Flow tube analysis of the chemical composition of freshly nucleated secondary organic aerosol particles

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An aerosol mass spectrometer for particles with diameters below 30 nm called the Chemical Analyzer for Charged Ultrafine Particles (CAChUP) has been developed. The instrument was designed to study the chemical composition of freshly nucleated secondary aerosol particles.

CAChUP consists of a custom-built aerosol sizing and collection unit coupled to a time-of-flight mass spectrometer (TOF-MS). The aerosol sizing and collection unit is composed of three major parts: (1) a unipolar aerosol charger, based on corona discharge from carbon fibres (e.g. Han *et al*, 2008), with an extrinsic charging efficiency of 32 % for 20 nm particles; (2) a compact radial differential mobility analyser (Zhang *et al,* 1995) for particle size separation in the diameter range from 1 nm to 100 nm (geometric standard deviation of 1.09); and (3) an electrostatic precipitator where the aerosol is collected on a high-voltage biased metal filament, while a nitrogen counterflow protects the sample from contamination. After collection, the aerosol sample is thermally desorbed, and the resulting gas sample is transferred to a Tofwerk CTOF mass spectrometer for chemical analysis.

First characterization experiments in the laboratory have been successfully conducted by means of a laminar flow tube. In the flow tube, secondary organic aerosol particles (SOA) have been produced from dark ozonolysis of gas phase alpha-pinene. Particles with a diameter of 25 nm were separated from the aerosol population in the flow tube and analysed for their molecular composition.

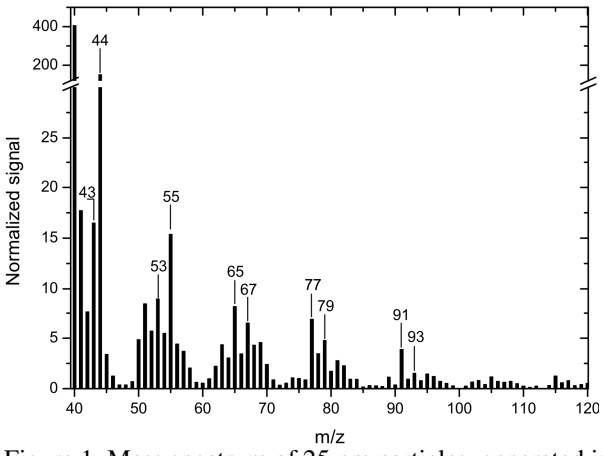

Figure 1. Mass spectrum of 25 nm particles, generated in a laminar flow tube from dark ozonolysis of alpha-pinene.

A particle mass spectrum of a one hour collection period is presented in Fig. 1. The mass spectrum compares well with previous measurements of SOA from alpha-pinene ozonolysis (e.g. Shilling *et al*, 2009).

Further experiments regarding the chemical composition of SOA during growth will be presented. For this purpose particles are generated from ozonolysis of different individual terpenes and their mixtures in the laminar flow tube. The flow tube is designed to set the reaction time of terpenes and ozone between a few seconds up to several minutes, thus resulting in the production of particles of differing sizes and ages. Flow tube experiments allow the collection of one distinct particle diameter for an extended time period, and therefore, a sufficiently large aerosol mass is available for analysis even when extremely small particle diameters (< 10 nm) are to be analysed. The aim of this study is to investigate the evolution of the chemical composition of freshly formed secondary aerosol particles.

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