Size characterization of airborne SiO_2 nanoparticles with on-line and off-line measurement techniques: results of an interlaboratory comparison

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Day after day, new applications using manufactured nanoparticles appear in industry. To evaluate the occupational risk associated with airborne nanoparticles, it is important to have reliable, accurate, and standardized measurement methods. It is therefore necessary to work on pre-standardization projects to develop reference methods to characterize different parameters such as the number and the size distribution of airborne nanoparticles.

This study was performed within the framework of the Technical Working Area (TWA) 34 –"Properties of Nanoparticle Populations" of the Versailles Project on Advanced Materials and Standards (VAMAS) in the project n°3 "Techniques for characterizing size distribution of airborne nanoparticles" and was focused on manufactured SiO_2 nanoparticles because of their widespread use in industry. The working group of this project was composed of eleven National Metrology Institutes and five laboratories involved in nanoparticle metrology. The aim of this project was to develop accurate and traceable size characterization methods for airborne nanoparticles that include the entire measurement chain (sampling, analysis, data processing). The developed protocols were validated by an interlaboratory comparison based on metrological approaches including metrological traceability, calibration and evaluation of the measurement uncertainties (Motzkus *et al.*, 2013). Two types of nano-aerosols, composed of one population (monomodal aerosol OP) and two populations of non-agglomerated nanoparticles (bimodal aerosol DP), were investigated in this study.

Scanning mobility particle size spectrometers (SMPS) were used for on-line measurements of size distributions. Transmission electron microscopy (TEM), scanning electron microscopy (SEM) and atomic force microscopy (AFM) were used for off-line measurements. From the interlaboratory intercomparison, the results of the main size distribution parameters (mean and mode diameters) were compared. Table 1 presents the results obtained for aerosol OP. SD corresponds to the calculated standard deviations of the average measurements of all SMPS, TEM, SEM, and AFM laboratories involved in this interlaboratory comparison.

Table 1. Results of the interlaboratory comparison

On-line and Off-line techniques	Averaged mean diameter (nm)	2 x SD (nm)	Averaged mode diameter (nm)	2 x SD (nm)
SMPS	35.1	6.4	35.4	2.0
TEM	35.1	7.4	35.6	7.6
SEM	39.0	14.2	38.3	14.1
AFM	30.3	3.7	30.4	5.1

This study provides internationally harmonized measurement procedures for size distribution characterization of spherical airborne nanoparticles to support development of corresponding standards, e. g., by ISO TC 229 "Nanotechnologies".

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