*Supplement of*

**Photoenhanced sulfate formation by the heterogeneous uptake of SO2 on non-photoactive mineral dust**

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**This file includes:**

The calculation for Reynolds number (*Re*)

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**The calculation for Reynolds number (*Re*)**

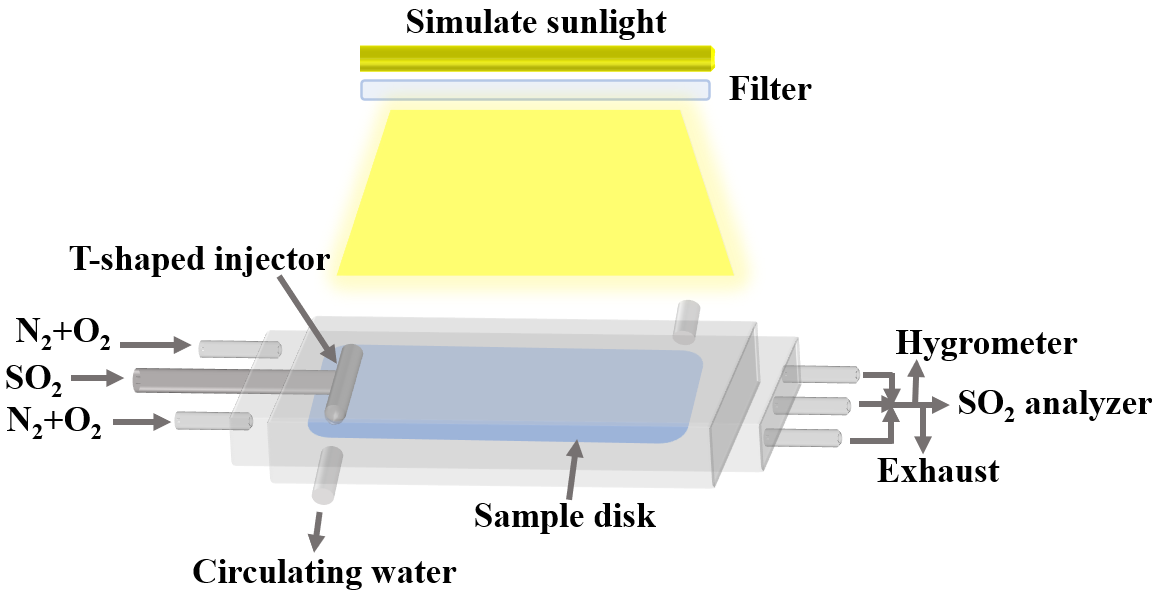
The Reynolds number (*Re*) was determined by the equation S1,

*Re*= *ρvD*/*μ* (S1)

where *ρ*, *v*, *D* and *μ* represent the density of air (1.2 kg m–3), the flow rate in the reactor (0.011 m s–1), the equivalent diameter (0.032 m) and the viscosity coefficient of air (1.5 × 10–5 Pa s–1), respectively.



**Figure S1.** The UV-vis light absorption spectra of SiO2, kaolinite, Al2O3, MgO and CaO.



**Figure S2.** Diagram of the rectangular flow reactor.



**Figure S3.** The spectral irradiance of the xenon lamp for SO2 uptake and DRIFTS experiments and the solar for the 48o solar zenith clear sky at Shenyang (41.45N, 123.25E) on June 6th, 2022, at 12:00 local time.



**Figure S4.** Determination of the linearity of ln(*C*0*/C*t) against the reaction time by varying the length of SiO2 coating (red) and the blank reactor (black) contacting with SO2. Reaction conditions: SiO2 mass of 0.2 g, irradiation intensity of 250 7.93 × 1016 photons cm−2 s−1, temperature of 298 K, RH of 40% and O2 content of 20%.



**Figure S5.** The temporal variation of SO2 in blank experiments under irradiation. Reaction conditions: blank flow reactor, irradiation intensity of 7.93 × 1016 photons cm−2 s−1, RH of 40%, temperature of 298 K, and O2 content of 20%.



**Figure S6.** Initial uptake coefficients and steady-state uptake coefficients of SO2 as a function of the SiO2 mass.

**Table S1.** The chemical composition of SiO2.

|  |  |
| --- | --- |
| Chemical composition | Fraction (wt%) |
| SiO2 | 99.02 |
| Al2O3 | 0.75 |
| K2O | 0.17 |
| Fe2O3 | 0.03 |
| CaO | 0.01 |



**Figure S7.** *In situ* DRIFTS spectra of SiO2 in the range of 1500−900 cm−1 during the uptake process of SO2 (2 ppm) for 600 min in the dark and under irradiation.



**Figure S8.** (a) Temporal variations of the SO2 concentration on SiO2 at different RHs. (b) Temporal variations of the SO2 concentration on SiO2 in N2 and air. The background changes of the SO2 concentration in the blank reactor have been deducted. Reaction conditions: SiO2 mass of 0.2 g, irradiation intensity of 7.93 × 1016 photons cm−2 s−1, temperature of 298 K, O2 content of 20% for (a) and RH of 40% for (b).



**Figure S9.** *In situ* DRIFTS spectra of SiO2 during the uptake process of SO2 (2 ppm) under different RHs (a) and O2 contents (b).



**Figure S10.** Temporal variations of the SO2 concentration on kaolinite, Al2O3, MgO and CaO.



**Figure S11.** Temporal variations of the SO2 concentration on SiO2 at pH = 9.



**Figure S12.** (a) *In situ* DRIFTS spectra on the surface of SiO2 mixed with Ru(bpy)3(Cl)2 in the absence (purple line) and presence of SO2 (yellow line) for 300 min. (b) *In situ* DRIFTS spectra during the uptake process of SO2 (2 ppm) in the absence (red line) and presence of NaHCO3 (green line) for 300 min.



**Figure S13.** The temporal variation of SO2 on SiO2 in the dark and the visible light (>420 nm).