Supporting Information for

Amorphous Fe_2O_3 for photocatalytic hydrogen evolution

Zhaoyong Lin, Chun Du, Bo Yan and Guowei Yang*

State Key Laboratory of Optoelectronic Materials and Technologies, Nanotechnology Research Center, School of Materials Science & Engineering, Sun Yat-sen University, Guangzhou 510275, Guangdong, P. R. China.

*Corresponding author: stsygw@mail.sysu.edu.cn

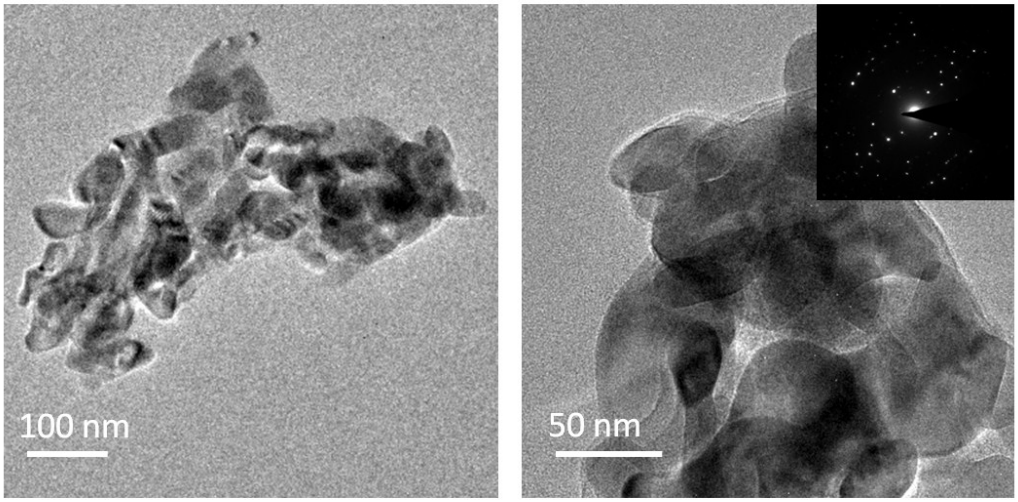

Figure S1 TEM image and SAED pattern of the raw material CHPs.

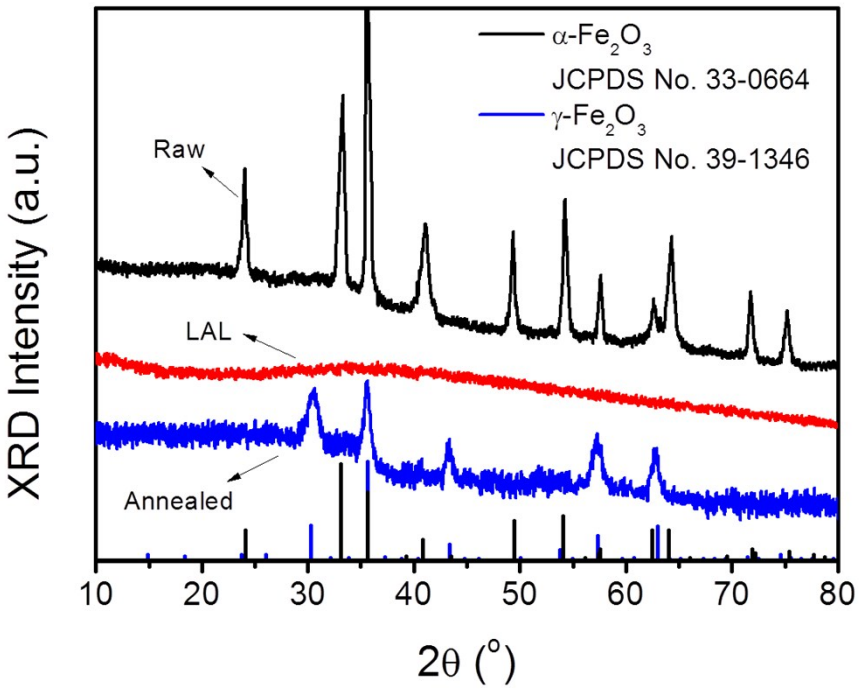

Figure S2 XRD patterns of CHPs (Raw), AFNs (LAL) and CMNs (Annealed). Standard XRD patterns of α-Fe_2O_3 (JCPDS No. 33-0664) and γ-Fe_2O_3 (JCPDS No. 39-1346) are illustrated with black and blue lines respectively.

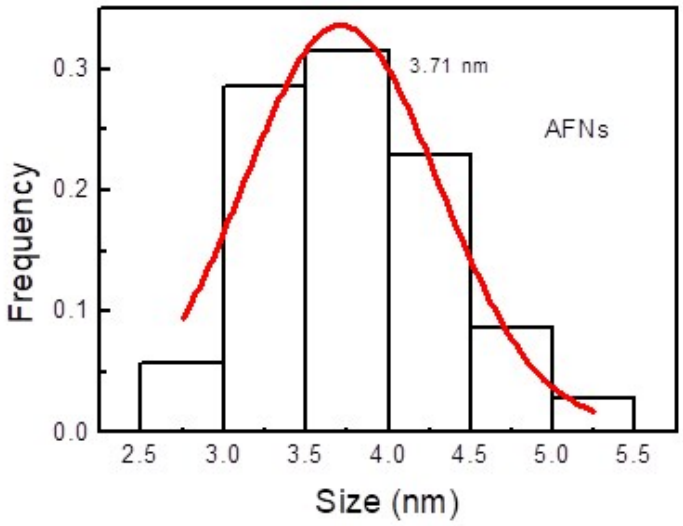

Figure S3 Size distribution histogram with the Gaussian fitting curve of AFNs.

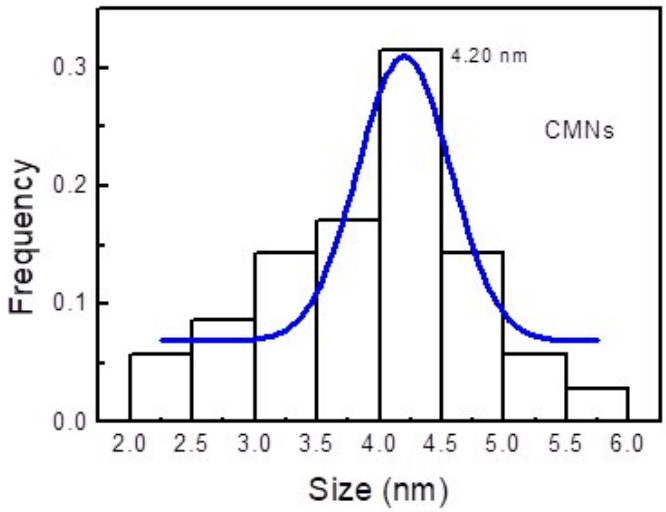

Figure S4 Size distribution histogram with the Gaussian fitting curve of CMNs.

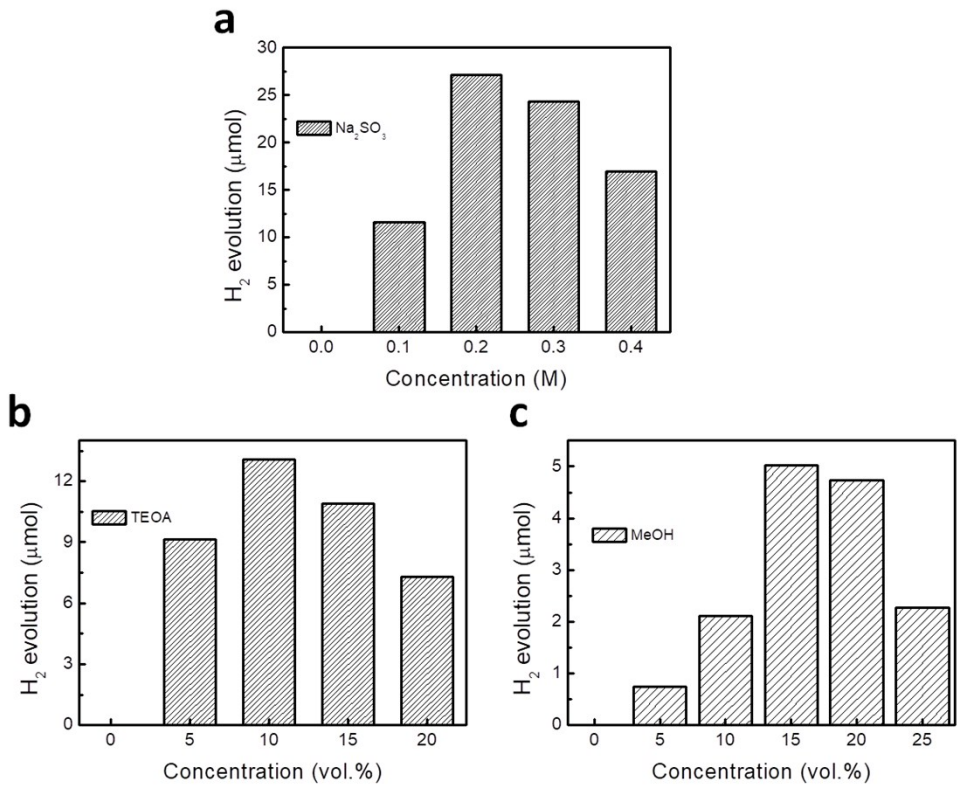

Figure S5 Phtocatalytic H_2 evolution over AFNs upon AM 1.5 irradiation using different hole scavengers with different concentration for 3 h. (**a**) Na_2S/Na_2SO_3 solution with fixed Na_2S/Na_2SO_3molar ratio of 1.4. The horizontal axis indicates the concentration of Na_2SO_3. (**b**) TEOA aqueous solution with different volume fraction.(**c**) MeOH aqueous solution with different volume fraction.

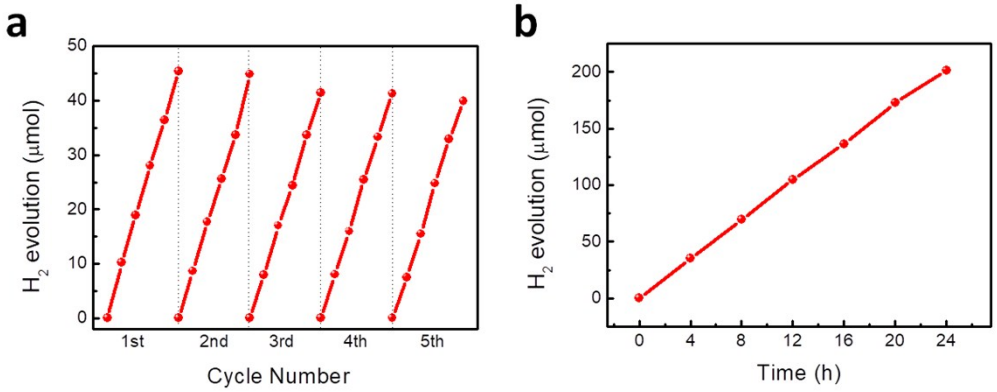

Figure S6 Phtocatalytic H_2 evolution stability evalution over AFNs upon AM 1.5 irradiation. (**a**) Cycling tests with 5 rounds. Each round was performed for 5 h. (**b**) Long-term photocatalysis for 24 h.

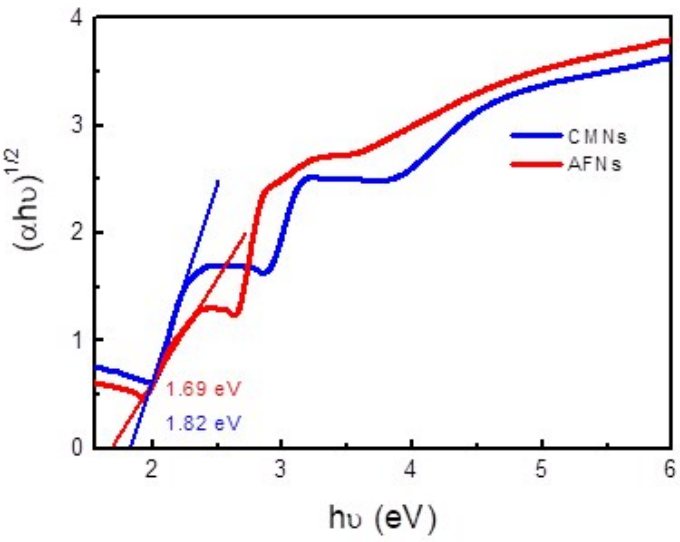

Figure S7 Tauc plots of AFNs and CMNs.

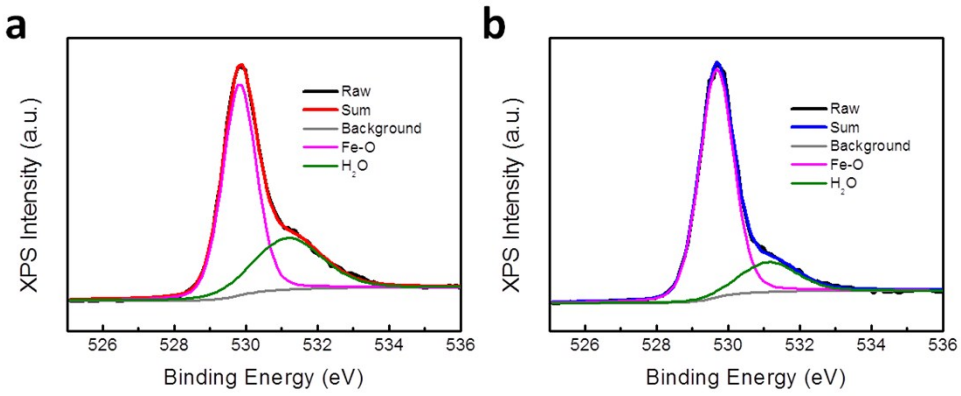

Figure S8 O 1s XPS spectra and the deconvolution results of (**a**) AFNs and (**b**) CMNs.

Table S1 The parameters of the TRPL decay curves at 410 nm.

Sample	τ_1 **(ps)**	τ_2 **(ps)**	$\mathbf{A_1}$ **(%)**	$\mathbf{A_2}$ **(%)**	τ **(ps)**
AFNs	94	142	36.3	63.7	129
CMNs	84	197	27.8	72.2	181

Table S2 The parameters of the TRPL decay curves at 545 nm.

Sample	τ_1 **(ps)**	τ_2 **(ps)**	$\mathbf{A_1}$ **(%)**	$\mathbf{A_2}$ **(%)**	τ **(ps)**
AFNs	86	107	54.2	45.8	97
CMNs	16	29	39.5	60.5	26

Table S3 The parameters of the TRPL decay curves at 780 nm.

Sample	τ_1 **(ps)**	τ_2 **(ps)**	$\mathbf{A_1}$ **(%)**	$\mathbf{A_2}$ **(%)**	τ **(ps)**
AFNs	11	28	71.3	28.7	20
CMNs	8	16	62.5	37.5	12

Table S4 Comparison of the photocatalytic activity of AFNs with other amorphous photocatalysts.

Photocatalyst	**Cocatalyst**	**Illumination**	**Scavenger**	**Specific rate (μmol h^{-1} g^{-1})**	**Reference**
AFNs	None	AM1.5	Na_2SO_3	449.5	This work
AFNs	None	<420 nm	Na_2SO_3	331	This work
AFNs	None	420-760 nm	Na_2SO_3	153.5	This work
$TiO_2 \cdot nH_2O$	None	200-1000 nm	Methanol	250-350	[S1]
Zn-Ge-O	None	>420 nm	Methanol	62	[S2]
Zn-Ge-O	Pt	>420 nm	Methanol	282	[S2]
Carbon nitride	None	>420 nm	TEOA	Trace	[S3]
Carbon nitride	Pt	>420 nm	TEOA	180	[S3]
Carbon nitride	Pt	>440 nm	TEOA	157.9	[S4]

Reference

[S1] Z. Zhang, P. A. Maggard, *J. Photoch. Photobio. A***2007**, 186, 8.

[S2] L. Qian, J. F. Chen, Y. H. Li, L. Wu, H. F. Wang, A. P. Chen, P. Hu, L. R. Zheng, H. G. Yang, *Angew. Chem. Int. Ed.***201**5, 54, 11467.

[S3] M. Z. Rahman, J. Moffatt, N. Spooner, *Mater. Horiz.***2018**, 5, 553.

[S4]Y. Kang, Y. Yang, L. Yin, X. Kang, G. Liu, *Adv. Mater.***2015**, 27, 4572.