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Supplemental Information

Particle Classification by the Tandem Differential Mobility Analyzer – Particle Mass Analyzer System

by

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S1. APM transfer function for the parabolic flow model

In the case of the parabolic flow model, \( s_i \) are provided by numerically solving the following equation (Ehara et al. 1996)

\[
\lambda (s_i) = \frac{3}{2} \left[ 1 - \rho^2 (s_i) \right] \ln \left[ \frac{\rho (s_i) + 1}{\rho (s_i) - 1} \right] + 3 \rho (s_i) \tag{S1}.
\]

In this equation, \( \rho(s) \) is defined as

\[
\rho (s) = \frac{1}{\delta} \sqrt{\frac{V_{APM}}{s \omega^2 \ln (r_{z,APM} / r_{z,APM}) - r_{z,APM}}} \tag{S2}.
\]

The APM transfer function \( \Omega (s) \) is represented by

\[
\Omega (s) = \left( \rho^h - \rho^l \right) \frac{3 - \left( \rho^h \right)^2 - \rho^h \rho^l - \left( \rho^l \right)^2}{4} \tag{S3}.
\]

\( \rho^l \) and \( \rho^h \) are calculated using the following equation

\[
\zeta = \frac{3}{2 \lambda} \left[ 1 - \rho^2 (s) \right] \ln \left[ \frac{\rho - \rho (s)}{\rho^l (\rho, \zeta) - \rho (s)} \right] - \frac{3}{4 \lambda} \left[ \left( \rho + \rho (s) \right)^2 - \left( \rho^l (\rho, \zeta) + \rho (s) \right)^2 \right] \tag{S4}.
\]

For the regions B and C, \( \rho^l \) is calculated using equation S4 by substituting \( \{ \rho, \zeta \} = \{-1, 1\} \). \( \rho^h \) for the regions C and D are similarly obtained using a parameter set of \( \{ \rho, \zeta \} = \{1, 1\} \). \( \rho^l \) for the region B is 1, and \( \rho^l \) is equal to -1 for the region D.
Figure S1. Examples of locations for multiple charged particles. The integers in the figure indicate the number of particle charges. The specific mass $s$ and electrical mobility $Z_p$ were fixed at 3.04 kg C$^{-1}$ and $2.69 \times 10^{-8}$ m$^2$ V$^{-1}$ s$^{-1}$, respectively. For single charged particles (+1), these values correspond to $\{m_p, d_c\} = \{0.49 \text{ fg}, 100 \text{ nm}\}$. The corresponding value of $\rho_{\text{eff}}$ for such single charged particles is 930 kg m$^{-3}$. The distance between the line for $\rho_{\text{eff}} = 930$ kg m$^{-3}$ and the positions of the multiple charged particles tends to be far for highly charged particles. When particles have a narrow population around the line for $\rho_{\text{eff}} = 930$ kg m$^{-3}$, highly charged particles have a lower chance of being selected by the DMA-APM system due to the longer distance in the $\log(m_p)$-$\log(d_m)$ space.