Supporting Information for:

High Yields of Formic Acid and Acetic Acid during Multi-generational Oxidation of Toluene

Hengqing Shen[1,2], Liubin Huang[1*], Yue Zhao[3], Min Zhao[1], Yu Yang[1], Huan Li[4], Huihui Wu[2], Zhongming Chen[2*]

[1]Environment Research Institute, Shandong University, Qingdao, Shandong 266237, China

[2]State Key Laboratory of Regional Environment and Sustainability, College of Environmental Sciences and Engineering, Peking University, Beijing 100871, China

[3]School of Environmental Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China

[4]China Center for Information Industry Development, Beijing 100871, China

[*] **Corresponding Author**

Liubin Huang (hliubin@sdu.edu.cn) and Zhongming Chen (zmchen@pku.edu.cn).
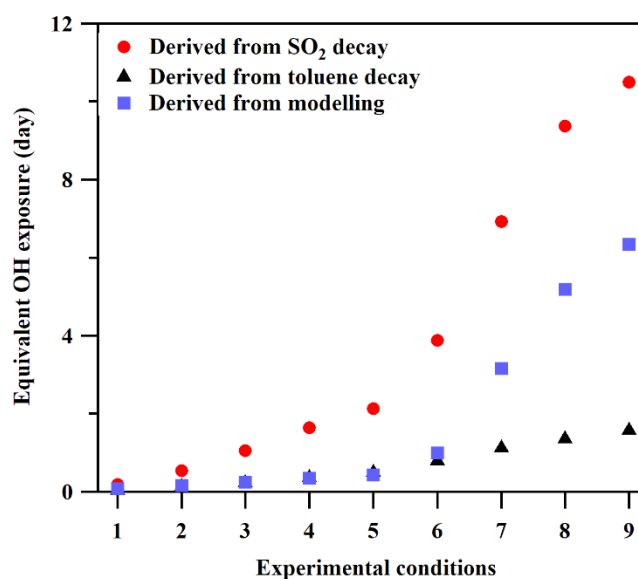
Figure S1. •OH exposures derived from three different methods (SO_2 decay, toluene decay, and modeling). The experimental conditions of 1–9 correspond to one lamp illuminated with the residence time of 3.9 s (1), 15.8 s (2), 27.5 s (3), 39.3 s (4), and 51.0 s (5), and to 2 (6), 4 (7), 6 (8), and 8 (9) lamps illuminated with the residence time of 51.0 s.
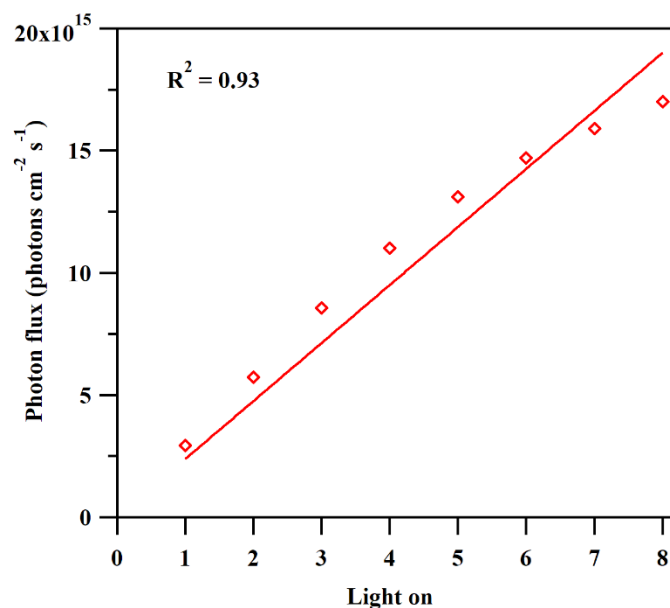
Figure S2. Photon fluxes estimated by the model with different lamps illuminated (up to 8).
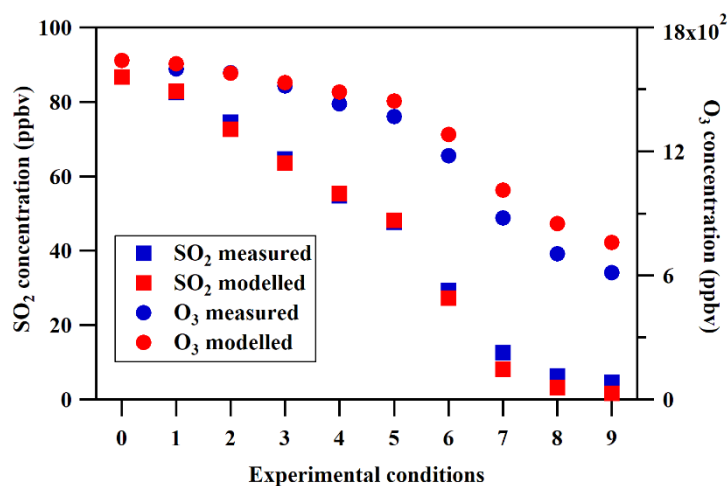
Figure S3. Comparison of the decay of SO_2 and O_3 measured in the OFR and simulated by the model. The experimental conditions of 0–9 correspond to no lamp illuminated (0), one lamp illuminated with the residence time of 3.9 s (1), 15.8 s (2), 27.5 s (3), 39.3 s (4), and 51.0 s (5), and to 2 (6), 4 (7), 6 (8), and 8 (9) lamps illuminated with the residence time of 51.0 s.

Table S1. The derived equivalent •OH exposures under different experimental conditions.

Number of lamps illuminated	Positions of sample collection[a]	Residence time (s)	Modeled •OH concentration (molecules cm^{-3})		Rquivalent •OH exposures (days)	
			20% RH	70% RH	20% RH	70% RH
1	5%	3.9	5.21×10^9	1.59×10^{10}	0.07	0.20
1	25%	15.8	3.15×10^9	8.77×10^9	0.16	0.44
1	45%	27.5	2.69×10^9	1.05×10^{10}	0.24	0.93
1	65%	39.3	2.67×10^9	1.20×10^{10}	0.34	1.52
1	85%	51.0	2.62×10^9	1.48×10^{10}	0.43	2.43
2	85%	51.0	6.04×10^9	4.33×10^{10}	0.99	7.10
4	85%	51.0	1.93×10^{10}	8.04×10^{10}	3.16	13.18
6	85%	51.0	3.16×10^{10}	9.33×10^{10}	5.19	15.30
8	85%	51.0	3.87×10^{10}	9.54×10^{10}	6.34	15.64

[a] axial length of the OFR