TECHNIQUES FOR CHARACTERIZING MORPHOLOGY AND SIZE OF AIRBORNE NANOPARTICLES

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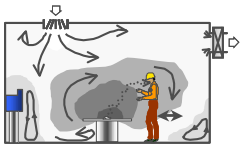
Objectives

Nanoparticles are encountered in ambient air as well as in the workplace. As epidemiological studies have shown an association between increased particulate air pollution and adverse health effects in susceptible members of the population, it is particularly important that there are accurate methods for measuring the amount, and size distribution, of airborne particles.

Protecting Human

Ambient measurements



Process and operator

The goal of this project is to develop characterization methods for airborne nanoparticles that will both accurately and rapidly provide reliable data for developing future exposure methods and occupational safety regulations.
The characterization methods include sampling, instrumentation and technical protocols that will be validated by round robin tests.

This study is led in the framework of TWA 34 - Properties of Nanoparticle populations of the Versailles Project on Advanced Materials and Standards (VAMAS).

The participants of this project are essentially National Metrology Institutes such as BAM (Germany), CENAM (Mexico), DFM (Denmark), NMIA (Australia), NMISA (South Africa), INPL (Israel), KRISS (South Korea), LNE (France), NIST (USA), NMIJ-AIST (Japan), NPL (UK), NPLI (India) and laboratories such as IRSN (The French Institute for Radiological Protection and Nuclear Safety) and the University of Genoa in Italy (3 years project).

Experimental protocol

Characterization of SiO_2 airborne nanoparticles in terms of shape and size distribution

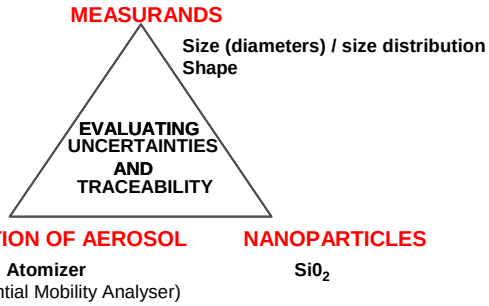
Different steps:

- Study of the feasibility of the generation of these nanoparticles by atomizing a characterized SiO_2 colloidal suspension and by measuring their size distributions with a Scanning Mobility Particle Sizer (SMPS) system.

- Organization of a round robin test on the characterization of SiO_2 airborne nanoparticles which will be divided in two parts:

✓ Use of techniques on-line like SMPS,

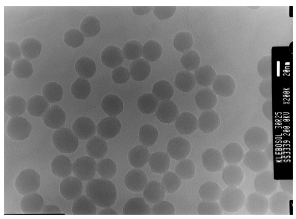
✓ Use of indirect techniques such as microscopy (mainly Transmission Electron Microscopy and Atomic Force Microscopy). ; study of different sampling methods (filtration, thermophoresis or electrophoresis sampling and impaction-diffusion-interception sampling) on several support types (filters, grids,...).



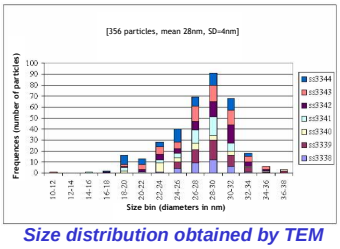
Results

➢ **Preliminary tests performed by different laboratories to characterize 3 colloidal suspensions with different techniques**: *Dynamic light scattering (DLS), Scanning electron microscopy (SEM), Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM)*

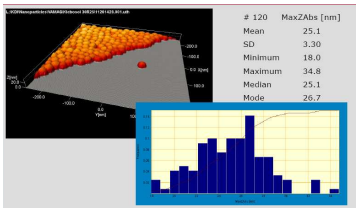
Results on one colloidal suspension



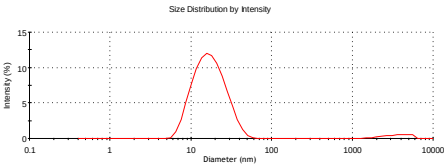
Images obtained by TEM (UNIGE)



Size distribution obtained by TEM



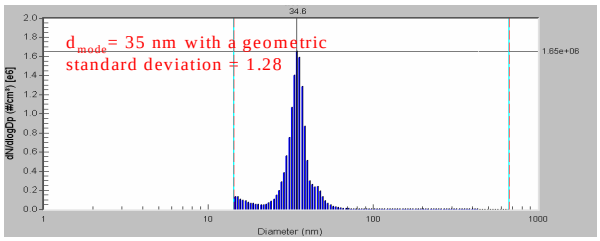
Measurement parameter values and results with the AFM (DFM)



Size distribution versus intensity obtained by DLS (CENAM)

The results obtained by the different techniques for the SiO_2 colloidal suspension gives sizes which are comparable.

➢ **Study for evaluating the feasibility** (stability, repeatability and reproducibility) **of the generation protocol of SiO_2 airborne nanoparticles with SMPS**



Count size distribution measured by SMPS for a colloidal suspension (LNE-IRSN)

	Average	Standard deviation
Median (nm)	34.60	0.15
Mean (nm)	34.56	0.23
Geometric Mean (nm)	33.47	0.30
Mode (nm)	35.08	0.89
Geometric Standard deviation	1.30	0.02
Total Concentration (particles/cm³)	2.2×10^5	1.1×10^4

Average values for count size distributions of 40 measurements obtained with the SMPS during a generation time of 90 min

The protocol generation gives a size distribution which is stable during the time, repeatable and reproducible.

Conclusions

This study will provide international harmonized methodologies for characterizing the size and the shape of airborne nanoparticles which will be used to develop agreed and applicable standards for organizations in charge of standardization (ISO TC 229 "Nanotechnology" and CEN TC 352).