

Experimental investigation of aerosol particle composition and growth rates

D. Wimmer¹, J. Kangasluoma¹, P. Winkler², M. Kulmala¹ and T. Petäjä¹

¹Department of Physics, University of Helsinki, Gustaf Hallströmin katu 2a, 00560, Helsinki, Finland

²Faculty of Physics, University of Vienna, Boltzmannngasse 5/2/75, A-1090 Vienna, Austria

Keywords: nano particles, CPC battery, growth rates, chemical composition.

Presenting author email: daniela.wimmer@univie.ac.at

Aerosol particles have both natural and anthropogenic sources. Apart from having a major influence on our health, aerosols also impact Earth's climate.

In addition to primary sources, a large source of secondary aerosol particles exists. The secondary pathway works via gas-to-particle conversion. If the conditions are favourable, small molecular clusters are formed via condensation of low volatile gas phase compounds. Those freshly formed molecules can grow to larger clusters and form cloud condensation nuclei (CCN). When studying these processes in detail, the particle growth rates and the chemical composition are especially interesting as they determine the potential role of these initially formed clusters to become CCN. Roughly 50% of the global cloud condensation nuclei originate from atmospheric nucleation processes (Merikanto *et al.*, 2009)

The most commonly used method to determine the chemical composition of atmospheric aerosol particles is mass spectrometry (MS). High resolution mass spectrometers are capable of resolving the chemical fingerprint of molecular clusters in the size range up to ≈ 2 nm in mobility diameter. Other mass spectrometers, such as the thermal desorption mass spectrometer (TDCIMS; Voisin *et al.*, 2003) or size selective methods, such as the hygroscopicity tandem differential mobility analyser (HTDMA; Nenes *et al.*, 2001) allow to determine the chemical composition of atmospheric aerosol particles starting from sizes of about 6 nm in mobility diameter. Condensation particle counters (CPCs) are based on mixing the aerosol flow with a condensable vapour and creating supersaturation by passing the mixed sample through regions with different temperatures. Experimental studies have shown that the activation efficiency of a CPC depends strongly on a combination of the aerosol particle composition and the working liquid that is used in the CPC (Iida *et al.*, 2009, Wimmer *et al.*, 2013, Kangasluoma *et al.*, 2013). Combining different CPCs with different working liquids, the composition of ambient aerosol particles can be derived indirectly. By using a DMA upstream of the CPCs, the difference in the signals measured by the different CPCs can be attributed to the chemistry of the measured aerosol particles alone. Previous field studies have shown that by only using four different CPCs, two of them with different working liquids (water and butanol) with different cut-off diameters, the hygroscopicity of atmospheric aerosol particles can be determined (Riipinen *et al.*, 2009). This project aims at combining the direct composition analysis using mass spectrometry with the indirect method, using different

CPCs together with a DMA.

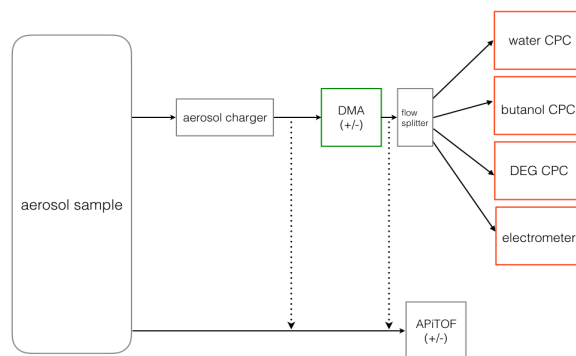


Figure 1. Schematic drawing of the experimental setup of the nano CPC battery. The APiTOF will be used either for direct sampling or downstream of the charger or downstream of the DMA.

We performed intensive laboratory experiments to analyse and verify the performance of the nano CPC battery with respect to particle composition. The deployment of the nano CPC battery for field measurements requires careful design of the inlet system. Diffusion losses should be minimized as much as possible and good mixing should be ensured to get a good signal in all the CPCs. We present results from the characterization of the inlet system including the aerosol charger. Different types of chargers (e.g. corona charger, radioactive charger, chemical ionisation) are tested. We characterize them for their applicability for charging sub-3 nm aerosol particles.

This work was supported by the Austrian Science Fund

Merikanto *et al.* (2009), *Atmos. Chem. Phys.* **9**, 8601-8616

Voisin *et al.* (2003), *Aerosol Sci Technol* **37**, 471-475

Nenes *et al.* (2001), *J Geophys Res – Atmos* **106**, 3449-3474

Iida *et al.* (2009), *Aerosol Sci Technol* **43**, 81-96

Wimmer *et al.* (2013), *Atmos. Meas. Tech.* **6**, 1793-1804

Kangasluoma *et al.* (2014), *Atmos. Meas. Tech.* **7**, 689-700

Riipinen *et al.* (2009), *Atmos. Chem. Phys.* **9**, 3317-3330