Reproducible aerosol generation for mass balance studies and dosimetry investigation with low particle masses

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Keywords: nanoparticle, fluorescent particles, dosimetry, Air-Liquid Interface exposure,

Many aerosol systems are nowadays driven with nanoparticles to investigate different aspects of them especially the biological responses. To characterize those systems it is important to know where particles, whether intentionally or unintentionally, are deposited and in the case of toxicological studies to exactly determine the relevant in vitro dose. Exposing human lung cells in an Exposure System at the Air Liquid Interface (ALI) only some percent of the particles deposit on the cell culture surface (Mülhopt et al., 2016). Due to their low mass and the complex geometry of the systems, measurement methods often reach their limitations. For this purpose a highly fluorescent aerosol can be used as also masses of some ng are detectable (Mülhopt et al., 2008).

Standard procedures for generation of calibration aerosols are published by VDI in guideline 3491 (Verein Deutscher Ingenieure, 2015). With respect to the descripted reactor for generation of dry latex particles, a reactor is set up and used to spray an aqueous solution of fluorescein sodium into the drying zone. For generating the spray a two phase nozzle is used (Schlick, Germany) with pressurized dry air. The two phase nozzle can be varied in their parameters regarding the flow rate of liquid, the air pressure and the opening angle of the cap. These parameters were investigated with respect to the stability of the generated aerosol which is characterized by its number size distribution determined by Scanning Mobility Particle Sizer (TSI GmbH, Aachen, Germany).

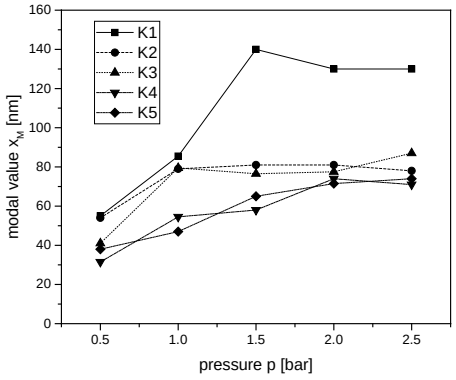

Figure 1 Modal value x_M of fluorescein sodium salt particles in dependence of two phase nozzle parameters pressure p and cap position K

The size distributions dN/dlog(dp) were evaluated regarding the modal value xM, the total number concentration cN and the geometric standard deviation σ_g in dependence of the parameters of the two phase nozzle. With varying the pressure of the air and the opening angle of the nozzle cap (parameter K) to spray the suspension modal values in the range of 30 up to 140 nm could be generated (Figure 1). It offers the possibility to generate different model aerosols in the nanometer range for dosimetry studies.

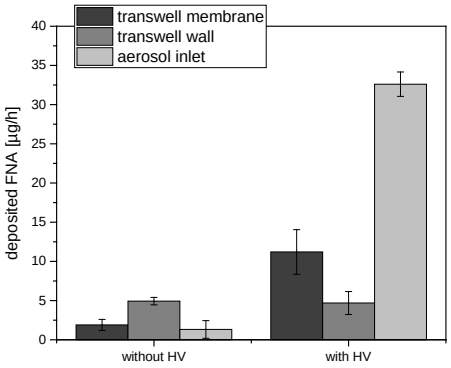

Figure 2. Deposited fluorescein sodium particle masses on different relevant surfaces in an ALI exposure chamber with respect to the deposition mechanism: without HV = diffusional deposition, with HV = electrostatic deposition

Figure 2 shows the distribution of particle masses on the inlet surface and the wall of a Transwell Membrane insert in relation to the relevant surface which is the membrane usually containing the cell culture. With this highly fluorescent aerosol instruments like the ALI exposure chamber can be investigated with respect to their particle deposition behaviour and the relevant in vitro dose at the ALI.

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