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Aerosol Dynamics of Nanoparticles in Workplace Exposure

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Recent research has indicated that the toxicity of inhaled ultra fine particles may be associated with the size of particles deposited (Oberdörster, 2000). For the estimation of health effects it is therefore important to obtain knowledge about the evolution of particle size from the point of release to the (human) receptor under conditions relevant for workplace exposure. These could include time and background aerosol.

State-of-the-art nanoparticle generation and aerosol monitoring equipment was used to show that the properties of the generated nanoparticle aerosols changes dramatically when released in the ambient air compared to their initial properties within the reactor.

An aerosol chamber was designed with the dimensions 1·1·2 m and a volume of 2 m³ (see figure 1). On the floor a speed-adjustable fan is placed, allowing a variation of the flow pattern from still air to a fully turbulent flow. At several points distributed over the walls sampling probes allow the release of particles and the extraction of small sample flows from the chamber. The probes consist of simple tubes and are fixed at a distance of 10 cm from the wall to avoid disturbance by the presence of the surface. Depending on initial size distribution (according to the production process), nanoparticle concentration and surface chemistry, the properties of the formed nano-sized aerosol when released was investigated as function of time and distance from point of release in terms of

- Size distribution and concentration
- Morphology
- Interaction with pre-existing ambient aerosol particles.

Platinum nanoparticles with a mean diameter of 9 nm and a geometric standard deviation of 1.3 are generated using a Hot-Wire Generator (HWG). These particles were fed to the chamber for several hours and the particle size distributions (PSD) were measured. Then, the particle feed was shut off while detecting the PSDs for several more hours. Experiments were done at varied fan speed. To model ambient air particles, spherical silica particles (Monospheres, Merck KGaA) with a diameter of 1 µm were released to the chamber using an atomizer and experiments with the same settings as for the Pt particles (time of release and measuring of PSDs, fan speed) were done.

To demonstrate the interactions of exposed nanoparticles with ambient air particles, the silica particles were released to the chamber with a constant concentration of about $1\text{-}2\cdot10^4$ cm^{-3}, which is a typical indoor particle concentration. Then Pt particles were released and the size distribution evolution was measured with SMPS and an optical particle counter (Grimm, Model 1.109). It was shown that the Pt particles coagulate with the coarse particles very fast and could not been detected with the particle counters anymore.

Measurements were also done with a multistage cascade impactor (18 nm – 20 µm) to demonstrate that the Pt particles were still dispersed in air adhering to the silica particles. The Pt nanoparticles were then distinguished chemically from the ambient aerosol by ICP-OES (Inductively coupled plasma optical emission spectroscopy).

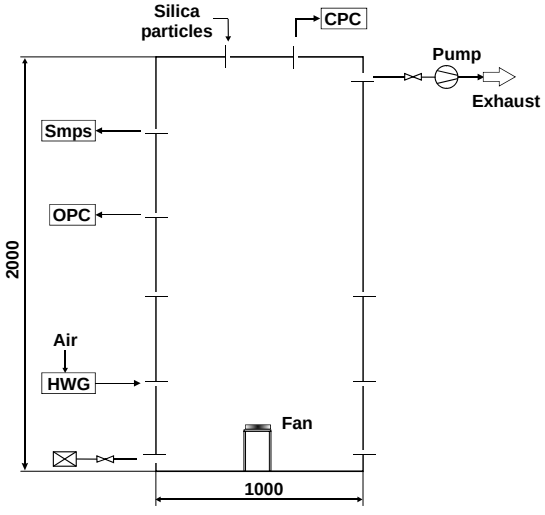

Figure 1. Experimental set-up.

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Oberdörster, G. (2000). *Phil. Trans. R. Soc. London Ser. A,* 358(1775), 2719-2740.