## **Support information**

## Effect of Fe/Sn doping on the photocatalytic performance of multi-shelled ZnO microspheres:

### experimental and theoretical investigations

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# Table S1

Catalyst	Catalyst	Degraded	Irradiation light source	Reaction rate	Reference
	dosage	material		constant (k/min <sup>-1</sup> )	
N-ZnO/g-C <sub>3</sub> N <sub>4</sub>	1g/L	0.02g/L MB	300W Xenon lamp	0.030	[42]
ZnO/NiFe <sub>2</sub> O <sub>4</sub>	0.4g/L	0.2g/L MB	360W UV-lamp	0.029	[43]
Fe, Ni-ZnO	1g/L	0.02g/L MB	300W Xenon lamp	0.012	[44]
ZnWO <sub>4</sub> -CDs	0.4g/L	0.01g/L CIP	350W Xenon lamp	0.014	[45]
g-C <sub>3</sub> N <sub>4</sub> /TiO <sub>2</sub> /kaolinite	2g/L	0.01g/L CIP	90mW/cm <sup>2</sup> visible light	0.00813	[46]
$g\text{-}C_3N_4\!/Bi_4O_5Br_2$	0.2g/L	0.01g/L CIP	300W Xenon lamp	0.005	[47]
BiOBr/Ag QDs	0.2g/L	0.01g/L CIP	300W Xenon light	0.0076	[48]
ZF-3	0.1g/L	0.01g/L MB	250W Xenon lamp	0.0305	This work
ZS-2	0.1g/L	0.01g/L CIP	300W Xenon lamp	0.0184	This work

Table S1 Photocatalytic degradation activity for degradation of MB or CIP by different reported catalysts



Fig. S1 Schematic illustration of the formation process of the Fe/Sn doped multi-shelled ZnO microspheres

## Fig. S1



Fig. S2 Supercell model structure of the samples (a for the un-doped ZnO, b for the 1.09% doping ratio, c for the

2.18% doping ratio, d for the 4.36% doping ratio), where the blue and red balls represent zinc and oxygen atoms,

especially the green balls stand for the doped Fe/Sn atom

Fig. S3



Fig. S3 SEM and FTIR of synthesized carbon sphere template



Fig. S4 FESEM images of the synthesized samples (here a and b for the un-doped ZnO, c and d for Fe- doped ZnO,

e and f for the Sn- doped ZnO, g and h for the ZnO nanoparticles used in the photocatalytic activity tests)

ZS-2 1494.35mg/L			44.428mg/L	1.64% (Sn/Zn)		
ZF-3	3	1388.35mg/L	4.63mg/L		0.397%(Fe/Zn)	
San	nple	Zn	Fe	Sn	Doping concentration	
Concentration/ppb			Concentration/ppb		Concentration/ppb	
50000 - 0 -	*	200 400 500		100000 50000 0		
د <sup>150000</sup> -		y=580.331x+989.85 R=0.9999	10000 - 8000 -	R=0.9998	y=946.05x+3.7 R=0.9999	
200000 -			14000 - 12000 -	y=55.37x+40.7 200000		
250000 -	<ul> <li>standard curve</li> <li>ZF-3 (Zn/1388.35mg/L)</li> <li>ZS-2 (Zn/1494.35mg/L)</li> </ul>	, ;	18000 standard curve 16000 - ZF-3(Fe/4.63mg/L)	300000	Standard curve ZS-2(Sn/44.428mg/L)	

Fig. S5 The Fe/Sn doping concentration in ZF-3 and ZS-2 based on the ICP-MS results

# Fig. S5



Fig. S6 XPS spectra of prepared samples (here a-d for ZF-3 and e-h for ZS-2)





Fig. S7 The photocatalytic degradation pseudo-first-order kinetic data for different contaminant (here a-b for the

photodegradation of MB and c-d for the degradation of CIP)





Fig. S8 Comparison of detailed distribution of DOS near the Fermi level of structure models (here a for the un-

doped ZnO, b for the 2.16% Fe dope ZnO and c for the 2.16% Sn doped ZnO)





Fig. S9 Trapping experiments with EDTA-2Na over ZF-3 and ZS-2