Supplementary information

Factors on the separation of photogenerated charges and the charge dynamics in oxide/$ZnFe_2O_4$ composites

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Scanning electron microscopy and energy dispersive spectrometry

Morphologies and chemical compositions were observed using scanning electron microscopy (SEM, JSM-6700F, JEOL) combining with energy dispersive spectrometry (EDS, INCA-ENERGY). The SEM images of four composites (WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with the molar ratio 4:1) are shown in **Fig. SI1** (a)-(d), respectively. From the SEM images, four composites all take on the phenomenon of aggregation and agglomerate to bulks. It is also shown that the particle sizes of composites from SEM are similar to TEM.

Fig. SI1 (e)-(h) illustrate the energy spectra of four composites (WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with the molar ratio 4:1), respectively. Each energy spectrum includes the elements of their compositions and the atomic percents are almost consistent with the nominal molar ratios. The **Table SI1** shows the atomic percents of four composites from their energy spectra and the corresponding composition ratios are about W:Zn:Fe:O=4:1:2:16, Bi:Zn:Fe:O=4:1:2:10, Ti:Zn:Fe:O=4:1:2:12 and Sn:Zn:Fe:O=4:1:2:12, respectively.

Supplementary Tables

Table SI1 The atomic percents of four composites (WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO) with the molar ratio 4:1 of (W, Bi, Ti and Sn)/Zn from their energy dispersive spectra.

material	WO_3/ZFO				α-Bi_2O_3/ZFO				TiO_2/ZFO				SnO_2/ZFO			
element	W	Zn	Fe	O	Bi	Zn	Fe	O	Ti	Zn	Fe	O	Sn	Zn	Fe	O
atomic percent	17.41	4.36	8.66	69.56	23.57	5.84	11.72	58.86	21.08	5.23	10.51	63.18	21.11	5.18	10.48	63.22

Table SI2 The average particle sizes of WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with four molar ratios.

Material	WO_3/ZFO	α-Bi_2O_3/ZFO	TiO_2/ZFO	SnO_2/ZFO
molar ratio	average particle sizes (nm)			
2:1	198	395	201	306
4:1	21	202	83	218
6:1	165	343	172	372
8:1	200	238	186	524

Table SI3 The surface areas of WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with four molar ratios.

Material	WO_3/ZFO	α-Bi_2O_3/ZFO	TiO_2/ZFO	SnO_2/ZFO
molar ratio	Surface area (m^2/g)			
2:1	2.58	39.9	5.72	2.97
4:1	23.6	78.2	13.8	4.19
6:1	3.01	46.5	6.74	2.42
8:1	2.41	66.2	6.22	1.76

Table SI4 The zeta potentials of WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with four molar ratios.

Material	WO_3/ZFO	α-Bi_2O_3/ZFO	TiO_2/ZFO	SnO_2/ZFO
molar ratio	zeta potentials (mV)			
2:1	-38	-21.4	-30.6	10.7
4:1	-23.8	22.4	-21.4	33.3
6:1	-36.7	-10.2	-24.8	-16.6
8:1	-38.1	-21.6	-26.9	8.61

Supplementary Figures

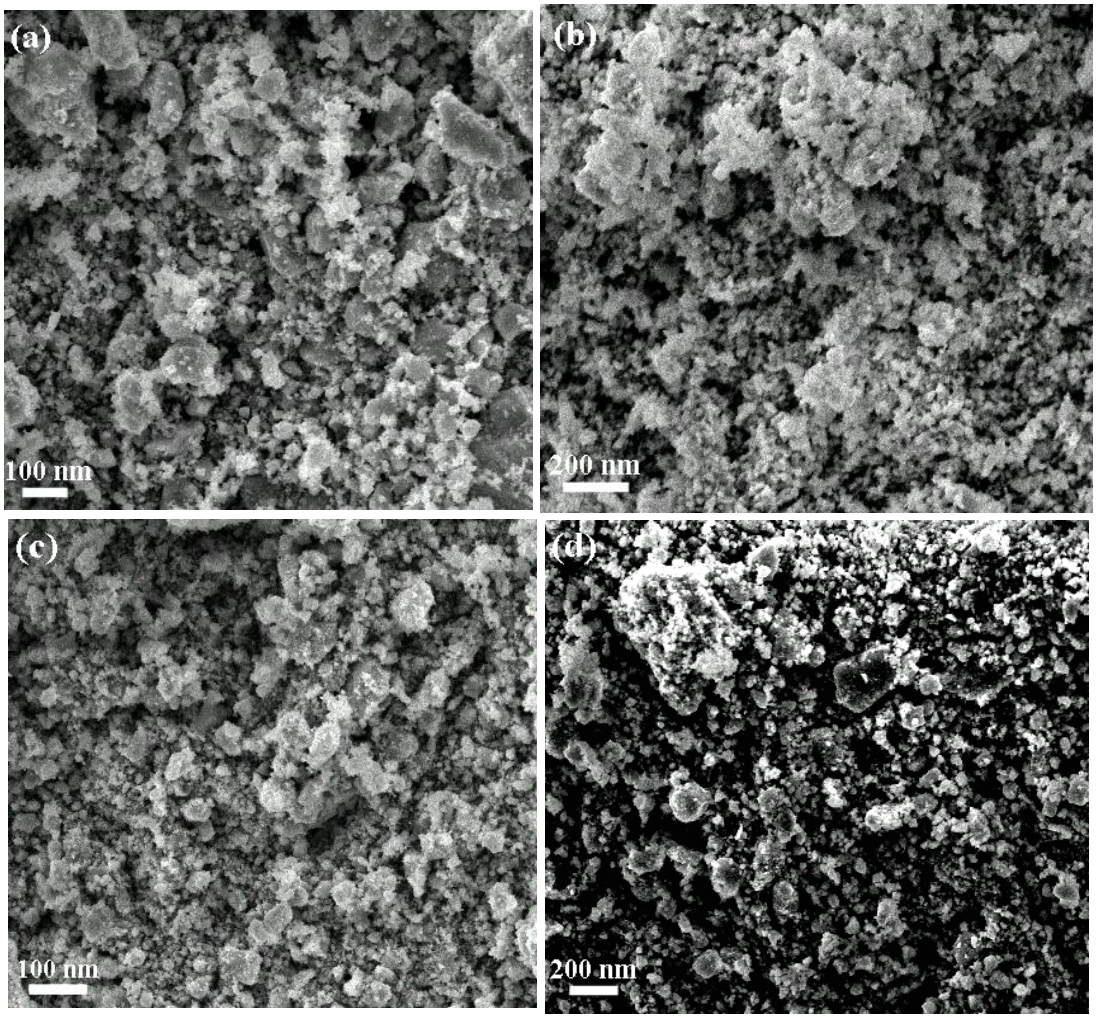

Fig. SI1 ((a), (b), (c) and (d)) SEM images of WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with the molar ratio 4:1, respectively.

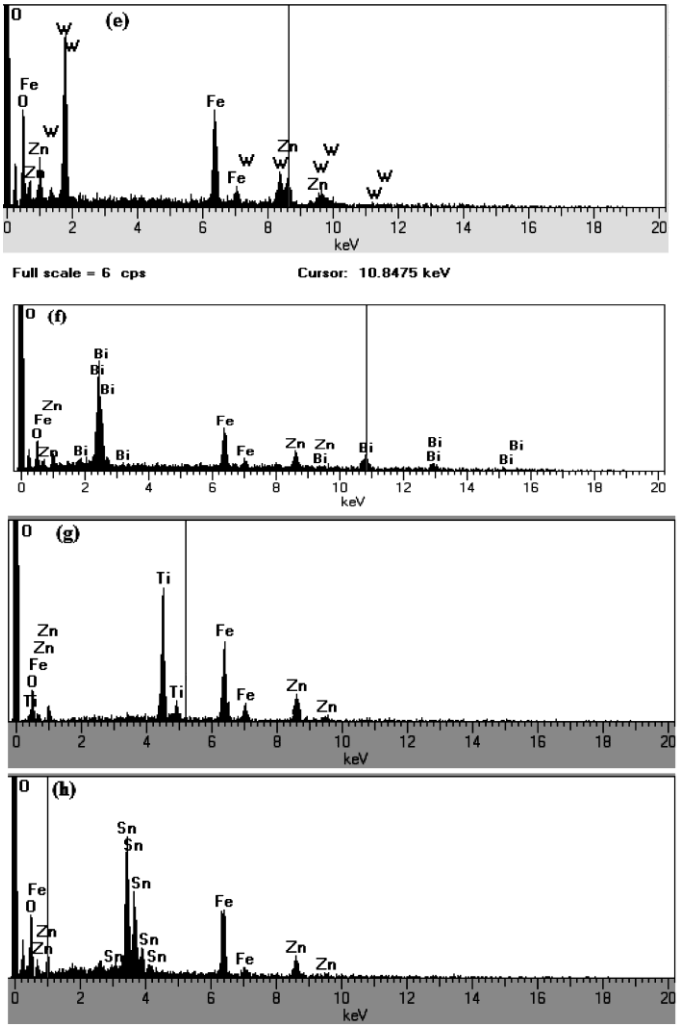

Fig. SI1 ((e), (f), (g) and (h)) Energy dispersive spectrometry (EDS) of WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with the molar ratio 4:1, respectively.

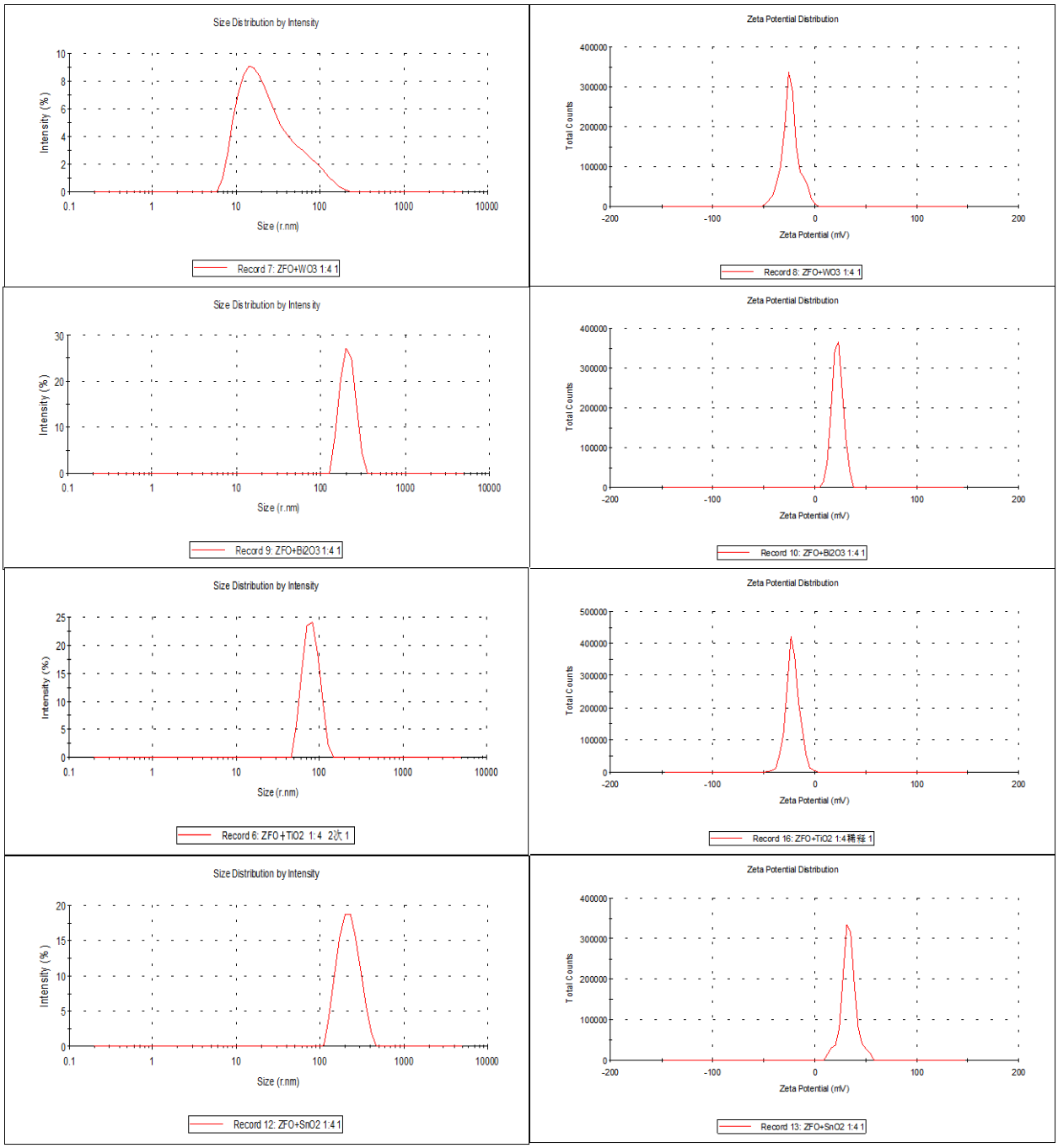

Fig. SI2 The distribution of particle sizes and zeta potentials for WO_3/ZFO, α-Bi_2O_3/ZFO, TiO_2/ZFO and SnO_2/ZFO with molar ratio 4:1.

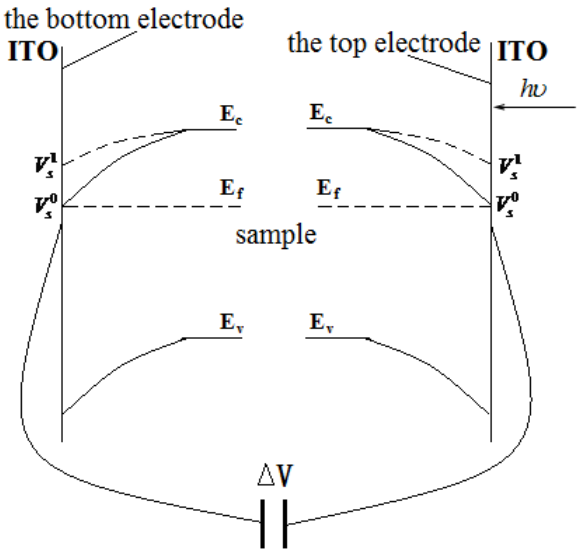

Fig. SI3 The schematic diagram of sandwich structure consisting of ITO (indium tin oxide) and material in the steady-state SPS, TPV and EFISPS. (E_c: the bottom of conduction band; E_v: the top of valence band; E_f: the Fermi energy level; ΔV: the difference of different surface potential; V_s^0: the surface potential before illumination; V_s^1: the surface potential after illumination; V_s^0, V_s^1<0; $h\upsilon$: the incident photon energy).