($Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.02}$-LDH//Pt/C).

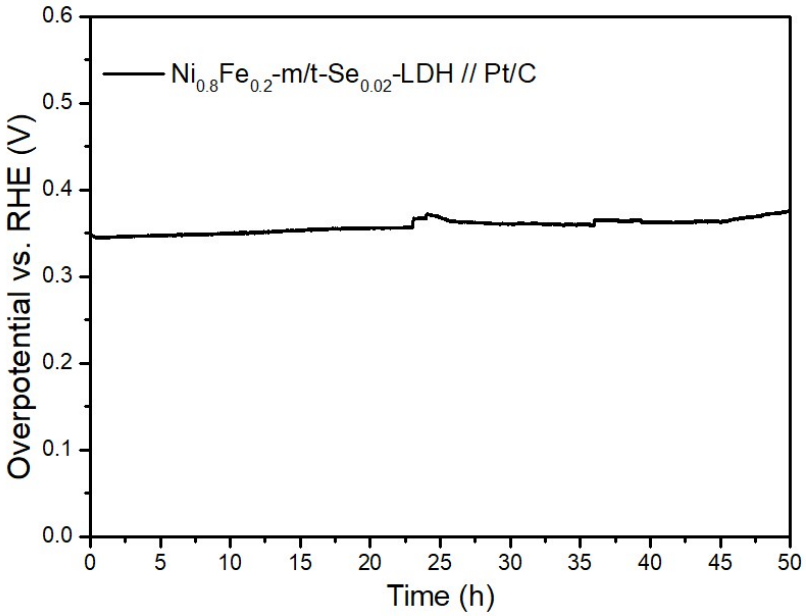

Figure S21. Overall water splitting polarization curves of $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.22}$-LDH//Pt in 30 wt% KOH electrolyte for 50 h.

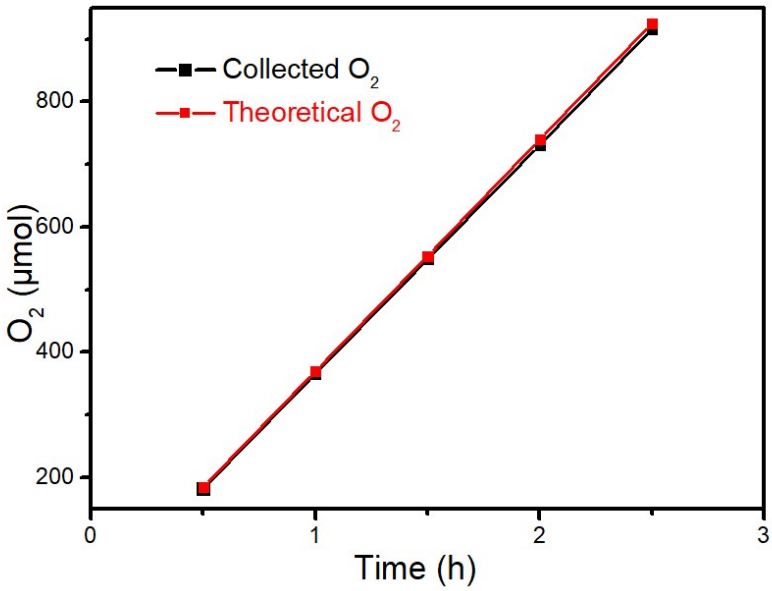

Figure S22. The amount of theoretically calculated (red line) and experimentally measured (black line) oxygen versus time for $Ni_{0.8}Fe_{0.2}$-m/t-$Se_{0.22}$-LDH in 1.0 M KOH electrolyte.

Table S1. Elemental compositions of the studied catalysts before and after OER measurements.

	Ni	Fe	O	Se	Fe/Ni ratio
$Ni_{0.8}Fe_{0.2}$-$^{m/t}Se_{0.02}$-LDH	35.18	9.08	54.78	0.96	0.258
$Ni_{0.8}Fe_{0.2}$-$^{t}Se_{0.02}$-LDH	35.26	9.23	54.56	0.95	0.262
$Ni_{0.8}Fe_{0.2}$-LDH	32	9.43	58.57	-	0.295
$Ni_{0.8}Fe_{0.2}$-$^{m/t}Se_{0.02}$-LDH after OER	30.94	8.07	60.09	0.9	0.261
$Ni_{0.8}Fe_{0.2}$-$^{t}Se_{0.02}$-LDH after OER	33.04	7.89	58.16	0.91	0.239
$Ni_{0.8}Fe_{0.2}$-LDH after OER	33.59	3.22	63.19	-	0.096