

## Parallel-DMA (PDMA) – a tool for characterization and enrichment of aerosol nanoparticles

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Electrostatic methods provide numerous options for the characterization and investigation of aerosol nanoparticles. Differential mobility analysis (DMA) has proven its ability to characterize according to size and separate inorganic particles as well as aerosol particles of biological origin such as proteins or viruses. Because it operates under atmospheric pressure it offers an opportunity also to utilize this technique for micro-preparative applications. For that reason a parallel-DMA (PDMA) system was constructed and has proven its feasibility to simultaneously monitor the size distribution of aerosolized nanoparticles and to select one specific fraction particle size fraction (Allmaier et al. 2008). PDMA contains of two identical DMAs working in parallel. The scanning nano-DMA1 delivers the complete size spectrum of the aerosolized particles. The nanoDMA1 is combined with an electrical aerosol detection device working on the Faraday cup principle. An identical separation unit – the nano-DMA2 - running parallel with the nano-DMA1 operates at one given voltage setting (separation) and can be used for sampling or enrichment (collection) of the one selected size class of nanoparticles..

For further physical or chemical investigation of this specific classified size fraction it is necessary to remove the nanoparticles from the gas phase after nano-DMA2 separation. Thus the PDMA was used in combination with an electrostatic nano-sampler (ENS). The ENS was designed specifically for the usage on bionanoaerosol particles but it works equally well for inorganic particles. It uses electrostatic force to collect charged particles exiting the nanoDMA2. The ENS is a kind of an impinger using a liquid as collecting media to provide “soft landing” to the particles. Between the nozzle outlet and the liquid surface an electrostatic field is applied. The appropriate choice of liquid offers both the conductivity and if needed an appropriate environment to preserve biological activity of particles impacted and captured on its surface. Several proteins, dendrimers and silica particles covering equivalent mobility diameters from 5 to 30 nm were chosen to evaluate the collection efficiency of the ENS.

It was shown that the appropriate voltage applied to the liquid could increase the collection efficiency of the ENS up to 100 % for all investigated particles. The ultimate verification of the feasibility of the PDMA-ENS system is to prove the presence and, in

the case of bioaerosols, the biological viability of the size-selected nanoparticles in the ENS liquid.

Various nanoparticles were classified and sampled on liquid surface in the ENS over periods of up to 50 hours. The sample was consequently re-injected to the Electrospray Aerosol Generator (Mod. 3480, TSI, Inc.) and again analyzed with the PDMA. Fig.1 shows the size distributions for HS-30 silica particles (Sigma Aldrich). The exactly same location of measured peaks for the stock suspension and in the liquid sampled silica particles proves the feasibility of the approach.

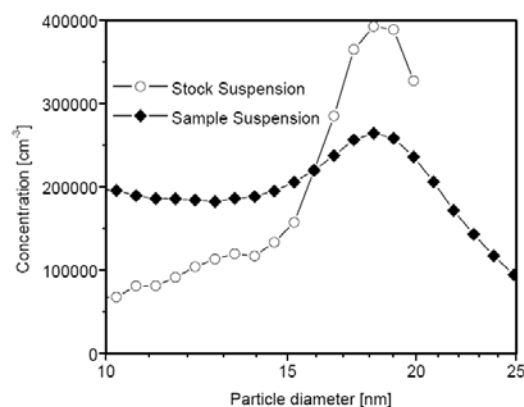


Figure 1. PDMA size distributions of silica particles.

An enzyme activity of the sampled enzyme was tested to answer the question on the preservation of the biological function after the aerosolization, charging, separation and sampling step. The bioactivity of the enzyme  $\beta$ -galactosidase (equivalent mobility diameter 8 nm) was measured before and after the sampling process. The enzyme activity test revealed the existence of activity in the enzyme after the sampling process. This is an evidence for a successful effort combining electrospraying and DMA-technique with “soft landing” collection and enrichment of biological nanoparticles.

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Allmaier, G. et al. (2008), *Journal of the American Society of Mass Spectrometry* **19**, 1062-1068.