Characterisation of ambient and laboratory generated nanoparticles

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Epidemiological studies have identified associations between adverse health effects and particulate air pollution. The observed health impacts include acute morbidity and mortality. There is the suspicion that inhaled particles with sizes less than 100 nm, commonly referred to as ultrafine particles or nanoparticles, play a major role in this topic of public concern. A special feature of ambient nanoparticles is their high number concentration, on the order of 10^{10} m^{-3} in moderately polluted urban areas. On the other hand, owing to their small size, they are responsible for only about 1-3% of the mass concentration of inhaled ambient particles. Hence it is unlikely that adverse health effects can be attributed to the minute amount of toxic material that may be contained in nanoparticles.

Animal studies aim at identifying mechanistic pathways that could explain particle induced adverse health effects. An important topic of research in this matter is the fate of insoluble nanoparticles after their deposition in the lung. Key problems of such investigations are the optimisation of particle production techniques and the characterisation of the generated particles in terms of their composition, size and size distribution, state of agglomeration and surface area. In this contribution the state of the art in the production and characterisation of health relevant nanoparticles will be reviewed. Carbon nanoparticles can be generated by a variety of techniques based on the incomplete combustion or the thermal decomposition of aromatic oils or other liquid or gaseous hydrocarbons. More flexibility in terms of nanoparticle composition can be achieved using a spark discharge. The size distributions of the generated particles and aggregates are commonly determined using differential mobility analysers. The methods of particle characterisation include high-resolution transmission electron microscopy (HRTEM), scanning electron microscopy (SEM), sometimes combined with energy dispersive X-ray analysis (EDX), atomic force microscopy (AFM), time-of-flight secondary ion mass spectrometry (TOF-SIMS) and other forms of mass spectrometry. Different means of surface characterisation are also available. Most frequently used is the BET technique after Brunauer, Emmett and Teller, which is based on a determination of the particle's gas absorption characteristics. The overview will be completed by a few examples of animal studies involving exposure to nanoparticles.