Generation of monomobile mobility standards with three aerosol neutralizers

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In order to provide unambiguous measurement results, exact calibration and evaluation of instrumentation is a crucial precondition. In aerosol sciences mobility standards are an important tool for this purpose. Electrospray sources turned out to be an efficient way to produce monomobile particles smaller than 100 nm. Successfully generated molecular mobility standards from large organic salts "enable accurate mobility measurements in the nanometer size range" (Ude and Fernández de la Mora, 2005). However one problem arises. Even though smaller clusters (1-2 nm range) with higher mobilities can be determined accurately, larger clusters (> 2nm) with lower mobilities cannot. In this area, the mobility spectrum is distorted by even larger multiply charged clusters or particles as the probability of multiple charging increases with higher mobility equivalent diameters. This process can be avoided by using an aerosol neutralizer/charger.

This work addresses this issue by comparing three different aerosol neutralizers: a radioactive source, a soft x-ray charger and a corona charger. The former two are bipolar chargers, whereas the latter one is a unipolar charger. The advantage of unipolar chargers lies in the fact that it "does not reach an equilibrium charge distribution"(Intra and Tippayawong, 2009). This is especially important for sub 10 nm particles.

The monomobile molecular clusters of different tetra-alkyl ammonium ions are generated using an electrospray ion source and are classified by a high resolution DMA (Steiner et al., 2010). The number concentration of charged clusters exiting the DMA is determined by an electrometer. A schematic overview of the experimental setup is given in figure 1.

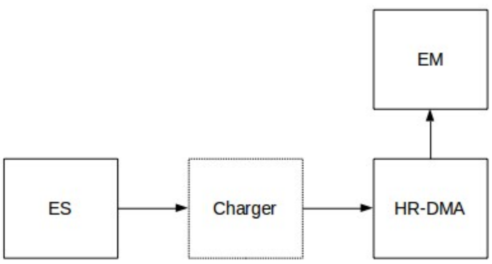

Figure 1. Experimental setup ES: electrospray; charger: ^{241}AM source, soft x-ray charger or corona charger, dashed lines indicate that not in every experiment a charger is used; HR-DMA: high resolution DMA; EM: electrometer.

Figure 2 shows the positive inverse mobility spectrum obtained from measurements with tetra-heptyl ammonium bromide conducted without (above) and with (beneath) aerosol neutralizer.

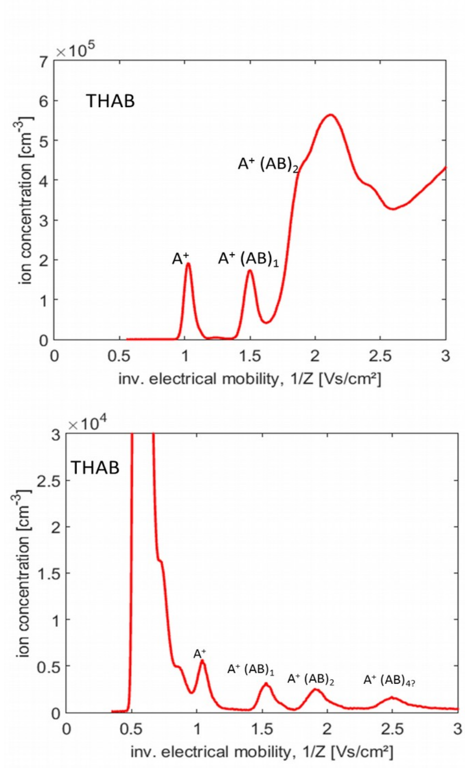

Figure 2. Singly charged clusters of THAB detected by HR-DMA, with and without neutralizer (^{241}AM). The first peak of the lower graph refers to the charger ions of the neutralizer, for better visibility of the mobility spectrum the scale is adjusted to the second peak, the monomer of THAB.

Similar results are expected for the soft x-ray charger. A recently built corona needle charger, which generates unipolar ions is expected to significantly improve the measurement leading to clearly visible peaks within the mobility spectrum ideally up to mobility equivalent diameters of around 4 nm.

Intra, P. and Tippayawong, N. (2009) *Journal of Electrostatics,* 67, 605-615.

Steiner, G., et al. (2010) *Aerosol Sci. Technol.,* 44:4, 308-315.

Ude, S. and Fernández de la Mora, J. (2005) *J. Aerosol Sci.,* 36, 1224-1237.