Electronic Supplementary Information (ESI)

Enhanced production of H$_2$ under visible light via a co-deposited Pt and Ir species on g-C$_3$N$_4$

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Content

Experimental for synthesis of other catalysts

H-C$_3$N$_4$ and Pt/H-C$_3$N$_4$. First, 300 mg g-C$_3$N$_4$ was transferred into a crucible, and heated at 400 °C for 4 h (10 °C·min^{-1}). Except IrCl$_4$ solution not added, this procedure was the same as that used for IrO$_2$/C$_3$N$_4$ synthesis. The resulting samples are devoted as H-C$_3$N$_4$. Second, Pt/H-C$_3$N$_4$ was prepared from H-C$_3$N$_4$, under the same conditions used for 0.5Pt/C$_3$N$_4$ synthesis

MoS$_2$/C$_3$N$_4$. First, MoS$_2$ was synthesized by following previous report. Sodium molybdate (0.726 g, 3.0 mmol) and thioacetamide (1.2 g, 16 mmol) were dissolved in 80 mL of distilled water. After stirring for 1 h, the mixture was transferred to a 100 mL Teflon liner, sealed in the stainless-steel autoclave and heated at 210 °C for 24 h. After collection, the products were collected and washed with de-ionized water for several times and dried at 60 °C. Second, 300 mg g-C$_3$N$_4$ was suspended in 40 mL of absolute ethanol and subjected to ultra-sonication for 30 min. To the suspension, MoS$_2$ dispersion (1.5 mL, 1 mg/mL) was slowly added under ultra-sonication. After stirring for 1 h. the product was filtered, washed, and dried at 60℃. This sample is denoted as MoS$_2$/C$_3$N$_4$.

NiS/C$_3$N$_4$. It was prepared by direct precipitation method. First, 300 mg g-C$_3$N$_4$ was dispersed in 60 mL water by ultrasound. Second, 600 μL 0.027 M Ni(NO$_3$)$_2$ solution was dropped into the dispersion,. After stirring for 30 min, 600 μL 0.027 M Na$_2$S solution was dropped into the above mixed solution. After 1 h stirring, the samples were filtered, rinsed with distilled water, and dried at 60 °C and denoted as NiS/C$_3$N$_4$.

Table S1 X-ray diffraction pattern analysis for samples[a]

Samples	Peak 100						Peak 002					
	2θ(°)	d (nm)	Area (10^4)	Int (10^4)	W (°)	d_s (nm)	2θ(°)	d (nm)	Area (10^5)	Int (10^5)	W (°)	d_s (nm)
g-C$_3$N$_4$	12.90	0.686	7.01	3.83	1.48	6.1	27.50	0.325	4.66	3.53	1.02	20.6
Pt/C$_3$N$_4$	12.86	0.688	5.96	3.17	1.60	5.6	27.44	0.325	4.01	3.09	1.02	19.2
IrO$_2$/C$_3$N$_4$	12.84	0.689	5.77	2.88	1.82	4.9	27.54	0.324	4.06	3.08	1.02	21.7
Pt/IrO$_2$/C$_3$N$_4$	12.84	0.689	6.28	3.27	1.74	5.1	27.54	0.324	4.24	3.21	1.00	22.1

[a]d, repeat distance; Int; peak intensity; W, peak width; d_s, crystallite size estimated with the Scherrer equation.
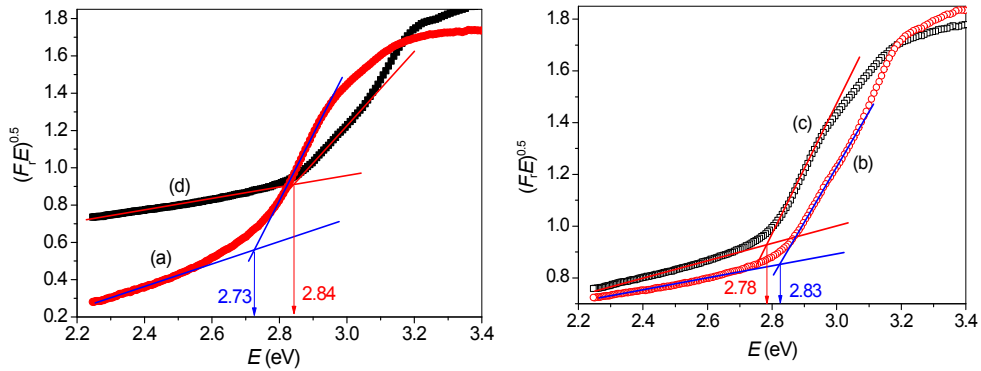
Fig. S1 Tauc plots for indirect transition, obtained from (a) g-C$_3$N$_4$, (b) IrO$_2$/C$_3$N$_4$, (c) Pt/C$_3$N$_4$, and (d) Pt/IrO$_2$/C$_3$N$_4$. Note that E is light energy, and F_r is Kubelka-Munk unit, $F_r = (1 − R)^2/(2R)$, where R is reflectance.
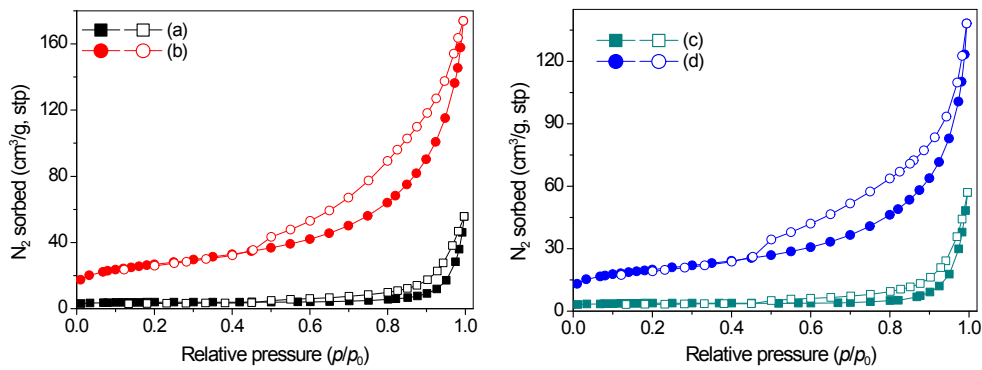

Fig. S2 Isotherms of N$_2$ adsorption (solid symbols) and desorption (open symbols) on the samples of (a) g-C$_3$N$_4$, (b) IrO$_2$/C$_3$N$_4$, (c) Pt/C$_3$N$_4$ and (d) Pt/IrO$_2$/C$_3$N$_4$.
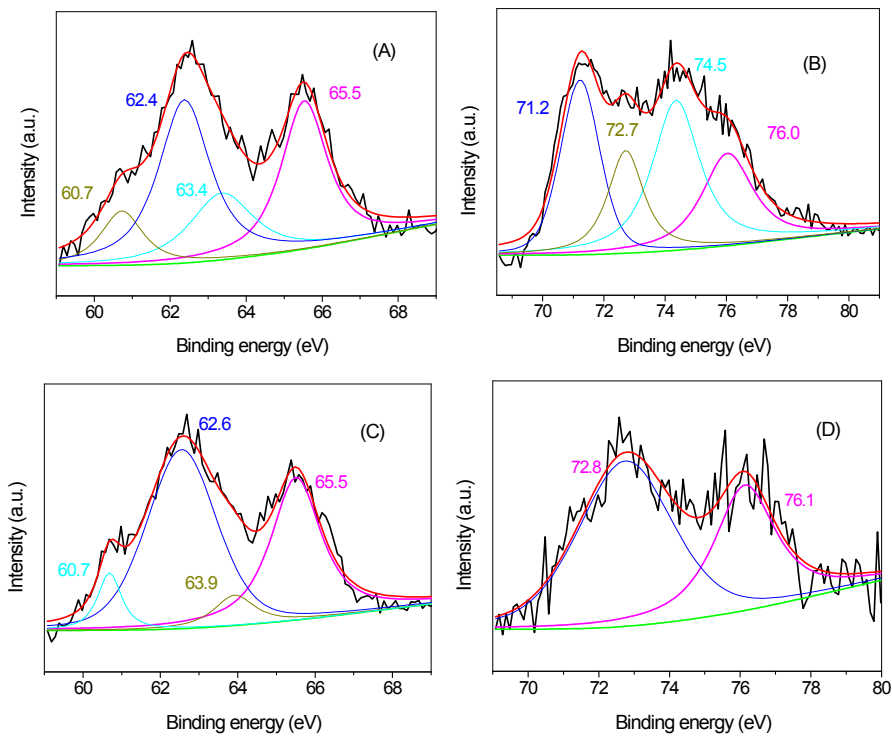
Fig. S3 XPS spectra for (A) Ir 4f in IrO_2/C_3N_4, and (B) Pt 4f in Pt/C_3N_4. (C) Ir 4f, and (D) Pt 4f, recorded with $Pt/IrO_2/C_3N_4$ after repeat experiments.
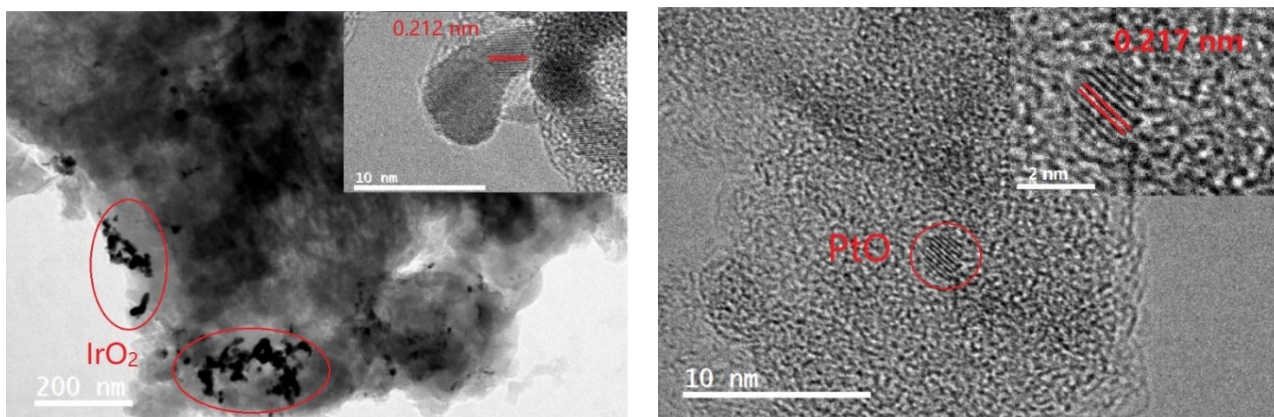

Fig. S4 HRTEM images of $Pt/IrO_2/C_3N_4$ for IrO_2 and PtO.
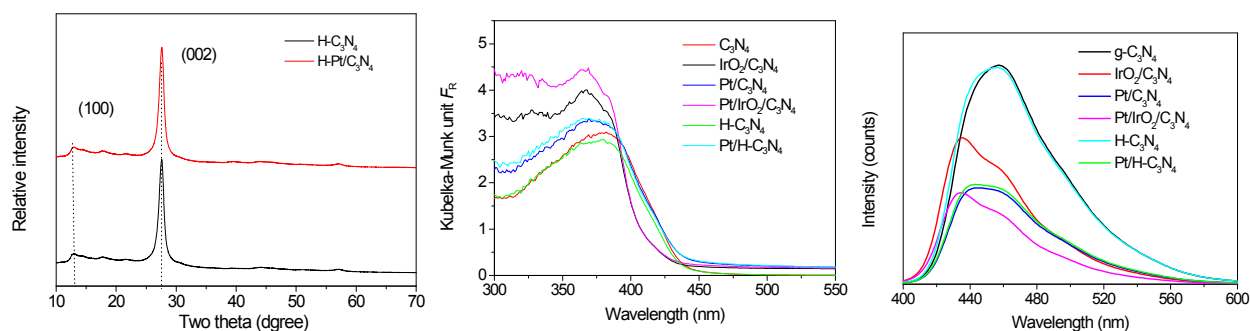

Fig. S5 XRD, absorption, and photoluminescence spectra of the solids indicated by the legends.
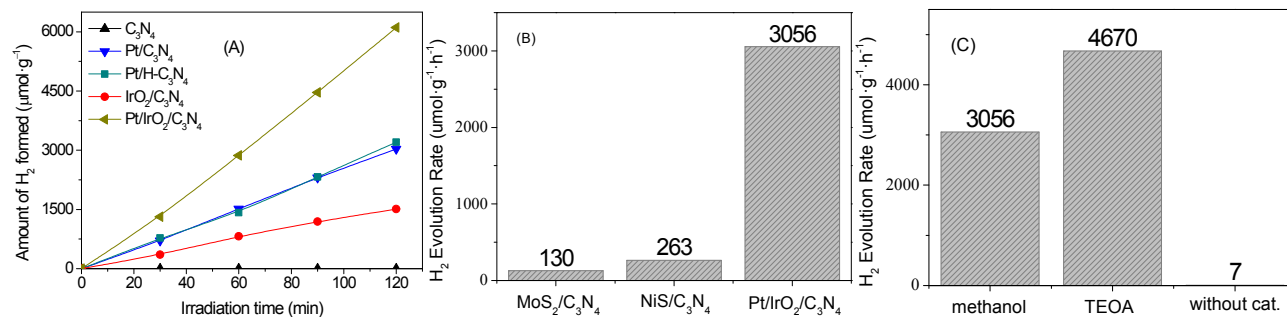

Fig. S6 H_2 evolution for (A) $Pt/H-C_3N_4$, (B) MoS_2/C_3N_4, and NiS/C_3N_4, and (C) $Pt/IrO_2/C_3N_4$ in presence of TEOA.
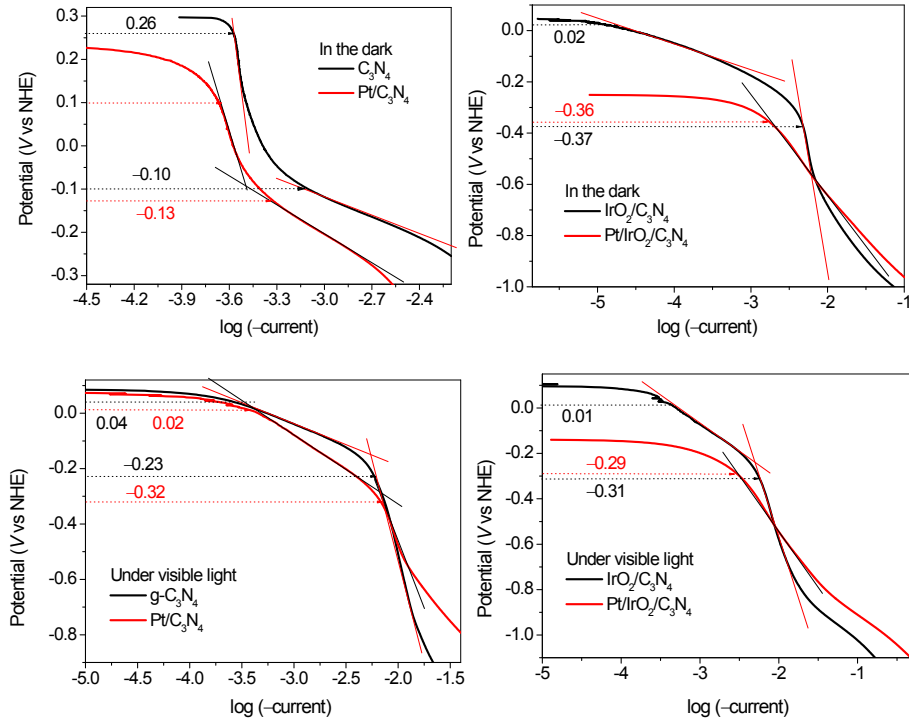
Fig. S7 Curve fitting to Fig. 4A for proton reduction on the electrodes, as shown by the legends.
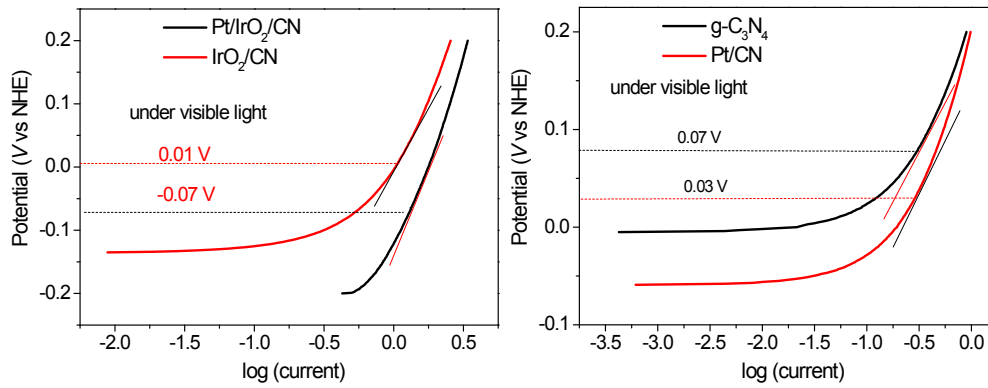

Fig. S8 Curve fitting to Fig. 4B for water oxidation on the electrodes, as shown by the legends.
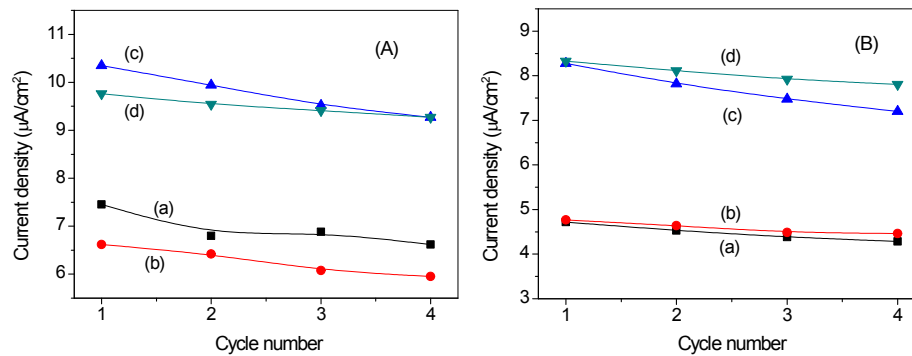

Fig. S9 (A) Maximum photocurrent, and (B) steady photocurrent for Fig. 4C in the text.
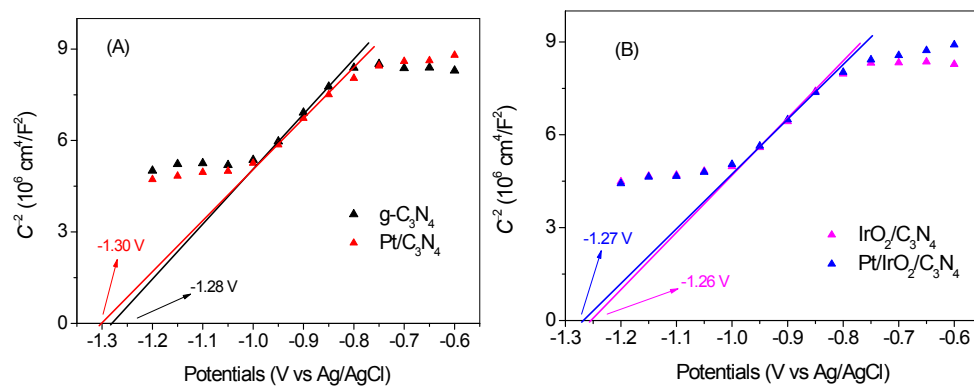
Fig. S10 Mott–Schottky plots for a film electrode of samples, measured in 0.5 M NaClO$_4$ in the dark and under N$_2$, as shown by the legends.