Elucidating the mechanisms of atmospheric new particle formation in the highly polluted Po Valley, Italy

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Figure S1. Particle size distributions (x-axis time, y-axis size in nm and color code is number concentration in dN/dlogDp) from 1.3 – 800 nm as measured by three different instruments (upper panel Hauke-DMPS, middle panel Halfmini-DMPS and lower panel PSM) for (a) an NPF with growth event (12th of April), (b) an NPF with growth event, and (c) a non-NPF day.

Figure S2. The average formation rate of 1.7 nm particles ($J_{1.7}$) during NPF with growth, NPF without growth and no NPF events during our sampling period.
Figure S3. The relationship between sulfuric acid dimer concentration (SA dimer), monomer concentration (SA), and the CS in the Po Valley region. The theoretical molecular collision rate constant (k) was set as $4 \times 10^{-10}$ cm$^3$ s$^{-1}$ (Stolzenburg et al., 2020).

Figure S4. (a) C$_2$H$_7$N signal observed from March to April (excluding outliers). (b) Peak fitting at m/z 46. (c) Zoomed-in view of C$_2$H$_8$N$^+$ (DMA) peak fitting.
Figure S5. Mass defect plots for ion clusters during the NPF without growth day (10:00 – 14:00 LT of April 17th). The size of the dots is proportional to the logarithm of the signal intensity of each cluster.

Figure S6. Mass defect plots for neutral clusters during the non NPF period (10:00 – 14:00 LT of March 16th). The size of the dots is proportional to the logarithm of the signal intensity of each cluster.

Figure S7. Signal fractions to total identified organic molecules with different numbers of oxygen and carbon atoms of CHO compounds in the (a) non-NPF day (March 16), (b) NPF with no growth day (April 17) and NPF with growth day (April 20) during peak hours (10:00 – 14:00 LT).
Figure S8. (a) the NH₃, (b) NR-PM₁, (c) RH, and (d) NO₂ for NPF with growth (NPF&GR), NPF without growth (NPF&noGR) and no NPF event (NoNPF) days. In each box plot, the median (middle horizontal line), 25th and 75th percentiles (bottom and top ends of the box, respectively), and 10th and 90th percentiles (bottom and top whiskers, respectively) are presented. The NR-PM₁ is from a co-located aerosol mass spectrometer measurement (Paglione et al., 2020).

Table S1. Ambient NH₃ and DMA concentrations from different measurement sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Sampling period</th>
<th>DMA (ppt)</th>
<th>NH₃ (ppb)</th>
<th>Instrument</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>Oct 2018-Nov 2018</td>
<td>7.3</td>
<td>20.8</td>
<td>H₂O⁺-tof-CIMS (both DMA and NH₃)</td>
<td>(Cai et al., 2021)</td>
</tr>
<tr>
<td>Wangdu</td>
<td>Dec 2018-Jan 2019</td>
<td>14.6</td>
<td>31.2</td>
<td>Vocus (DMA), DOAS (NH₃)</td>
<td>(Wang et al., 2020; Liu et al., 2023)</td>
</tr>
<tr>
<td>Shanghai</td>
<td>Jul 2015-Aug 2015</td>
<td>40</td>
<td>6.2</td>
<td>Protonated ethanol-CIMS (DMA), DOAS (NH₃)</td>
<td>(Yao et al., 2016; Wang et al., 2015)</td>
</tr>
<tr>
<td>Nanjing</td>
<td>Sep 2022-Oct 2022</td>
<td>20.8</td>
<td>13.1</td>
<td>Vocus (DMA), Picarro (NH₃)</td>
<td>unpublished data</td>
</tr>
<tr>
<td>Hyytiälä</td>
<td>Mar-Dec 2015</td>
<td>&lt; LOD</td>
<td>0.066</td>
<td>MARGA (both DMA and NH₃)</td>
<td>(Hemmilä et al., 2018)</td>
</tr>
<tr>
<td>Po Valley</td>
<td>Mar 2022-May 2022</td>
<td>Not quantified</td>
<td>10.6</td>
<td>Vocus (DMA), Teledyne-API (NH₃)</td>
<td>this study</td>
</tr>
</tbody>
</table>

Note: The Limit of Detection (LOD) for DMA with instrument for Measuring AeRosols and Gases in Ambient Air (MARGA) is 1.7 ppt and the LOD for DMA with Vocus is ~2 ppt.

DOAS is short for differential optical absorption spectroscopy.
Reference


