Supporting information

A cost-effective, stable, magnetically recyclable photocatalyst of ultra-high organic pollutant degradation efficiency: SnFe$_2$O$_4$ nanocrystals from a carrier solvent assisted interfacial reaction process

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Taiwan
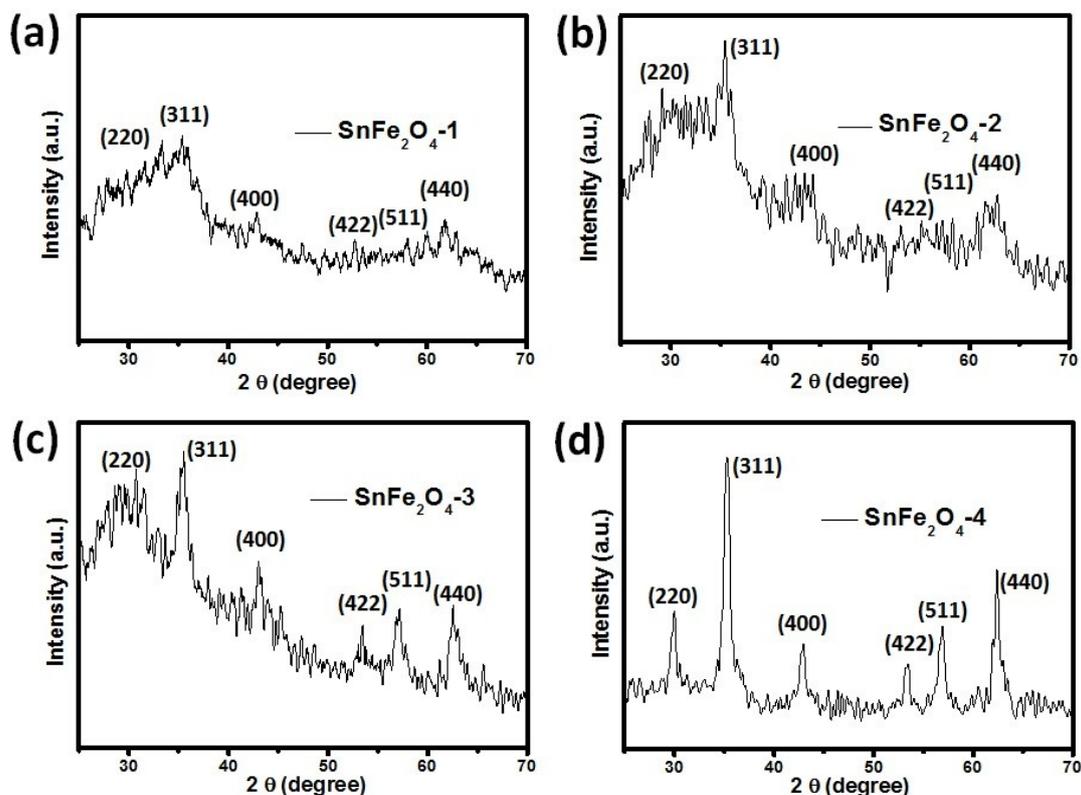
*Email : *SYLu@mx.nthu.edu.tw*

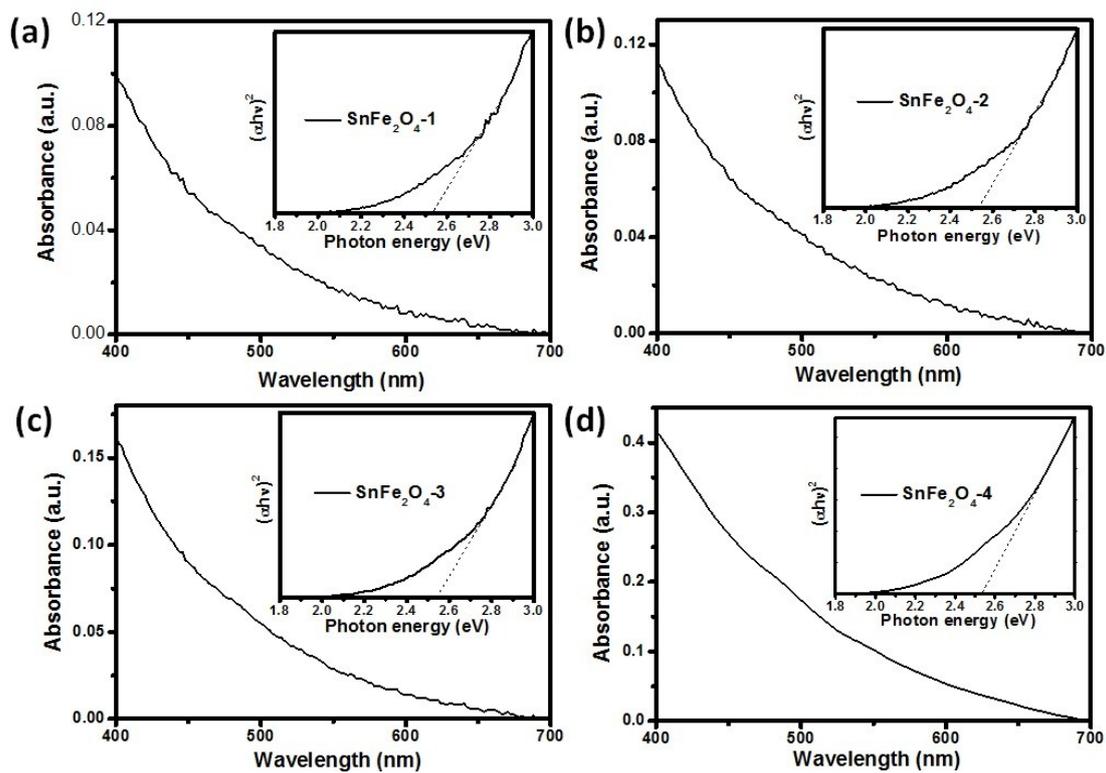**Fig. S1.** XRD patterns of samples SnFe$_2$O$_4$-1 to SnFe$_2$O$_4$-4.

Fig. S2. UV-visible spectrum of samples $SnFe_2O_4$-1 to $SnFe_2O_4$-4. Inset shows $(\alpha h\nu)^2$ vs. photon energy plot for bandgap determination.
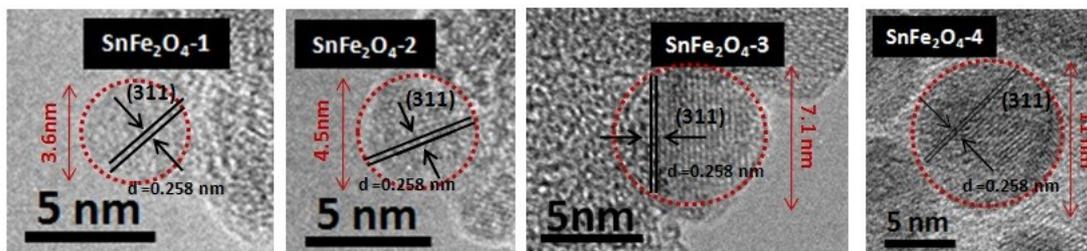

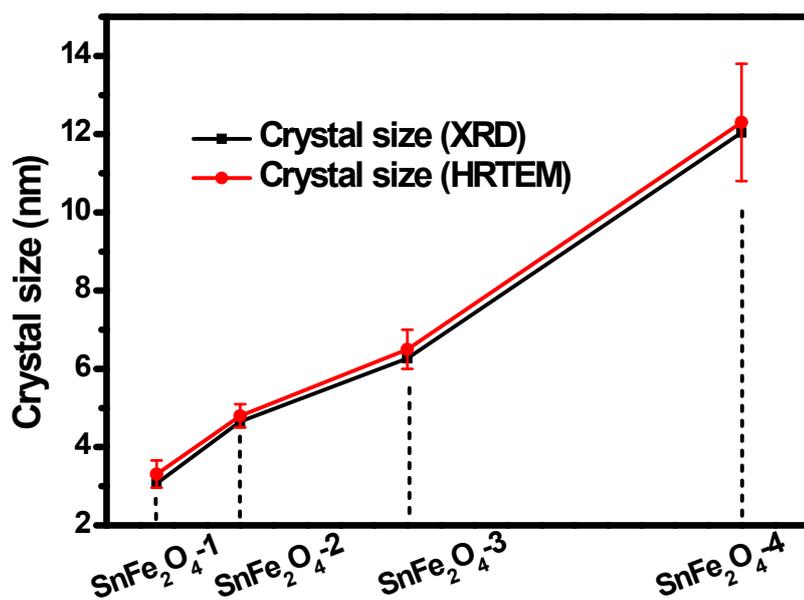**Fig. S3.** HRTEM images of samples $SnFe_2O_4$-1 to $SnFe_2O_4$-4.

Fig. S4. Comparison of nanocrystal sizes for all four $SnFe_2O_4$ samples, as determined from XRD patterns and HRTEM images.
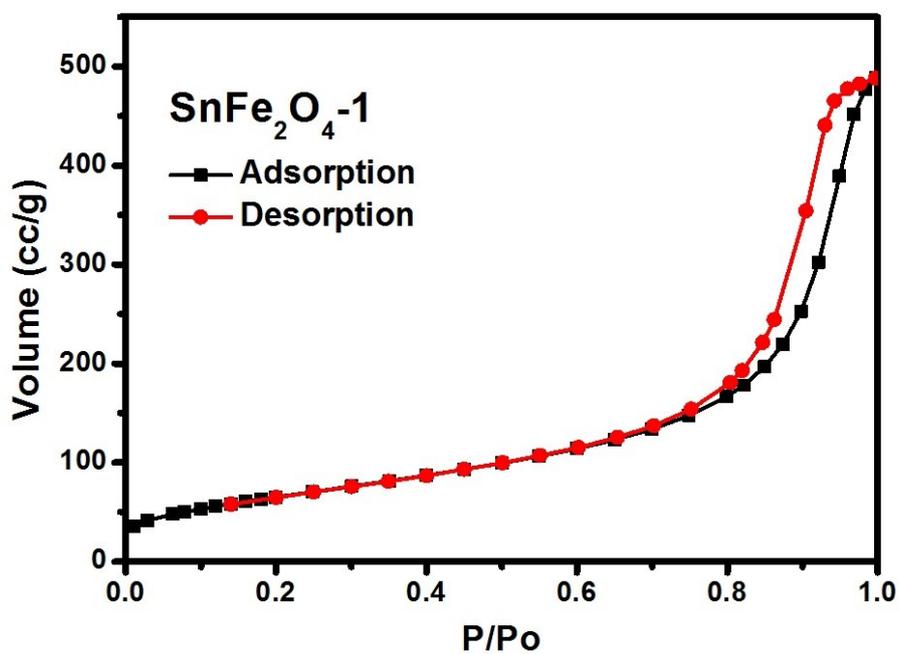

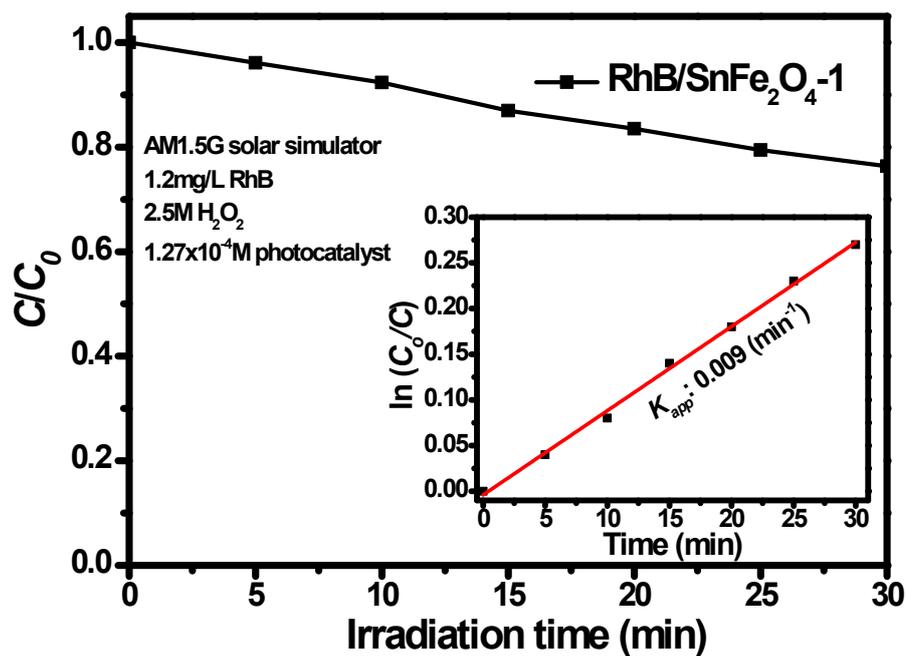**Fig. S5.** N_2 adsorption/desorption isotherms of sample $SnFe_2O_4$-1.

Fig. S6. C/C_o versus time curve for RhB solution containing sample SnFe$_2$O$_4$-1 without H$_2$O$_2$ addition. Inset shows determination of K_{app}.
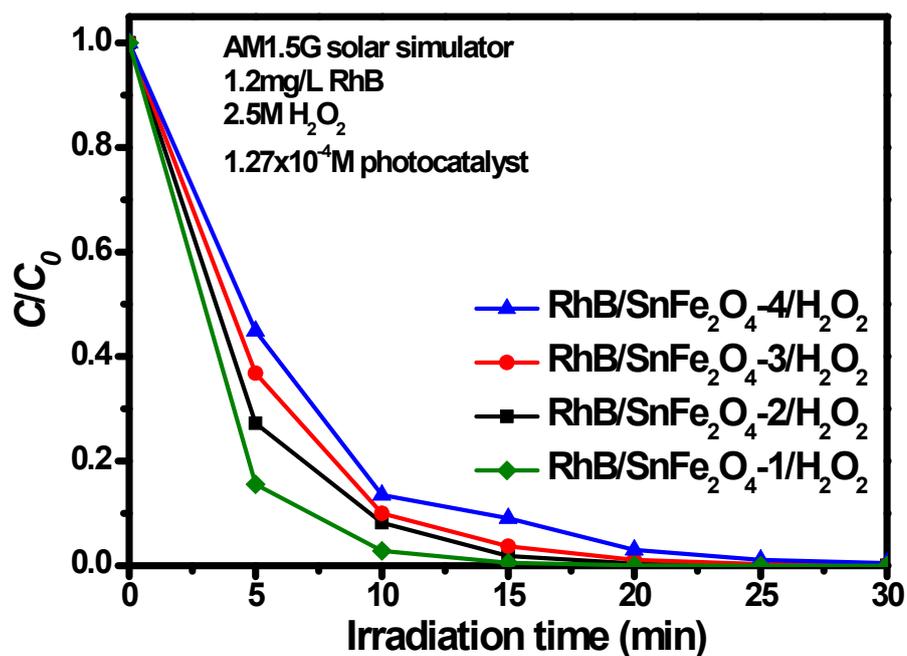
Fig. S7. C/C_o versus time curves for RhB solution containing samples SnFe$_2$O$_4$-1 to SnFe$_2$O$_4$-4 with H$_2$O$_2$ addition.

Fig. S8. (a) Absorption spectra of sample SnFe$_2$O$_4$-1 suspensions at selected concentrations, (b) correlation curve of absorbance of SnFe$_2$O$_4$ suspension at 400 nm vs. SnFe$_2$O$_4$ concentration.

Fig. S9. Cycling voltammograms recorded for (a) sample SnFe$_2$O$_4$-1, (b) commercial graphite electrode.

Table S1 Atomic ratios of Fe vs. Sn of samples $SnFe_2O_4$-1 to $SnFe_2O_4$-4.
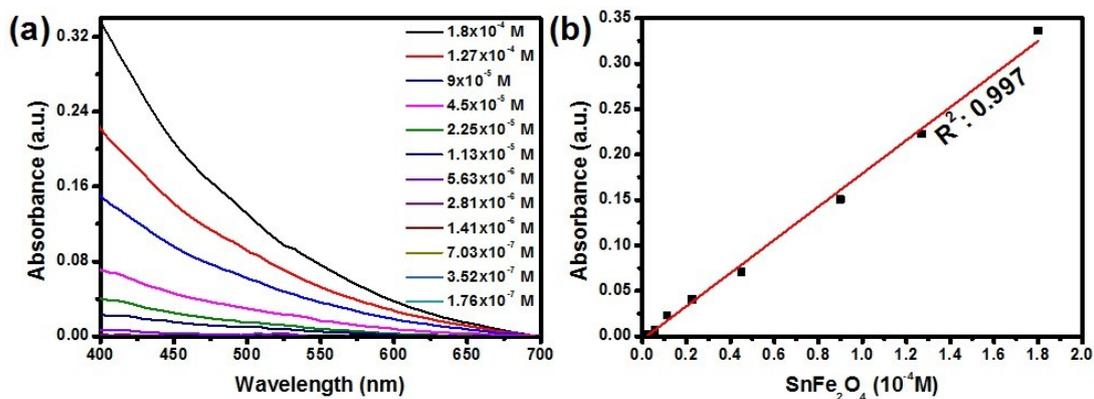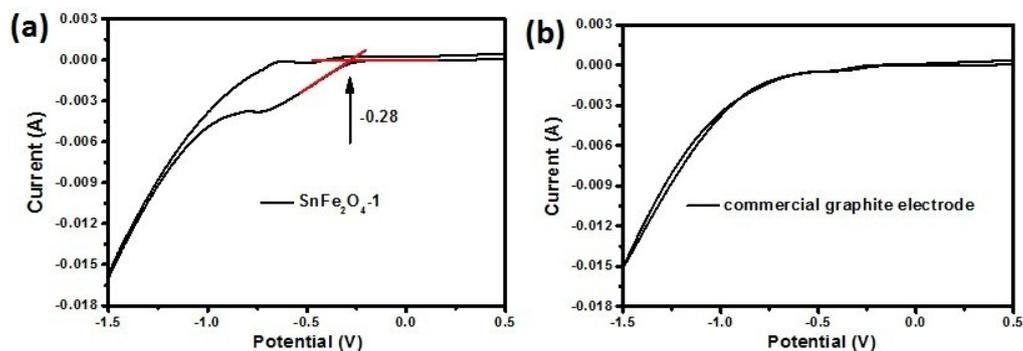
Photocatalyst	Fe / Sn (atomic ratio)
$SnFe_2O_4$-1	2.08
$SnFe_2O_4$-2	2.19
$SnFe_2O_4$-3	2.03
$SnFe_2O_4$-4	2.34

Table S2 Grain sizes and coercivities of samples $SnFe_2O_4$-1 to $SnFe_2O_4$-4.

Photocatalyst	Grain size (nm)	Coercivity (Oe)
$SnFe_2O_4$-1	3.1	7.5
$SnFe_2O_4$-2	4.7	10
$SnFe_2O_4$-3	6.3	22
$SnFe_2O_4$-4	12.0	4.0

Table S3 Compilation of apparent reaction rate constants for RhB degradation in Fenton-like processes.

Reference	Type of catalyst	Source of light	Concentration of RhB (mg/L)	Concentration of catalyst(M)	Apparent reaction rate constant; K_{app} (min^{-1})
[S1]	$BiVO_4$	350W Xe lamp, simulated sunlight	9.58	3.09×10^{-3}	0.098
This work	$SnFe_2O_4$	150W Xe lamp, simulated sunlight	10	1.27×10^{-4}	0.13
[S2]	$BiFeO_3$	500 W Halogen lamp with a cutoff filter (> 420 nm)	4.79	1.6×10^{-3}	0.056
[S3]	$g-C_3N_4$	500 W Halogen lamp with a cutoff filter (> 420 nm)	4.79	0.5 (g/L)	0.044

[S4]	EuFeO$_3$	500 W Xe lamp with a cutoff filter (> 420 nm)	5	3.9×10^{-3}	0.002
[S5]	Bi$_2$WO$_6$/Cu^0	500 W Xe lamp with a cutoff filter (> 420 nm)	4.79	1.4×10^{-3}	0.03
This work	SnFe$_2$O$_4$	150W Xe lamp, simulated sunlight /with a cutoff filter (> 422 nm)	5	1.27×10^{-4}	0.21/ 0.15

Table S4. Band structure parameters of SnFe$_2$O$_4$ NCs.

sample	E_{red} (V)	LUMO[a](eV)	HOMO[b](eV)	λ_{abs}[c] (nm)	E_g[d] (eV)
SnFe$_2$O$_4$-1	-0.28	-4.43	-6.96	505	2.53

[a]Determined by Eq. (1). [b]Determined from LUMO and band gap energy. [c]Measured by UV−visible absorption spectrum. [d]Estimated from UV−visible absorption spectrum.

Experimental determination of conduction band position of SnFe$_2$O$_4$ NCs:

Here, we determine the conduction band position of SnFe$_2$O$_4$ NCs with cyclic voltammetry analyses. The working electrode was prepared by drop-casting ethanolic suspension of SnFe$_2$O$_4$ NCs onto a graphite electrode followed by drying at 60 °C. The counter electrode was Pt coil, and Ag/AgCl served as the reference electrode. The cyclic voltammograms were recorded in an electrolyte of 0.1 M Na$_2$SO$_4$(aq) with a negative scan starting from 0.5 to −1.5 V and then back to 0.5 V at a scan rate of 30 mV/s. The LUMO energy (E_{LUMO}) of electroactive materials can be estimated from the onset reduction potential (E_{red}), according to the following equation[S6,S7]

$$E_{LUMO} = -(E_{red} + 4.71) \text{ eV} \qquad (1)$$

Here, the onset potential is referenced to the Ag/AgCl electrode. The value of 4.71 represents the difference between the vacuum level potential of the normal hydrogen electrode (NHE) and the potential of the Ag/AgCl electrode versus NHE.[S8,S9] We started from 0.5 V and proceeded with a negative potential scan from 0.5 to −1.5 V and then back to 0.5 V. The onset reduction potentials of sample SnFe$_2$O$_4$-1 was thus determined to be −0.28 V as shown in Fig. S9(a). A commercial graphite electrode

was taken as a control, and no reduction peak can be identified under the same testing condition, as shown in Fig. S9(b). The results of relevant band structure data were summarized in Table S4.

References:

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