

# Carbon-Supported Platinum-Grafted Gold-Nickel Nanoclusters for Hydrogen Evolution Reaction

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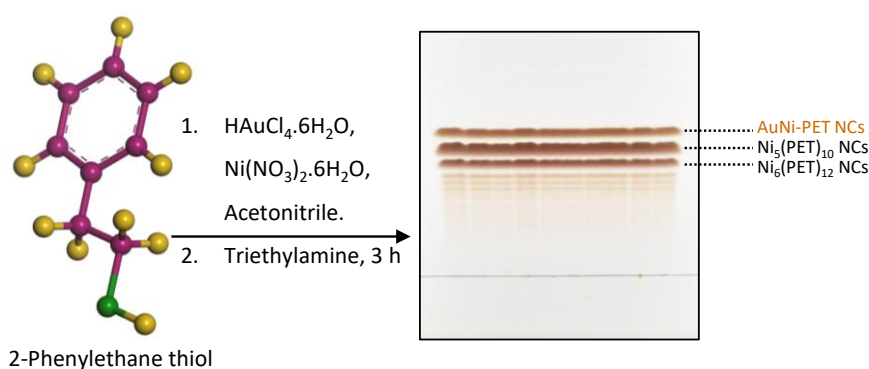
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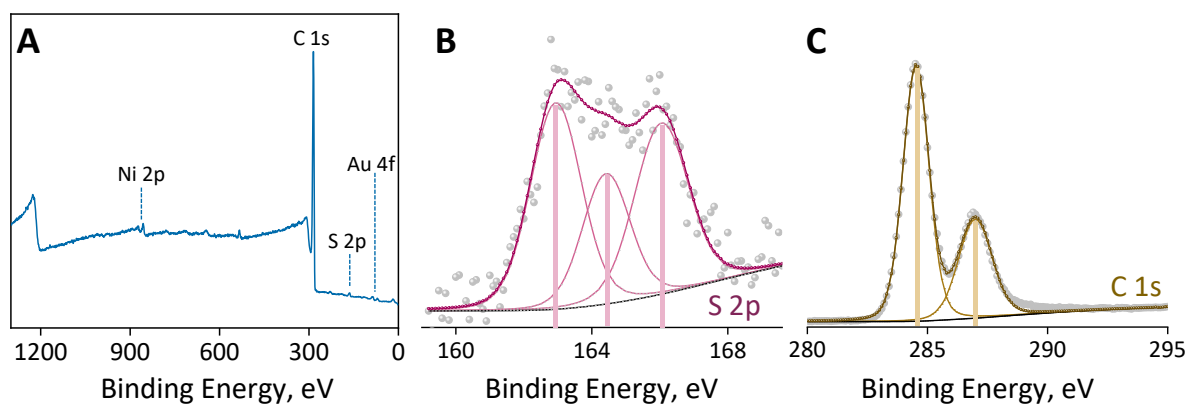
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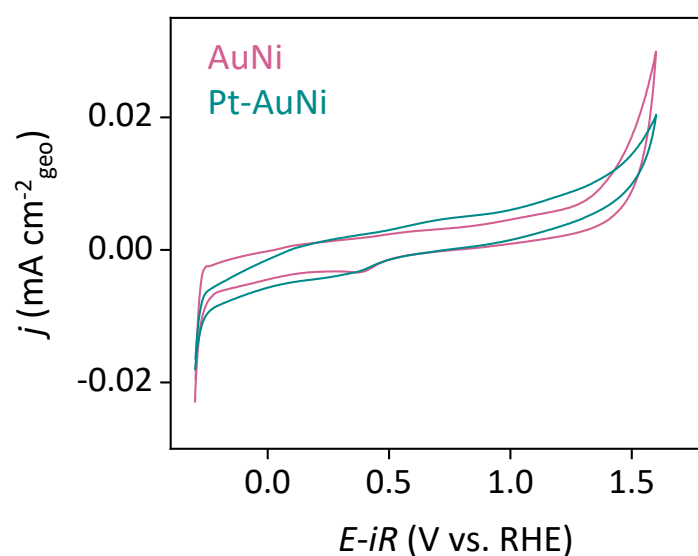
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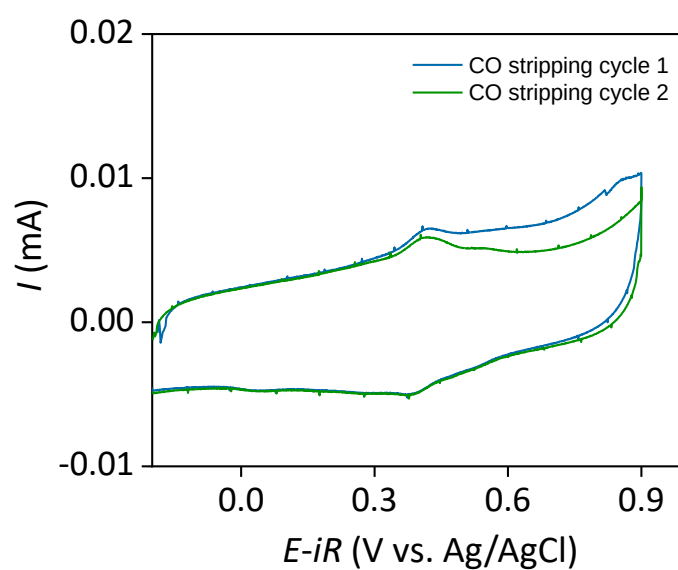
**Figure S1.** Synthesis and separation of NCs using PTLC.



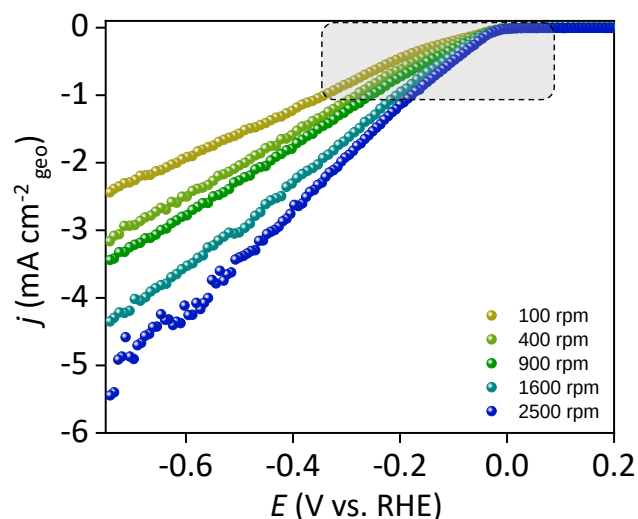
**Figure S2.** XPS analysis corresponding to the synthesized AuNi NCs, showing (A) survey spectrum, (B) S 2p, (C) C 1s peaks.



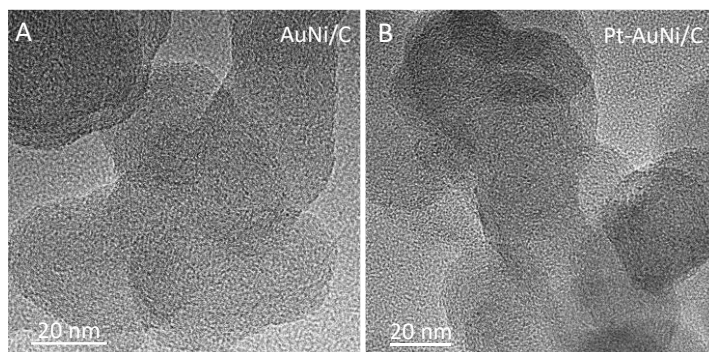
**Figure S3.** Cyclic voltammograms of the NCs before and after Pt incorporation.



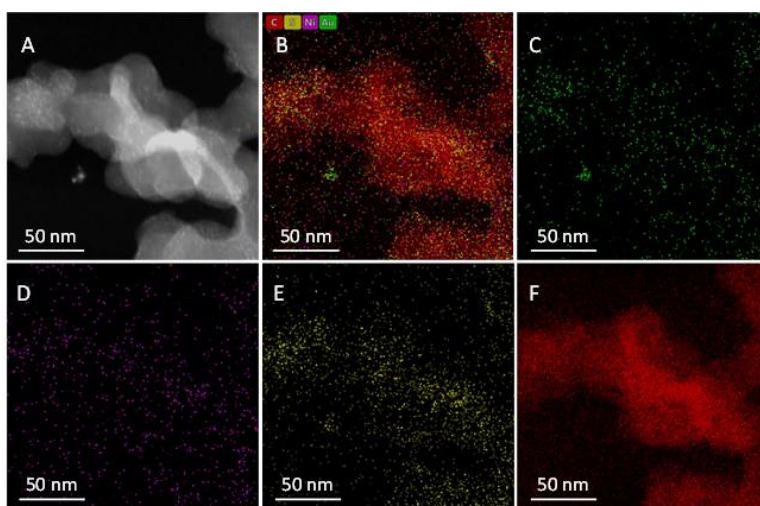
**Figure S4.** CO-stripping cyclic voltammograms on the Pt-AuNi.



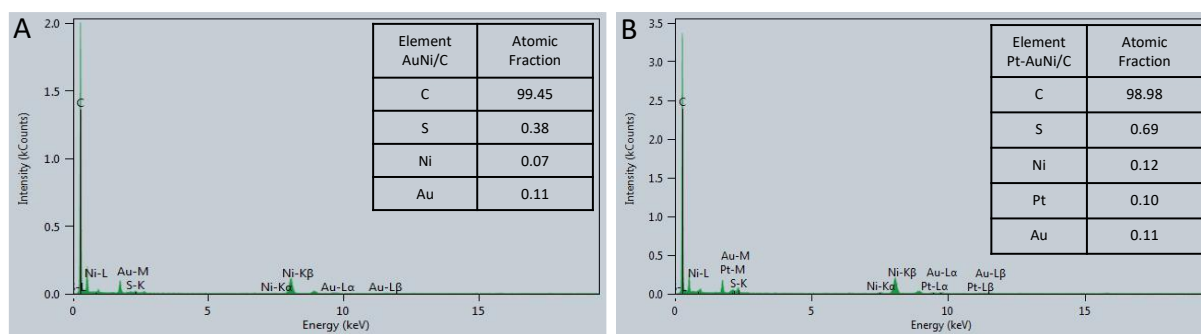
**Figure S5.** HER polarization curves of Pt-AuNi/C in 0.1 M H<sub>2</sub>SO<sub>4</sub> at 5 mV s<sup>-1</sup> obtained using rotating disk electrode (RDE) at different rotation rates. The highlighted region indicates the existence of quasi-steady state limiting behavior.



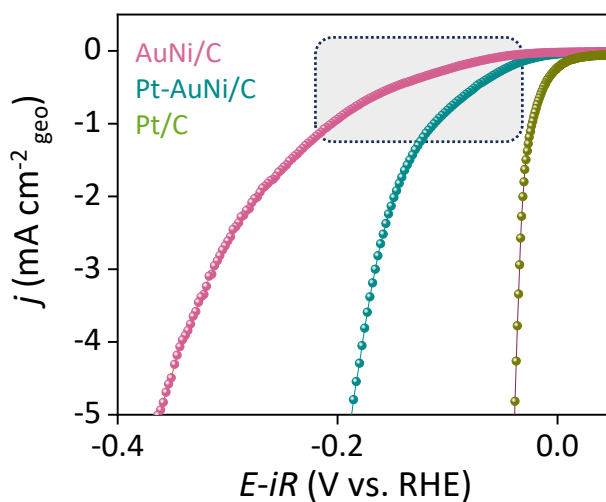
**Figure S6.** (A, B) HRTEM images of (A) AuNi, and (B) Pt-AuNi NCs after incorporating on Vulcan carbon.



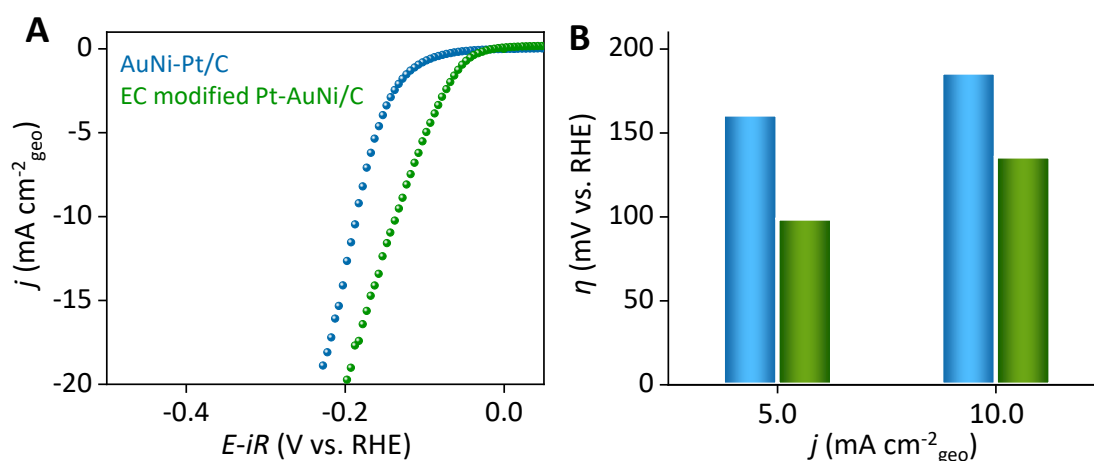
**Figure S7.** (A) HAADF-STEM and (B) combined elemental map image of AuNi/C along with elemental maps of (C) gold; (D) nickel; (E) sulphur; and (F) carbon.



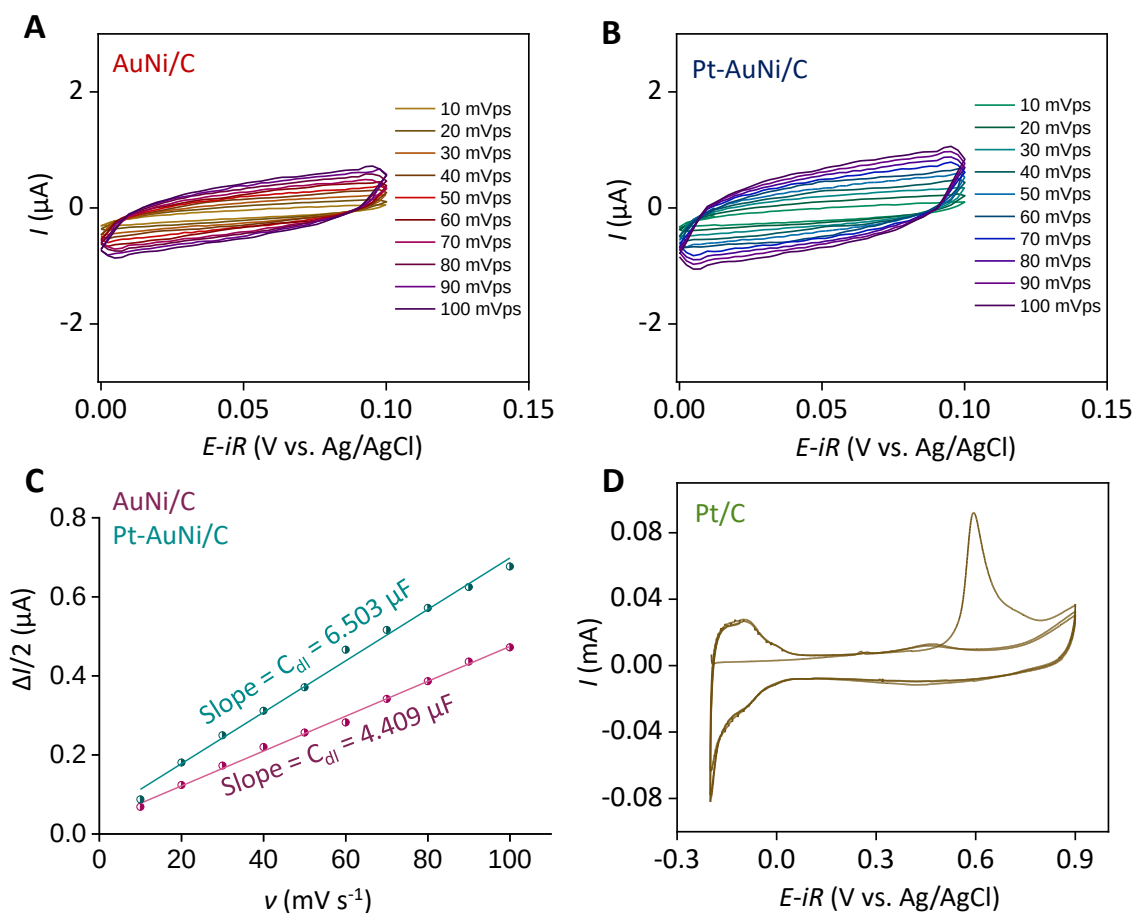
**Figure S8.** EDS spectra of (A) AuNi/C and (B) Pt-AuNi/C with atomic fraction of the elements.



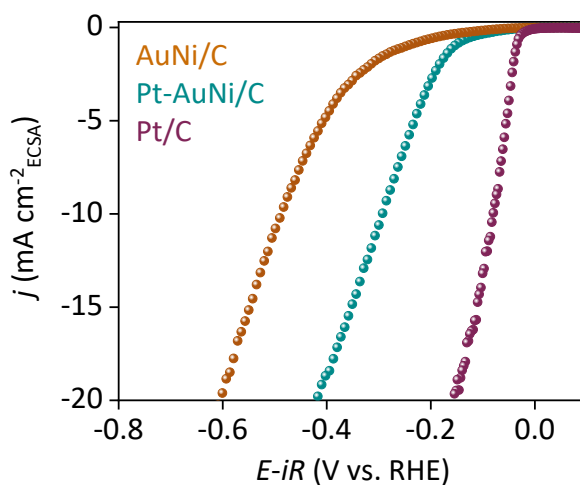
**Figure S9.** The enlarged low-potential region of HER polarization curve of AuNi/C, Pt-AuNi/C, and Pt/C in 0.1 M H<sub>2</sub>SO<sub>4</sub> at a scan rate of 5 mV s<sup>-1</sup> showing an indication of suppressed steady state limitation.



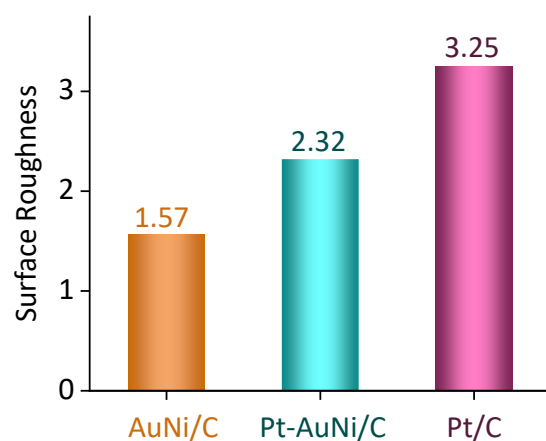
**Figure S10.** (A) HER polarization curves, and (B) the overpotential comparison of Pt-AuNi/C after electrochemical activation in 1 M KOH at -2.5 V for 5s.



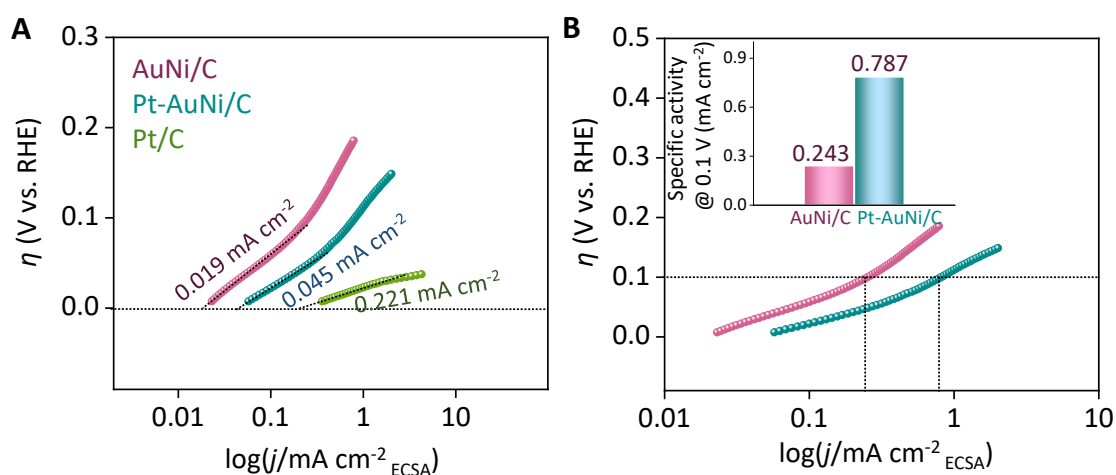
**Figure S11.** (A, B) Cyclic voltammogram showing scan rate effect of (A) AuNi/C, and (B) Pt-AuNi/C in the non-faradaic region (from 0 V to 0.1 V vs. Ag/AgCl). (C) The plot of scan rate against capacitive current. (D) Cyclic voltammogram showing CO stripping on Pt/C.



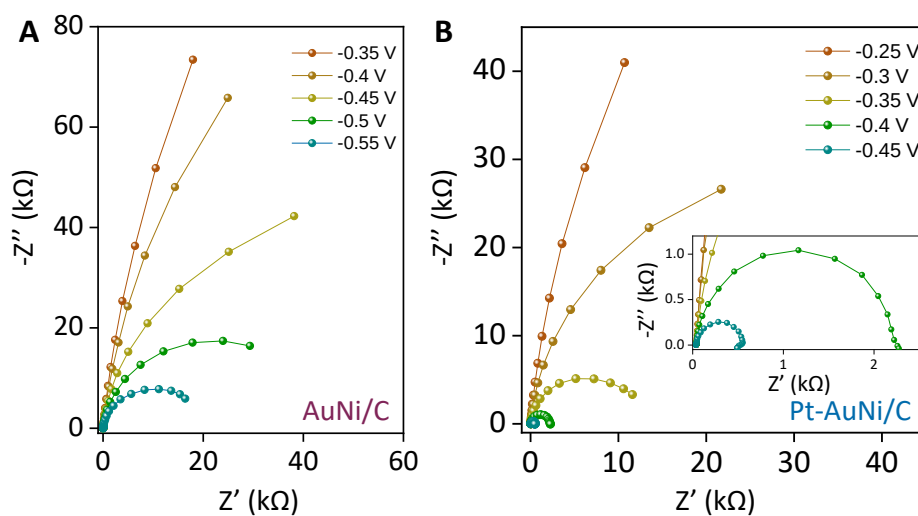
**Figure S12.** ECSA normalized HER polarization curve of 10% AuNi/C, 10% Pt-AuNi/C, and 10% Pt/C catalysts in 0.1 M H<sub>2</sub>SO<sub>4</sub> at a scan rate of 5 mV s<sup>-1</sup>.



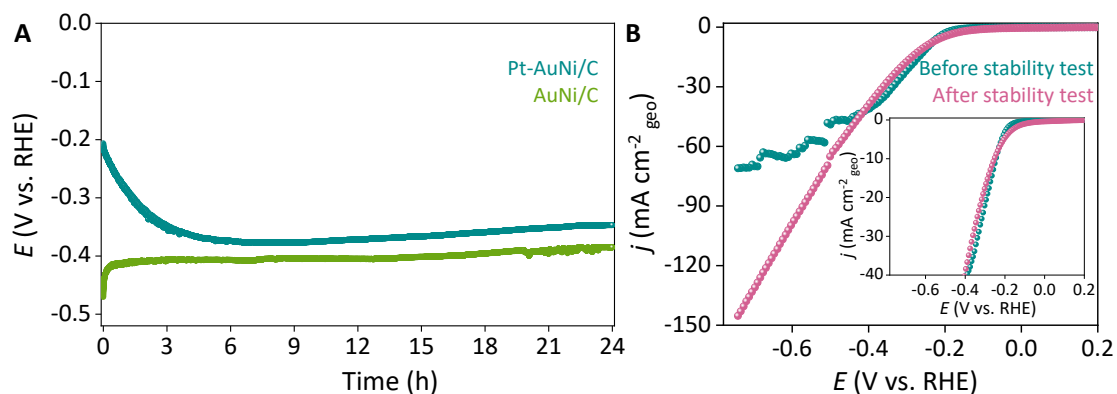
**Figure S13.** Comparison of roughness factor (ratio of ECSA to the geometrical surface area) of AuNi/C, Pt-AuNi/C, and Pt/C.



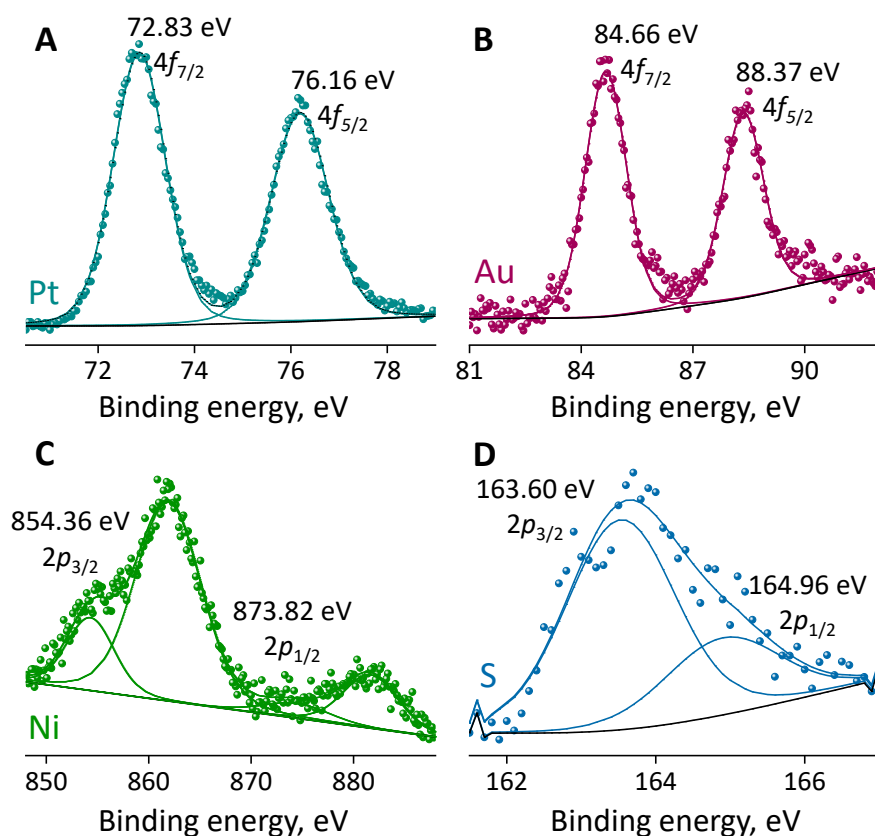
**Figure S14.** (A) Calculation of exchange current density by extrapolating the Tafel slopes to zero overpotentials. (B) Comparison of specific capacities of AuNi/C and Pt-AuNi/C at an overpotential of 0.1 V vs RHE.



**Figure S15.** Nyquist plots of (A) AuNi/C, and (B) Pt-AuNi/C at different overpotentials.



**Figure S16.** (A) Chronopotentiometry showing the stability and performance of Pt-AuNi/C and AuNi/C for 24 hours. (B) HER polarization curve showing the performance of Pt-AuNi/C before and after the 24-hour stability test in 0.1 M H<sub>2</sub>SO<sub>4</sub> at 5 mV s<sup>-1</sup>.



**Figure S17.** XPS spectra showing the nature of (A) Pt 4f, (B) Au 4f, (C) Ni 2p, and (D) S 2p of Pt-AuNi/C after the stability test.