

Measurement of the Number Concentration of Nanoparticles in Suspensions with the use of an Electrospray Source coupled with a Liquid Flow Meter and a Scanning Mobility Particle Sizer

G. B. Baur, and K. Vasilatou

Laboratory of Particles and Aerosols, Federal Institute of Metrology METAS, Bern-Wabern, CH-3003, Switzerland

Keywords: Electrospray, Nanoparticles, Colloidal suspensions, Characterization, Concentration.

Presenting author email: konstantina.vasilatou@metas.ch

The use of nanoparticles (NPs) in biology, medicine, food industry or paintings increased extensively during the last decade. For all these applications an accurate characterization of the NPs properties is required.

The determination of the NPs-concentration is of great importance for the characterization of colloidal suspensions. Routinely the assessment of the NPs absolute concentration is carried out using UV/vis spectroscopy (Haiss *et al.*, 2007). However, accurate measurements require the particle extinction coefficient which depends on the particle size and shape. Moreover, this method does not allow accurate measurement of the particle size distribution over a large size range.

Several authors have reported on the measurement of the mobility size distribution of NPs using an Electrospray (ES) combined with a differential mobility analyzer (DMA) and a condensation particle counter (CPC) (see Lenggoro *et al.*, 2002, Li *et al.*, 2013 and references therein). Recently, a similar setup was used for the determination of the number concentration of NPs in suspensions (Li *et al.*, 2011). This method requires the determination of the droplet size generated by the ES source which is later used for the statistical analysis of the droplet-induced oligomer formation upon dispersion of the suspension by the ES.

The objective of the current work is to develop a simple and accurate method that allows the simultaneous measurement of the particle size distribution and the absolute concentration of NPs in suspensions. The system consists of an ES, a DMA and a CPC as reported in previous studies, but the ES is coupled here with a liquid mass flow meter (MFM). The colloidal suspension is first diluted in an ammonium acetate buffer before being dispersed in the ES at a flowrate measured by the MFM. The particle size distribution is determined in the gas phase with the DMA/CPC, whereas the absolute particle concentration in the suspension is calculated by measuring the liquid flow rate through the capillary, the flowrates of the carrier gases (dry purified air and CO₂) entering the ES and the particle counts per unit volume measured by the CPC. All the devices used in this study were calibrated in a traceable manner.

The aerosol formation process was optimized depending on the size and concentration of the NPs in the sample. By adjusting the dilution factor, the buffer concentration and the liquid flow rate, particles with a mobility diameter ranging from 20 to 700 nm could be measured.

We will present measurements of monodisperse spherical gold, silica and polymeric NPs of different sizes and concentrations which were either commercially available or synthesized by our project partners (14IND12 EMPIR-Innanpart project). These samples were prior characterized with respect to particle size and number concentration by methods, such as Small Angle X-ray Scattering (SAXS), single-particle Inductively Coupled Plasma Mass Spectrometry (spICPMS), Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM).

Hence we will demonstrate the ability of our method for an accurate characterization of the number concentration and the size distribution of NPs in suspensions. The method is very general and can be applied to NPs of different materials.

This work is part of the 14IND12 Innanpart project funded by the European Union through the European Metrology Programme for Innovation and Research (EMPIR). The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States.

Haiss, W., Thanh, N. T. K., Aveyard, J. and Fernig, D. G. (2007) *Anal. Chem.* **79**, 4215-4221.

Lenggoro, I. W., Xia, B., Okuyama, K. and Fernandez de la Mora, J (2002) *Langmuir* **18**, 4584-4591.

Li, M., Guha, S., Zangmeister, R., Tarlov, M. J. and Zachariah M. R. (2011) *Langmuir* **27**, 14732-14739.

Li, M., You, R., Mulholland, G. W. and Zachariah, M. R. (2013) *Aerosol Sci. Tech.* **47**, 1101-1107.