

## Hygroscopic growth and activation of uncoated and coated soot particles and their relation to ice nucleation

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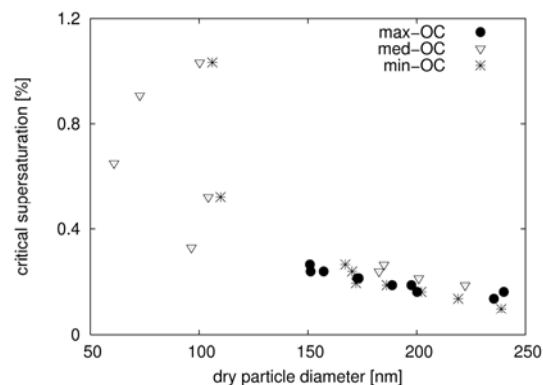
Soot particles, which are insoluble in water, are emitted by biomass burning and fossil fuel combustion. During their presence in the atmosphere, soluble substances condense on these particles and alter their cloud-forming potential (Andreae & Rosenfeld, 2008). Thus measurements of the hygroscopic growth (HTDMA, LACIS-mobile), activation behavior (DMT-CCNC) - scope of this paper - and ice nucleation (AIDA chamber (Möhler et al., 2001)) were performed to estimate the cloud-forming potential of pure and coated soot particles. Globally, soot particles contribute up to 2.5 % to the atmospheric aerosol (Horvath, 1993). In the framework of the investigations described here, soot particles were generated either applying a graphite-spark-generator (GFG1000) or a flame-soot-generator (Mini-CAST). With respect to the hygroscopic growth and activation behavior, the influences of the carrier-gas (GFG-soot), the OC-content (CAST-soot) and of different coating materials were investigated.

soot-type	coating	growth factor
GFG-Ar	non	1.03
GFG-N <sub>2</sub>	non	n. d.
CAST-min OC	non	1.04
CAST-med OC	non	1.04
CAST-max OC	non	n. d.
CAST-min OC	sulfuric acid	1.15
CAST-med OC	sulfuric acid	1.4
CAST-max OC	sulfuric acid	1.9

**Table 1: Measured growth factors applying LACIS-mobile for different soot types at 98.4% relative humidity (n. d. - not detected).**

Differences in the hygroscopic growth and activation behavior of GFG generated soot particles were found for the two carrier-gases considered. If nitrogen was used, neither hygroscopic growth nor activation were observed. In contrast, when argon was used, particles featured a slight hygroscopic growth and were easier to activate. Hygroscopic growth increases with decreasing OC-content of the CAST-soot, up to growth factor (GF) 1.04 at 98.4 % relative humidity (see also table 1). Lower OC-contents also result in the particles being activated more easily.

Coating with sulfuric acid enhances the hygroscopic growth (table 1) and activation behavior of CAST-soot for different OC-contents (figure 1). Attempts of coating the soot particles (CAST and GFG) with oxalic and succinic acid resulted in no measurable change in their hygroscopic growth and activation behavior. This is most likely due to evaporation of the coating material.



**Figure 1: Measured activation behavior of CAST soot coated with sulfuric acid and different OC-contents.**

Comparing hygroscopic growth and activation to ice-nucleation behavior similar trends were observed. GFG-soot with argon as carrier-gas acts as a better ice nuclei than GFG-soot with nitrogen. For the CAST-soot the ice-nucleation activity decreases with increasing OC-content. Coating of the CAST soot particles with sulfuric acid shows different effects on the ice nucleation behavior with a trend to less ice formation in the deposition mode at lower ice saturation ratios, but the occurrence of an immersion freezing mode was observed close to the thresholds for homogeneous freezing of pure sulfuric acid particles.

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