Supporting Information

The degradation of 2-methylisobornyl alcohol and geosmin through micro-nano bubbles activated ozone process: the dual mechanism of enhanced degradation efficiency

Text S1 Detection conditions of 2-MIB and GSM degradation products

The water samples were filtered through a 0.45 μm filter membrane and then extracted by a solid-phase extraction (SPE) instrument. The HLB SPE column was used, the column was activated with methanol and purified water, the solid-phase extraction water sample was 400 ml, the uploading rate was 15 $mL \cdot min^{-1}$, and the elution was carried out by dichloromethane. The chromatographic working conditions in the gas chromatography–mass spectrometry (GC–MS) instrument were as follows: the injection mode was GC-ALS, the pressure of the injection port was 12 psi, the temperature of the heater was 250 ℃, the injection volume was 5μL, the temperature of the auxiliary line was 280 ℃, and the carrier gas used was high-purity helium (99.9999%). The temperature was controlled by the following steps: the starting temperature was 60 ℃ and remained unchanged for 1 min; then, the temperature was increased to 180 ℃ at the rate of 10 $℃ \cdot min^{-1}$ and remained unchanged for 3 min. The ion source of the mass spectrometer was an electron ionization (EI) source, the ion source temperature was 230 ℃, the temperature of the MS quadrupole was 150 ℃, and the ionization energy was 70 eV. Full-scan mode was selected for qualitative analysis, SIM mode was selected for quantitative analysis, the 2-MIB qualitative ions were m/z 95, 107, and 135, the quantitative ions were m/z 95, the GSM qualitative ions were m/z 112 and 125, and the quantitative ions were m/z 112.

The degradation product samples were pretreated as follows: the pH of the solution was adjusted to 10 with 2 $mol \cdot L^{-1}$ NaOH, the samples were enriched and concentrated with a solid phase extraction column, the samples were dried and derivatized with diazomethane, and analysis by GC–MS was performed. The test conditions of the GC–MS and the qualitative analysis methods were the same as those of the GSM and 2-MIB.

Txet S2 Detection conditions of *p*-CBA

The p-CBA concentration was detected by liquid chromatography (model Waters 2487/2695, Waters) with a reversed-phase column (RP-18), a detection wavelength of λmax of 238 nm, a mobile phase of 50% acetonitrile and 50% aqueous 0.01% phosphoric acid.

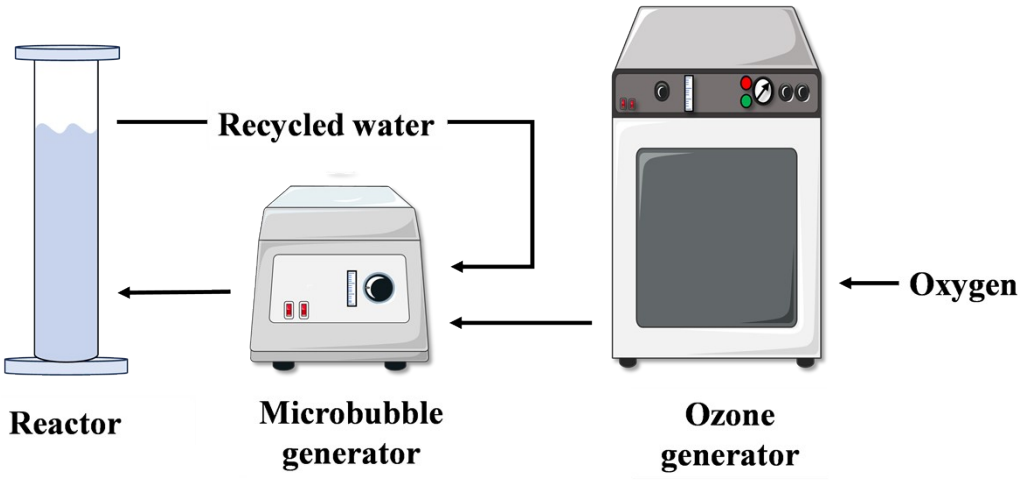


Fig. S1. Schematic of experimental setup

Table S1 Raw water quality

Source of water	Water of filter	Water of reservoir
Turbidity (NTU)	0.019-0.048	2.141-2.754
pH	7.69-7.78	8.19-8.25
UV_{254} (cm^{-1})	0.026-0.033	0.310-0.326
NH_4^+-N ($mol \cdot L^{-1}$)	0.01-0.11	0.09-0.26
DOC ($mol \cdot L^{-1}$)	2.571-2.738	4.256-4.551
Concentration of Bromide ion ($\mu g \cdot L^{-1}$)	23-37	51-79

Table S2. The acute and Chronic Toxic Classification according to GHS.

Acute toxicity (mg/L)	Chronic toxicity (mg/L)	Classification
$LC_{50}/EC_{50}<1$	ChV<0.1	Very toxic
$1<LC_{50}/EC_{50}<10$	0.1<ChV<1	Toxic
$10<LC_{50}/EC_{50}<100$	1<ChV<10	Harmful
$LC_{50}/EC_{50}>100$	ChV>100	Not harmful

Table S3. List of 2-MIB and its oxidation products

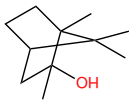
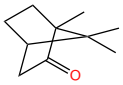
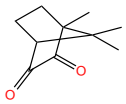
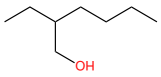
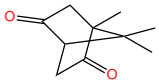
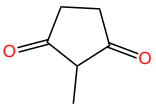
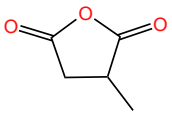
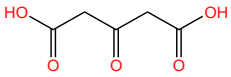
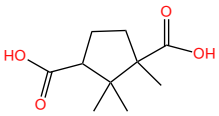
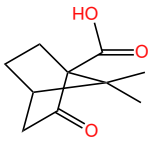
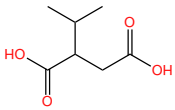
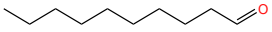
Number	Compound	Structural formula	Chemical formula	Relative molecular mass	CAS Registry number
1	2-MIB		C11H20O	168.276	2371-42-8
2	TP152		C10H16O	152.233	464-49-3
3	TP166a		C10H14O2	166.217	10373-78-1
4	TP130		C8H18O	130.231	106-67-2
5	TP166b		C10H14O2	166.217	4230-32-4
6	TP112		C6H8O2	112.127	765-69-5
7	TP114		C5H6ozone	114.100	4100-80-5
8	TP174		C7H10O5	174.151	1830-54-2
9	TP228		C12H20O4	228.285	7282-27-1
10	TP182a		C10H14ozone	182.220	40724-67-2
11	TP160		C7H12O4	160.170	2338-45-6
12	TP156		C10H20O	156.269	112-31-2

Table S4. List of GSMs and their oxidation products

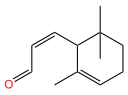
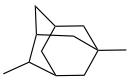
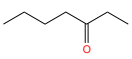
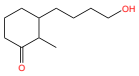
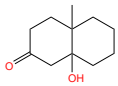
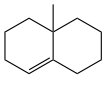
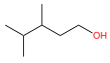
Number	Compound	Structural formula	Chemical formula	Relative molecular mass	CAS Registry number
1	GSM		C12H22O	182.303	19700-21-1
2	TP192		C13H20O	192.30	79-77-6
3	TP140		C9H16O	140.220	2408-37-9
4	TP164a		C12H20	164.290	24145-89-9
5	TP114		C7H14O	114.19	106-35-4
6	TP184		C11H20O2	184.279	91212-98-5
7	TP182b		C11H18O2	182.263	910892-33-0
8	TP126		C8H14O	126.199	645-62-5
9	TP164b		C12H20	164.290	56362-87-9
10	TP150		C11H18	150.265	13943-77-6
11	TP182c		C12H22O	182.303	-
12	TP98		C6H10O	98.143	108-94-1
13	TP116		C7H16O	116.204	6570-87-2

Table S5. Acute and Chronic Toxicity Assessment of 2-MIB and Its Degradation Products Using ECOSAR

Compound	Acute toxicity: mg/L			Chronic toxicity: mg/L		
	fish (LC_{50})	daphnia (LC_{50})	green algae (EC_{50})	fish (ChV)	daphnia (ChV)	green algae (ChV)
2-MIB	9.303	5.959	7.305	1.048	0.813	2.502
TP152	14.423	9.019	10.010	1.580	1.150	3.249
TP166a	1819.988	920.549	425.102	155.214	65.070	86.052
TP130	27.416	16.543	15.844	2.879	1.911	4.751
TP166b	1091.587	564.871	286.673	95.634	43.547	61.055
TP112	2750.735	1342.099	534.021	224.832	85.819	99.766
TP114	462.812	244.703	135.740	41.589	19.569	30.329
TP174	1617.537	4713.094	3305.883	235.929	7982.074	304.370
TP228	8.584	16.130	5.912	0.53	8.409	2.058
TP182a	2227.940	1242.774	860.219	213.259	115.354	216.539
TP160	25215.727	12548.985	5419.338	2109.731	847.898	1058.098
TP156	1.066	0.715	1.625	0.081	0.145	0.865

Table S6. Acute and Chronic Toxicity Assessment of GSM and Its Degradation Products Using ECOSAR

Compound	Acute toxicity: mg/L			Chronic toxicity: mg/L		
	fish (LC_{50})	daphnia (LC_{50})	green algae (EC_{50})	fish (ChV)	daphnia (ChV)	green algae (ChV)
GSM	5.886	3.861	5.228	0.682	0.563	1.889
TP192	2.772	0.867	0.828	0.296	0.222	0.742
TP140	48.874	28.834	25.162	4.998	3.128	7.176
TP164a	0.406	0.299	0.65	0.054	0.06	0.303
TP114	164.154	90.907	61.071	15.579	8.27	15.128
TP184	161.207	91.277	67.208	15.705	8.832	17.491
TP182b	52.334	34.027	18.467	4.194	3.285	15.727
TP126	0.161	22.563	14.978	0.004	1.897	2.897
TP164b	0.283	0.212	0.492	0.038	0.044	0.238
TP150	0.614	0.442	0.876	0.079	0.083	0.389
TP182c	6.339	4.145	5.536	0.732	0.599	1.985
TP98	491.475	257.425	137.349	43.677	20.054	30.052
TP116	67.542	38.948	30.926	6.723	3.965	8.382