# Support information

**Test S1**

The specific materials and chemical agents involved in this study were as follows. The spodumene flotation tailings (SFT) was obtained from Western Sichuan, the coal gasification fine slag (CGFS) was got from Shandong Luxi Region, and kaolinite was acquired from Longyan City, Fujian Province. Sulfamethoxazole ($C_{10}H_{11}N_3O_3S$, ≥98%), ammonium molybdate tetrahydrate ($(NH_4)6Mo_7O_{24}\cdot H_2O$, AR), thioacetamide ($C_2H_5NS$, AR), furfuryl alcohol ($C_5H_6O_2$, AR), tert-butanol ($C_4H_{10}O$, AR) and humic acid were purchased from Macklin Biochemical Technology Co., Ltd (Shanghai China). Sodium bicarbonate ($NaHCO_3$), sodium dihydrogen phosphate ($NaH_2PO_4$), sodium chloride (NaCl), sodium hydroxide (NaOH), peroxymonosulfate ($2KHSO_5\cdot KHSO_4\cdot K_2SO_4$, PMS), ferrous sulfate heptahydrate ($FeSO_4\cdot 7H_2O$, AR) and starch soluble ($(C_6H_{10}O_5)_n$), AR) were purchased from Shanghai Aladdin Biochemical Technology Co., Ltd. Sulfuric acid ($H_2SO_4$) and formic acid ($CH_2O_2$, AR) were purchased from Beijing Chemical Works. The methanol and acetonitrile used in HPLC were provided by Fisher Chemical. All solutions were prepared by deionized distilled water which was produced by a Millipore Milli-Q system.

**Text S2**

The microstructure and element distribution of the samples were examined by scanning electron microscopy (SEM) (Gemini SEM 300, Zeiss, Germany) with energy dispersive spectrum analysis (EDS). X-ray diffraction (XRD) used BRUCKER D8 ADVANCE X-ray powder diffractometer, $2\theta$ range of 5°–80°. The surface chemical states of the synthesized samples were obtained by X-ray photoelectron spectroscopy (XPS, Thermo Scientific ESCALAB 250Xi). The Fe leaching rate of MF and MFC were investigated by ICP-MS (PerkinElmer ICP-MS NexION300D, America). The types and relative content of active free radicals were measured by the electron paramagnetic resonance (EPR) instrument (EPR, Bruker, Germany). The intermediates of SMX degradation were detected by high performance liquid chromatography-mass spectrometry (LC-MS, U3000, Thermo Fisher Scientific, USA).

**Table S1** Details of SMX and its intermediates

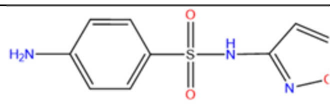
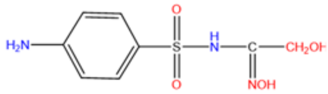
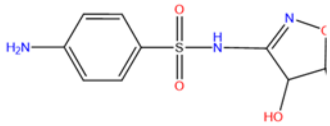
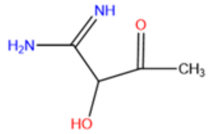
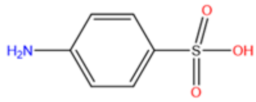
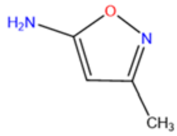
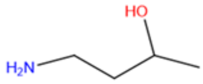
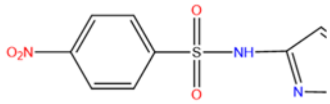
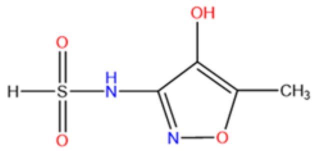
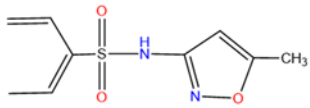
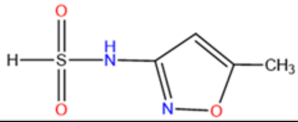
| Abbreviation or code name | Chemical formula | Structure | Anion mode (*m*/*z*) |
|---|---|---|---|
| SMX | $C_{10}H_{11}N_3O_3S$ |  | — |
| P1 | $C_8H_{11}N_3O_4S$ |  | 245.06 |
| P2 | $C_{10}H_{13}N_3O_5S$ |  | 286.87 |
| P3 | $C_4H_8N_2O_2$ |  | 115.17 |
| P4 | $C_6H_7N_1O_3S$ |  | 171.14 |
| P5 | $C_4H_6N_2O$ |  | 97.12 |
| P6 | $C_4H_{11}NO$ |  | 88.15 |
| P7 | $C_{10}H_9N_3O_5S$ |  | 282.08 |
| P8 | $C_4H_6N_2O_4S$ |  | 177.08 |
| P9 | $C_9H_{12}N_2O_3S$ |  | 229.03 |
| P10 | $C_4H_6N_2O_3S$ |  | 161.15 |

**Table S2** Predicting acute and chronic toxicity of SMX and its intermediates

| Compound | Acute toxicity/(mg·L$^{-1}$) | | | Chronic toxicity (Chv)/(mg·L$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | Fish (LC50) | Daphnid (LC50) | Algae(EC50) | Fish | Daphnid | Algae |
| SMX | 410.762 | 1.872 | 6.615 | 2.337 | 0.086 | 10.402 |
| P1 | 26709.738 | 1955.776 | 4231.651 | 6867.202 | 100.031 | 988.676 |
| P2 | 8446.509 | 683.974 | 1212.71. | 1597.981 | 38.580 | 304.655 |
| P3 | 2.66e+005 | 15422.803 | 53035 | 1.4e+005 | 628.185 | 10466.307 |
| P4 | 1.72e+005 | 13.549 | 184.558 | 1099.879 | 3.354 | 226.189 |
| P5 | 443.424 | 0.735 | 3.637 | 2.597 | 0.051 | 5.375 |
| P6 | 1022.739 | 89.030 | 136.810 | 155.215 | 5.388 | 6.208 |
| P7 | 306.332 | 483.427 | 8.139 | 0.330 | 16.189 | 5.499 |
| P8 | 664.666 | 512.052 | 3173.840 | 429.786 | 97.896 | 1150.145 |
| P9 | 126.176 | 165.027 | 3.661 | 0.173 | 7.233 | 2.937 |
| P10 | 28236.648 | 12622.519 | 3497.767 | 2081.597 | 632.674 | 537.757 |

Not harmful   Harmful   Toxic   Very toxic

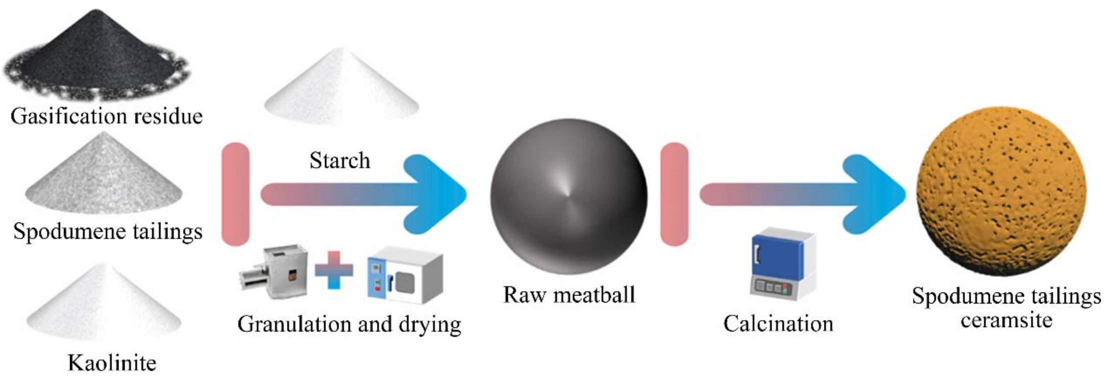



**Figure S1** Flow chart for spodumene tailings ceramsite preparation

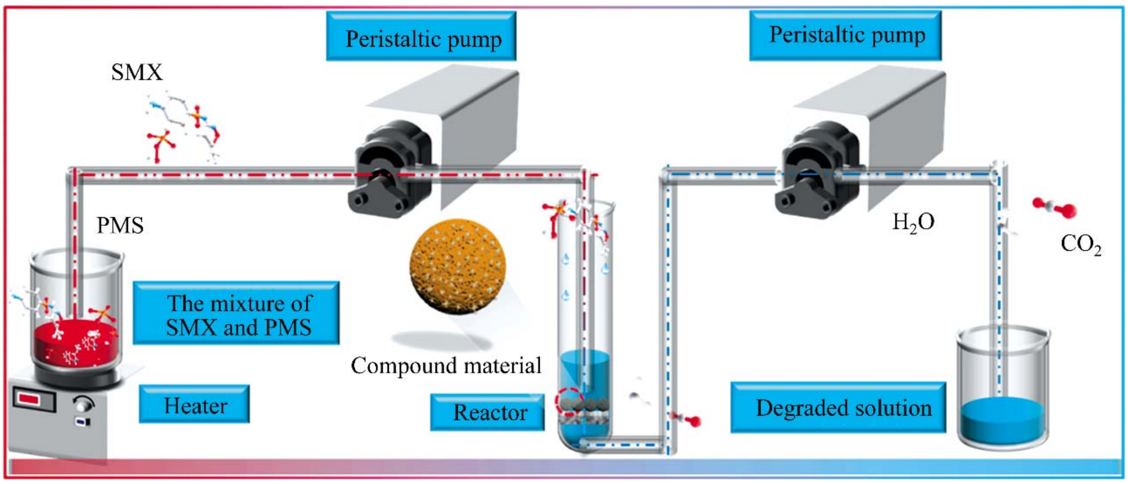



**Figure S2** Model of continuous flow degradation device

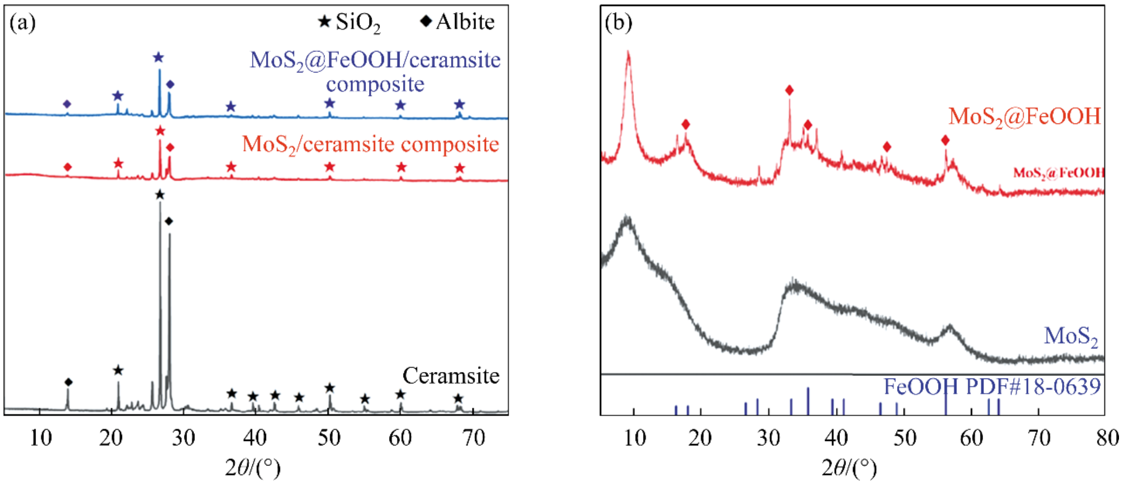



**Figure S3** (a) XRD patterns of ceramsite, $MoS_2$/ceramsite, MFC; (b) XRD patterns of $MoS_2$ and $MoS_2$@FeOOH

To determine the crystallographic and structural characteristics of the materials, we have conducted XRD tests. The characteristic diffraction peaks of spodumene tailings ceramsite are quartz ($SiO_2$) and albite [1]. $MoS_2$ has an amorphous structure and no obvious diffraction peaks are observed [2]. The diffraction peaks of FeOOH can be clearly observed in the XRD pattern of MF, corresponding to the standard card PDF#18-0639. Because the loading of $MoS_2$ and MF on the ceramsite carriers is relatively tiny, the corresponding characteristic peaks were not exhibited in the ceramsite composites.

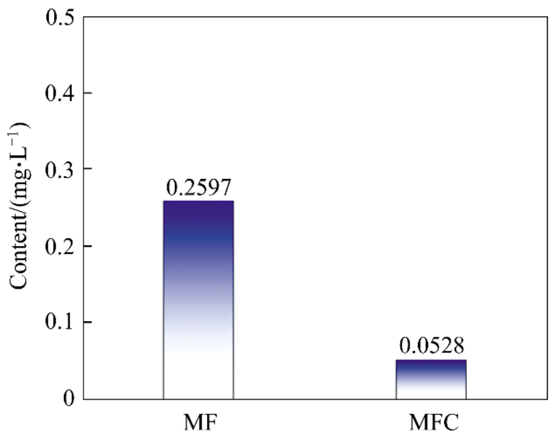



**Figure S4** The leaching content of Fe ions after reaction of MF and MFC

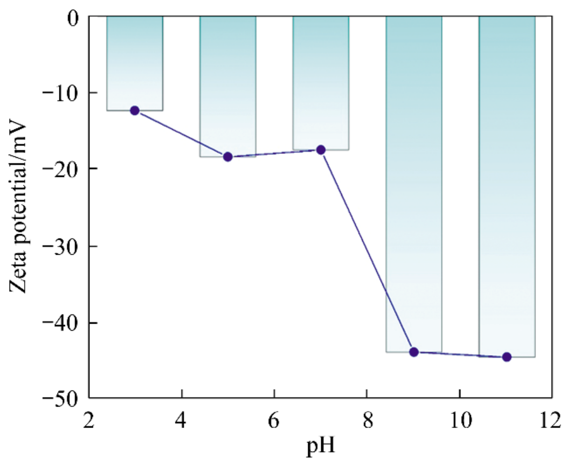



**Figure S5** Zeta potential of MFC

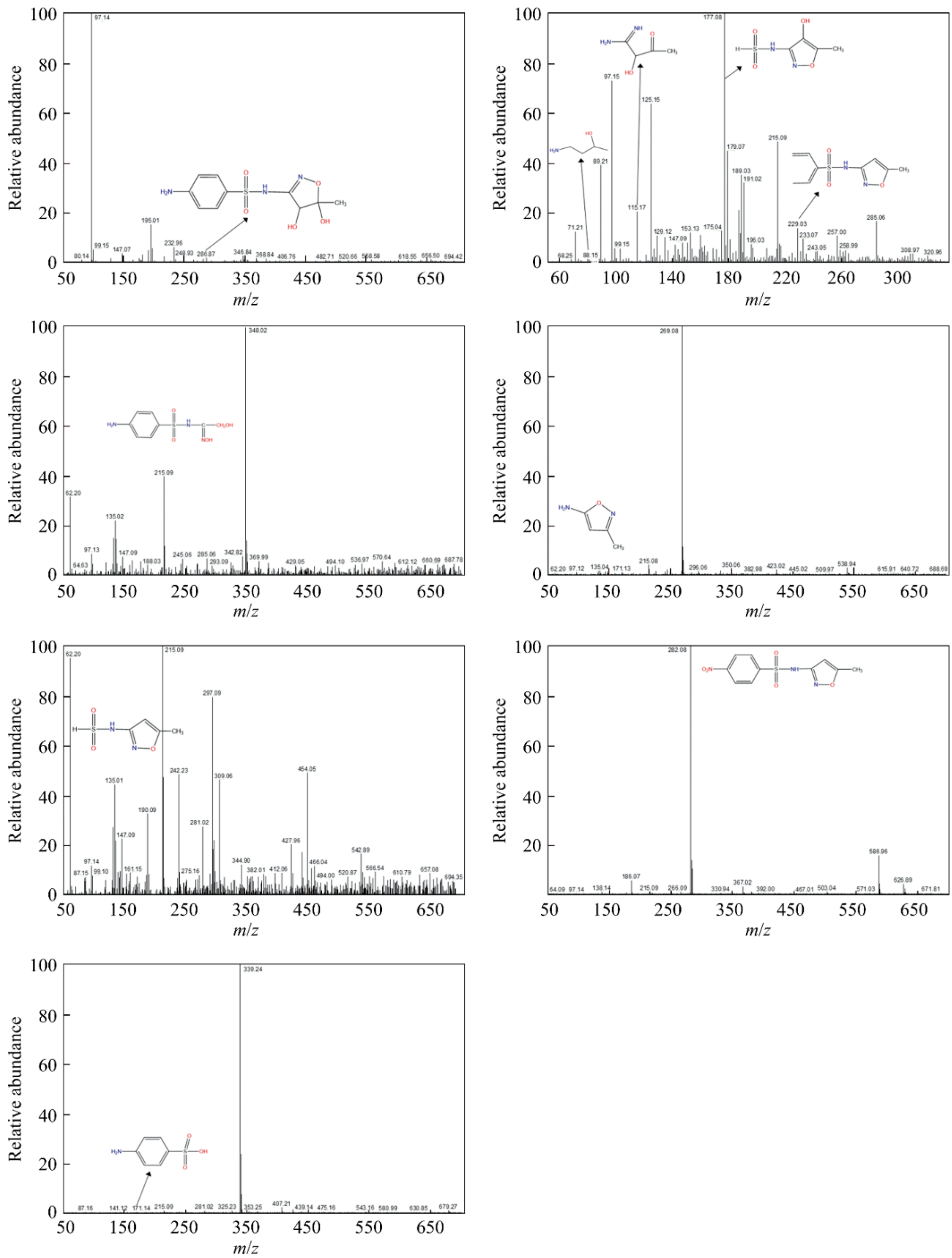



**Figure S6** LC-MS spectra of SMX transformation products

References

[1] YANG Jie, XU Long-hua, WU Hou-qin, et al. Sintering behavior and mechanical properties of sintered ceramics based on spodumene Tailings[J]. Journal of Central South University, 2021, 28(6): 1637−1651. DOI: 10.1007/s11771-021-4723-9.

[2] YI Cong-hao, HE Zu-yun, HU Yi-zhang, et al. FeOOH@MoS2 as a highly effective and stable activator of Peroxymonosulfate-based advanced oxidation processes for pollutant Degradation[J]. Surfaces and Interfaces, 2021, 27: 101465. DOI: 10.1016/j.surfin.2021.101465.