

Comparing particle number size distributions and number concentrations for airborne nanoparticles measured by SMPS, FMPS and UWCCP

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Nanomaterials hold great promise in fields as wide-ranging as health, food, energy, materials, and transport. Nanomaterials research and development is therefore very active, and the economic stakes are high. However, questions have also been raised related to the health risks associated with these substances. As they become more widely used, it is probable that occupational exposure through inhalation will increase. Hence, it is important to be able to measure these particles (Maynard *et al.*, 2006) to better describe and understand their behaviour.

This study aimed at comparing a number of instruments measuring airborne nanoparticles. Similar intercomparison studies have been performed previously (Leskinen *et al.*, 2012; Kaminski *et al.*, 2013), revealing acceptable discrepancies between results for different devices. However, we believe it is important to extend these comparisons by using different aerosols.

In this study, we simultaneously measured particle number size distributions using a Scanning Mobility Particle Sizer (SMPS, Grimm, composed of a Differential Mobility Analyzer DMA Vienna Type and a Condensation Particle Counter CPC model 5.403) and a Fast Mobility Particle Sizer (FMPS, TSI model 3091). The total number concentration was monitored with an Ultrafine Water-based Condensation Particle Counter (UWCCP, TSI model 3786). A Nanotracer (Aerasense, Philips, discontinued) was also placed in the experimental setup.

The CAIMAN facility (Jacoby *et al.*, 2011) was used to produce spherical silver nanoparticles and fractal-like nanostructured carbon agglomerates by spark-discharge, as shown in Figure 1.

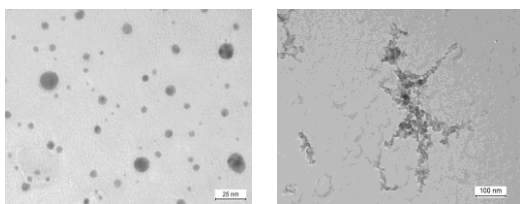


Figure 1. TEM picture of nanoparticles produced by the CAIMAN facility (left: silver, right: carbon).

Modal diameters of the particles produced ranged from 29 to 83 nm for silver, and from 25 to 153 nm for carbon. SMPS data for carbon particles were corrected according to Lall & Friedlander's theory (Lall & Friedlander, 2006), with an input primary particle diameter of 16 nm. Data relative to particle sizes are presented in Figure 2, where SMPS data are taken as the reference values.

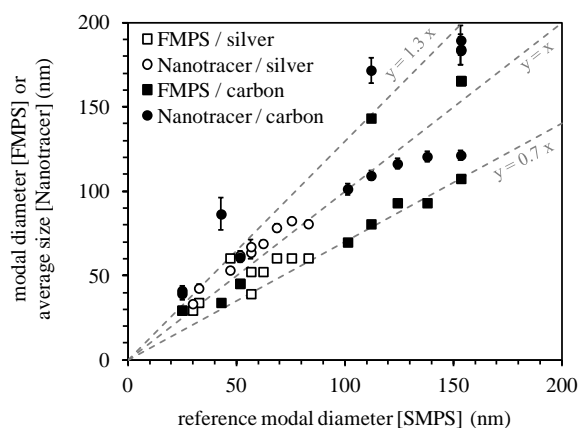


Figure 2. Comparison of particle sizes measured by the different instruments for the two test aerosols.

Relative discrepancies between FMPS measurements and reference were roughly $\pm 30\%$ for both silver and carbon nanoparticles. Average sizes measured by the Nanotracer correlated well with those returned by the reference system for silver particles (0% to 30% relative discrepancies), while for carbon nanoparticles, relative discrepancies were between -20% and 65%.

Number concentrations for the different devices were compared to the reference measurement from UWCCP. Concentrations measured by SMPS were half the reference value for silver particles, whatever the particle number size distribution and total concentration. The behavior of other devices and the influence of aerosol characteristics will be discussed.

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