Investigation of the effects of chemical and physical factors on the phase state of SOA particles

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Secondary organic aerosol (SOA) formed from partitioning of oxidation products of volatile organic compounds (VOC) accounts for a significant portion of atmospheric particulate matter. Behaviour of SOA particles in the atmosphere is affected by the phase of particles; not heeding these effects can result in errors when the atmospheric implications of SOA particles are predicted. Phase change of the particles can be induced e.g. by temperature change, absorption of water, or other solvent, or by chemical aging.

The phase state of SOA particles cannot be measured directly. Present studies show that particle bounce correlates with the phase state of particles (Virtanen et *al.* (2010), Saukko et *al.* (2012a), Saukko et *al.* (2012b)). A similar but modified method was employed in this study. The schematic of the new measurement system is shown in Figure 1. The system consists of a size classification DMA (selected sizes 70-150 nm), humidity control unit, a single MOUDI-type impactor stage (cut-off size 67 nm) and two CPCs. Upstream and downstream pressures of the impactor stage were stabilized to 0.85 bar and 0.7 bar.

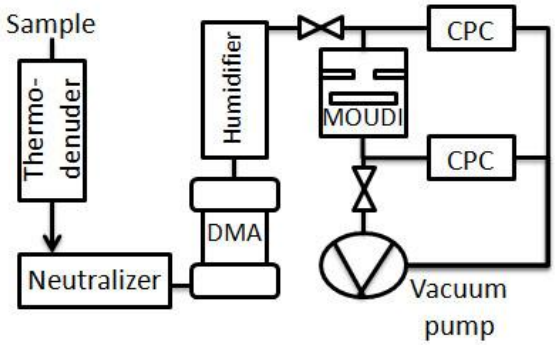

Figure 1: Schematic representation of the measurement system.

The chamber experiments were performed in the Manchester Photochemical Aerosol Chamber (Alfarra et al., 2012). In these experiments both biogenic and anthropogenic precursors were used (α-pinene, 1,3,5-trimethylbenzene, β-caryophyllene, limonene and n-heptadecane). The measurement schedule for different VOC mixtures is shown in Table 1. Mixtures of one to three precursors were investigated with and without the presence of ammonium sulphate seeds.

The oxidation conditions in the chamber were altered, namely the NO_x-level (20-115 ppb) and the UV exposure (filter on/off) while the O_3 level and relative humidity (RH) in the chamber were constantly 40 ppb and 60%, respectively. The exposure to light (visible and UV) varied between 0 and 5 hours.

The particle bounce was investigated for RH between 5 and 80% in the impactor. These RH scans were conducted for several thermodenuder temperatures (25 - 75°C).

Table 1. Chamber experiment schedule for four VOCs and specific NO_x and O_3-levels (ppb). X means the existence of ammonium sulphate seeds or usage of UV filter.

1	2	3	NO_x	O_3	seed	filter
α-pin.	TMB		20	40		X
α-pin.	TMB		20	40		
α-pin.	TMB		115	40		X
α-pin.	TMB		20	40	X	X
α-pin.	β-car.		20	40		X
α-pin.	β-car.		20	40	X	X
limon.			20	40		X
α-pin.	β-car.		20	40		
α-pin.	TMB	β-car.	20	40		
α-pin.	TMB	β-car.	20	40	X	X
α-pin.	TMB	β-car.	20	40		X
α-pin.	limon.		20	40		X
β-car.	limon.		20	40		X
α-pin.	β-car.	limon.	20	40		X
n-hept			50	80		

In this paper, results of the particle bounce measurements will be compared to findings from measurements of particle composition and sub- and super-saturated water uptake determined by high resolution AMS, HTDMA and CCNc, respectively. Clear effects of chemical composition and aging, hygroscopicity and relative humidity on the phase state of the SOA particles were observed. In addition differences between the bounce fractions in the SOA-coated seed experiments with different temperatures and aging times were found.

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