Size-resolved Deposition Rates for Ultrafine and Submicron Particles in a Residential Housing Unit

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Supporting Information

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Number of pages: 10

Number of tables: 2

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NLIN procedure for data analysis

PROC NLIN is a well-established procedure in SAS. It utilizes an iterative process to estimate the specified unknown parameters which in this study are P_iC_{oi}, k_i and $C_i(0)$. The procedure starts from initially guessed values (starting values) for the parameters and subsequently searches for the best solution (combination of parameter values) that yields the minimum value of the residual sum of squares. In theory, there can be multiple solutions that give rise to convergence to end the procedure. However, the solutions might not always be meaningful or close to the actual values. For example, if the procedure starts from initially guessed values that are far from the actual values, it could converge to a local minimum and result in biased estimates. To prevent this situation from occurring, we set P_iC_{oi}, k_i and $C_i(0)$ to be greater than zero because the particle concentrations and deposition rates should theoretically be positive values. Additionally, we specified the ranges and the intervals to allow multiple starting values for all three parameters so that the NLIN procedure could determine the best combination of the starting values. In fact, the NLN procedure converged to the same estimated values even without using multiple starting values for P_iC_{oi}, k_i and $C_i(0)$. This was most likely due to the distinct profiles of the decay curves which contributed to more robust estimation in this study.

In the analysis, we treated $C_i(0)$ as an unknown parameter instead of using the actual measurements. The major reason for that was because the determination of k_i from the decay curve was sensitive to the initial concentration. We therefore specified it as an unknown parameter and allowed the NLIN procedure to estimate its value based on the data. This approach was advantageous in three aspects. First, we minimized the influence of the instrument uncertainty for more robust k_i estimation by not using the actual measurements, given that k_i was sensitive to $C_i(0)$. Secondly, we could still compare the estimated values from NLIN procedure to the actual measurements to check for consistency. Thirdly, consistency between the estimated and measured $C_i(0)$ indicated reliable estimation for $P_i C_{oi}$ and k_i because all three parameters were approximated simultaneously in the same procedure.

Table S1. Pairwise comparisons of size-resolved deposition rates for three target air exchange rates (A=0.60, 0.90 and 1.20 ACH).

Particle size (nm)	A=0.60 vs.0.90 (h^{-1})		A=0.90 vs. 1.20 (h^{-1})		A=0.60 vs. 1.20 (h^{-1})	
	F Value	Prob>F	F Value	Prob>F	F Value	Prob>F
<25	1.07	0.3040	1.29	0.2589	3.84	0.0530
25-35	0.05	0.8277	0.58	0.4468	0.23	0.6327
35-45	0.02	0.8775	9.19	0.0032*	8.44	0.0046*
45-55	0.36	0.5525	2.60	0.1101	4.15	0.0445
55-65	0.01	0.9167	5.51	0.0211	4.80	0.0311
65-80	2.34	0.1292	12.28	0.0007*	3.44	0.0670
80-100	0.02	0.8774	9.37	0.0029*	8.79	0.0039*
100-150	1.35	0.2476	0.12	0.7252	2.08	0.1525
150-200	0.49	0.4850	4.22	0.0428	7.48	0.0075*
200-300	0.89	0.3480	0.04	0.8472	1.25	0.2668
>300	0.08	0.7722	1.47	0.2289	0.96	0.3289
Total	0.60	0.4396	9.01	0.0035*	4.18	0.0437

* $p < 0.0167$.

Table S2. The avearage size-resolved particle deposition rates across the nine tests (0.61-1.24 ACH).

Particle size (nm)	n	Estimated k_i (h^{-1})	Approx. s.e. (h^{-1})	Approx. 95% C.I.	
				Lower	Upper
<25	110	4.75	0.11	4.53	4.97
25-35	110	3.32	0.06	3.20	3.43
35-45	110	2.48*	0.05	2.39	2.58
45-55	110	2.00	0.06	1.89	2.11
55-65	110	1.71*	0.05	1.60	1.81
65-80	110	1.45*	0.04	1.36	1.54
80-100	110	1.24*	0.06	1.13	1.36
100-150	110	1.03	0.05	0.93	1.12
150-200	110	0.95*	0.07	0.82	1.08
200-300	110	1.00	0.08	0.84	1.17
>300	110	1.17	0.13	0.92	1.42
Total	110	2.20*	0.03	2.14	2.27

* $p < 0.05$.

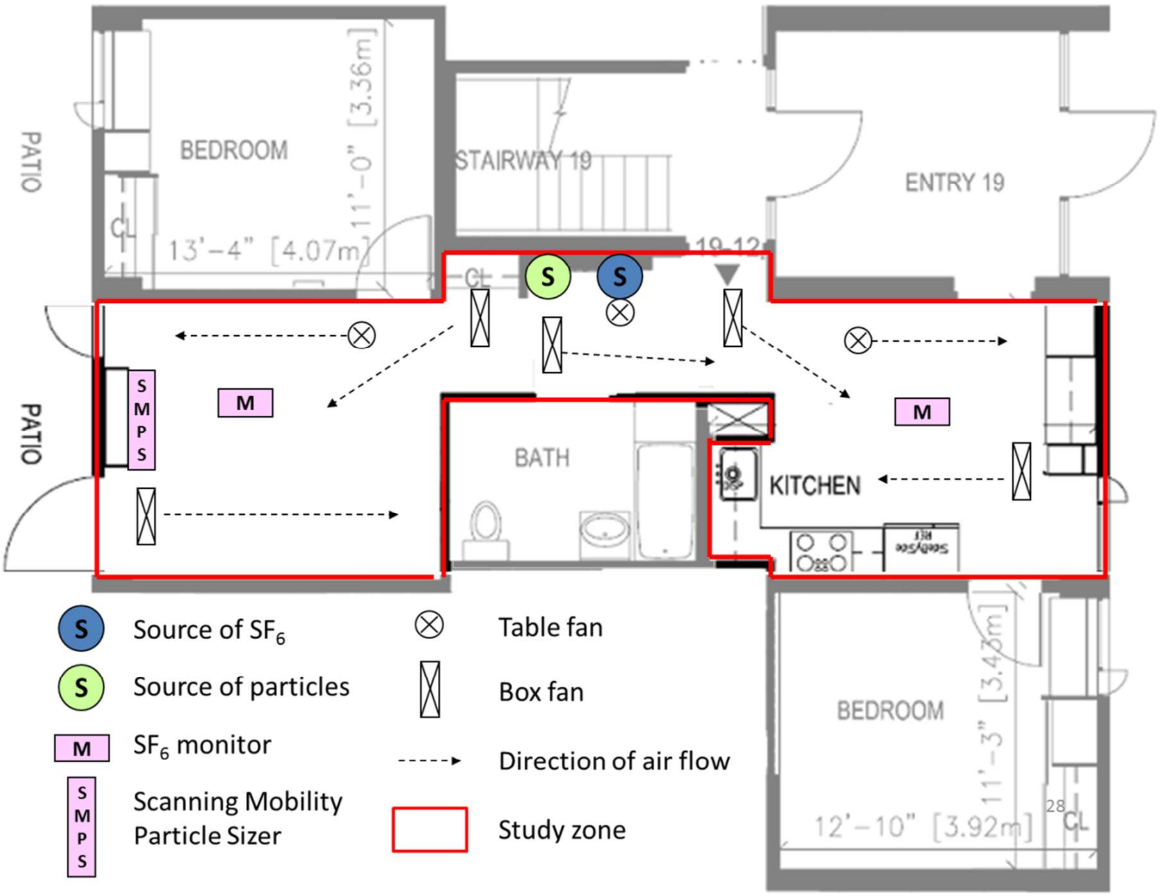

Figure S1. The layout of the instruments and devices in the apartment unit. The area enclosed by the red line denotes the study zone.

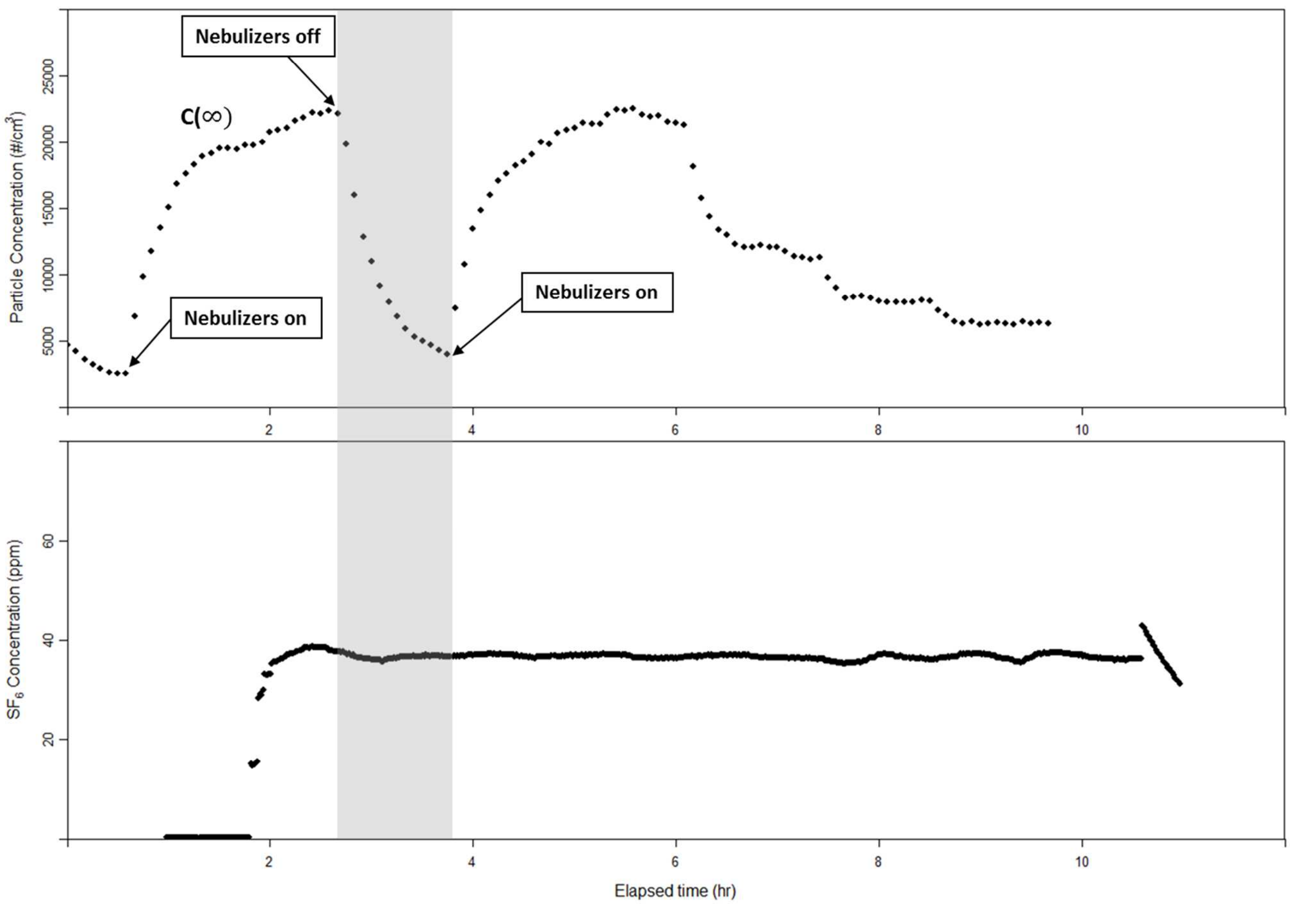

Figure S2. An example of the continuous measurements of total particle and SF_6concentrations over one sampling day (under 0.91 ACH). The shaded area included the data used to determine the size-resolved particle deposition rates in the present study.

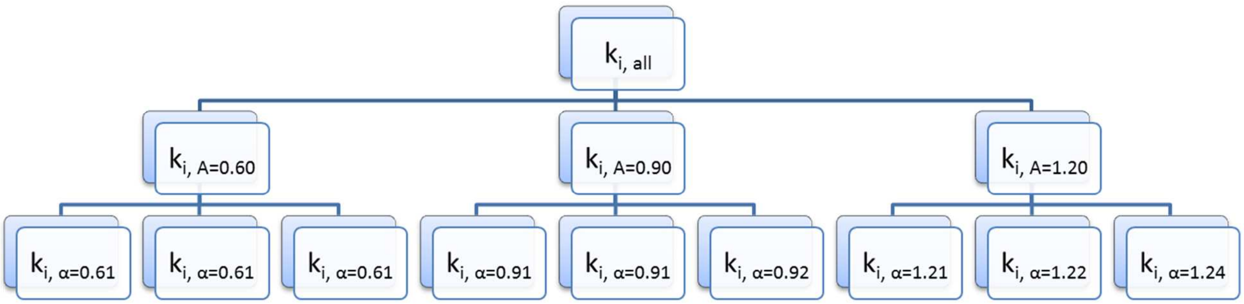

Figure S3. Three levels of analyses for k_i: (1) $k_{i,\alpha}$ as the size-resolved deposition rates for each test, (2) $k_{i,A}$ as the average size-resolved deposition rates under three target air exchange rates (A=0.60, 0.90 and 1.20 ACH), and (3) $k_{i,all}$ as the average size-resolved deposition rates across all the nine tests (0.61-1.24 ACH).

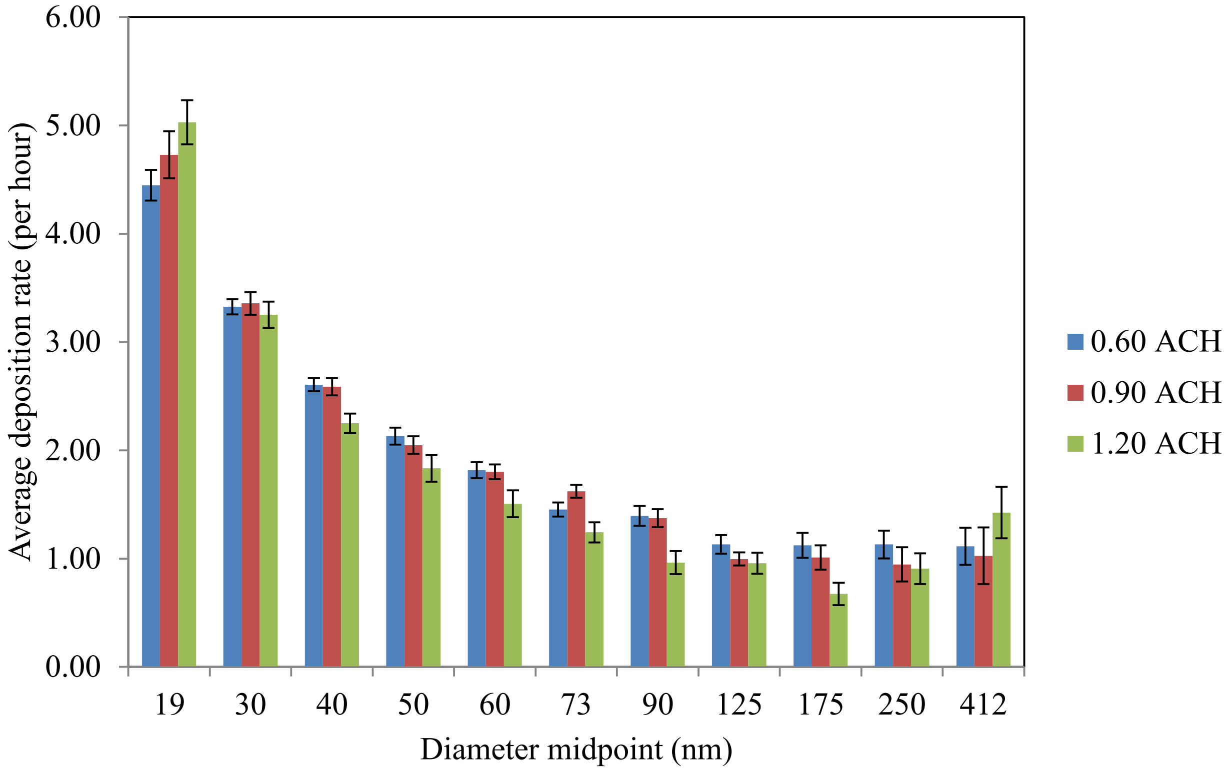

Figure S4. Estimated particle deposition rates corresponding to the three target air exchange rates. The error bars represent one standard error from the mean.

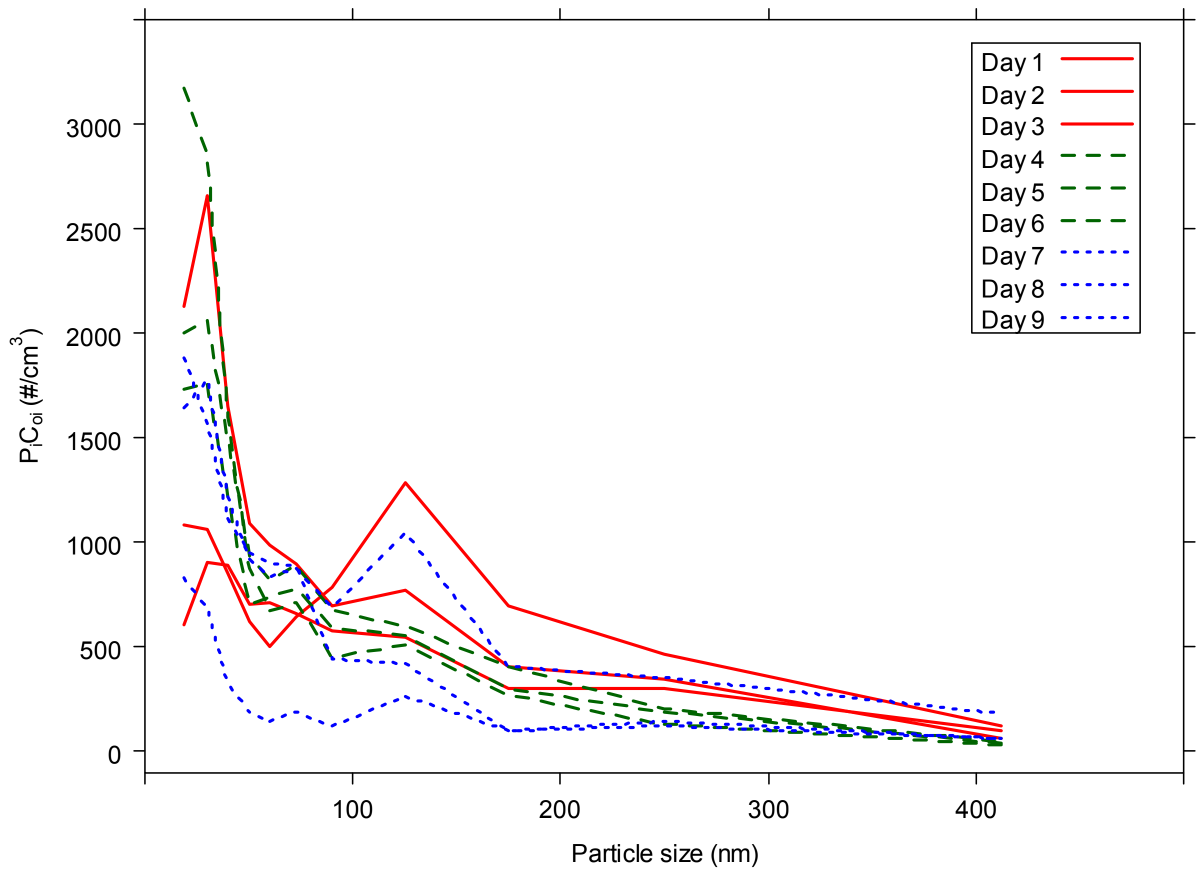

Figure S5. Estimated size-resolved P_iC_{oi} from the NLIN procedure by test day. Each day corresponded to measurements under one constant air exchange rate. The first three days (depicted in red) were for A=0.60 ACH while the middle (in dark green) and the last (in blue) three days were for A=0.90 and 1.20 ACH, respectively.