

Supplementary Information

Significant impacts of NO₂ and NH₃ on the sulfate formations on the surface of nano MgO particles in a smog chamber

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Table S1 Characteristics of instruments used in the smog chamber experiments

Instrument	Producer and Model	Functions	Performance Index
Zero-air generator	Thermo Fisher Science, Model-111	Provides zero air	Maximum flow 20 L min ⁻¹ ; HC < 0.1ppm; NO < 0.5 ppb; NO ₂ < 0.5 ppb; O ₃ < 0.8 ppb; SO ₂ < 0.5 ppb; NH ₃ < 0.5 ppb; RH < 5%; PM < 1 cm ⁻³
O ₃ generator	Beijing Tonglin Technology Co., Ltd, Model 3S-T3	Provides O ₃	Rate of 37.5 mg min ⁻¹
O ₃ generator	Thermo Fisher Scientific, Model-49i IPS	Provides O ₃	Flow: 4 L min ⁻¹ ; Range of 0-1000 ppb
Solid particle disperser	PALAS, RBG-1000	Produces dry nanoscale particles	Particle generation rate of 616 mg h ⁻¹
Aerosol neutralizer	SIMCO, Model-6110A	Neutralizes electrical properties of particles	Dissipation time < 4 seconds Ion balance < ±25V
SO ₂ analyzer	Thermo Fisher Scientific, Model-43i	Determinate concentration of SO ₂	Detection range 0-50 ppm; Accuracy of ±1.0 ppb
NO-NO ₂ -NO _x analyzer	Thermo Fisher Scientific, Model-42i	Determinate concentration of NO-NO ₂ -NO _x	Detection range 0-50 ppm; Accuracy of ±1.0 ppb
O ₃ analyzer	Thermo Fisher Scientific, Model-49i	Determinate concentration of O ₃	Detection range 0-50 ppm; Accuracy of ±1.0 ppb
NH ₃ analyzer	Thermo Fisher Scientific, Model-17i	Determinate concentration of NH ₃	Detection range 0-50 ppm; Accuracy of ±1.0 ppb
Multi-Gas Calibrator	Thermo Fisher Scientific, Model-146i	Calibration gas analyzer	Provides accurate concentrations of SO ₂ , NO ₂ and NH ₃ or other gases
Particle size spectrometer	TOPAS, Model LAP322	Measure the size distribution of PM	Detection range of 200 nm-5 μm
Particle sampler	MSP, Model 125R NanoMoudi-II TM	Membrane sampling PM	Collect PM in 13 levels
Ion chromatography	Dionex™ ICS-2100; Thermo Fisher Scientific, Aquion	Measurement of water soluble anions and cations	Digital signal range: 0 to 15000 μS

Table S2 The initial conditions of SO₂ heterogeneous reactions on the surface of nano MgO aerosol particles in the different reaction systems in this study period

Exp. No.	Reaction System	React time (min)	Initial reaction conditions							
			SO ₂ (ppb)	MgO Particle (μg m ⁻³)	T (°C)	RH (%)	O ₃ (ppb)	Lamp (number)	NO ₂ (ppb)	NH ₃ (ppb)
1	SO ₂ -MgO-dark	240	239.91	322.25	21.5	24.5	-	-	-	-
			237.98	315.46	20.9	24.5	-	-	-	-
2		240	237.89	690.45	25.0	23.0	-	-	-	-
			240.63	766.30	24.7	19.1	-	-	-	-
3		240	238.15	878.12	24.2	40.2	-	-	-	-
			237.39	937.25	21.3	39.5	-	-	-	-
4		240	241.38	1288.54	23.4	61.4	-	-	-	-
			241.62	1136.16	23.8	60.8	-	-	-	-
5		240	239.64	1130.62	21.9	79.5	-	-	-	-
			241.45	1035.28	20.8	79.5	-	-	-	-
6		240	233.98	1206.15	20.9	15.8	-	-	206.53	-
			237.89	1050.17	16.1	17.8	-	-	204.51	-
7		240	225.89	1231.90	20.8	14.2	-	-	389.45	-
			240.41	1137.25	21.9	19.7	-	-	395.46	-
8		240	224.89	1174.34	23.7	18.6	-	-	587.46	-
			237.69	1275.64	18.3	19.5	-	-	601.05	-
9		285	248.18	934.48	21.7	11.9	-	-	-	229.41
	241.76		895.25	16.1	17.7	-	-	-	209.16	
10	285	241.48	780.55	23.5	10.3	-	-	-	408.78	
		237.30	837.11	18.2	18.7	-	-	-	405.93	
11	285	233.38	820.15	21.7	12.4	-	-	-	603.28	
		239.02	856.24	17.6	22.6	-	-	-	597.17	
12	SO ₂ -MgO-hν	300	237.33	319.67	28.0	22.0	-	20	-	-
			236.98	314.55	21.8	16.2	-	20	-	-
13		300	241.91	337.60	26.6	21.2	-	40	-	-
			235.89	306.88	17.6	18.6	-	40	-	-
14		300	245.62	546.98	26.7	25.6	-	40	-	-
			235.95	502.34	18.7	22.1	-	40	-	-
15		300	240.41	346.20	21.3	18.4	-	40	105.37	-
			243.14	440.59	22.0	19.8	-	40	102.67	-
16		300	244.89	564.52	18.3	24.5	-	40	210.24	-
			235.92	489.76	19.7	19.8	-	40	204.36	-
17		300	239.00	396.69	22.1	23.7	-	40	401.91	-

			241.06	486.27	16.5	20.3	-	40	398.34	-
18	300		238.71	408.84	19.1	23.1	-	40	-	113.76
			211.00	420.00	22.1	22.6	-	40	-	110.00
19	300		237.94	414.51	21.1	19.3	-	40	-	199.52
			231.18	406.55	18.9	24.2	-	40	-	199.08
20	300		251.42	409.84	18.3	24.4	-	40	-	379.72
			238.06	442.60	25.7	15.5	-	40	-	364.41
21	300		240.52	475.19	25.1	22.4	86.12	-	-	-
			240.10	484.34	20.8	21.8	93.17	-	-	-
22	300		233.80	507.33	23.7	22.3	198.69	-	-	-
			237.03	531.12	19.0	22.9	200.94	-	-	-
23	300		260.77	490.78	23.2	21.9	301.24	-	-	-
			236.81	481.24	18.4	19.0	299.68	-	-	-
24	300		234.41	460.56	20.4	22.8	88.85	-	93.49	-
			236.04	495.15	22.3	20.1	98.20	-	96.37	-
25	300	SO ₂ -MgO-	247.28	424.28	22.1	21.8	97.25	-	200.89	-
		O ₃	239.04	431.54	19.2	19.1	96.9	-	198.39	-
26	300		238.41	463.31	22.3	23.6	83.75	-	350.59	-
			232.51	454.03	18.9	19.6	88.42	-	371.42	-
27	300		226.07	422.60	16.9	23.1	92.36	-	-	69.00
			231.56	428.36	17.5	24.7	94.61	-	-	69.90
28	300		225.70	478.60	23.4	23.6	98.28	-	-	153.27
			238.94	493.21	19.6	19.4	95.80	-	-	152.12
29	300		254.24	413.24	21.5	21.9	88.51	-	-	309.03
			240.72	437.35	19.5	17.2	94.20	-	-	297.06