

Supplementary Material for:

Recent advances in constructing three-dimensional graphitic carbon nitride based materials and their applications in environmental photocatalysis, photo-electrochemistry, and electrochemistry

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Table S1: The 3D CNBMs for degrading organic pollutants.

Catalyst	Light source	Catalyst concentration (g/L)	Pollutant concentration (mg/L)	Degradation efficiency	Enhancement factor over reference photocatalyst	Main active species	References
HP-CN	35 W metal halide lamp ($\lambda \geq 420$ nm)	0.5	RhB: 10 MO: 10	RhB: 98%, 3 h MO: 35%, 3 h	bulk g-C ₃ N ₄ : RhB: 5.0 MO: 22.3	N/A	(Shen et al., 2015)
CNGA	500W Xe lamp ($\lambda > 420$ nm)	1	MO: 20	MO: 92%, 4 h	g-C ₃ N ₄ : 7.6	h^+ , $\cdot OH$	(Tong et al., 2015)
C ₃ N ₄ -agar hybrid hydrogel	500W Xe lamp ($\lambda = 420$ nm)	0.5	MB: 3×10^{-5} mol/L Phenol: 5 ppm	N/A	pure g-C ₃ N ₄ : MB: 4.5 Phenol: 1.3	N/A	(Zhang et al., 2016a)
TE-C ₃ N ₄	500W UV lamp ($\lambda = 200$ -400 nm)	1	RhB: 20	100%, 200 min	pure g-C ₃ N ₄ : 1.4	N/A	(Yuan et al., 2016)
C ₃ N ₄ /SiO ₂	500 W Xe lamp with a 420 nm	0.5	MB: 3×10^{-5} mol/L	N/A	pure g-C ₃ N ₄ : MB: 6	N/A	(Zhang et al., 2016b)

Catalyst	Light source	Catalyst concentration (g/L)	Pollutant concentration (mg/L)	Degradation efficiency	Enhancement factor over reference photocatalyst	Main active species	References
	cutoff filter		Phenol: 5 ppm		Phenol: 3.1		
TiO ₂ /GAs	500 W Xe lamp illumination	0.3	MB: 20	90%, 30 min	pure TiO ₂ : 11.8 pure TiO ₂ : 2.8	N/A	(Li et al., 2016)
TiO ₂ /gC ₃ N ₄ /G	with N ₂ atmosphere	2	NB: 0.2 mol/L	97%, 4 h	pure g-C ₃ N ₄ : 3.7	N/A	(Zhang et al., 2017a)
Cu ₂ O/g-C ₃ N ₄ /RGO	A 300W Xe lamp with 400 nm cut-off filter	0.5	MB: 30 MO: 30	MB: 96%, 80 min MO: 83%, 80 min	N/A	·OH, ·O ₂ ⁻	(Yan et al., 2017)
CN/GOAs	300W Xe lamp (λ>420 nm)	0.12	MB: 20 MO: 20	min MO: 91.1%, 40 min	N/A	·O ₂ ⁻	(Tang et al., 2017)
g-C ₃ N ₄ /BiOBr/RGO	A 300W Xe lamp with 420 nm cut-off filter	1	RhB: 10	66%, 1 h	g-C ₃ N ₄ : 2.2 BiOBr: 2	h ⁺ , ·O ₂ ⁻	(Yu et al., 2017)

Catalyst	Light source	Catalyst concentration (g/L)	Pollutant concentration (mg/L)	Degradation efficiency	Enhancement factor over reference photocatalyst	Main active species	References
TiO _{2-x} /Ag/g-C ₃ N ₄	A 300W Xe lamp with 420 nm cut-off filter	0.7	MB: 10 MO: 10	MB: 99% MO: 87%	N/A	·OH, ·O ₂ ⁻	(Cao et al., 2018)
g-C ₃ N ₄ -TiO ₂ -GA	500W Xe lamp (λ>420 nm)	0.2	RhB: 20	98.4%, 60 min	N/A	N/A	(Zhang et al., 2018)
GA-CQDs/CNN	A 300W Xe lamp with 420 nm cut-off filter	0.3	MO: 30	91.1%, 4 h	BCN: 7.6 CNN: 2.3	N/A	(He et al., 2018)
NiO/g-C ₃ N ₄	a 500 W halogen lamp	0.5	MG: 10 ppm	96.9%, 150 min	NiO: 1.3 g-C ₃ N ₄ : 2.3	h ⁺ , ·O ₂ ⁻	(Tzvetkov et al., 2018)
g-C ₃ N ₄ /Bi ₂ WO ₆	A 400 W metal halide with a 400 nm cut-off filter	0.8	MO: 10	MO: 98.2%, 120min	Bi ₂ WO ₆ : 2.5 g-C ₃ N ₄ : 3.1	·OH, h ⁺	(Gao et al., 2018)
g-C ₃ N ₄ aggregates of	A 300W Xe lamp with 420	0.5	TC: 30	97.9%, 12 min	BCN: 3.1	·OH, ·O ₂ ⁻	(Wang et al., 2018a)

Catalyst	Light source	Catalyst concentration (g/L)	Pollutant concentration (mg/L)	Degradation efficiency	Enhancement factor over reference photocatalyst	Main active species	References
hollow bubbles	nm cut-off filter						
g-C ₃ N ₄ -ZnO@GA(30%)	300W ($\lambda \geq 420$ nm)	0.2	RhB: 20	81.0%, 2 h	ZnO @ GA: 2.8	$\cdot\text{OH}$, h^+ , $\cdot\text{O}_2^-$	(Zhang et al., 2019)
	300W ($\lambda \leq 380$ nm)	0.2	RhB: 20	82.7%, 2 h	ZnO @ GA: 2.4	$\cdot\text{OH}$, h^+ , $\cdot\text{O}_2^-$	
GO/MoS ₂ /g-C ₃ N ₄	N/A	1	RhB:20	96.7%, 5 h	N/A	$\cdot\text{OH}$, h^+ , $\cdot\text{O}_2^-$	(Yan et al., 2019)
CdS/g-C ₃ N ₄	500W ($\lambda \leq 420$ nm)	1	RhB: 10	95.6%, 2 h	CdS: 3.64 g-C ₃ N ₄ : 6.93	h^+ , $\cdot\text{O}_2^-$	(Liu et al., 2020)
g-C ₃ N ₄ /Cu ₂ O	500W ($\lambda \leq 420$ nm)	0.6	MO:10	97%, 2 h	N/A	$\cdot\text{OH}$, h^+ , $\cdot\text{O}_2^-$	(Si et al., 2020)
g-C ₃ N ₄ /α-Fe ₂ O ₃ /GA	N/A	0.5	MB: 14.37	76.5%, 2 h	CN: 4.75 CNGA: 2.33 g-C ₃ N ₄ : 2.7	$\cdot\text{OH}$, h^+	(Kim et al., 2020)
Nb ₂ O ₅ -gC ₃ N ₄ /rGA	300W ($\lambda \geq 420$ nm)	0.375	RhB:20	94.8%, 100 min	NbNR-CN: 1.86	h^+ , $\cdot\text{O}_2^-$	(Xu et al., 2020)

Catalyst	Light source	Catalyst concentration (g/L)	Pollutant concentration (mg/L)	Degradation efficiency	Enhancement factor over reference photocatalyst	Main active species	References
C/g-C ₃ N ₄	200W ($\lambda \leq 420$ nm)	1	RhB: 10	90%, 10 min	N/A	h^+ , $\cdot O_2^-$	(Deng et al., 2020)

Table S2: The 3D CNBMs for photocatalytic H₂ production.

Catalyst	Light source	Reaction solution	HER	Reference photocatalyst and its activity	Enhancement factor over ref photocatalyst	AQE(%)	References
Porous g-C ₃ N ₄	$\lambda > 420$ nm	N/A	68.5 $\mu\text{mol/h}$	bulk g-C ₃ N ₄ : 14.3 $\mu\text{mol/h}$	4.8	N/A	(Shen et al., 2014)
MCN	300W Xe lamp ($\lambda = 420\text{nm}$)	TEOA, 10 vol%	60.2 $\mu\text{mol/h}$	bulk g-C ₃ N ₄ : 9.86 $\mu\text{mol/h}$	6.1	7.8	(Huang et al., 2015)
PCNM	300W Xe lamp ($\lambda > 420\text{nm}$)	TEOA, 10 vol%	29.0 $\mu\text{mol/h}$	g-C ₃ N ₄ powder: 10.2 $\mu\text{mol/h}$	2.84	N/A	(Liang et al., 2015)
3 wt% Pt @g-C ₃ N ₄ -NBs	300W Xe lamp ($\lambda < 420\text{nm}$)	TEOA, 10 vol%	1360 $\mu\text{mol/h/g}$	2 wt% Pt @bulk g-C ₃ N ₄ : 124.7 $\mu\text{mol/h/g}$	10.9	12	(Zeng et al., 2016)
CNMS	300W Xe lamp ($\lambda >$	TEOA, 10 vol%	392 $\mu\text{mol/h}$	bulk g-C ₃ N ₄ : 27 $\mu\text{mol/h}$	14.5	6.3	(Huang et al., 2016)

Catalyst	Light source	Reaction solution	HER	Reference photocatalyst and its activity	Enhancement factor over ref photocatalyst	AQE(%)	References
3D g-C ₃ N ₄ /TNA	420nm) 300W Xe lamp ($\lambda \geq 400\text{nm}$)	methanol, 10 vol%	243 $\mu\text{mol/h/g}$	sole g-C ₃ N ₄ : 51.7	4.7	N/A	(Zhang et al., 2017b)
BPMCn	300W Xe lamp ($\lambda > 400\text{nm}$)	TEOA, 10 vol%	1640 $\mu\text{mol/h/g}$	pure g-C ₃ N ₄ : 267 $\mu\text{mol/h}$	6.1	N/A	(Cao et al., 2017)
UM3	300W Xe lamp ($\lambda > 420\text{nm}$)	lactic acid, 20 vol%	3579 $\mu\text{mol/h/g}$	bulk g-C ₃ N ₄ : 147 $\mu\text{mol/h/g}$	23	2.78	(Tian et al., 2017)
N-TiO ₂ /g-C ₃ N ₄ @NixP	300 W Xe lamp	N/A	5438 $\mu\text{mol/h/g}$	N-TiO ₂ /g-C ₃ N ₄ : 725 $\mu\text{mol/h/g}$	7.5	N/A	(Wu et al., 2018)
flower-like P-doped mesoporous g-	A 300W Xe lamp with 420 nm cut-off	TEOA	256.4 $\mu\text{mol/h}$	bulk g-C ₃ N ₄ : 10.7 $\mu\text{mol/h}$	24	N/A	(Yang et al., 2018)

Catalyst	Light source	Reaction solution	HER	Reference photocatalyst and its activity	Enhancement factor over ref photocatalyst	AQE(%)	References
C ₃ N ₄	filter						
Ni(OH) ₂ /gC ₃ N ₄	300W ($\lambda > 400$ nm)	TEOA, 20 vol%	87.2 $\mu\text{mol/h}$	unmodified 3D g-C ₃ N ₄ : 1.4 $\mu\text{mol/h}$	76	8.2	(Cao et al., 2019)
CNGO/CNQD	300W ($\lambda = 350\text{-}870$ nm)	ethanol, 25 vol %	1231 $\mu\text{mol/h}$	CN: 76.9	16	13	(Huang et al., 2019)
3D C/g-C ₃ N ₄	300W ($\lambda > 420$ nm)	TEOA, 10 vol%	1610 $\mu\text{mol/h/g}$	g-C ₃ N ₄ : 230 $\mu\text{mol/h/g}$	7	15	(Wang et al., 2019)
Meso-gC ₃ N ₄ /WP/Me so-gC ₃ N ₄	N/A	methanol, 20 vol%	198.16 $\mu\text{mol/h/g}$	pristine g-C ₃ N ₄ : 19.8 $\mu\text{mol/h/g}$	10	N/A	(Yang et al., 2020)
CNF	300W ($\lambda < 400$ nm)	TEOA, 10 vol%	129.5 $\mu\text{mol/h}$	N/A	bulk CN: 27.6 pure CNF: 1.8	N/A	(Zhao et al., 2020)
PCNC	300W ($\lambda \geq 420$ nm)	TEOA, 20 vol%	5289.9 $\mu\text{mol/h/g}$	CN: 146.8 $\mu\text{mol/h/g}$	36	32.4	(Sun et al., 2020b)
g-C ₃ N ₄ /Ti ₃ C ₂	300W ($\lambda \geq 420$ nm)	TEOA, 10 vol%	116.2 $\mu\text{mol/h/g}$	pristine g-C ₃ N ₄ : 1.4 $\mu\text{mol/h}$	6	N/A	(Li et al., 2020)

Catalyst	Light source	Reaction solution	HER	Reference photocatalyst and its activity	Enhancement factor over ref photocatalyst	AQE(%)	References
	nm)	vol%	$\mu\text{mol/h/g}$	C_3N_4 : 19.4 $\mu\text{mol/h/g}$ 3% Pt@bulk			
PPCN	$\lambda \geq 420 \text{ nm}$	TEOA, 15 vol%	430 $\mu\text{mol/h/g}$	C_3N_4 (BCN): 45 $\mu\text{mol/h/g}$	9.5	N/A	(Qiu et al., 2020)

Table S3: The 3D CNBMs for CO₂ reduction.

Catalyst	Light source	Activity	Reference photocatalyst and its activity	References
Meso-g-C ₃ N ₄	Hg lamp	CO: 3.48 mmol/g	flake-like g-C ₃ N ₄ , CO: 2.26 mmol/g	(Wang et al., 2014)
α -Fe ₂ O ₃ /g-C ₃ N ₄	300W Xe lamp ($\lambda > 420\text{nm}$)	CO: 27.2 mmol/h/g	pure g-C ₃ N ₄ , CO: 10.3 $\mu\text{mol/h/g}$	(Jiang et al., 2018)
g-C ₃ N ₄ /BiFeWO _x	300W Xe lamp	CO: 43 $\mu\text{mol/h}$	BiFeWO _x , CO: 5.2 $\mu\text{mol/h}$ g-C ₃ N ₄ , CO: 8.9 $\mu\text{mol/h}$	(Wang et al., 2018c)
3D g-C ₃ N ₄ /C-NS	500W Xe lamp	CO: 229 $\mu\text{mol/h}$ CH ₄ : 112 $\mu\text{mol/h}$	H-g-C ₃ N ₄ /C-NS, CO: 18.32 $\mu\text{mol/h}$ CH ₄ : 8.96 $\mu\text{mol/h}$	(Wang et al., 2018b)
CoZnAl-LDH/RGO/g-C ₃ N ₄	300W Xe lamp	CO: 50.53 $\mu\text{mol/h}$	g-C ₃ N ₄ , CO: 2.13 $\mu\text{mol/h}$	(Yang et al., 2019b)
Au/g-C ₃ N ₄	8W Hg lamp	CO: 77.5 $\mu\text{mol/h}$ CH ₄ : 38.5 $\mu\text{mol/h}$	g-C ₃ N ₄ , CO: 13 $\mu\text{mol/h}$ CH ₄ : 4.1 $\mu\text{mol/h}$	(Li et al., 2019)
CeO ₂ /ZnIn ₂ S ₄	300W Xe lamp	CH ₄ : 0.542 $\mu\text{mol/h/g}$	ZnIn ₂ S ₄ , CH ₄ : 0.139 $\mu\text{mol/h/g}$ CeO ₂ , CH ₄ : 0.073	(Yang et al., 2019a)

Catalyst	Light source	Activity	Reference photocatalyst and its activity	References
Cu-NPs/g-C ₃ N ₄ foam	300W Xe lamp	CO: 10.247 $\mu\text{mol/h/g}$	$\mu\text{mol/h/g}$ g-C ₃ N ₄ powder CO: 1.61 $\mu\text{mol/h/g}$	(Sun et al., 2020a)

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