Support Information

One-step pyrolysis prepared Sulfur-doped biochar loaded with Iron nanoparticles as an effective peroxymonosulfate activator for RhB degradation

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Figure S1. UV-vis spectra and color variation (inset figure) of RhB at different reaction time in Fe/$S_{0.05}$-BC/PMS. Experimental conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ^{o}C; pH = 7.0.

Figure S2. Reusability of Fe/$S_{0.05}$-BC for RhB degradation. Reaction conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ^{o}C; pH = 7.0.

Figure S3. (a) XPS survey spectra, (b) High-resolution Fe 2p, and (c) S 2p spectra of used Fe/$S_{0.05}$-BC.

Figure S4. TOC removal of RhB by different system. Experimental conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.2 g/L; [PMS] = 2 g/L; Temperature = 30 ^{o}C; pH = 7.0.

Figure S5. Degradation rate of various organic pollutants by Fe/$S_{0.05}$-BC/PMS system. Reaction conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ^{o}C; pH = 7.0.

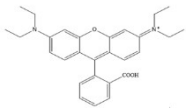
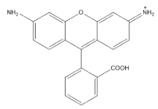
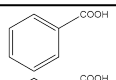
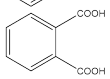
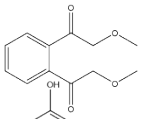
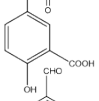
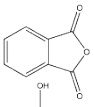
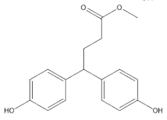
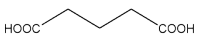
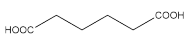
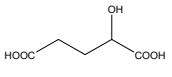
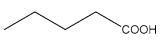
Figure S6. RhB degradation in the presence of methanol, TBA, p-benzoquinone, KI and L-Histidine as radical scavenger. Experimental conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ^{o}C; pH = 7.0

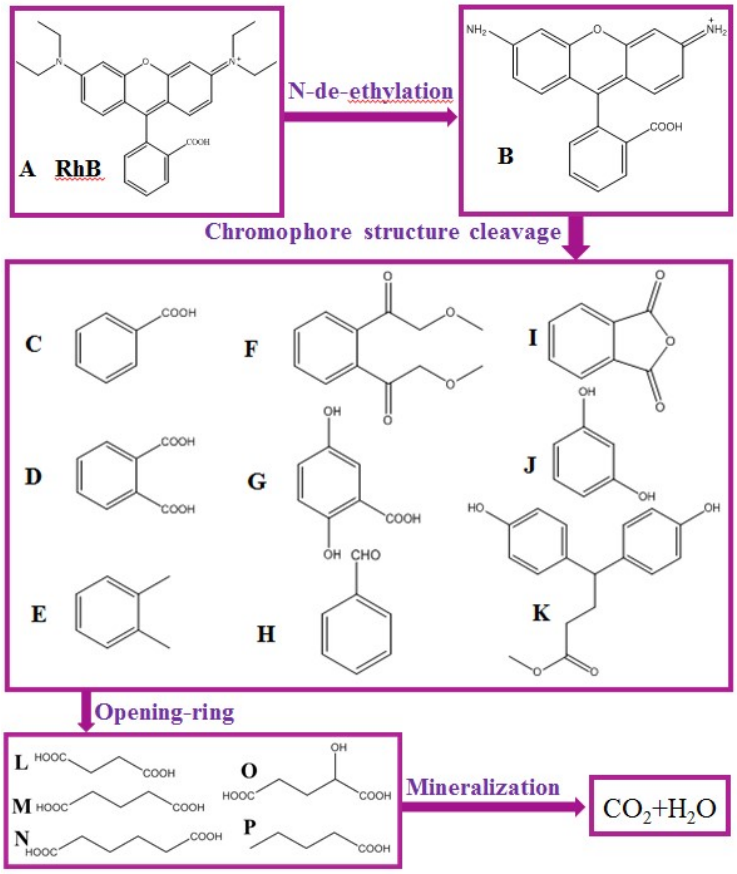
Figure S7. HPLC-HRMS/MS mass spectra of the intermediates from the RhB degradation in the system of Fe/$S_{0.05}$-BC activating PMS. The above graph is mass spectrum of RhB degradation solution, and the below graph is standard mass spectrum of the corresponding intermediate in library in each spectrum.

Table S1. Dosage of raw materials for synthesis of different Fe/S-BC

Composites name	Mass ratios of $Na_2S_2O_3 \cdot 5H_2O$ (%)	Weight of $FeCl_3$ (g)	Weight of cherry stone powder (g)
Fe-BC	0	5.78	2.0
$Fe/S_{0.03}$-BC	3%	5.78	2.0
$Fe/S_{0.05}$-BC	5%	5.78	2.0
$Fe/S_{0.1}$-BC	10%	5.78	2.0

Table S2. The intermediates detected by HPLC-ESI-HRMS/MS from the RhB degradation in the system of Fe/$S_{0.05}$-BC activating PMS

Pathway		Structure	Name	Formula	Formula weight
	A		Rhodamine B	$C_{28}H_{31}ClN_2O_3$	479.01
N-de-ethylation Products	B		6-amino-9-(2-carboxyphenyl)-3H-xanthen-3-iminium	$C_{20}H_{15}N_2O_3^+$	331.1077
Chromophore cleavage Products	C		Benzoic acid	$C_7H_6O_2$	122.0368
	D		Phthalic acid	$C_8H_6O_4$	166.0266
	E		O-xylene	C_8H_{10}	106.0783
	F		1,1'-(1,2-phenylene)bis(2-methoxyethan-1-one)	$C_{12}H_{14}O_4$	222.0892
	G		2,5-dihydroxybenzoic acid	$C_7H_6O_4$	154.0266
	H		Benzaldehyde	C_7H_6O	106.0419
	I		Isobenzofuran-1,3-dione	$C_8H_4O_3$	148.0160
	J		Resorcinol	$C_6H_6O_2$	110.0368
	K		Methyl 4,4-bis(4-hydroxyphenol) butanoate	$C_{17}H_{18}O_4$	286.1205
Opening-ring Products	L		Glutaric acid	$C_5H_8O_4$	132.0423
	M		Adipic acid	$C_6H_{10}O_4$	146.0579
	N		2-hydroxypentanedioic acid	$C_5H_8O_5$	148.0372
	O		Pentanoic acid	$C_5H_{10}O_2$	102.0681



Scheme S1. Possible degradation pathway of RhB in the Fe/$S_{0.05}$-BC/PMS system

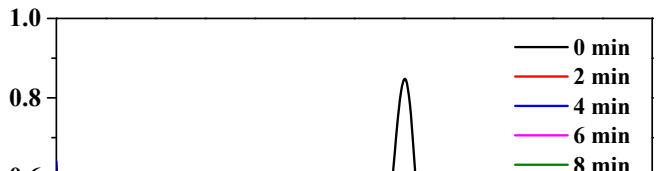


Figure S1. UV-vis spectra and color variation (inset figure) of RhB at different reaction time in Fe/$S_{0.05}$-BC/PMS. Experimental conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ^{o}C; pH = 7.0.

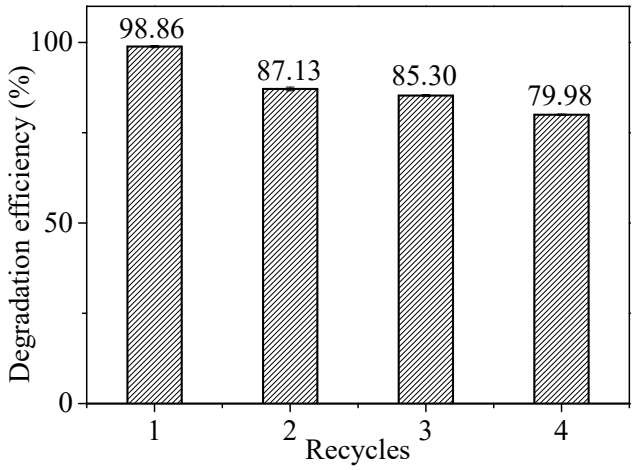


Figure S2. Reusability of Fe/$S_{0.05}$-BC for RhB degradation. Reaction conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ^{o}C; pH = 7.0

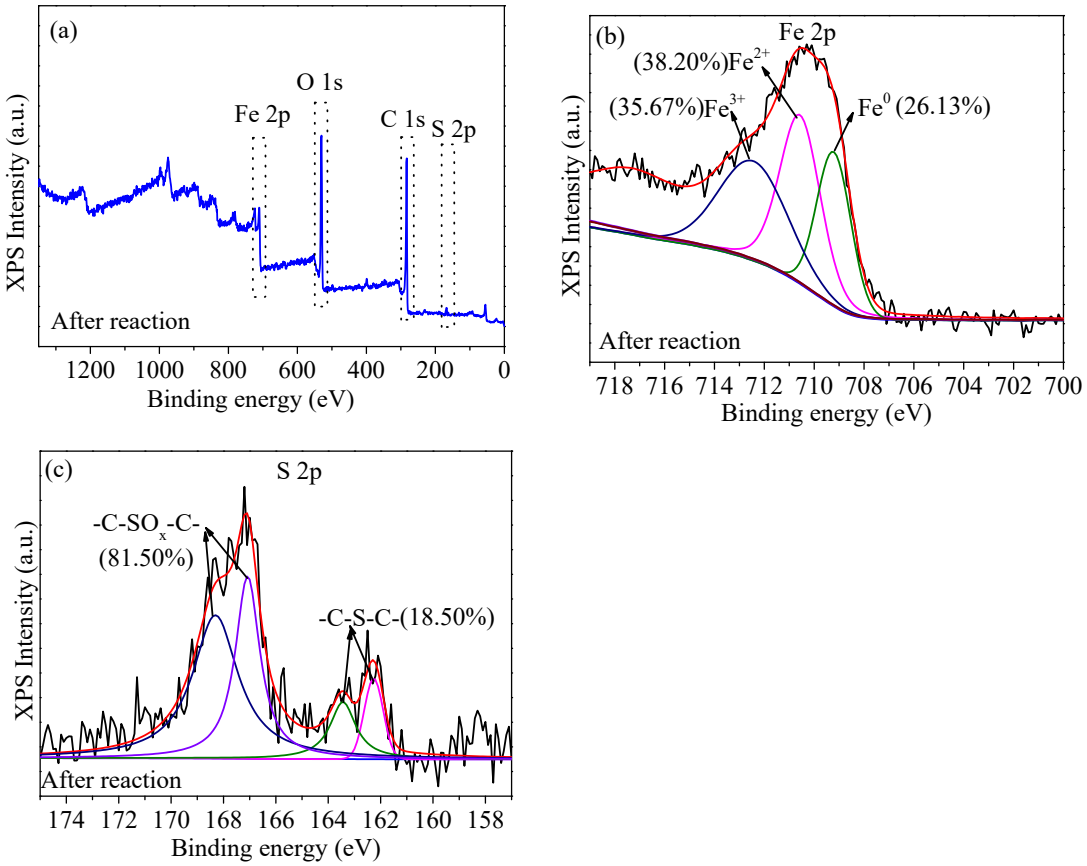


Figure S3. (a) XPS survey spectra, (b) High-resolution Fe 2p, and (c) S 2p spectra of used $Fe/S_{0.05}$-BC

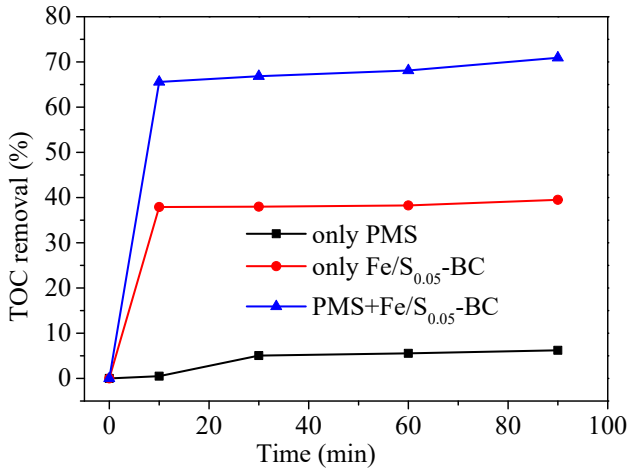


Figure S4. TOC removal of RhB by different system. Experimental conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.2 g/L; [PMS] = 2 g/L; Temperature = 30 °C; pH = 7.0.

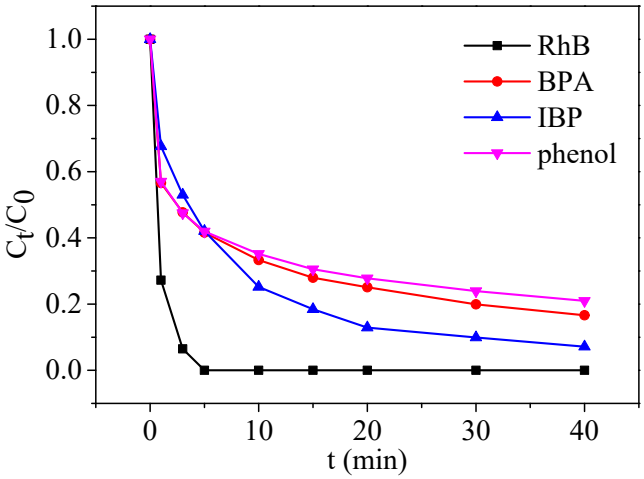


Figure S5. Degradation rate of various organic pollutants by Fe/$S_{0.05}$-BC/PMS system. Reaction conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 °C; pH = 7.0.

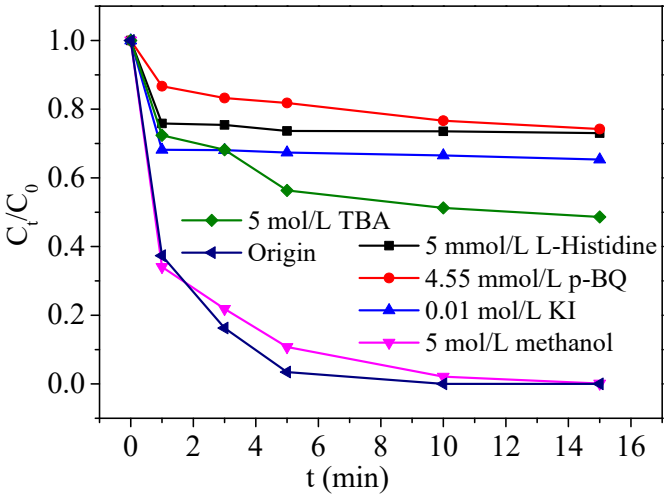
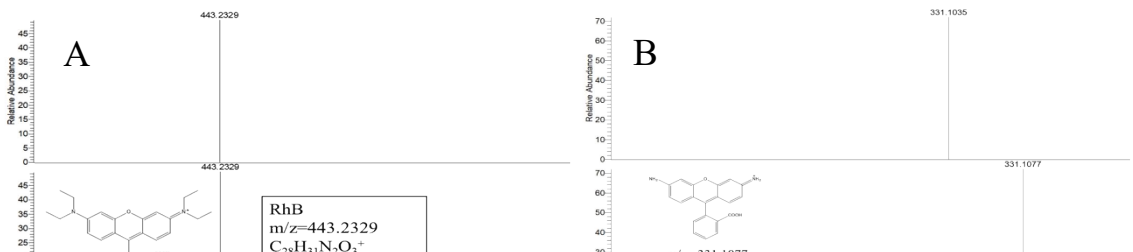
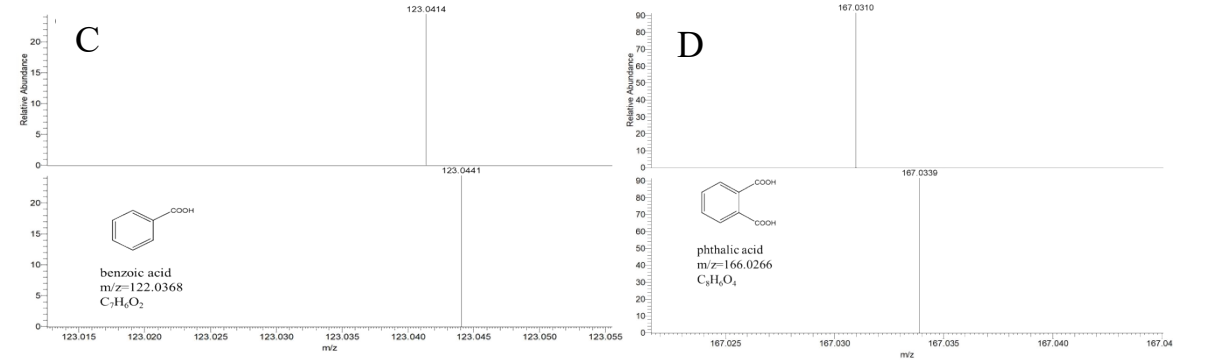


Figure S6. RhB degradation in the presence of methanol, TBA, p-benzoquinone, KI and L-Histidine as radical scavenger. Experimental conditions: [RhB] = 20 mg/L; [Fe/$S_{0.05}$-BC] = 0.05 g/L; [PMS] = 0.5 g/L; Temperature = 30 ºC; pH = 7.0




C
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123.0441
benzoic acid
m/z=122.0368
$C_7H_6O_2$
D
167.0310
167.0339
phthalic acid
m/z=166.0266
$C_8H_6O_4$
E
107.0855
107.0855
o-xylene
m/z=106.0783
C_8H_{10}
F
223.0934
223.0965
1,1'-(1,2-phenylene)bis(2-methoxyethan-1-one)
m/z=222.0892
$C_{12}H_{14}O_4$
G
155.0310
155.0535
155.0339
2,5-dihydroxybenzoic acid
m/z=154.0266
$C_7H_6O_4$
H
107.0408
107.0492
107.0491
Benzaldehyde
m/z=106.0419
C_7H_6O
I
149.0229
185.1143
193.1306
183.1350
149.0233
isobenzofuran-1,3-dione
m/z: 148.0160
$C_8H_4O_3$
J
111.0414
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L
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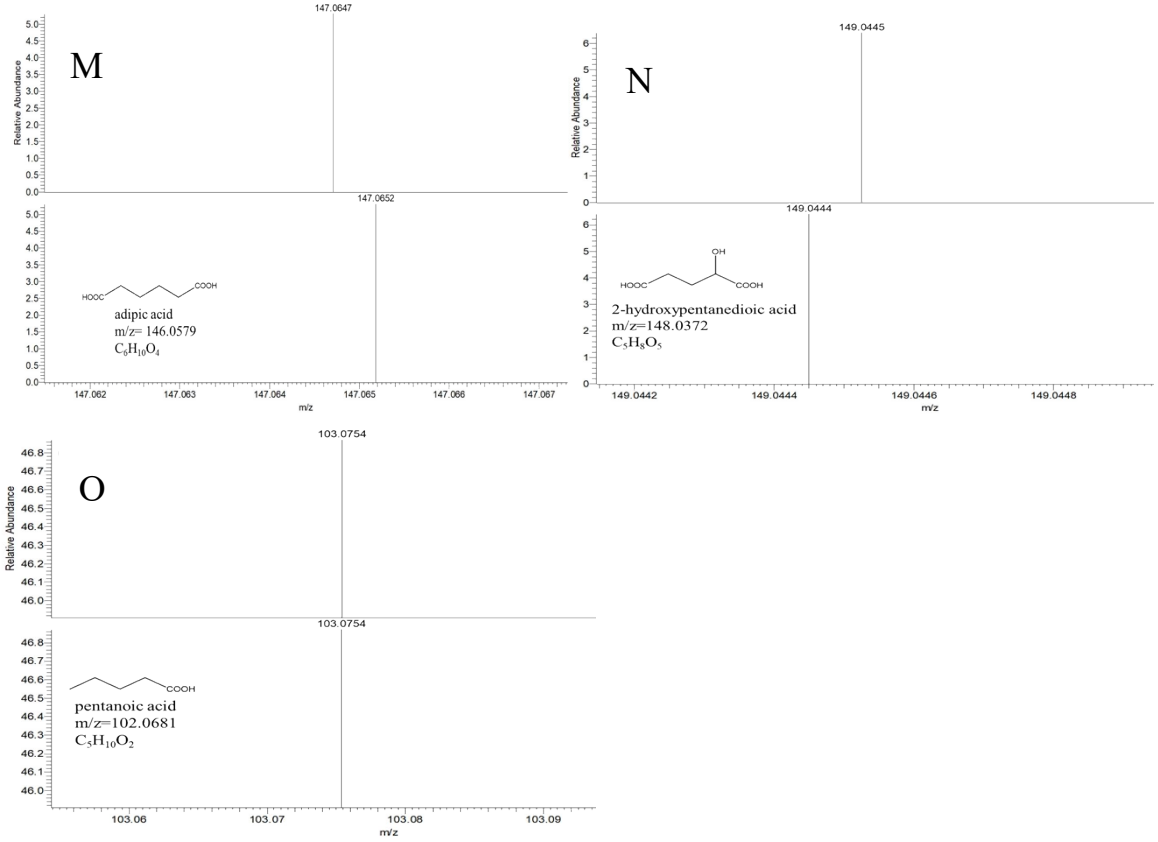

Fig. S7. HPLC-HRMS/MS mass spectra of the intermediates from the RhB degradation in the system of Fe/$S_{0.05}$-BC activating PMS. The above graph is mass spectrum of RhB degradation solution, and the below graph is standard mass spectrum of the corresponding intermediate in library in each spectrum