Supporting information

Single Nanobubble Formation on Au Nanoelectrodes and Au@WS_2 Nanoelectrodes: Voltammetric Analysis and Electrocatalysis

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Table S1. HER kinetic parameters (k^0 and α) obtained from data fitting, bubble formation potentials (E_{bubble}), NE Radii for Eight Au NEs (values are reported as mean ± standard deviation).

Au NE radius (nm)	k^0 (m/s)	α	E_{bubble} (V) vs Ag/AgCl
8	5.1×10^{-5}	0.45	-0.812
17	4.7×10^{-5}	0.38	-0.775
23	2.3×10^{-6}	0.39	-0.806
30	7.5×10^{-6}	0.41	-0.792
37	4.2×10^{-7}	0.43	-0.821
average	2.16×10^{-5}	0.41	

Table S2. HER kinetic parameters (K^0, k^0, and α) obtained from data fitting, bubble formation potentials (E_{bubble}), NE radius, and surface coverage of adsorbed H (θ) at E_{bubble} for eight Au@WS_2 NEs (values are reported as mean ± standard deviation).

Au@WS_2 NE radius (nm)	K^0 (m/s)	k^0 (m/s)	α	E_{bubble} (V) vs Ag/AgCl	θ
10	1.1×10^{-5}	1.5	0.54	-0.537	0.98
15	1.0×10^{-5}	2.7×10^{-4}	0.55	-0.516	0.99
26	2.3×10^{-5}	5.6×10^{-4}	0.52	-0.509	0.98
30	1.5×10^{-5}	7.1×10^{-4}	0.55	-0.525	0.99
39	4.2×10^{-5}	3.4×10^{-5}	0.51	-0.518	0.99
44	3.7×10^{-5}	9.2×10^{-5}	0.49	-0.573	0.96
49	1.9×10^{-5}	1.2×10^{-6}	0.57	-0.567	0.97
average	2.2×10^{-5}	2.6×10^{-4}	0.53		0.98

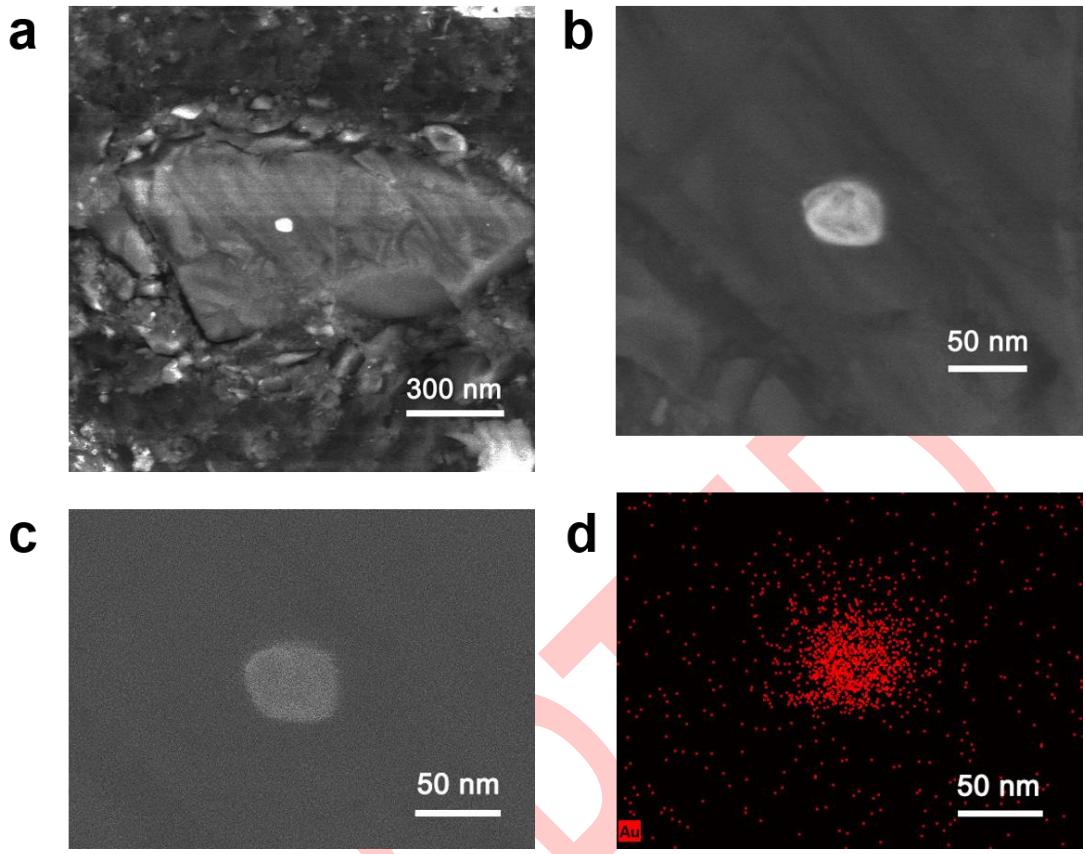

Figure S1. (a) The SEM image of Au NE surface. (b) A magnification of the surface of the NE in Figure S1A. (c, d) EDS element mapping characterization of Au NE surface.

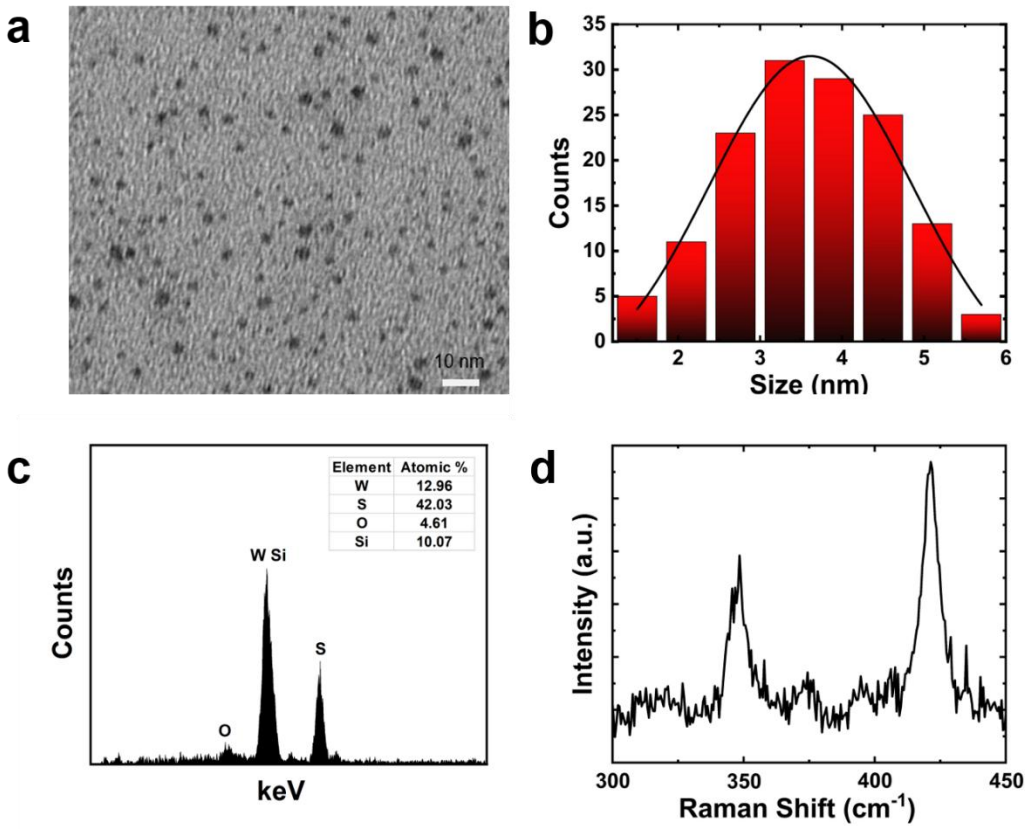

Figure S2. (a) The TEM image of WS_2 QDs. (b) The size distribution of WS_2 QDs. (c) EDS elemental analysis of WS_2 QDs. (d) Raman spectrum of WS_2 QDs.

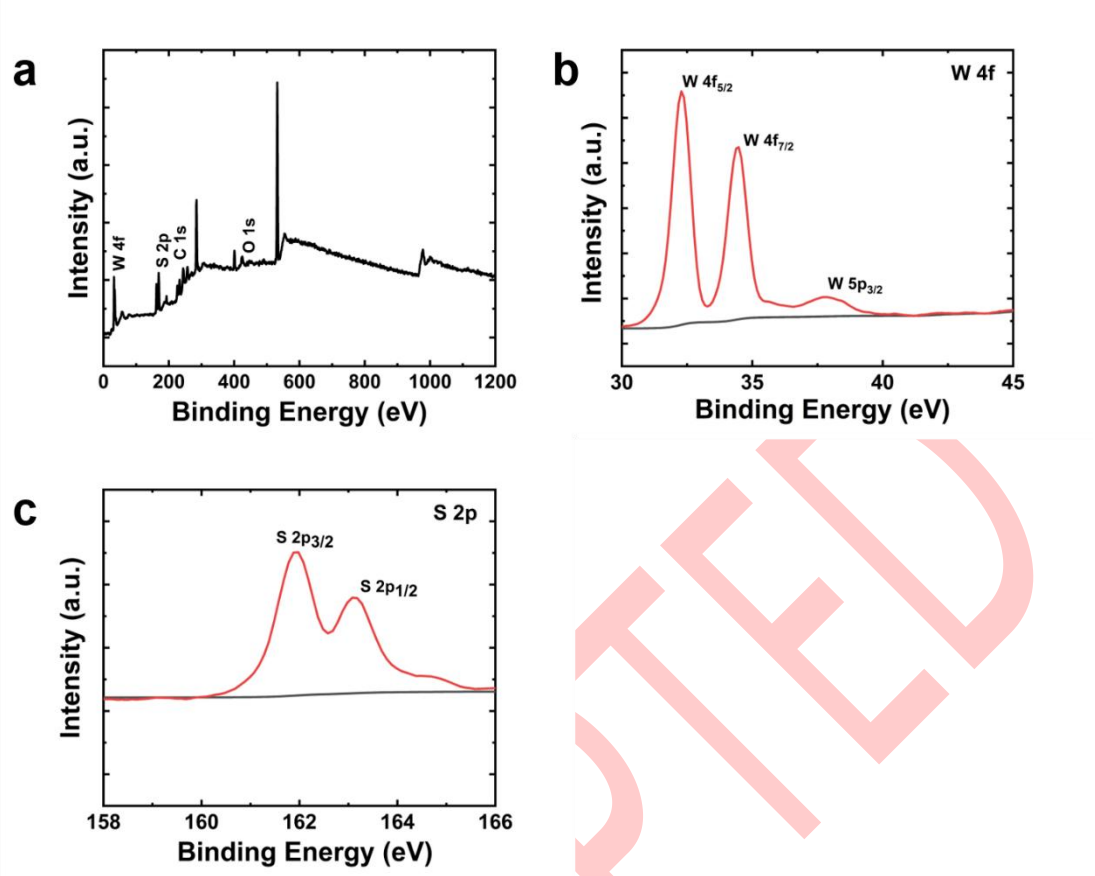

Figure S3. (a) XPS spectrum of WS_2 QDs. (b) Narrow-band XPS spectrum of W 4f. (c) Narrow-band XPS spectrum of S 2p.

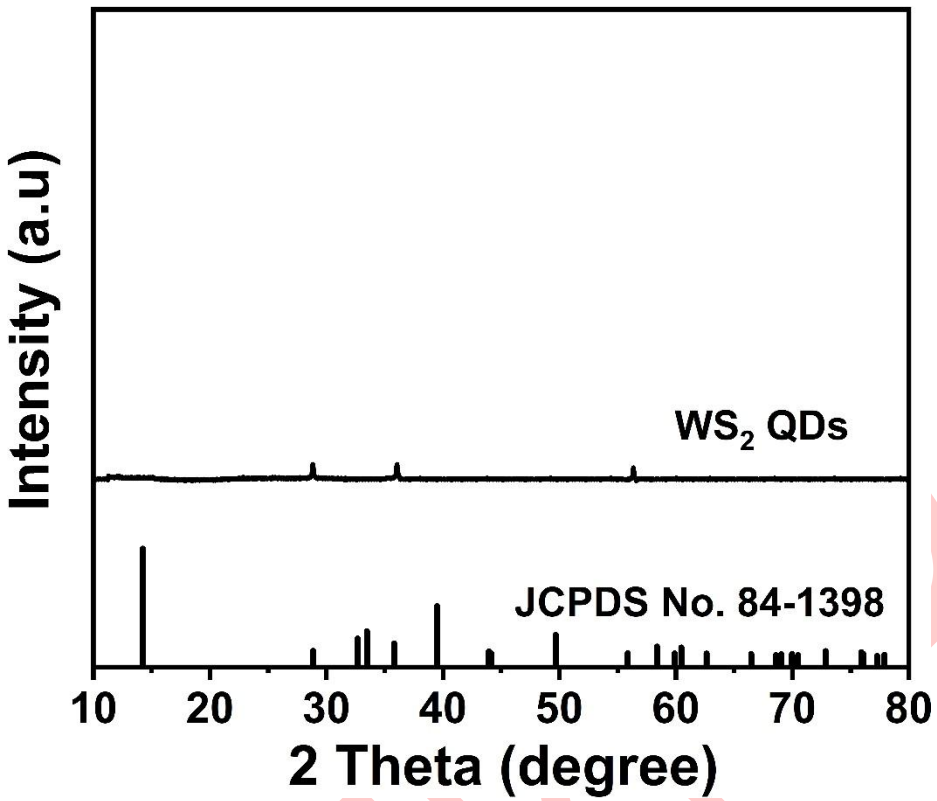

Figure S4. The XRD patterns of WS_2 QDs.

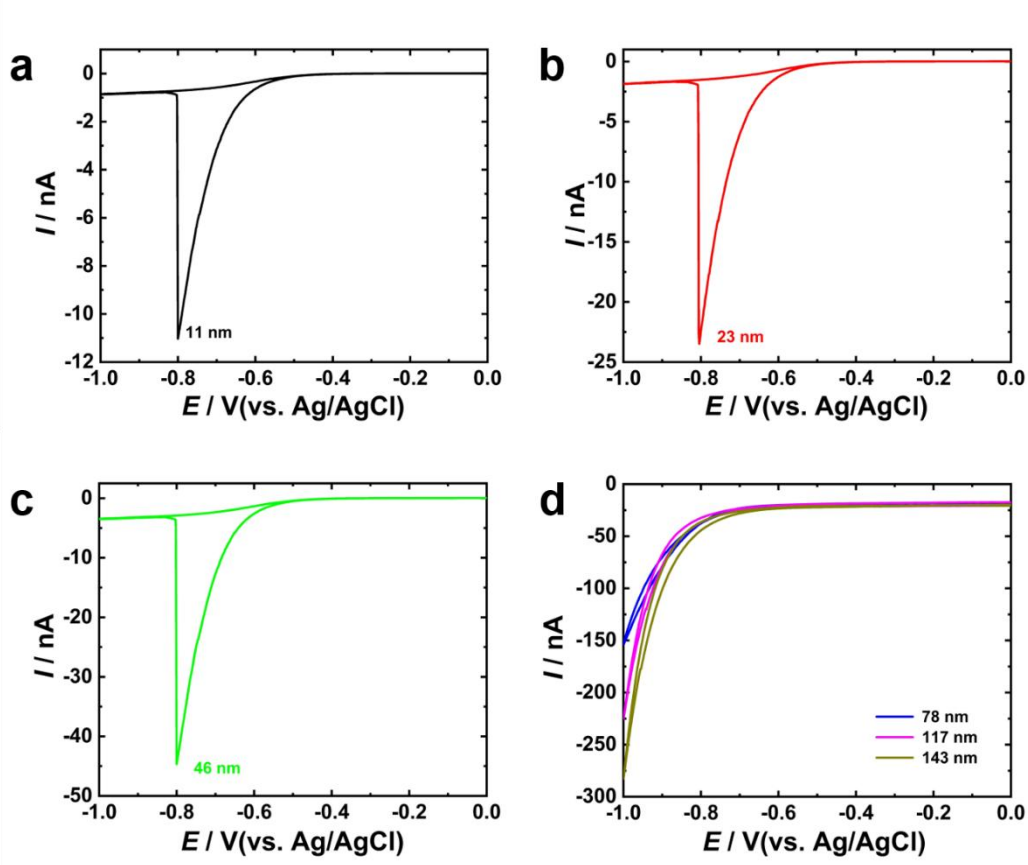

Figure S5. Cyclic voltammetric responses as a function of the radius of the Au NE in a 0.5 M H_2SO_4 solution with a scan rate of 10 mV/s.

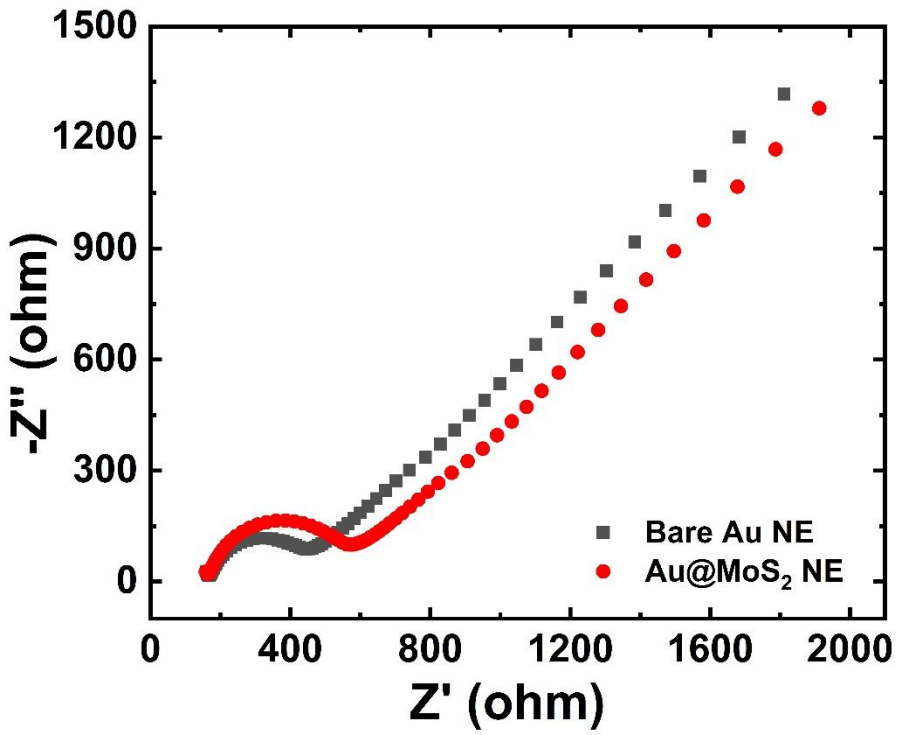

Figure S6. EIS characterization of Au NE and Au@WS_2 NE.

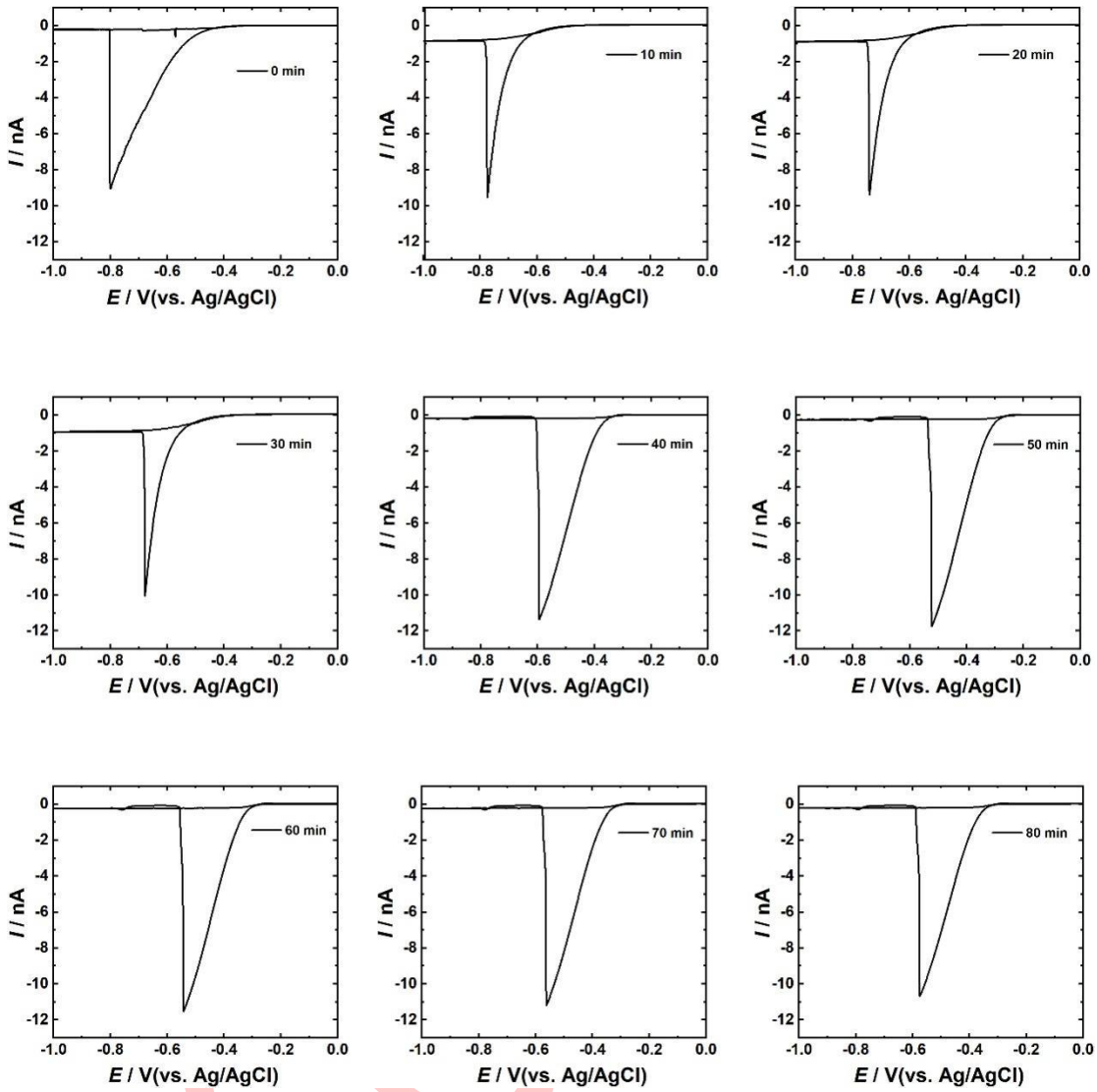

Figure S7. Cyclic voltammograms at 10 mV/s for a 30 nm radius Au NE in 2 mg/mL WS_2 QDs solution after various immersion times.

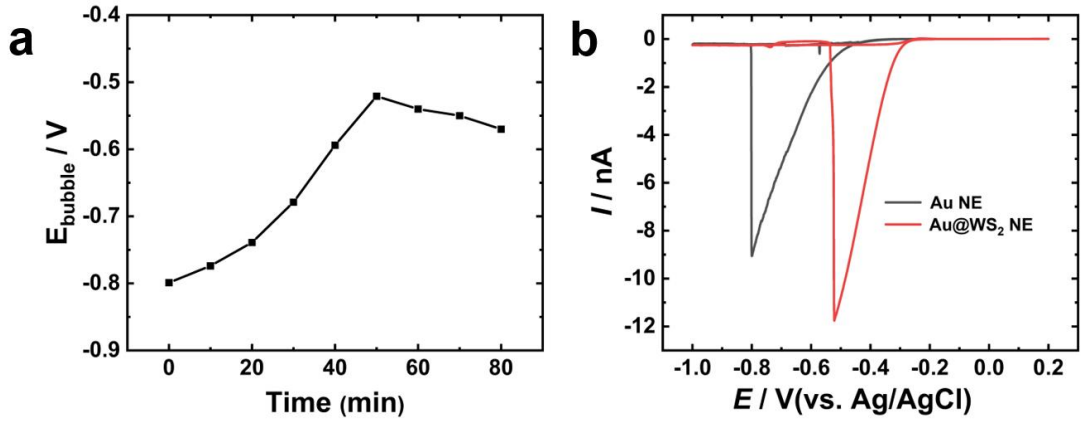

Figure S8. (a) The potential of nanobubble formation as a function of the time of that Au NEs were immersed in 2 mg/mL WS_2 QDs solution, radius, 30 nm. (b) Cyclic voltammograms of a 30 nm radius Au and Au@WS_2 NE in N_2 purged 0.5 M H_2SO_4 solution at a scan rate of 20 mV/s, immerse time, 60 min.

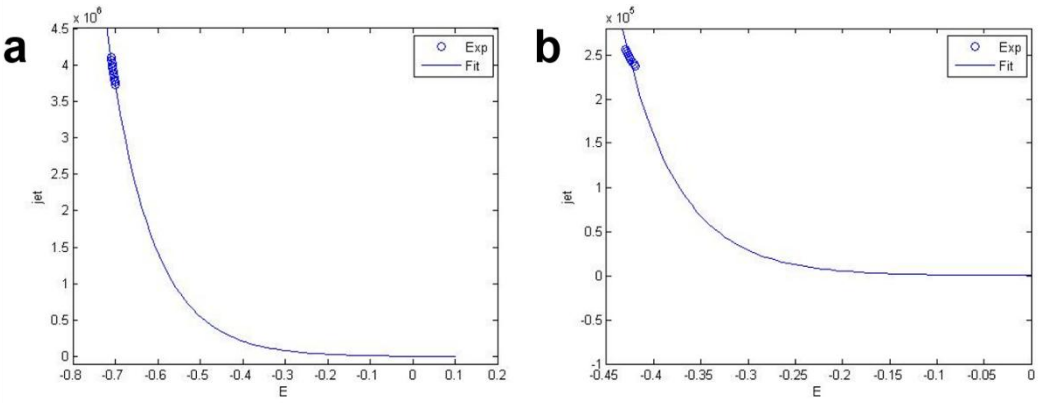

Figure S9. Experimental cyclic voltammograms (black dot) and their corresponding best fits (blue line) for a (a) 20 nm radius Au NE and (b) 30 nm radius Au@WS_2 NE. The unit of j_{et} and E is A/m^2 and V (vs Ag/AgCl).