Supporting information

N doped carbon nanotubes encapsulated Co materials with strong magnetic property generate $\cdot O_2^-$ through activate hydrogen peroxide to effectively degrade Rhodamine B

Shuang Liu[#], Hongyan Li[#], Mingxin Yan[#], Hui Kong, Lei Chen, Jiawei Zhang, Jingxiang Zhao, Qinghai Cai*

Key Lab for Photonic and Electronic Bandgap Materials, Ministry of Education, School of Physics and electronic Engineering, School of Chemistry and Chemical Engineering, Center for Modern Education Technique and Experiment, Heilongjiang Province Collaborative Innovation Center of Cold Region Ecological Safety, Harbin Normal University, No. 1 Shida Road Limin development Zone, Harbin 150025, P. R. China.

[*] Corresponding authors.

E-mail addresses: qinghaic@163.com (Qinghai Cai)

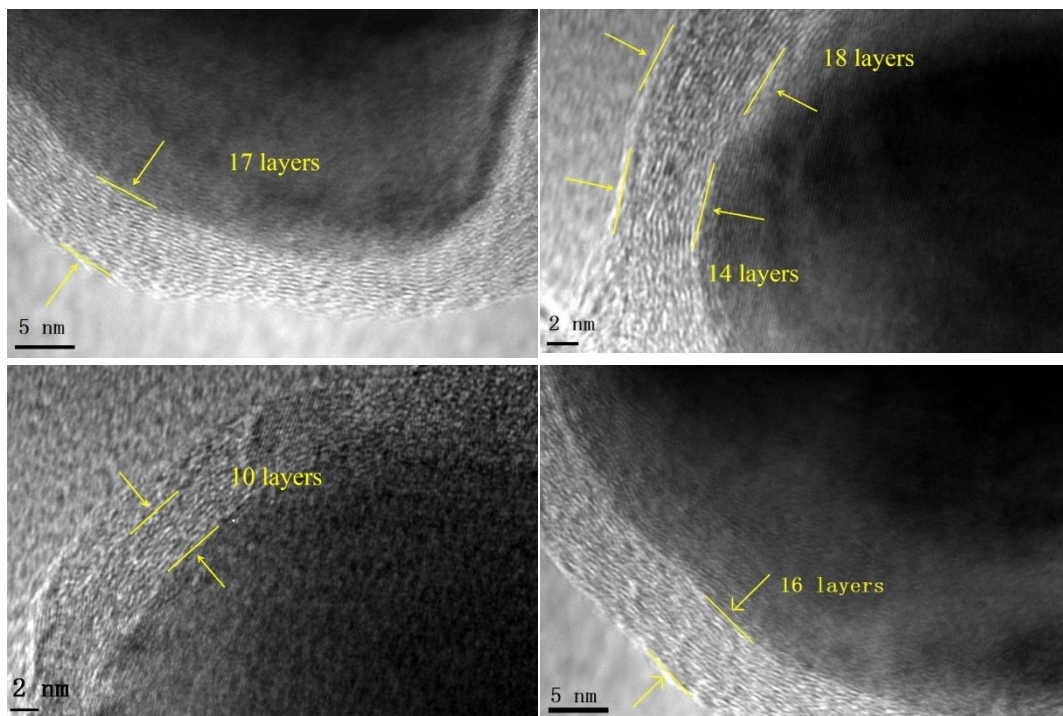[#] Shuang Liu, Hongyan Li and Mingxin Yan contribute equally to this work.
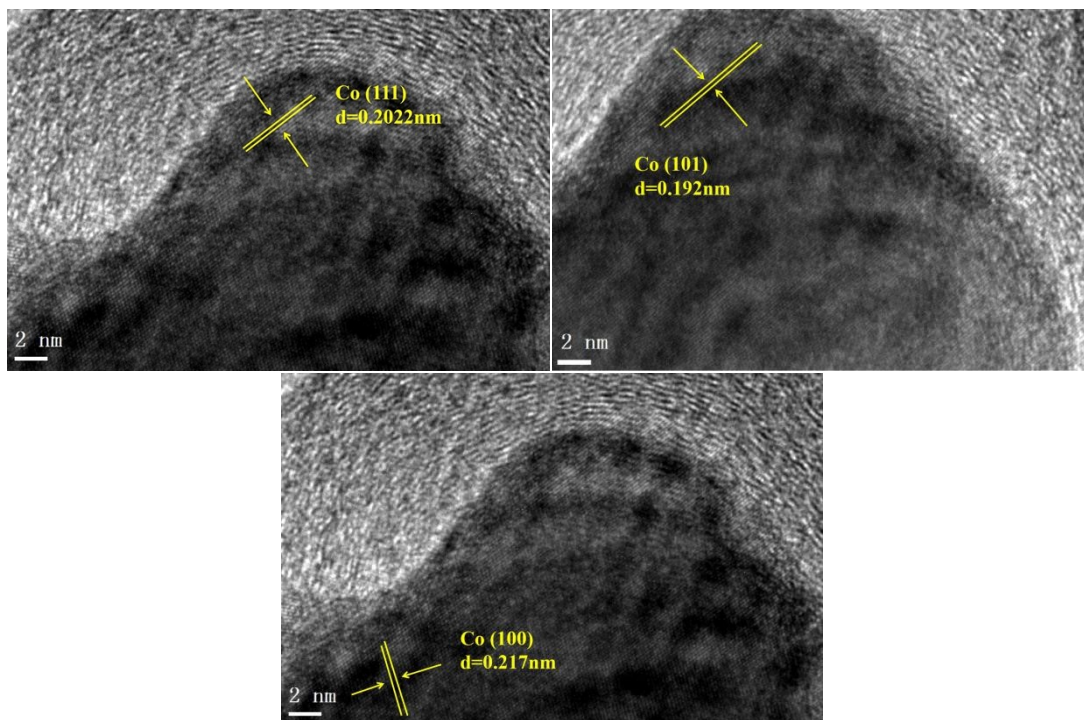
Fig. S1 Carbon layers of Co@NC-500 in HRTEM images

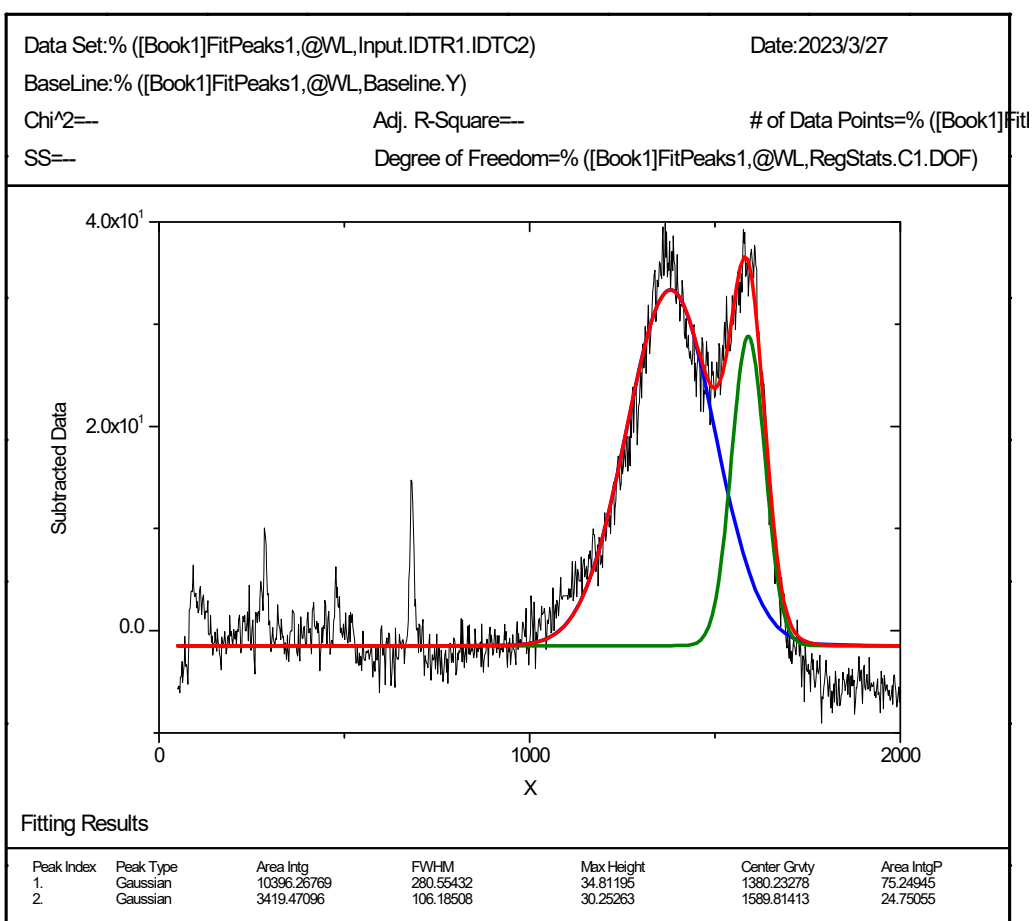**Fig. S2** lattice stripes for Co@NC-500 in HRTEM images

Fig. S3 Raman spectrum of Co@NC material

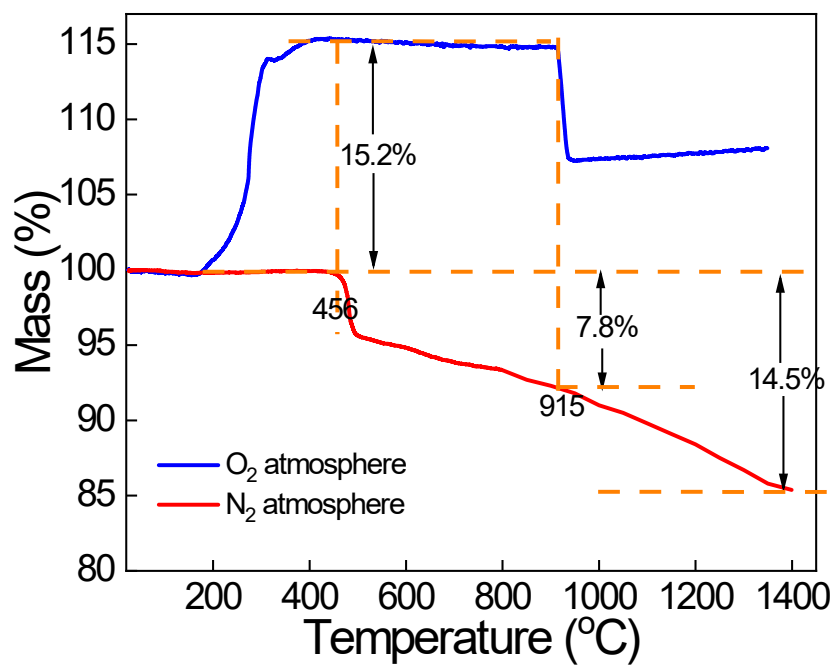$[I_D/I_G \text{ (intensity)} = 30.25/34.81 = 0.87]$
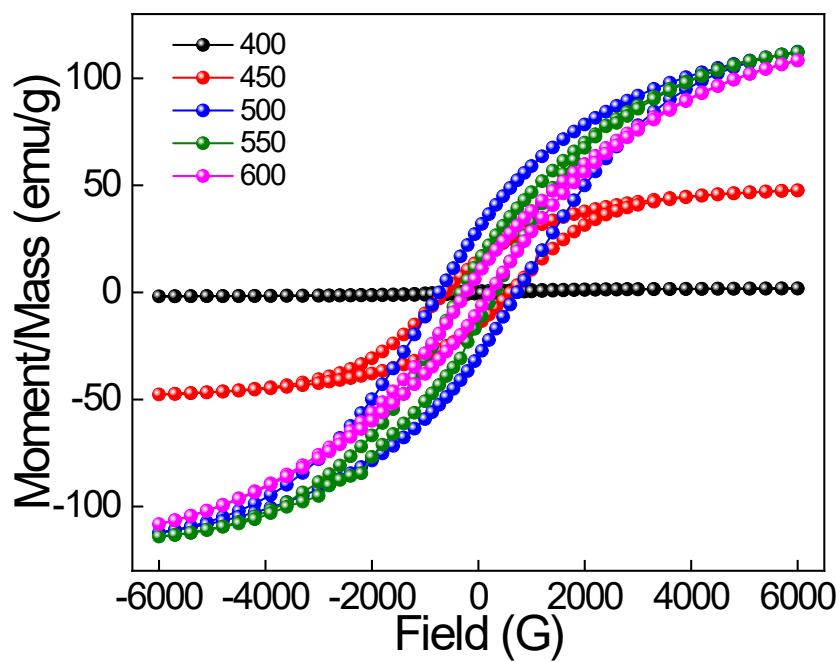
Fig. S4 TG of Co@NC-500 material.

Fig. S5 Magnetic properties of Co@NC prepared at various calcination temperature.
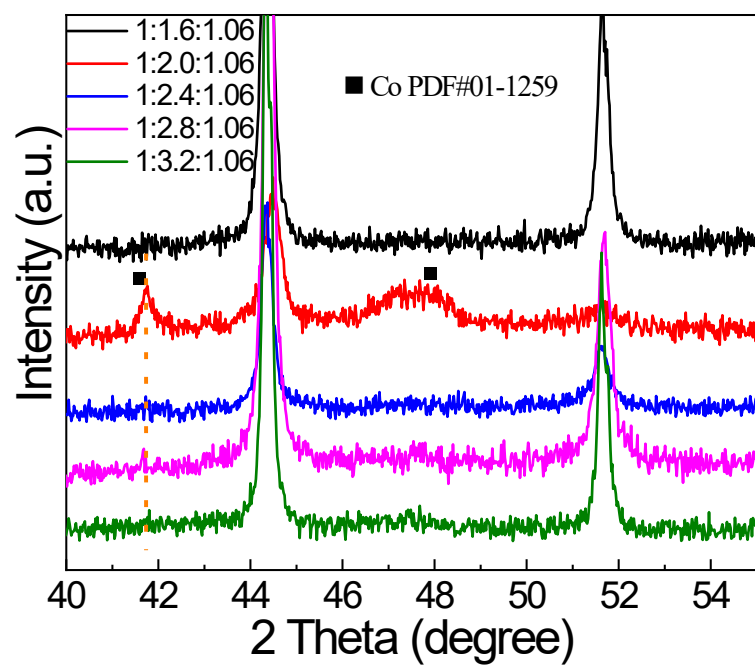
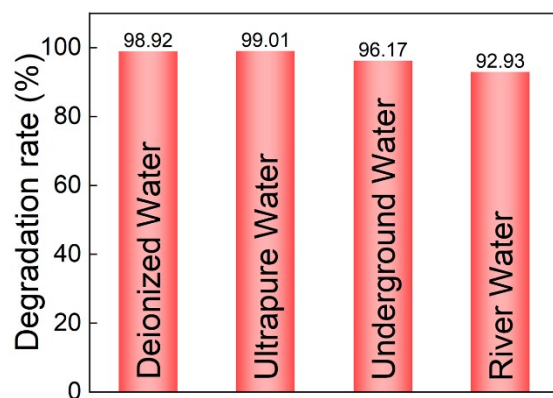**Fig. S6** XRD patterns of Co@NC with various contents of Ma

Fig. S7 The degradation performance of Co@NC-500/H$_2$O$_2$ system for RhB in four water samples.

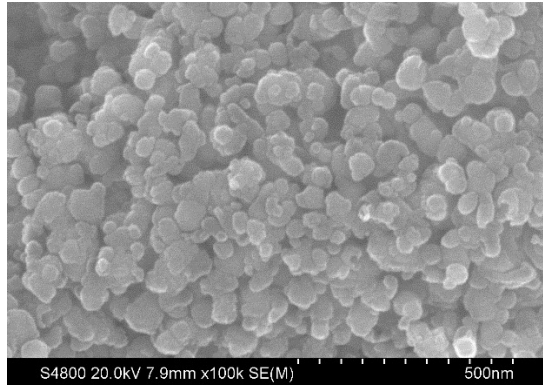**Fig. S8** SEM image of Co@NC-500 sample after cycling.

Table S1 Element composition detected by XPS

Elements	BE	At%
C1s	284.93	71.65
N 1s	398.98	9.89
O1s	531.90	11.28
Co2p	778.84	7.13

Table S2 Magnetic properties of Co@NC prepared at various calcination temperature

Temperature (deg.)	Bs (emu/g)	Br (emu/g)	Hc(Oe)
400	1.8	0.5	526.7
450	47.7	14.7	602.2
500	101.3	35.0	999.5
550	113.1	14.1	291.7
600	108.3	8.6	250.0
650	135.2	17.8	290.2

Table S3 Magnetic properties of Co@NC

Molar ratio of OA:Ma:Co	Bs (emu/g)	Br (emu/g)	Hc(Oe)
0.6:2:1.06	142.4	2.9	34.5
1.0:2:1.06	101.3	35.0	999.5
1.4:2:1.06	0.6	0.07	500.0
1.8:2:1.06	86.6	33.3	1068.6
1:1.6:1.06	123.8	3.0	89.0
1:2.4:1.06	77.6	23.3	946.3
1:2.8:1.06	117.0	9.7	250.0
1:3.2:1.06	65.7	22.8	966.7
1:2:0.85	6.5	2.8	1049.0
1:2:1.27	119.6	3.6	53.0
1:2:1.48	193.6	7.1	70.2