Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

$Ni_{12}P_5$ nanoparticles embedded into porous g-C_3N_4 nanosheets as a noble-metal-free hetero-structural photocatalyst for efficient H_2 production under visible light

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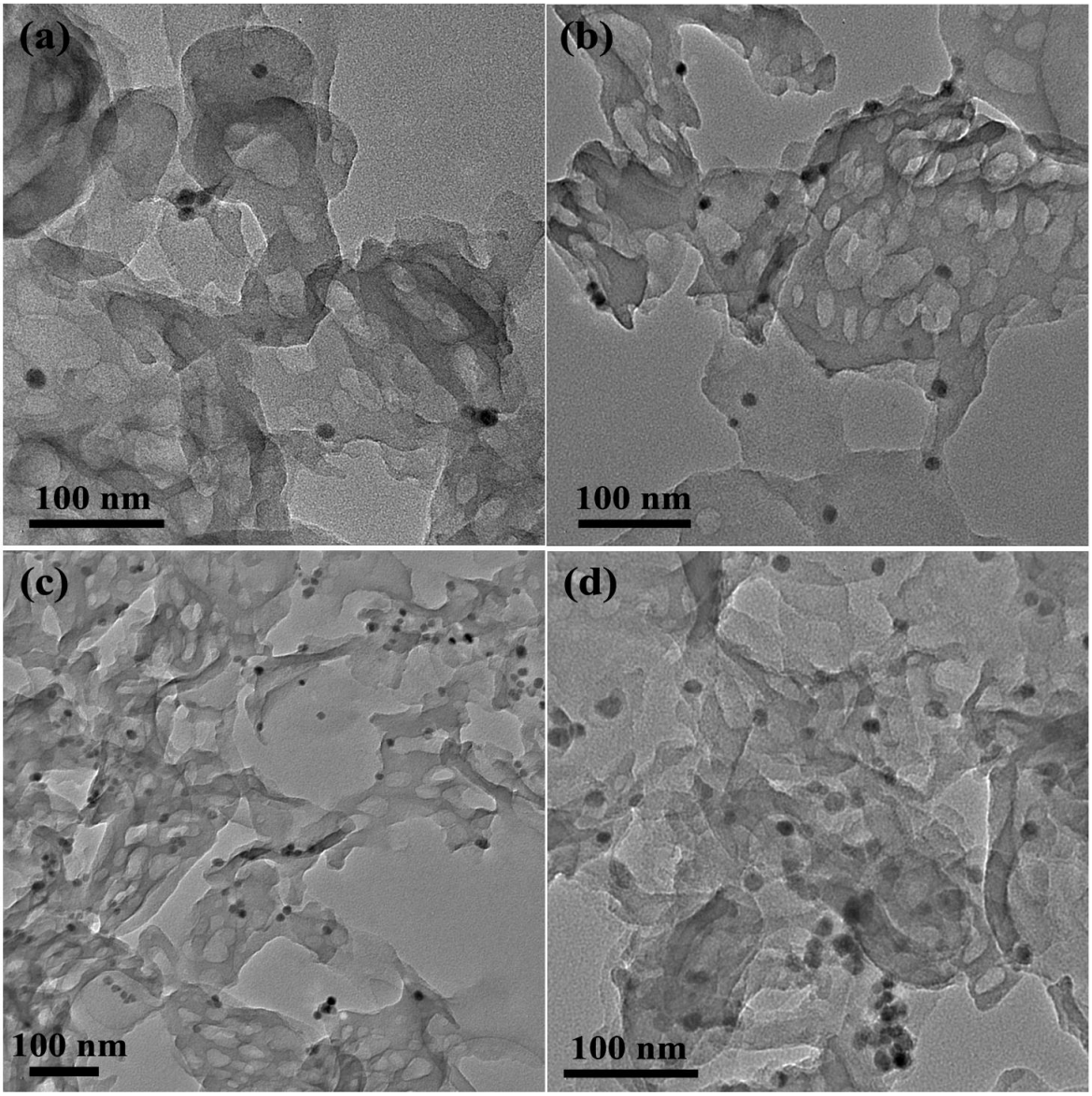

Fig. S1 TEM images of 1NP-CN (a), 3NP-CN (b), 7NP-CN (c) and 10NP-CN (d) samples.

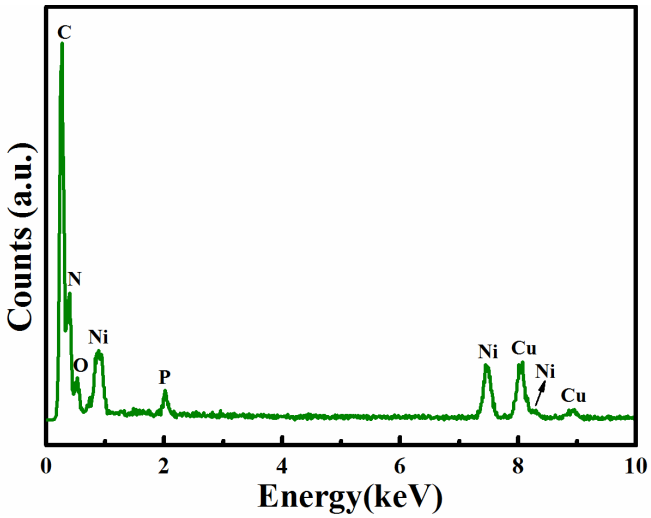

Fig. S2 EDX spectrum of the 5NP-CN sample.

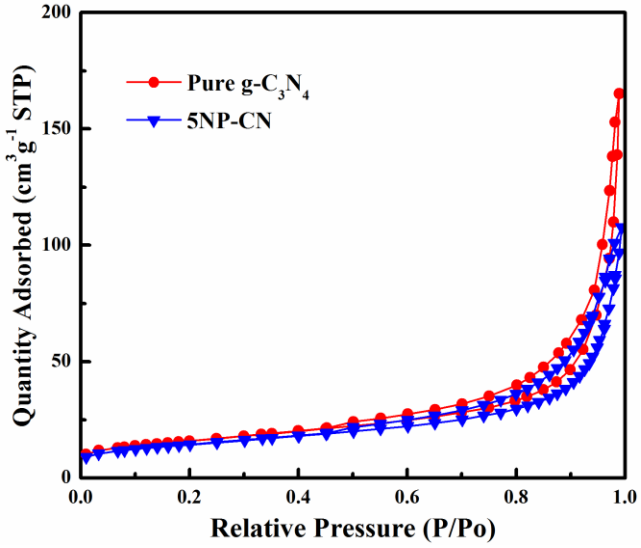

Fig. S3 Nitrogen isotherms of pure g-C_3N_4 and the representative 5NP-CN samples.

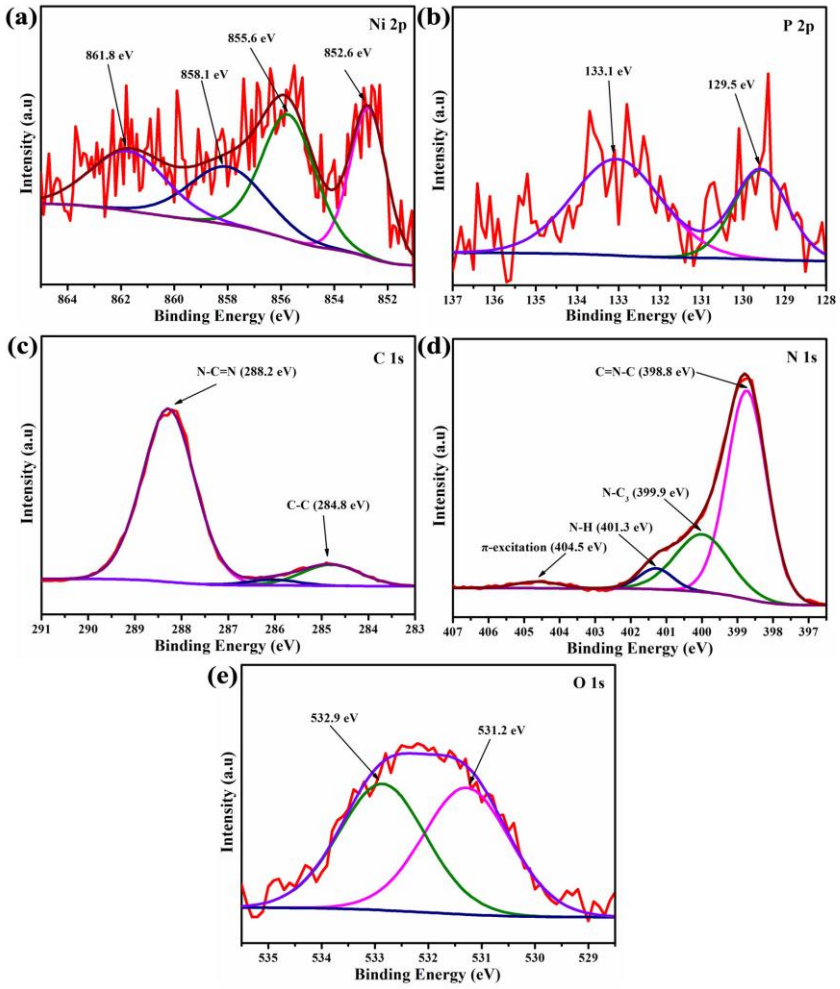

Fig. S4 High resolution XPS results of the 5NP-CN sample. (a) Ni 2p, (b) P 2p, (c) C 1s, (d) N 1s and (e) O 1s.

Table S1 Comparison of the photocatalytic H_2 evolution reaction of the g-C_3N_4-based systems loaded with non-noble-metal co-catalysts.

Catalyst	Synthetic method	Sacrificial reagent	Activity (μmol h^{-1} g^{-1})	AQY (%) (Wavelength)	Ref.
g-C_3N_4/WS_2	gas–solid reaction strategy	Methanol	101	---	S1
g-C_3N_4/WS_2	impregnation-sulfidation method	Lactic acid	240	---	S2
g-C_3N_4/$Ni_{12}P_5$	nanopowder was ground together in an agate mortar	TEOA	126.61	---	S3
g-C_3N_4/WC	heating a mixture of thiourea and commercial WC	TEOA	146.1	---	S4
g-C_3N_4/Ni_2P	mix suspension under stirring	TEOA	183.6	1.2 (420 nm)	S5
g-C_3N_4/Ni_2P	gas–solid reaction strategy	TEOA	644	4.8 (440 nm)	S6
g-C_3N_4/Ni_2P	gas–solid reaction strategy	TEOA	82.5	---	S7
g-C_3N_4/NiS	in situ ion-exchange method	TEOA	447.7	---	S8
g-C_3N_4/NiS	hydrothermal method	TEOA	482	1.9 (440 nm)	S9
g-C_3N_4/$Ni(OH)_2$	precipitation method	TEOA	152	1.1 (420 nm)	S10
g-C_3N_4/Ni/NiO	in situ immersion method	TEOA	200	---	S11
g-C_3N_4/Cu	H_2 reduction	Methanol	20.5	0.35 (420 nm)	S12
g-C_3N_4/MoS_2	in situ light-assisted method	TEOA	252	---	S13
$Ni_{12}P_5$/g-C_3N_4	**Solution-phase self-assembly method**	**TEOA**	**535.7**	**4.67 (420 nm)**	**Our work**

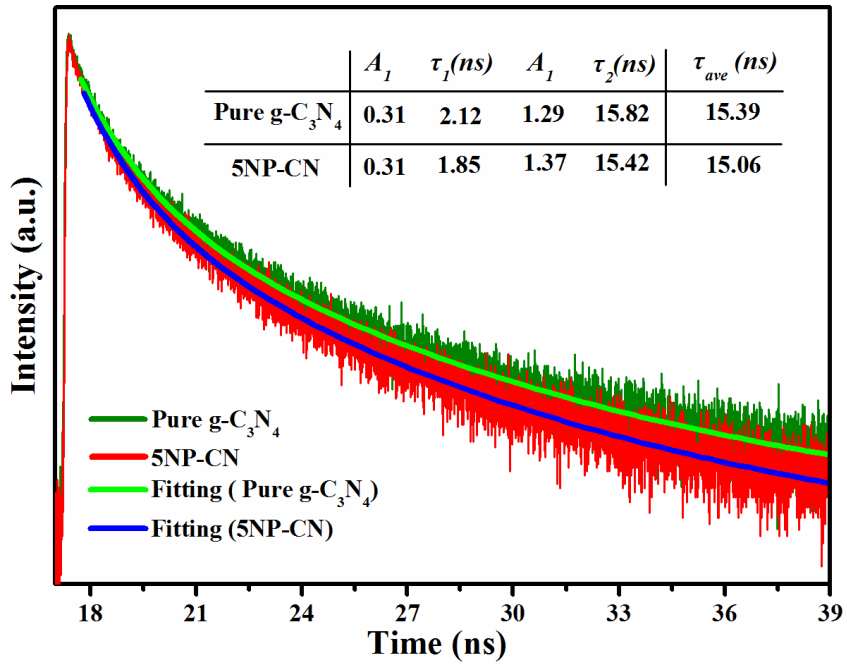

Fig. S5 TRPL decay curves of pure g-C_3N_4 and 5NP-CN samples.

References

[S1] M. S. Akple, J. Low, S. Wageh, A. A. Al-Ghamdi, J. Yu and J. Zhang, *Appl. Surf. Sci*., 2015, **358,** 196–203.

[S2] Y. Hou, Y. Zhu, Y. Xu and X. Wang, *Appl. Catal. B Environ*., 2014, **156,** 122–127.

[S3] J. Wen, J. Xie, R. Shen, X. Li, X. Y. Luo, H. Zhang, A. Zhang and G. Bi, *Dalton Trans*., 2017, **46,** 1794–1802.

[S4] K. He, J. Xie, Z. Yang, R. Shen, Y. Fang, S. Ma, X. Chen and X. Li, *Catal. Sci. Technol*., 2017, **7,** 1193–1202.

[S5] Y. Chen and Z. Qin, *Catal. Sci. Technol*., 2016, **6,** 8212–8221.

[S6] A. Indra, A. Acharjya, P. W. Menezes, C. Merschjann, D. Hollmann, M. Schwarze,M. Aktas, A. Friedrich, S. Lochbrunner, A. Thomas and M. Driess, *Angew. Chem*., 2017, **129,** 1675–1679.

[S7] P. Ye, X. Liu, J. Locozzia, Y. Yuan, L. Gu, G. Xu and Z. Lin, *J. Mater. Chem. A*, 2017, **5,** 8493–8498.

[S8] Z. Chen, P. Sun, B. Fan, Z. Zhang and X. Fang, *J. Phys. Chem. C*, 2014, **118,** 7801–7807.

[S9] J. Hong, Y. Wang, Y. Wang, W. Zhang and R. Xu, *ChemSusChem*, 2013, **6,** 2263–2268.

[S10] J. Yu, S. Wang, B. Cheng, Z. Lin and F. Huang, *Catal. Sci. Technol*., 2013, **3,** 1782–1789.

[S11] G. Zhang, G. Li and X. Wang, *ChemCatChem*, 2015, **7,** 2864–2870.

[S12] M. Fan, C. Song, T. Chen, X. Yan, D. Xu, W. Gu, W. Shi and L. Xiao, *RSC Adv*., 2016, **6,** 34633–34640.

[S13] H. Zhao, Y. Dong, P. Jiang, H. Miao, G. Wang and J. Zhang, *J. Mater. Chem. A*, 2015, **3,** 7375–7381.