Supporting Information:

Heterogeneous Photooxidation of Sulfur Dioxide in the Presence of Airborne Mineral Dust Particles

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S1. Spectral irradiance of UV lamps of the indoor chamber

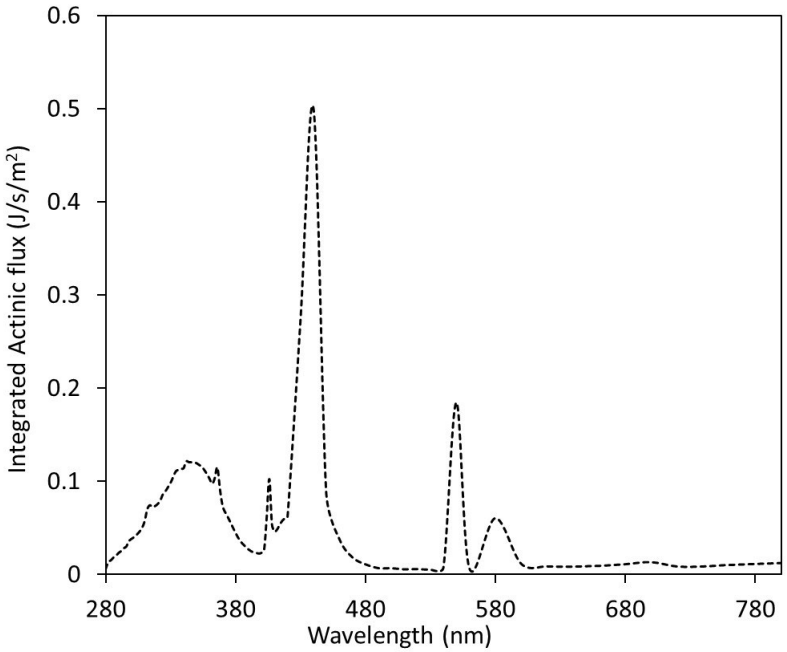

Figure S1. Spectral irradiance of the light sources used in the present study measured with a fibro-optical portable spectrometer (EPP2000, Stellar Net Inc., USA). The indoor chamber is equipped with 11 UVA lamps and 5 UVB lamps.

S2. Determination of size distribution of ATD particles

A lognormal distribution was used to determine the number size distribution of ATD particles. Assuming each mode of ATD particles is a log-normal distribution, the number distribution can be given as[1]

$$n(D) = \frac{N}{(2\pi)^{1/2} \ln \sigma_g} \exp\left[-\frac{(\ln D - \ln D_g)^2}{2 \ln^2 \sigma_g} \right] \quad (1)$$

Where N, D_g, and σ_g are the total number concentration, geometric mean diameter, and geometric standard deviation, respectively. Total surface area (S_0) ($cm^2\ m^{-3}$) of ATD particles were calculated as given below.

$$S_0 = \pi N D_g^2 \exp(2\sigma_g^2) \quad (2)$$

An average density of 2.6 g cm^{-3} is used. The geometric mean diameter and geometric standard deviation of ATD particles were ~530 nm and 1.44, respectively. To response to the reviewer, we added S_0 into Table 1.

S3. Operation of outdoor chamber experiments

To determine the acidity of ATD particles, outdoor chamber experiments were conducted using a 104 m^3 University of Florida Atmospheric Photochemical Outdoor Reactor (UF-APHOR). The UF-APHOR chamber is located on the roof of Black Hall at the University of Florida, Gainesville, Florida. A detailed description of the UF-APHOR chamber has been presented in a previous paper.[2] In brief, the dual chambers of half-cylinder design are made of FEP Teflon film. Prior to each outdoor experiment, the chamber was flushed with clean air for more than 2 days using a clean air generator (GC Series, IQAir). Subsequently, carbon tetrachloride (CCl_4) (99%, Acros, USA) was injected into the chamber to account for dilution of gaseous compounds. Before sunrise, ATD or silica particles were introduced into the chamber using a PARI LC Star nebulizer (Pari, Starnberg, Germany). To determine the mass

concentration of ATD particles, particles were collected on the teflon-coated glass fiber filter (Emfab TX40 HI20 WW; Pallflex Corp., Putnam, CT) for 20 minutes, and mass differences before and after the collection were measured using a microbalance (MX5, Mettler Toledo, Columbus, OH). Then, SO_2 was injected into the chamber from a tank of 500 ppm SO_2. The experimental conditions for SO_2 photooxidation in the presence of mineral dust particles using the UF-APHOR chamber are summarized in detail in Table S1. During the outdoor chamber experiment, temperature and RH were monitored using Temp/RH sensors (Campbell Scientific, CS215-L) in both chambers. To characterize natural sunlight, the intensity of solar UV radiation was measured using the ultraviolet radiometer (Eppley Laboratory, model TUVR, wavelength 290 to 385 nm) installed in the west chamber.

Table S1. Outdoor chamber experimental conditions for SO_2 oxidation in the presence of ATD particles

Date	Chamber[a]	Type of particles	Initial filter mass of particles (μg m^{-3})	Initial SO_2 conc. (ppb)	Initial NO_x conc. (ppb)	RH (%)	Temp. (°C)	Max TUVR (W m^{-2})
11/12/2015	E	ATD	273.45	152.76	1.28	14.94–45.07	13.87–39.94	24.54
11/12/2015	W	ATD	277.82	275.50	0.95	16.41–46.56	14.32–38.06	24.54

a.“E” represents east side of the chamber. “W” represents west side of the chamber.

b. Initial volume concentration of ATD particles measured with the SMPS

Table S2. Elemental and chemical analysis of ATD particles

Elemental analysis by EDS[a]		Chemical analysis from the manufacturer[b]	
Si	57.94 ± 0.22	SiO_2	68–76
Al	17.57 ± 0.15	Al_2O_3	10–15
K	5.90 ± 0.02	K_2O	2–5
Ca	5.42 ± 0.27	CaO	2–5
Fe	7.56 ± 0.11	Fe_2O_3	2–5
Na	1.88 ± 0.01	Na_2O	2–4
Mg	3.05 ± 0.04	MgO	1–2
Ti	0.68 ± 0.04	TiO_2	0.5–1
Total	100	Total	100

[a] Elements of ATD particles analyzed using the EDS in current study.

[b] The chemical components of ATD particles provided by the manufacturer (Powder Technology Inc., Minnesota, USA).

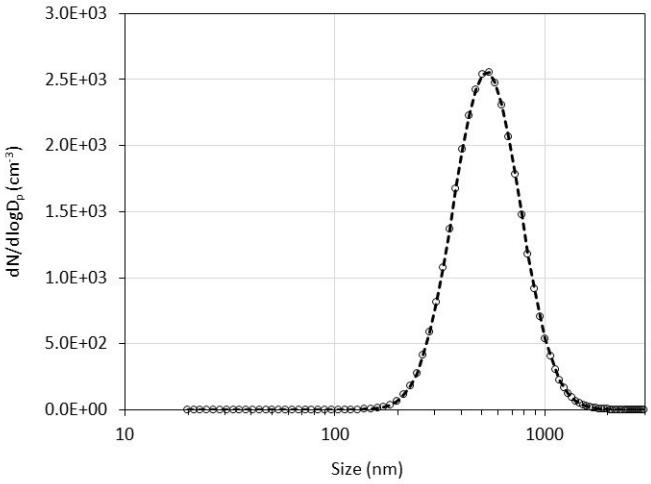

Figure S2. Particle size distribution of ATD particles tested in this study

References

1. G. M. Underwood, C. H. Song, M. Phadnis, G. R. Carmichael and V. H. Grassian, *Journal of Geophysical Research: Atmospheres*, 2001, **106**, 18055-18066.
2. Y. Im, M. Jang and R. L. Beardsley, *Atmos. Chem. Phys.*, 2014, **14**, 4013-4027.