

# Supplymentary Tables

Table. S1 Particle size of PtNi<sub>x</sub>/C

	PtNi/C-H	PtNi <sub>2</sub> /C-H	PtNi <sub>3</sub> /C-H	PtNi <sub>3</sub> /C-S
Average size (nm)	8.0	10.7	12.6	6.9

Table. S2 Lattice constant of PtNi<sub>x</sub>/C

	Pt/C	PtNi/C-H	PtNi <sub>2</sub> /C-H	PtNi <sub>3</sub> /C-H	PtNi <sub>3</sub> /C-S
(111)	3.92 Å	3.87 Å	3.86 Å	3.86 Å	3.90 Å
(200)	3.93 Å	3.93 Å	3.89 Å	3.88 Å	3.89 Å
(220)	3.94 Å	3.89 Å	3.86 Å	3.86 Å	3.89 Å

Table. S3 Electrochemical surface area, mass activity and specific activity of catalysts

Sample (@ 0.9V)	EASA (m <sup>2</sup> /g <sub>Pt</sub> )	Mass activity (A/mg <sub>Pt</sub> )
PtNi <sub>3</sub> /C-H AT	48.8	0.684
PtNi <sub>2</sub> /C-H AT	44.6	0.573
PtNi/C-H AT	39.9	0.485
PtNi <sub>3</sub> /C-S AT	23.8	0.292
Pt/C commercial	70.7	0.227

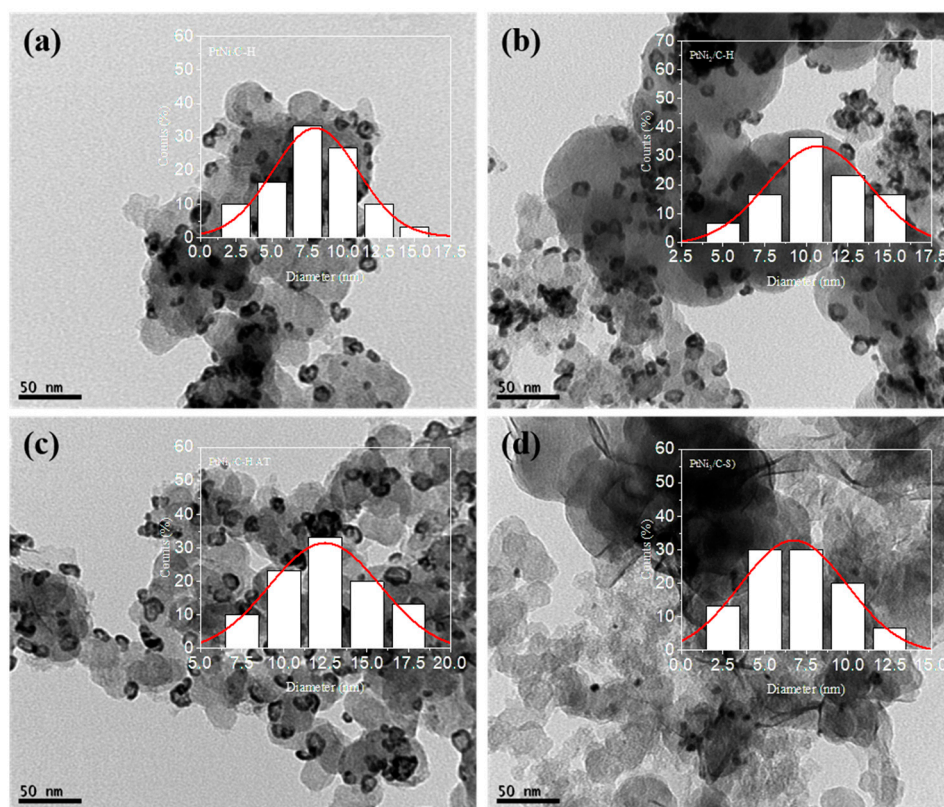
Table. S4 EASA of commercial Pt/C and PtNi<sub>3</sub>/C-H AT at 0.9V(vs. RHE) after 10,000 cycle ADT

	Initial	aft 10000 cycle	Decreasing ratio (%)
Pt/C commercial	69.0 m <sup>2</sup> /g <sub>Pt</sub>	48.2 m <sup>2</sup> /g <sub>Pt</sub>	30.1
PtNi <sub>3</sub> /C-H AT	49.3 m <sup>2</sup> /g <sub>Pt</sub>	37.1 m <sup>2</sup> /g <sub>Pt</sub>	24.7

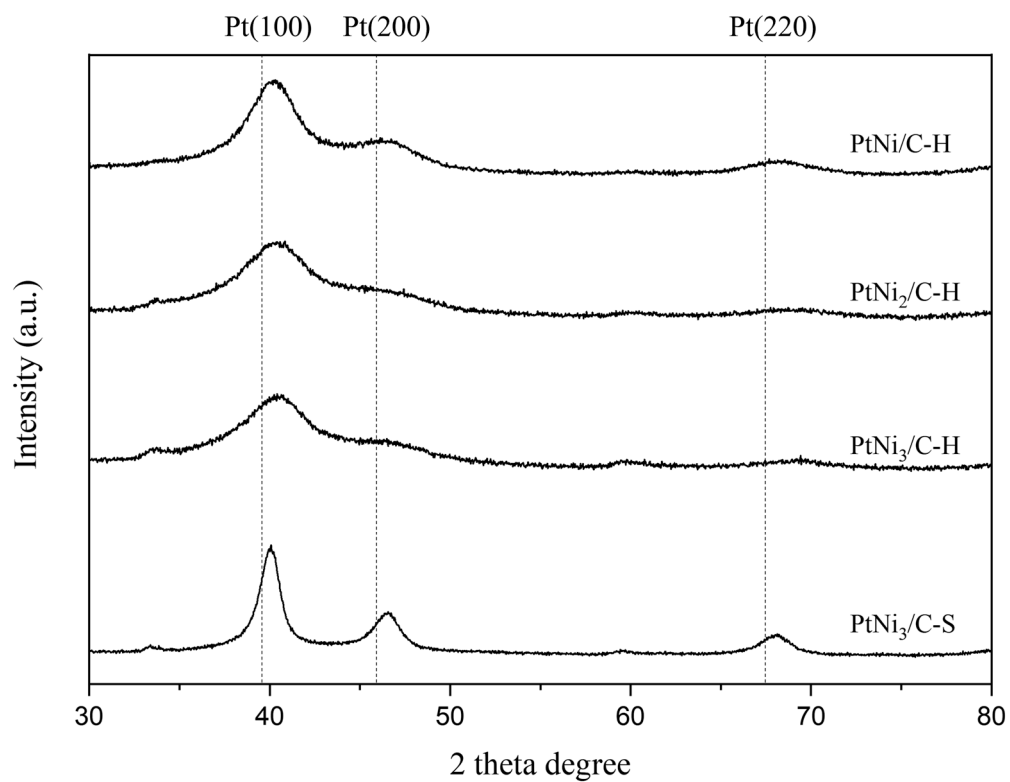
Table. S5 Mass activity of commercial Pt/C and PtNi<sub>3</sub>/C-H AT at 0.9V(vs. RHE) after 10,000 cycle ADT

	Initial	aft 10000 cycle	Decreasing ratio (%)
Pt/C commercial	0.297 A/mg <sub>Pt</sub>	0.176 A/mg <sub>Pt</sub>	40.7
PtNi <sub>3</sub> /C-H AT	0.679 A/mg <sub>Pt</sub>	0.482 A/mg <sub>Pt</sub>	29.0

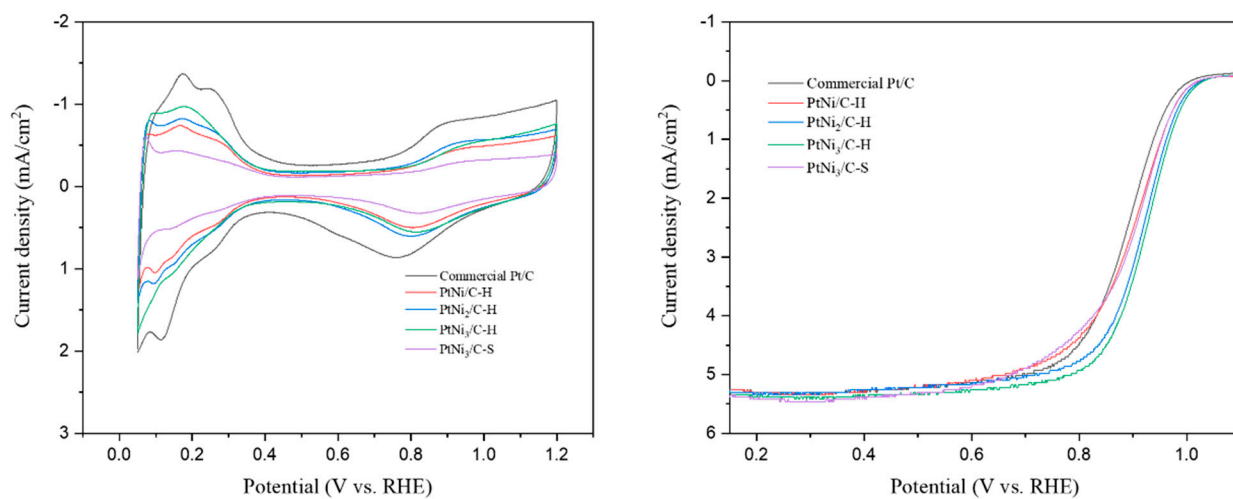
# Supplymentary Figures



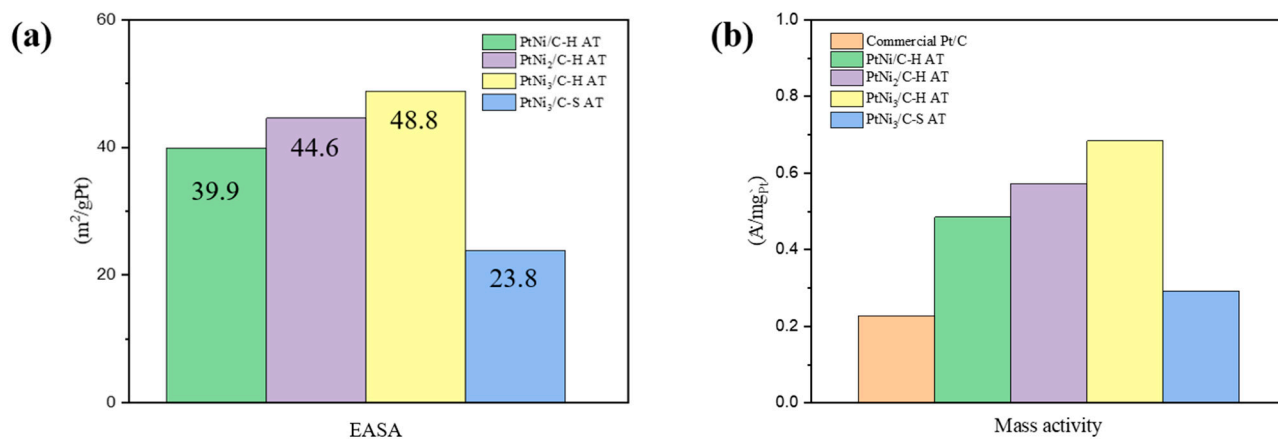
**Figure S1.** TEM images of (a) PtNi/C-H, (b) PtNi<sub>2</sub>/C-H, (c) PtNi<sub>3</sub>/C-H, (d) PtNi<sub>3</sub>/C-S



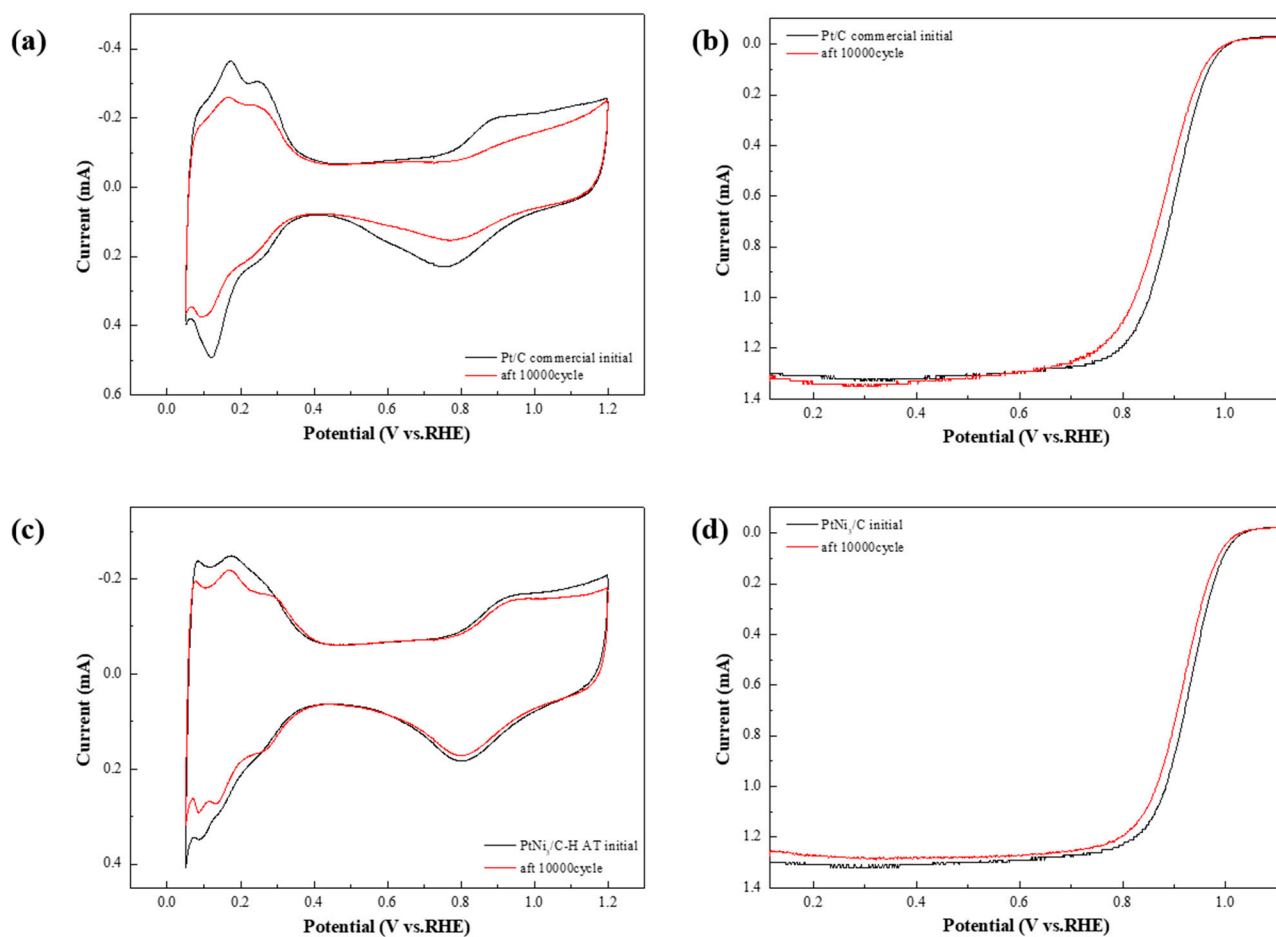
**Figure S2.** XRD pattern of PtNi<sub>x</sub>/C.



**Figure S3.** (a) CV and (b) ORR LSV of catalysts before acid treatment



**Figure S4. (a) EASA and (b) ORR Mass activity of catalysts**



**Figure S5. (a,c) Cyclic voltammogram and (b,d) ORR LSV of commercial Pt/C, PtNi<sub>3</sub>/C-H AT before and after 10,000 cycles ADT**