

Supplementary Materials for

Pt monolayer coating on complex network substrate with high catalytic activity for the hydrogen evolution reaction

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I. High Catalytic Activity

Table S1. Comparison of exchange current density for proton reduction reaction in 1 M H₂SO₄.

Catalyst	-Log (j_0 Acm ⁻²)
Pt sheet	3.1(39)
Pt monolayer/Au NF/Ni foam	3.3
Pt monolayer/Ag NF/Ni foam	3.4

II. TOF Calculation used in Table S2.

The TOF value is calculated using the following equation :

$$\text{TOF} = \frac{J \times A}{2 \times F \times m}$$

where J is the current density at overpotential = 0.1 V in Acm⁻². A is the area of the working electrode. F is the faraday constant (= 96485 Cmol⁻¹). m is the number of moles of the active materials deposited onto the electrode.(40)

Table S2. TOFs (s⁻¹) for electrocatalytic hydrogen generation by various catalysts in 0.5 M H₂SO₄ solution.^a

Catalyst	Wt% (Au, Ag)	Mass of NF (ug)	Moles (umol) (NF)	Mass of Pt ML (ugcm ⁻²)	TOF (s ⁻¹) / $\eta=100\text{mV}$
Au NF/Ni foam	0.38	139	0.7		96
Pt ML/Au NF/Ni foam				0.55	1839
Ag NF/Ni foam	0.53	189	1.83		24
Pt ML/Ag NF/Ni foam				0.55	1655

^a Average of multiple runs.

The metal NF wt% was determined by atomic absorption spectroscopy (AAS) measurements with the samples being digested in aqua regia (data listed in Table S2). The mass of the Pt ML is calculated by lattice constants of the cubic Pt crystal lattice parameters (41) and the surface area of the Ni foam was measured by physical adsorption instrument and an optical 3-D video microscope.

III. Cyclic voltammogram for H_{UPD} on Pt ML/Au NF/Ni foam electrode

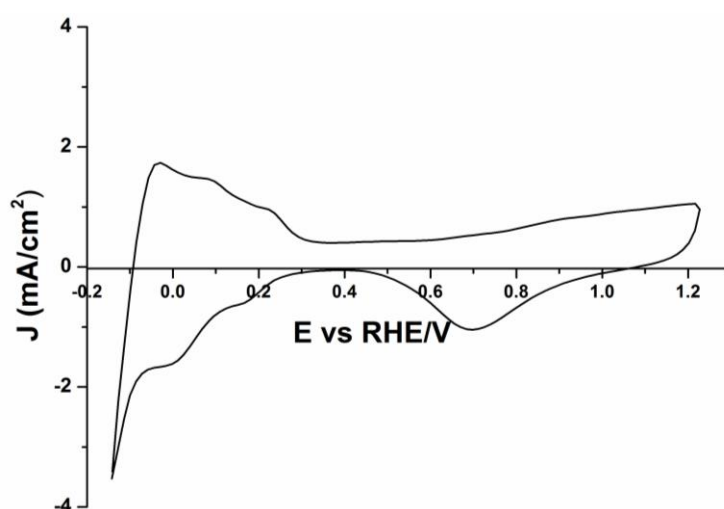


Fig. S1. Cyclic voltammogram for H_{UPD} on Pt monolayer/Au NF/Ni foam electrode in Ar-saturated 0.5 M H₂SO₄ at 50 mVs⁻¹ with two different positive potential limits. The current density is referenced to the actual Pt surface area.

The hydrogen adsorption/desorption is a powerful technique to determine the ESA of a Pt catalyst on Ni foam.¹ Based on the CV shown in Figure S1, the ESA_{Pt} can be measured using the following equation

$$ESA_{Pt} = Q_H / (0.21 A_{geo})$$

Where Q_H is the measured charge for H adsorption/desorption (H up) up on Pt; the correlation constant of 0.21 (mCcm⁻²) represents the coulometric charge required to deposit H up on Pt. Thus, coverage of Pt on Au NF from Pt²⁺ ions is 80.9 cm² per 1 cm² Ni foam.

IV. IR correction

The iR correction was taken as following (42)

$$E_{\text{correction}} = j \times A_{\text{electrode}} \times R$$
$$E_{\text{corrected}} = E_{\text{uncorrected}} - E_{\text{correction}} = E_{\text{uncorrected}} - j \times A_{\text{electrode}} \times R$$

Note that only the polarization curves and Tafel data were iR corrected.

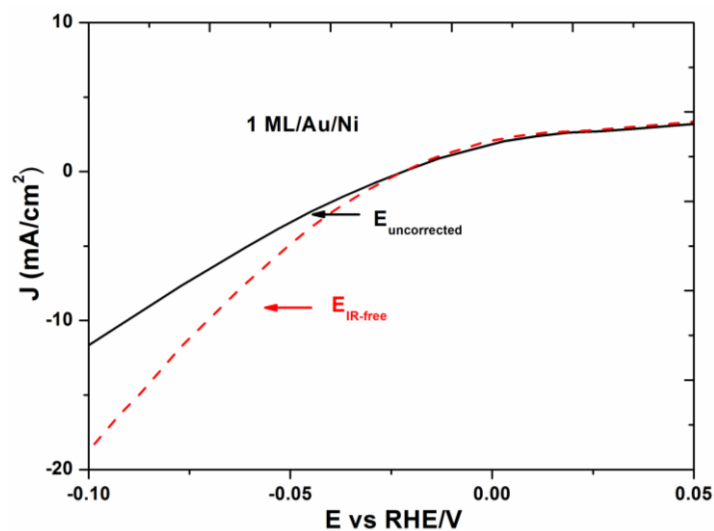


Fig. S2. HER polarization curve on Pt monolayer/Au NF/Ni foam in 0.5 M H₂SO₄ solution at 50 mV s⁻¹ (solid black lines) and after iR correction ($E_{IR-free}$, dotted red lines).

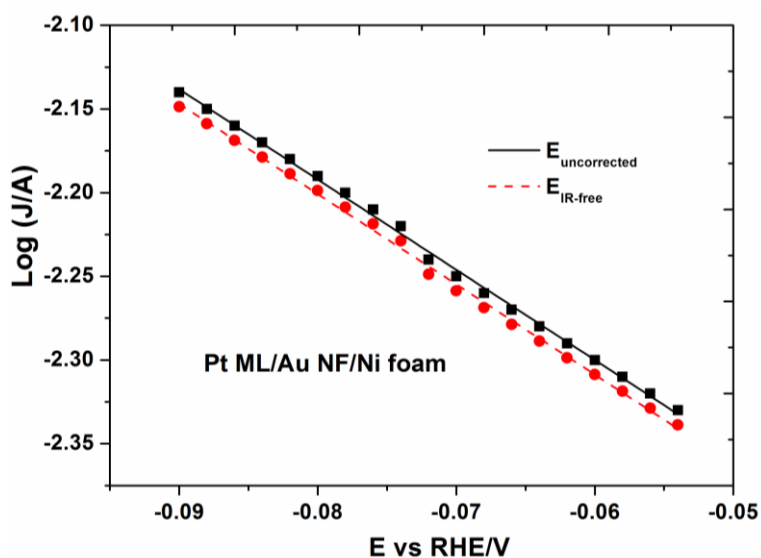


Fig. S3. Tafel curve on Pt monolayer/Au NF/Ni foam in 0.5 M H₂SO₄ solution at 50 mV s⁻¹ (solid black lines) and after iR correction ($E_{IR-free}$, dotted red lines).

V. XPS analysis (43)

Table S3. Relative metal concentrations at different areas of Pt monolayer/Au NF/Ni foam sample measured using XPS.

Name	Spot 1		Spot 2		Spot 3	
	Area	At%	Area	At%	Area	At%
Ni 2p	707733	99.11	754534	99.04	66477	99.01
Au 4d	5099	0.61	4667	0.64	4320	0.71
Pt 4d	2013	0.28	2152	0.32	2064	0.28

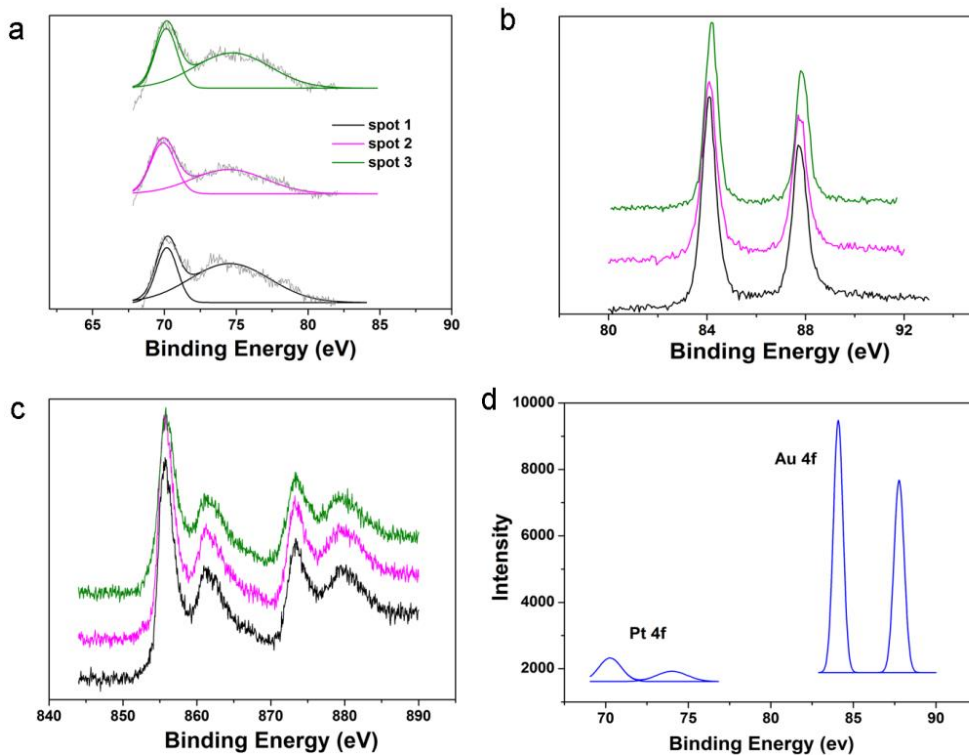
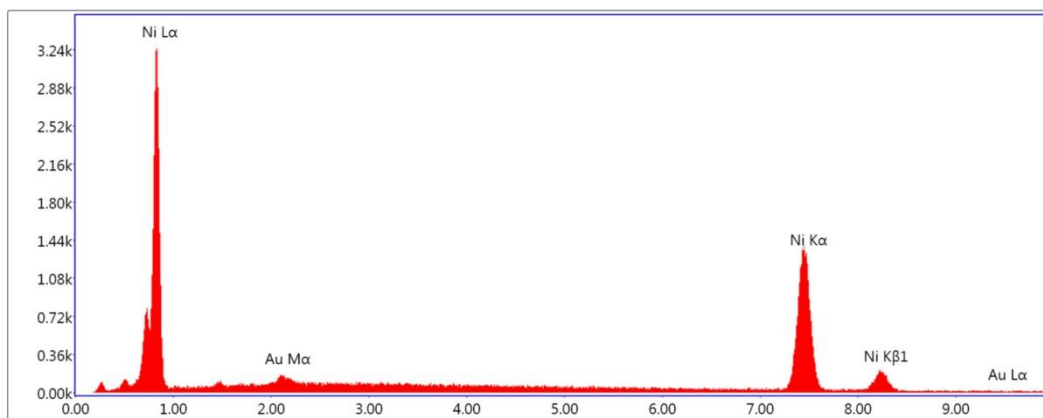


Fig. S4. The XPS spectra of the different points on a Pt monolayer/Au NF/Ni foam electrode.

VI. EDX and the element mapping image of the Au NF/Ni foam.



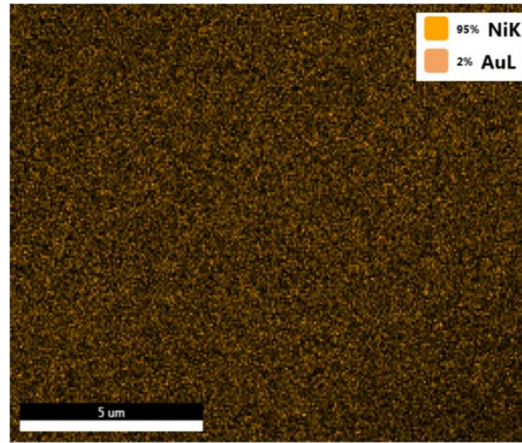


Fig. S5. EDX and the image of element mapping of the Au NF/Ni foam.