Supplementary Information

Development of Portable Mobility Spectrometer for Aerosol Exposure Measurement

Pramod Kulkarni*1, Chaolong Qi1, Nobuhiko Fukushima2

1Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health

Cincinnati, OH, 45226

2Kanomax Japan Inc.

Osaka, Japan

Aerosol Science and Technology
Table S1: Centroid channel/bin diameters for EMS and PAMS used in this study at high resolution (HR) and low resolution (LR)

|       | EMS HR 10.6 | EMS HR 11.7 | EMS HR 12.6 | EMS HR 14.6 | EMS HR 16.6 | EMS HR 18.8 | EMS HR 21.4 | EMS HR 24.5 | EMS HR 27.8 | EMS HR 31.8 | EMS HR 36.3 | EMS HR 41.6 | EMS HR 47.3 | EMS HR 54.7 | EMS HR 62.3 | EMS HR 72.3 | EMS HR 83  | EMS LR 15.1 | EMS LR 16.4 | EMS LR 20.5 | EMS LR 24.4 | EMS LR 30   | EMS LR 31.6 | EMS LR 38.4 | EMS LR 41.5 | EMS LR 52.3 | EMS LR 54.8 | EMS LR 70.5 | EMS LR 72.7 | EMS LR 94.3 | EMS LR 96.7 | EMS LR 129.2 | EMS LR 131.2 | EMS LR 179.5 | EMS LR 181.8 | EMS LR 254.9 | EMS LR 258.1 | EMS LR 371.3 | EMS LR 376.5 | EMS LR 556.5 | EMS LR 564.1 | EMS LR 855   | EMS LR 871.5 | EMS LR 94.6 | EMS LR 110  | EMS LR 128.3 | EMS LR 150.3 | EMS LR 176.9 | EMS LR 209.2 | EMS LR 248.8 | EMS LR 298  | EMS LR 359.1 | EMS LR 435.7 | EMS LR 438.9 |
Table S2: Instruments used in inter-comparison study

<table>
<thead>
<tr>
<th>Model, Manufacturer</th>
<th>Abbreviation</th>
<th>Calibrated on</th>
<th>Type of charger, and age</th>
<th>Aerosol-to-sheath flow ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanning Mobility Particle Sizer * Model 3936, TSI Inc.</td>
<td>SMPS3936</td>
<td>08/2013</td>
<td>Bipolar, Soft X-Ray, Model 3087, TSI 07/2012</td>
<td>8:1</td>
</tr>
<tr>
<td>Scanning Mobility Particle Sizer, Model 3034, TSI Inc.</td>
<td>SMPS3034</td>
<td>07/2003</td>
<td>Bipolar, Soft X-Ray, Model 3087, TSI 06/2012</td>
<td>8:1</td>
</tr>
<tr>
<td>Wide Range Particle Spectrometer, Model M1000XP, MSP Inc.</td>
<td>WPS</td>
<td>12/2011</td>
<td>Bipolar, Po210, manufacturing date 9/2011</td>
<td>10:1</td>
</tr>
<tr>
<td>NanoScan SMPS Nanoparticle Sizer, Model 3910, TSI Inc.</td>
<td>NanoScan</td>
<td>04/2013</td>
<td>Unipolar charger</td>
<td>3:1</td>
</tr>
<tr>
<td>Prototype PAMS</td>
<td>PAMS</td>
<td>07/22/2014</td>
<td>Bipolar, Dual-Corona Ionizer</td>
<td>8:1 or 4:1</td>
</tr>
</tbody>
</table>

* The EMS instrument used in this study employed the charger, DMA, and the CPC from this SMPS3936 system.
Figure S1: Transmission efficiency curve used for the inlet cyclone in PAMS

\[ y = \frac{a}{1 + e^{\frac{x-x_0}{b}}} \]

- \( a = 1.0 \)
- \( b = 26.2 \)
- \( x_0 = 959.8 \)
- \( R^2 = 1 \)
Aerosol with steady-state charge distribution

Negative corona electrode

Positive corona electrode

Grounded mesh

Figure S2: Cross-sectional view of the dual-corona bipolar charger
Figure S3: Visualization of laminar sheath flow in mDMA

The laminar sheath flow is uniformly distributed in the azimuthal direction.
Figure S4: TDMA curves for 20 nm diameter silver particles at aerosol and sheath flow rate of 50 and 200 cm³/min
Figure S5: Experimental Setup used to calibrate the CPC. Diffusion loss in transport tubing was accounted for each instrument.
Figure S6: Activation Efficiency Curve of the CPC
Figure S7: Schematic diagram of the Laboratory Setup used to test the performance of PAMS
Figure S8: Bias $b$ of measured $d_{pg}$ for near-monodisperse particles at (a) high resolution and (b) low resolution.
Figure S9: Variation in measured peak diameter ($d_{\text{peak}}$) and $d_{pg}$ as a function of step wait time ($t_{\text{wait}}$) at low resolution (LR) and high resolution (HR).