Finding the building blocks of atmospheric nucleation clusters – the nanoTOF project

G. Steiner[1,2], M. Breitenlechner[1], W. Jud[1], L. Fischer[1], M. Leiminger[1] and A. Hansel[1]

[1] University of Innsbruck, Institute of Ion Physics and Applied Physics, 6020 Innsbruck, Austria
[2] University of Vienna, Faculty of Physics, 1090 Vienna, Austria

Keywords: new particle formation, nucleation, clusters, mass spectrometry
Presenting author email: gerhard.steiner@uibk.ac.at

Recent advances in the understanding of atmospheric new particle formation (Kirkby et al. 2011, Almeida et al., 2013, Schobesberger et al. 2013) have highlighted the question whether the contributing mechanisms are correctly depicted by the presently used instrumentation or if only strongly bonded ion core clusters without loosely bonded ligands have been detected so far.

This work offers an alternative approach, using a new and innovative prototype mass spectrometer (MS) that includes an integrated axial mobility classification (AMC) in the inlet of the instrument. This feature enables the monitoring of the degree of fragmentation of the ionic clusters in the mass spectrometer. The new instrument, further on referred to as the "nanoTOF", is based on the soft, low fragmenting transition-technology of molecular ions into the high vacuum of a mass spectrometer as used in the Innsbruck PTR-MS and PTR-TOF developments (e.g. Graus et al. 2010).

The characterization of the AMC system is part of the first phase of the testing of the new nanoTOF inlet. For this purpose, well defined, monomobile electrospray generated cluster ions, size segregated by a Vienna-type high resolution Differential Mobility Analyzer (UDMA, Steiner et al. 2010) are fed to the nanoTOF inlet. Figure 1 sketches the experimental setup for the AMC characterization.

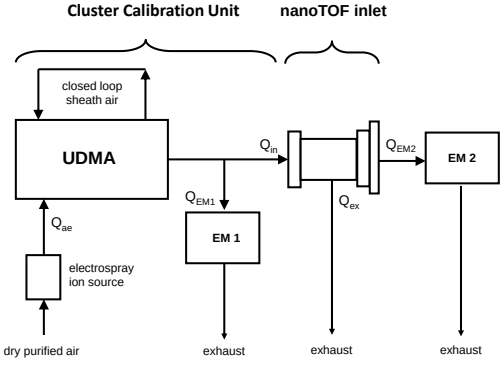

Fig. 1 Schematic of the experimental setup for the characterization of the nanoTOF inlet. UDMA (high resolution Differential Mobility Analyzer), EM1 and EM2 (Aerosol Electrometers)

The mobility classification in the nanoTOF uses the same technique as just recently presented by Bezantakos et al. (2015) and Tammet (2015): an electric field, opposed to an ion inlet flow, is slowing down the ions and only allows ions below a certain critical electrical ion mobility (large ions) to pass the potential maximum. By continuously reducing the potential barrier, also ions with higher mobilities are allowed to enter the mass spectrometer (MS) for detection. For testing the ion transmission efficiency and the mobility classification characteristics of the nanoTOF inlet, an Aerosol Electrometer was used instead of the MS for the detection of the ion current.

An example of the AMC mobility scan of the monomer ion $(A^+)_1(AB)_0$ of electrospray generated tetra-heptyl ammonium bromide (THABr) is shown in Fig.2.

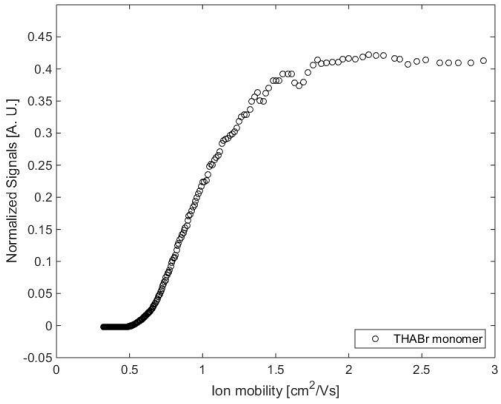

Fig. 2 Example for a AMC mobility scan of the THABr monomer ion $(A^+)_1(AB)_0$; m/z=410.473.

This work is funded by the Austrian Science Fund, FWF (project no. P27295), the "Tiroler Wissenschaftsfonds" (nanoTOF-ICE) and the University of Innsbruck promotion grant four young researchers.

Kirkby, J. et al. (2011) *Nature, 476, 429-433*

Almeida, J. et al. (2013) *Nature, 502, 359-363; doi 10.1038/nature12663*

Schobesberger, S et al. (2013) *P. Natl. Acad. Sci. doi: 10.1073/pnas.1306973110*

Graus, M., Müller, M., Hansel, A. (2010) *J. Am. Soc. Mass Spectrom., 21, 1037-1044.*

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

Bezantakos, S., et al.(2015) *Aerosol Sci. Technol, 49:1, iv–vi*

Tammet, H. (2015) *Aerosol Sci. Technol., 49, 220–228,*