Viologen Doping Induced Charge Storage of Carbon Nitride for Enhanced Photocatalytic Hydrogen Production

Fankai Bu, Runzhi Yuan, Zejun Zhang, Jun Wang, Junying Liu*, Yang-Chun Yong†

Biofuels Institute, School of Environment and Safety Engineering, Jiangsu University, 301 Xuefu Road, Zhenjiang 212013, China

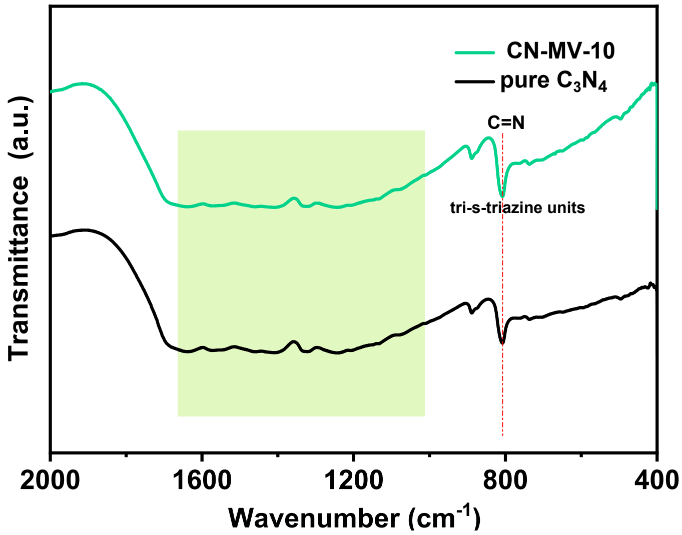

Fig. S1 FTIR spectra of g-C_3N_4 and the CN-MV-10 sample.

* Corresponding author. E-mail: lsliujy@ujs.edu.cn.
† Corresponding author. E-mail: ycyong@ujs.edu.cn.

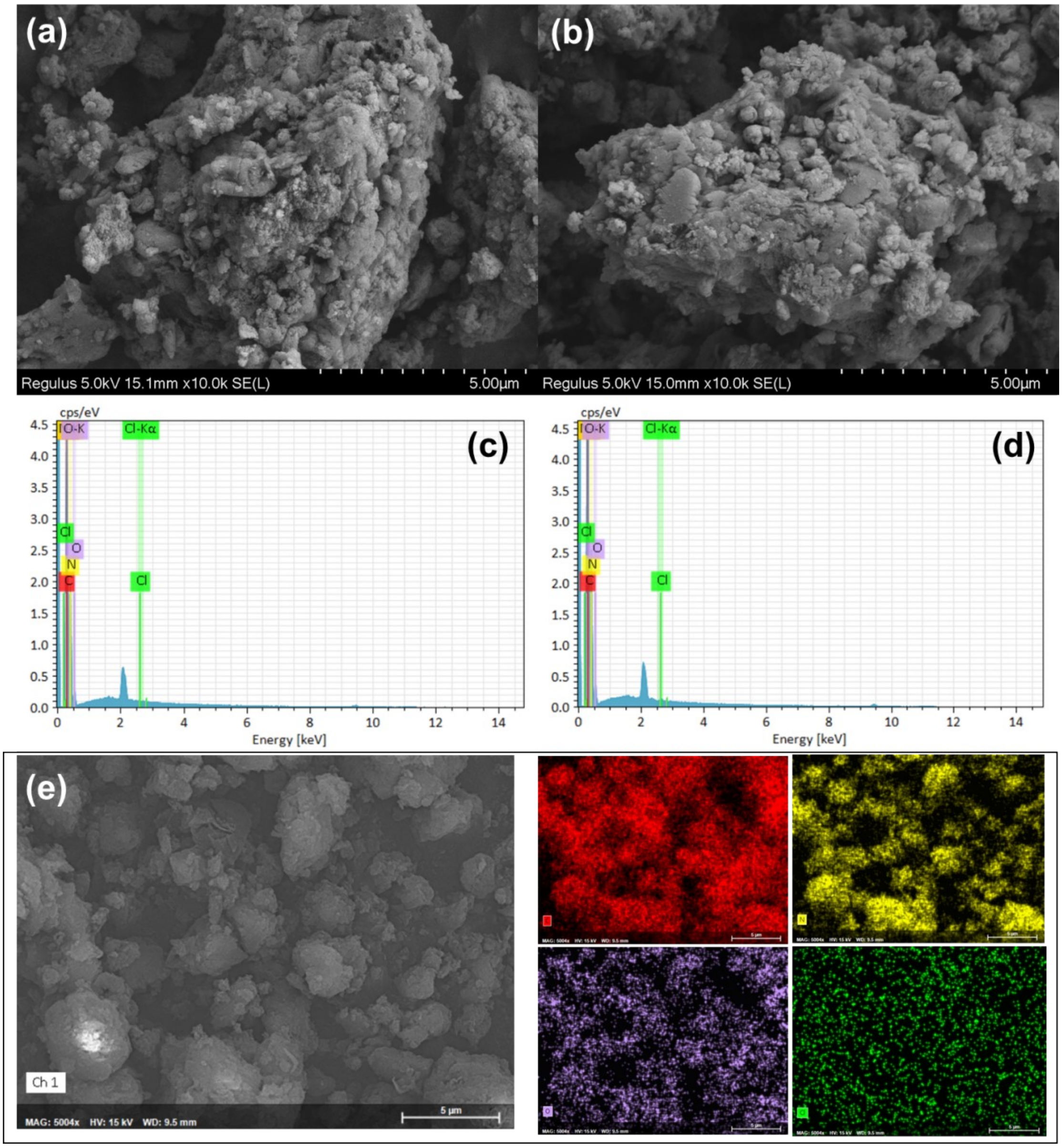

Fig. S2 SEM images and EDS spectrum of (a,c) g-C_3N_4 and (b,d) the CN-MV-10 sample. (e) Elemental mappings of the CN-MV-10 sample.

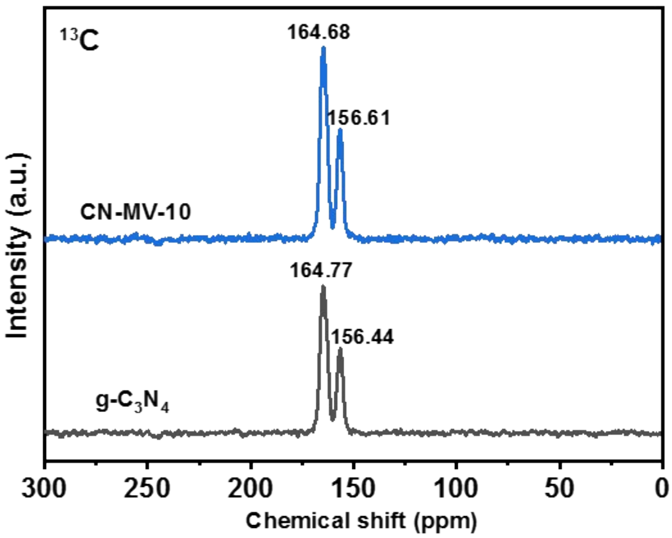

Fig. S3 Solid state 13C cross-polarization magic angle spinning (CP-MAS) nuclear magnetic resonance (NMR) of g-C_3N_4 and CN-MV-10.

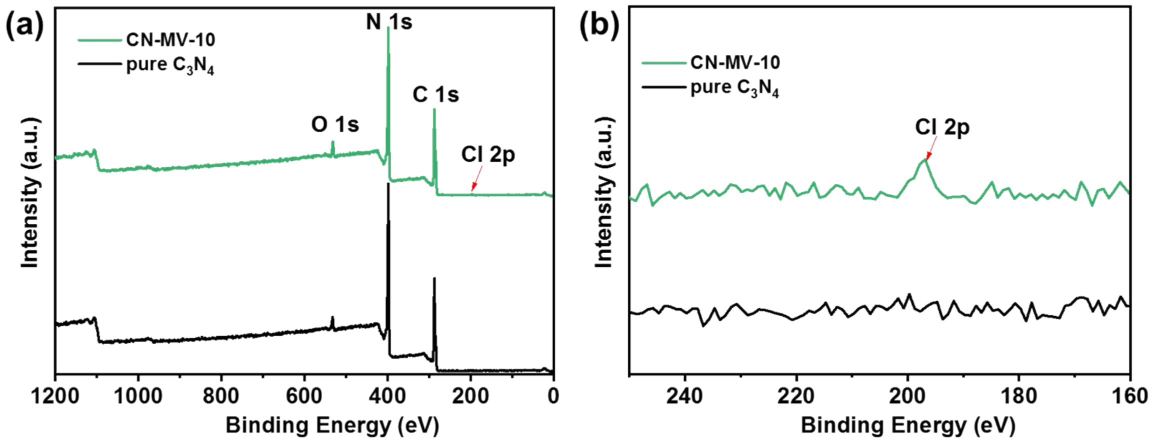

Fig. S4 (a) The XPS survey spectrum of pristine g-C_3N_4 and CN-MV-10. (b) Enlarged view of a portion of the XPS survey spectrum.

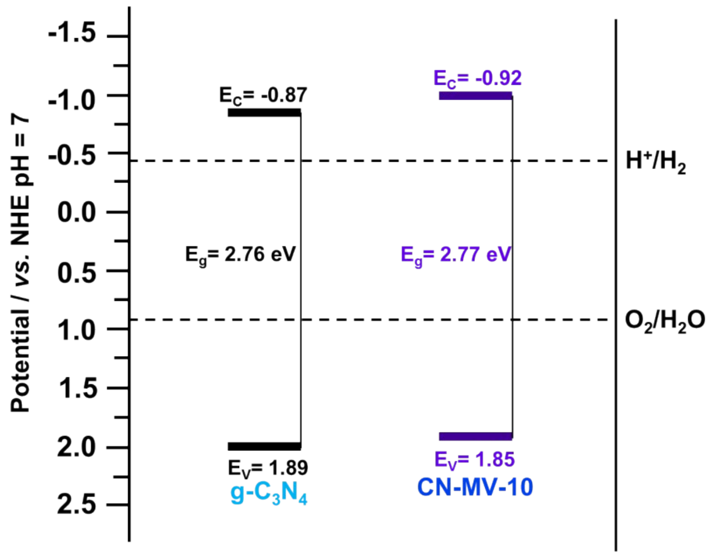

Fig. S5 Schematic illustration of the band structure of pure g-C_3N_4 and CN-MV-10.

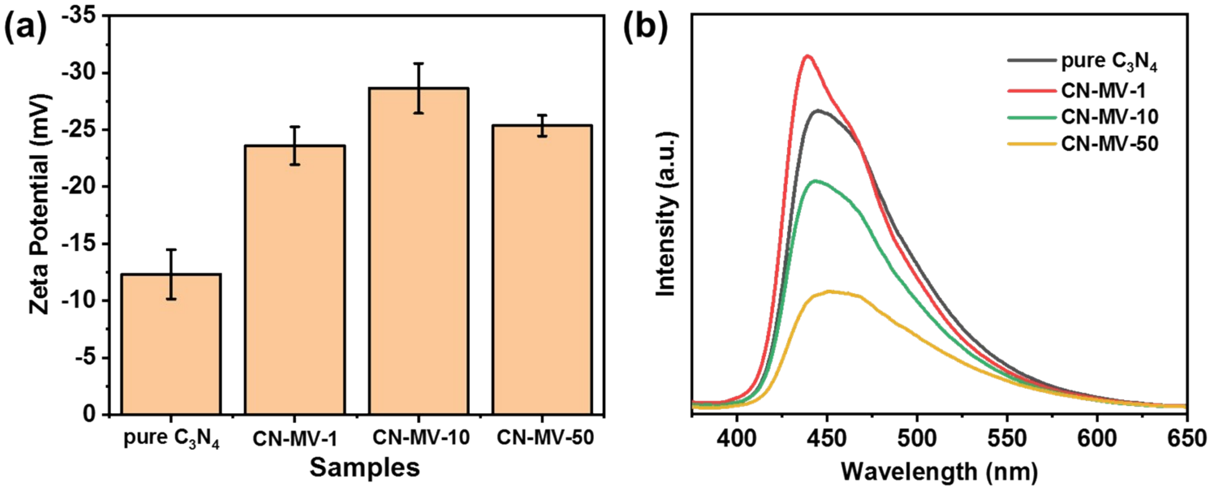

Fig. S6 (a) Zeta potentials and (b) PL spectra of g-C_3N_4 and CN-MV-*x*.

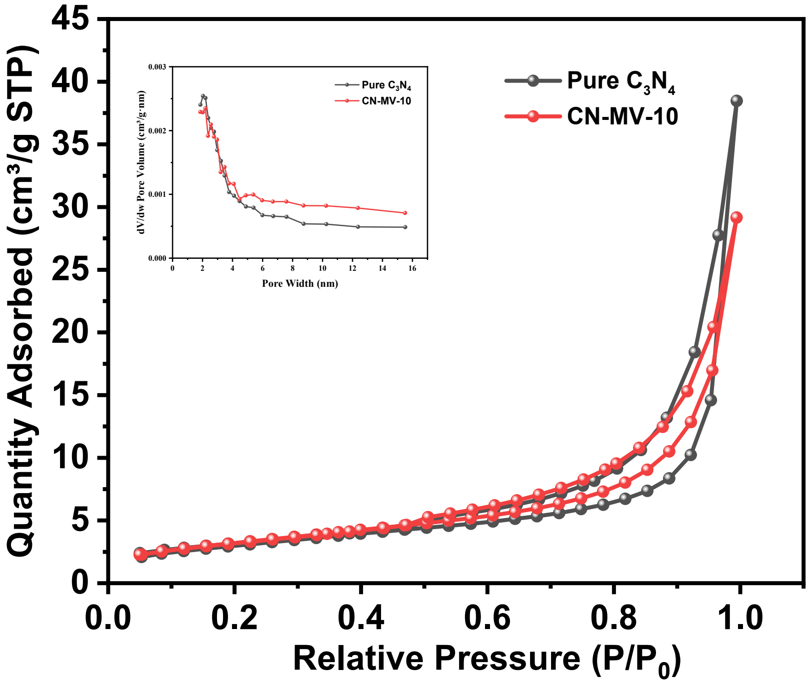

Fig. S7 N_2 adsorption/desorption curves and pore size distribution of pure C_3N_4 and CN-MV-10 samples.

Table S1 Comparison of specific surface area and pore size between Pure C_3N_4 and CN-MV-10

	BET Surface Area (m^2/g)	BJH Desorption average pore width (4V/A) (nm)
Pure C_3N_4	11.0077	6.5605
CN-MV-10	11.7936	5.8332

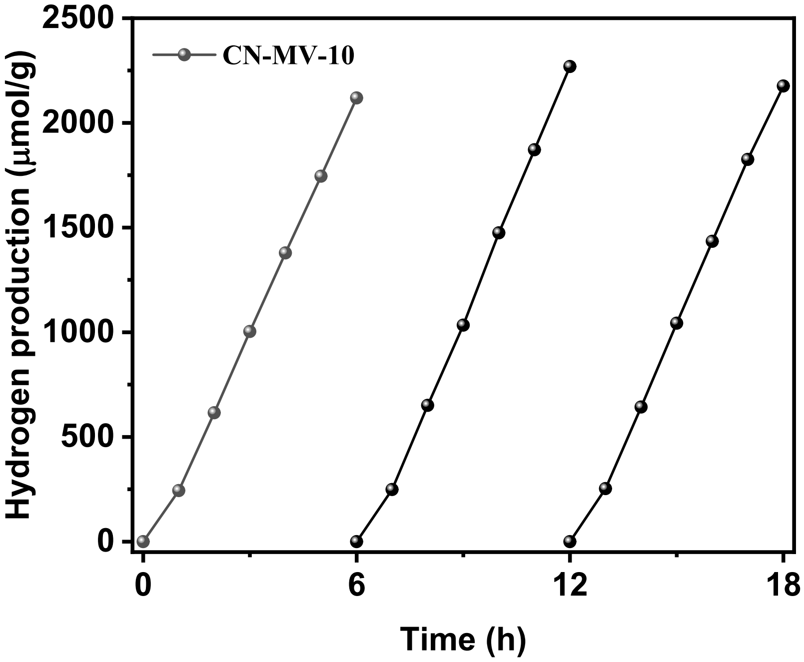

Fig. S8 Stability tests of photocatalytic hydrogen production for CN-MV-10

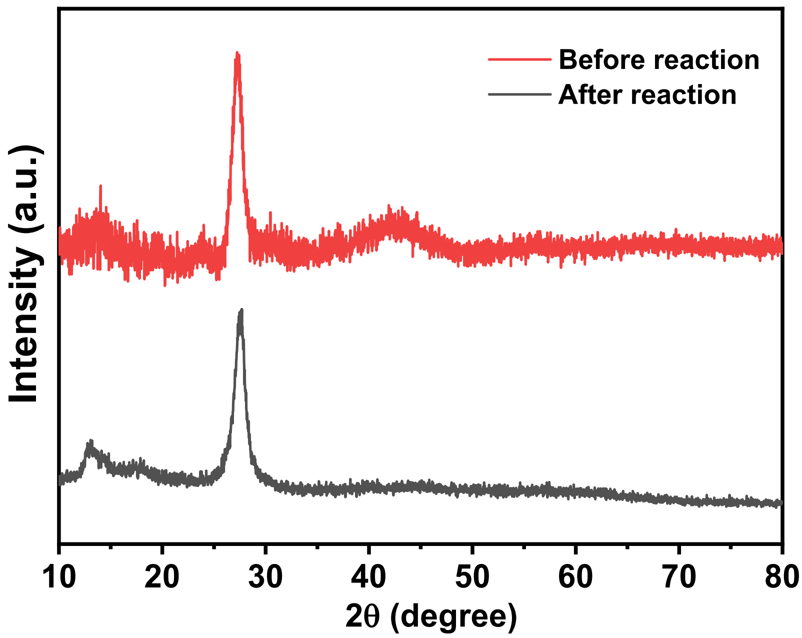

Fig.S9 Comparison of XRD before and after photocatalytic reaction

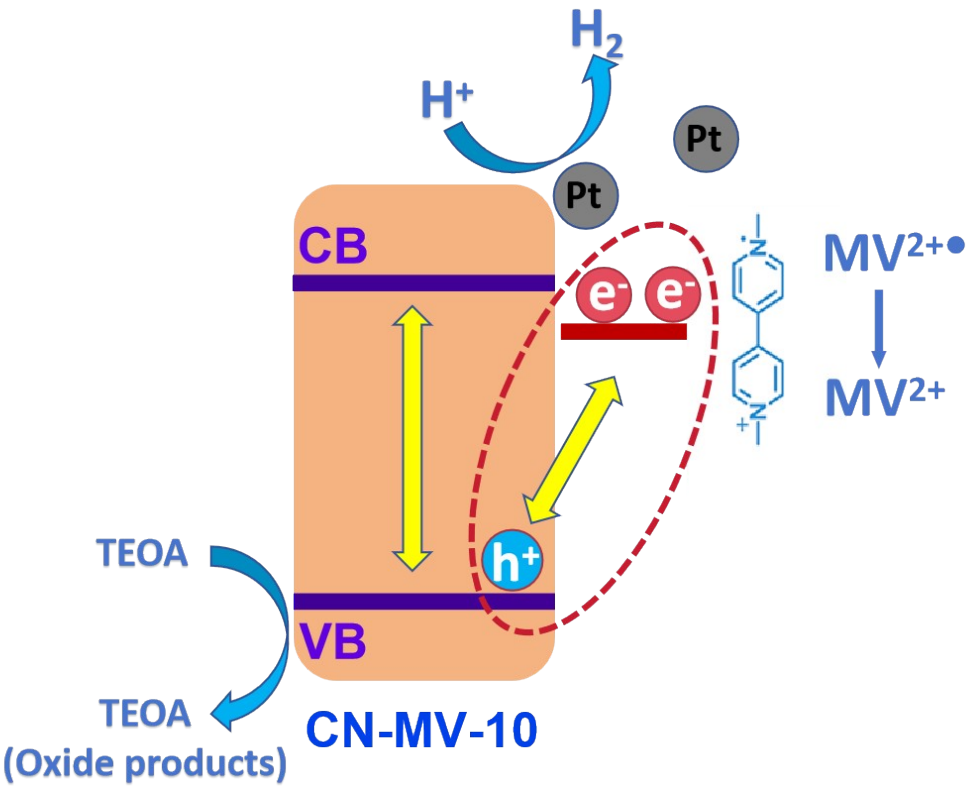

Fig.S10 proposed reaction mechanism of dark reaction hydrogen generation after illumination for the CN-MV-10 sample.

Table S2 Comparison of different research reports

Photocatalyst	**Hydrogen production rate (μ mol/g/h)**	**Co-catalyst**	**Sacrificial agent**	**Reference**
0.1HCCN	683.54	3wt%Pt	10vol%TEOA	1
Zn-Ni-P@g-C_3N_4	531.2	\	15vol%TEOA	2
$Ni_{0.4}Mo_{0.6}$/g-C_3N_4	1785	\	10vol%TEOA	3
CNK	919.5	3wt%Pt	10vol%TEOA	4
B–CN/P–CN(0.5:0.5)	655	3wt%Pt	10vol%TEOA	5
CN-M/CNU/Pt-TiO_2	1735	1wt%Pt	10vol%TEOA	6
CNC-0.1	212.8	1wt%Pt	15vol%TEOA	7
CN-40	1210.3	3wt%Pt	10vol%TEOA	8
CN-MV-10	1650	1wt%Pt	5vol%TEOA	This work

References

1.Y. Li, D. Zhang, X. Feng and Q. Xiang, Enhanced photocatalytic hydrogen production activity of highly crystalline carbon nitride synthesized by hydrochloric acid treatment, *Chinese J. Catal.*, 2020, **41**, 21-30.

2.Y. Li, Z. Jin, L. Zhang and K. Fan, Controllable design of Zn-Ni-P on g-C_3N_4 for efficient photocatalytic hydrogen production, *Chinese J. Catal.*, 2019, **40**, 390-402.

3.X. Han, D. Xu, L. An, C. Hou, Y. Li, Q. Zhang and H. Wang, Ni-Mo nanoparticles as co-catalyst for drastically enhanced photocatalytic hydrogen production activity over g-C_3N_4, *Appl. Catal. B-Environ.*, 2019, **243**, 136-144.

4.S. Sun, J. Li, J. Cui, X. Gou, Q. Yang, Y. Jiang, S. Liang and Z. Yang, Simultaneously engineering K-doping and exfoliation into graphitic carbon nitride (g-C_3N_4) for enhanced photocatalytic hydrogen production, *Int. J. Hydrogen Energ*, 2019, **44**, 778-787.

5.D. Yuan, Z. Li, X. Chen, J. Ding, H. Wan and G. Guan, Homodispersed B–CN/P–CN S-scheme homojunction for enhanced visible-light-driven hydrogen evolution, *Green Energ. Environ.*, 2022, **7**, 1119-1127.

6.H. Qin, X. Zhao, H. Zhao, L. Yan and W. Fan, Well-organized CN-M/CN-U/Pt-TiO_2 ternary heterojunction design for boosting photocatalytic H_2 production via electronic continuous and directional transmission, *Appl. Catal. A-Gen*, 2019, **576**, 74-84.

7.Q. Xu, B. Cheng, J. Yu and G. Liu, Making co-condensed amorphous carbon/g-C_3N_4 composites with improved visible-light photocatalytic H_2-production performance using Pt as cocatalyst, *Carbon*, 2017, **118**, 241-249.

8.Y. Liu, S. Zhao, C. Zhang, J. Fang, L. Xie, Y. Zhou and S. J. C. Zhuo, Hollow tubular carbon doping graphitic carbon nitride with adjustable structure for highly enhanced photocatalytic hydrogen production, *Carbon*, 2021, **182**, 287-296.