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

Supporting Information

Preparation of $ZnFe_2O_4$ nanostructures and high efficient visible-light-driven hydrogen generation with the assistance of nanoheterostructures

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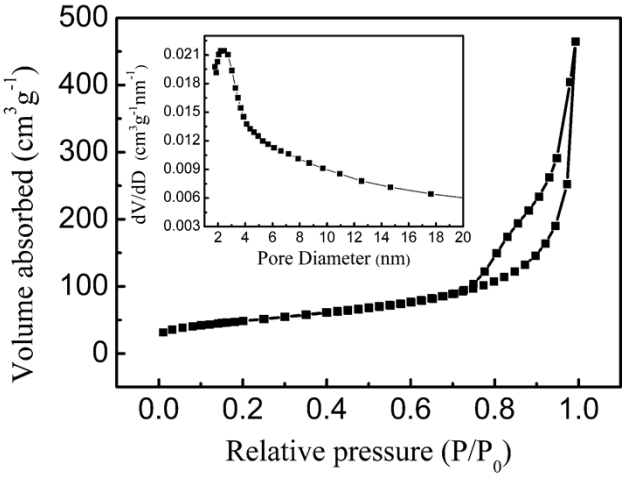

Fig. S1. Nitrogen adsorption–desorption isotherms and corresponding pore diameter distribution curves (inset) of $ZnFe_2O_4$ nanostructures.

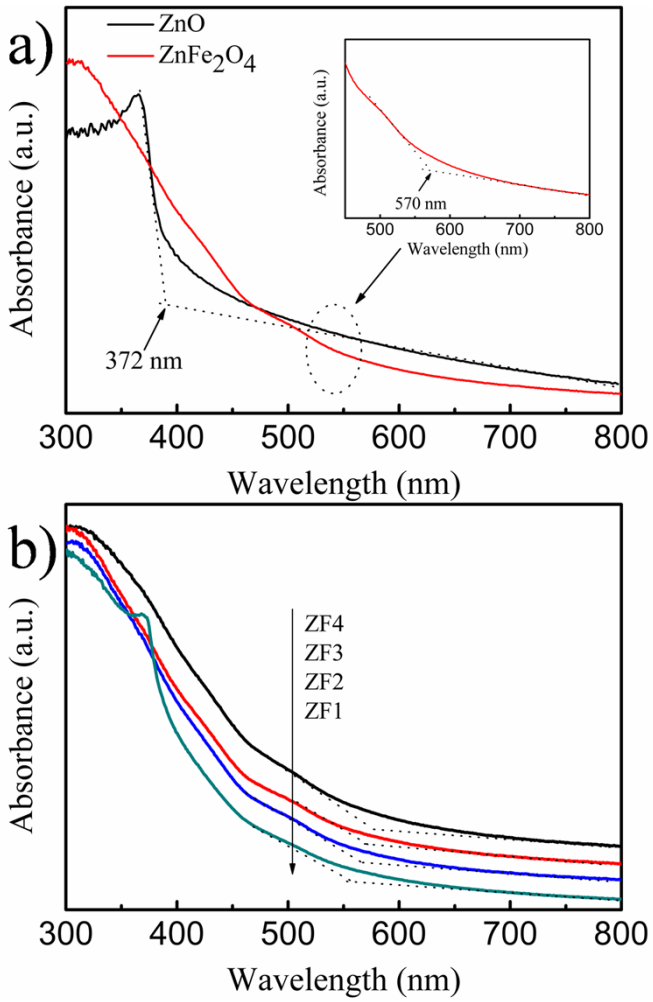

Fig. S2. a) UV–vis diffuse absorption spectra of $ZnFe_2O_4$ and ZnO, b) UV–vis diffuse absorption spectra of sample ZF1, ZF2, ZF3, ZF4.

Table S1. The bang gap of the as-prepared samples

Samples	Absorption edge (λ)/nm	Bang gap (E_g)/eV [a]
$ZnFe_2O_4$	570	2.18
ZnO	372	3.33
ZF1	567	2.19
ZF2	564	2.20
ZF3	562	2.21
ZF4	557	2.23

[a]Bang gap (E_g)=1240/λ

Table S2. Comparison of photocatalytic activity in hydrogen generation over $ZnFe_2O_4$-based photocatalytic.

Photocatalyst	Incident light	Reactant solution	Cocat-alyst	H2 generation rate (μmol h^{-1} g^{-1})	Ref.
$ZnFe_2O_4$ nanostructures	λ>420nm 300 W Xe-lamp	10 vol% CH_3OH	-	280	This work
$ZnFe_2O_4$/ZnO nanoheterostructures (sample ZF2)	λ>420nm 300 W Xe-lamp	10 vol% CH_3OH	-	2150	
$ZnFe_2O_4$ nanorod	λ>420nm 250 W Xe-lamp	17 vol% CH_3OH	-	47.57	1
$ZnFe_2O_4$ spherical particles	λ>420nm 250 W UV-vis lamp	Sodium sulfite (0.05 M)	-	20	2

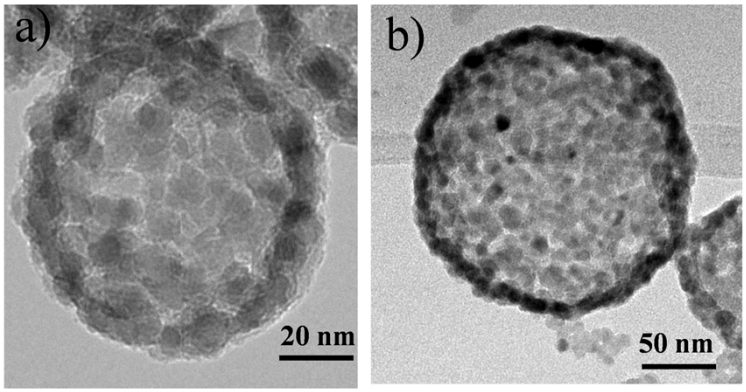

Fig. S3 The HRTEM images of different size of $ZnFe_2O_4$ nanospheres

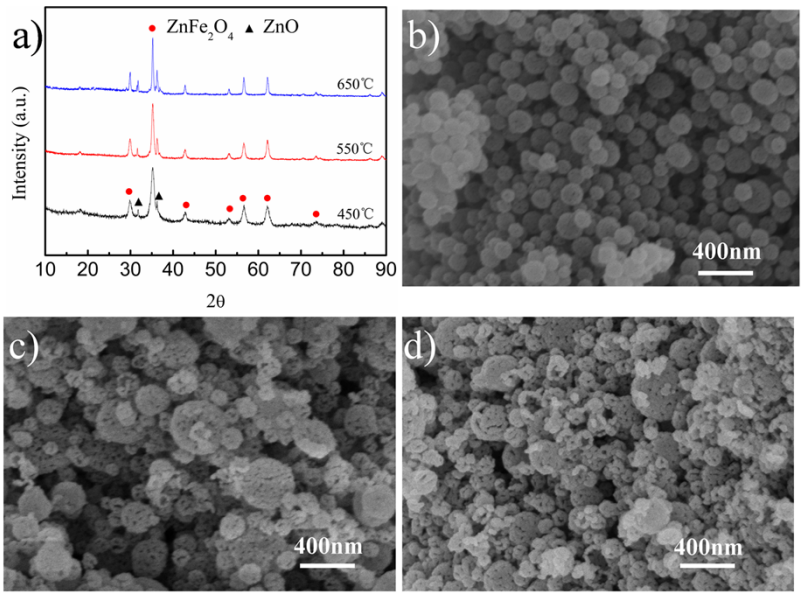

Fig. S4 a) The XRD pattern of sample ZF1 annealed at 450, 550 and 650 ℃. b,c,d) the SEM images of sample ZF1 annealed at 450, 550 and 650 ℃.

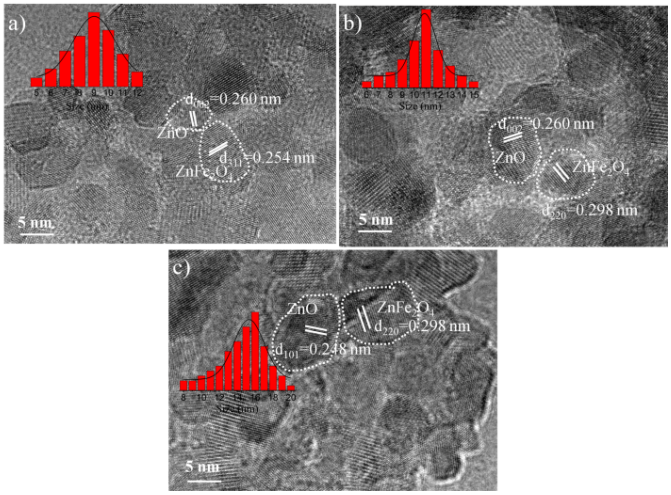

Fig. S5. a), b) and c) are the HRTEM images of sample ZF1, sample ZF3, and sample ZF4, respectively.

Table S3. The turnover number (TON) based on catalysts under visible light irradiation (λ>420 nm) within 5 h.

Samples	TON[a]
$ZnFe_2O_4$	0.34
ZF1	1.44
ZF2	2.97
ZF3	1.35
ZF4	0.31

[a]TON= Number of generated H_2 molecules / Number of ZnFe2O4 molecules.

Table S4. The hydrogen generation rate of the as-prepared samples under simulated solar light irradiation.

Samples	Hydrogen generation rate (mmol h^{-1} g^{-1})
$ZnFe_2O_4$	0.35
ZF1	1.37
ZF2	2.68
ZF3	1.15
ZF4	0.83
ZnO	0.18

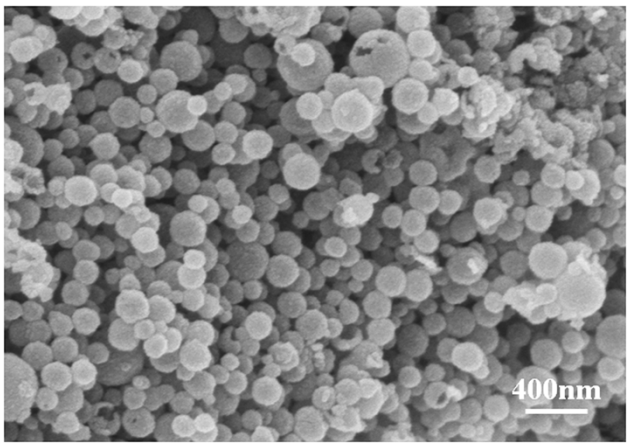

Fig. S6. Typical SEM images of $ZnFe_2O_4$/ZnO nanoheterostructures (sample ZF2) after photocatalytic reaction.

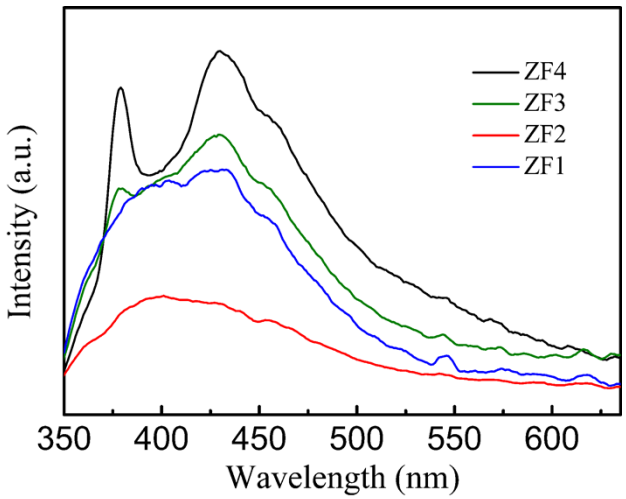

Fig. S7. The PL spectra of sample ZF1, sample ZF2, sample ZF3, and sample ZF4.

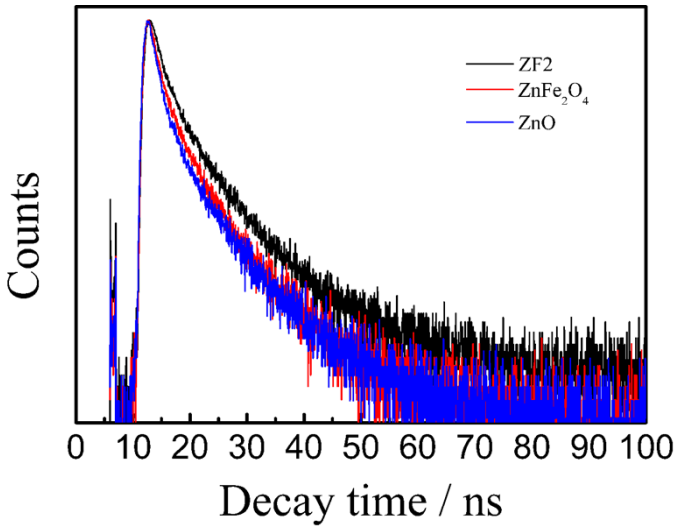

Fig. S8 Photoluminescence decay curves of sample ZF2, $ZnFe_2O_4$, ZnO.

Table S5 The photoluminescence decay time of all the samples derived from the time-resolved photoluminescence spectroscopy.

Sample	Decay time (ns)			Realtive amplitude (%)			Average life (<τ>, ns)[a]	χ^2
	τ_1	τ_2	τ_3	f_1	f_2	f_3		
$ZnFe_2O_4$	1.6305	5.6658	12.6384	46.24	37.29	16.47	7.98	1.172
ZF1	1.608	5.4223	14.4415	0.1826	0.5258	13.6529	10.43	1.133
ZF2	1.4723	6.4067	18.9043	0.2043	0.4258	0.3699	14.98	1.285
ZF3	1.7274	5.2801	13.6529	0.2903	0.4650	0.2447	9.44	1.159
ZF4	1.4120	5.1668	13.5449	0.3162	0.4946	0.1892	8.72	1.170
ZnO	1.6197	5.1443	11.9333	0.3437	0.4749	0.1814	7.61	1.152

[a]The average lifetime was calculated using equation: $<\tau>=(f_1\tau_1^2+f_2\tau_2^2+f_3\tau_3^2)/(f_1\tau_1+f_2\tau_1+f_3\tau_1)$

χ^2: the goodness of fit parameter.

References

1. H. Lv, L. Ma, P. Zeng, D. Ke and T. Peng, *Journal of Materials Chemistry*, 2010, **20**, 3665.
2. X. Xu, A. K. Azad and J. T. S. Irvine, *Catalysis Today*, 2013, **199**, 22-26.