A nano-DMA of rectangular planar plates

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A novel differential mobility analyzer (DMA) of rectangular planar plates has been developed for the sizing of nanoparticles in the range of 1 to 100 nm (IONER® N1).

A major concern in conventional cylindrical DMAs is the centering of the electrodes, since a very small misalignment can result in a severe degradation of the resolving power of the instrument. To avoid this difficulty, we have chosen a planar geometry, so that electrode centering is no longer an issue. In addition, parallel plates result also in a uniform electric field between the electrodes reducing the diffusional broadening of the transfer function in comparison to cylindrical DMAs. The machining and assembly of the electrodes are also easier and more precise for planar DMAs than for cylindrical DMAs, thereby reducing the cost of the instrument.

Recently a DMA of rectangular planar plates has been demonstrated for analyzing with high resolution ions of mobility in the range of 1 to 2 $cm^2 \cdot V^{-1} \cdot s^{-1}$ (IONER® X1, Santos *et al.* 2008). The successful performance of this instrument has motivated the development of the nano-DMA of parallel rectangular plates presented here. The IONER N1 has been designed to classify non-diffusive nanoparticles with a resolution of 10 when operating at aerosol and sheath flow rates of 2 and 20 $l \cdot min^{-1}$, respectively. Prevision has been done to keep laminar flow conditions at sheath flow rates up to 200 $l \cdot min^{-1}$ to enhance the resolution in the diffusive size range (<10 nm) for specific applications.

The working region of the IONER N1 is a rectangular duct formed of the electrodes (aluminium) and the insulating walls (PET). It has a height of 8 mm (separation between electrodes), a width of 90 mm (distance between insulators), and a length of 110 mm (distance between aerosol inlet and outlet). The aerosol flow enters and exits the classification zone through rectangular slits of 54 mm in length and 1.5 mm in width.

Preliminary experiments were conducted to test flow behaviour and the resolution of the IONER N1. Ions of tetraheptylammonium (THA) were generated by electrospraying a solution of tetraheptylammonium bromide (THABr) in ethanol (10^3 ppm w/v) and carried in a stream of synthetic air into the IONER N1. The current of the ions leaving the DMA was measured with an electrometer (IONER® EL-5010). In the experiments, the IONER N1 operated in open circuit mode with a HEPA filter followed by a mesh at the entrance of the sheath air to the DMA. The spectrum of THA ions was measured at an aerosol flow rate (q) of 2 $Nl \cdot min^{-1}$ and sheath flow rates (Q) of 10 to 50 $Nl \cdot min^{-1}$. The peaks correspondent to THA monomer (p = +1, Z = 0.96 $cm^2 \cdot V^{-1} \cdot s^{-1}$, d_E = 1.44 nm) are displayed in Fig. 1. The peaks were fitted to Gaussian functions and from these the resolution (R) of the DMA was calculated as the inverse of the Full Width at Half Height (*FWHH*) normalized with respect to the peak voltage (V_p), i.e. $R = V_p/FWHH$. Fig. 2 shows the resolution of the IONER N1 for THA monomer found in the experiments. The points follow fairly well the linear trend predicted by the theory ($R \sim V^{1/2}$) up to sheath flow rates of 50 $Nl \cdot min^{-1}$. Experiments with ions at higher sheath flow rates and with monodisperse non-diffusive particles are in progress.

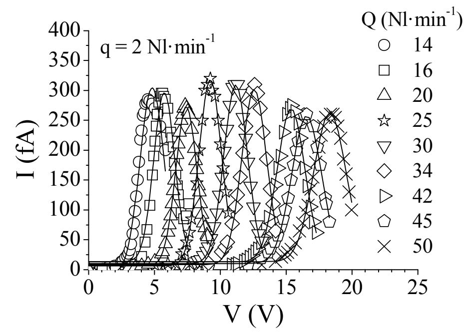

Figure 1. Spectra of THA monomer measured with IONER N1.

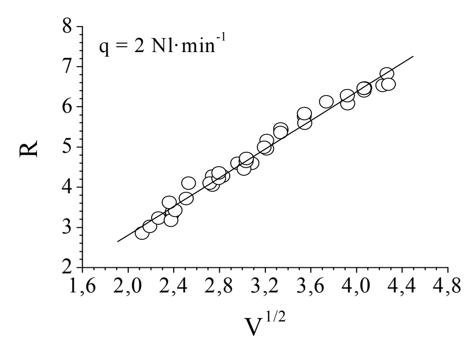

Figure 2. Resolution of IONER N1 for THA monomer.

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