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Supplementary Information

Solvent evaporation plus hydrogen reduction method to synthesize IrNi/C catalysts for hydrogen oxidation

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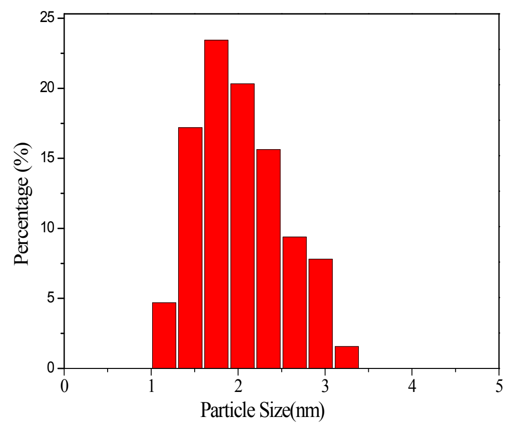

Fig. S1 Histogram of particle size distributions of the IrNi NPs.

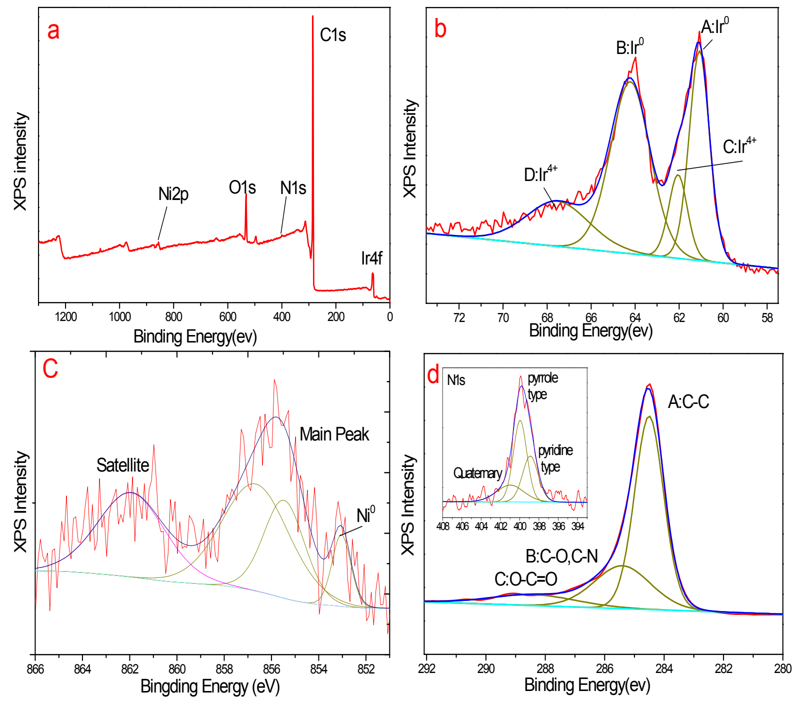

Fig. S2 XPS patterns for IrNi/C-NH_3-500. (a) full XPS spectrum. (b) Ir 4f spectrum. (c) Ni 2p spectrum. (d) C 1s spectrum and the inset is N 1s spectrum.

Fig. S2a gives the full XPS spectrum of the IrNi/C-NH_3-500. The surface atomic ratio of Ir/Ni is 2/1, fairly in line with the mol ratio in the bulk from the EDS data. Fig. S2b and S2c illustrate the XPS spectra for Ir 4f and Ni 2p core-level regions of the catalyst. Deconvolution of the Ir 4f region shows the presence of 2 pairs of doublets. The most intense doublet with binding energies of 61.08 (Ir $4f_{7/2}$) and 64.22 eV (Ir $4f_{5/2}$) is attributed to metallic Ir. Another doublet at 62.05 and 67.52 eV could be assigned to the Ir^{4+} in IrO_2. The XPS results suggest that 72% of the Ir is present in a metallic state and 28% is present in IrO_2. The Ni $2p_{3/2}$ spectra are characterized by a main peak (852-858eV) with a satellite at higher BE(860-865eV).[1,2,3] Deconvolution of the main peak shows the presence of Ni^0 and Ni^{x+}. Combining XPS spectra with the XRD results, it's verified that the contraction in

Ir-Ir bond is a consequence of Ni diffusing into the Ir cluster. The existence of oxidized Ni is attributed to surface-oxidation of the external surface Ni after long time ambient exposure. Fig. S2d gives the XPS spectra of C 1s and N 1s. C 1s spectrum shows three peak components at 284.5, 285.4 and 288.39 eV, which are assigned to the carbon component in C-C, C-O/C-N and O=C-O, respectively. As seen in the inset of Fig. S2d, the peaks at 398.9, 400, 401 eV of N can be attributed to pyridinic-like, quaternary and pyrrolic-like N, respectively, indicating the incorporation of N into the carbon support with a surface content of 0.63 at%.

Table S1 The structural parameters from XRD patterns and mass activities of the catalysts.

Catalyst	Ir(111) peak position(°)	d-spacing of 111(Å)	Lattice parameter a_{fcc} (Å)	Particle size (nm)	Mass activity ($A\bullet g_{IrNi}^{-1}$)
IrNi/C-NH_3-500	41.88	2.155	3.7325	2.7	453.4
IrNi/C-NaOH-500	42.10	2.142	3.7099	3.8	356.1
IrNi/C-500	42.51	2.124	3.6788	3.0	342.4
Ir/C-NH_3-500	40.66	2.218	3.8416	3.7	331.9
Ir_2Ni/C-NH_3-500	41.70	2.166	3.7515	2.6	407.5
$IrNi_2$/C-NH_3-500	42.69	2.116	3.6649	2.2	305.1
IrNi/C-NH_3-300	41.42	2.178	3.7723	1.3	366.4
IrNi/C-NH_3-400	41.62	2.170	3.7584	1.6	379.6
IrNi/C-NH_3-600	41.72	2.164	3.7480	4.8	283. 1

References:

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