

Monitorization of alveolar deposited surface area of nanoparticles and ultrafine particles in different environments

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Abstract

Nanotechnology is an important emerging industry with a projected annual market of around one trillion dollars by 2015. It involves the control of atoms and molecules to create new materials with a variety of useful functions. Although there are advantages on the utilization of these nano-scale materials, questions related with its impact over the environment and human health must be addressed too, so that potential risks can be limited at early stages of development. At this time, occupational health risks associated with manufacturing and use of nanoparticles are not yet clearly understood. However, workers may be exposed to nanoparticles through inhalation at levels that can greatly exceed ambient concentrations.

Current workplace exposure limits are based on particle mass, but this criteria could not be adequate in this case as nanoparticles are characterized by very large surface area, which has been pointed out as the distinctive characteristic that could even turn out an inert substance into another substance exhibiting very different interactions with biological fluids and cells. Therefore, it seems that, when assessing human exposure based on the mass concentration of particles, which is widely adopted for particles over 1 μm , would not work in this particular case. In fact, nanoparticles have far more surface area for the equivalent mass of larger particles, which increases the chance they may react with body tissues. Thus, it has been claimed that surface area should be used for nanoparticle exposure and dosing. As a result, assessing exposure based on the measurement of particle surface area is of increasing interest. It is well known that lung deposition is the most efficient way for airborne particles to enter the body and cause adverse health effects. If nanoparticles can deposit in the lung and remain there, have an active surface chemistry and interact with the body, then, there is potential for exposure. It was showed that surface area plays an important role in the toxicity of nanoparticles and this is the metric that best correlates with particle-induced adverse health effects. The potential for adverse health effects seems to be directly proportional to particle surface area. The objective of the study is to identify and validate methods and tools for measuring nanoparticles during production, manipulation and use of nanomaterials.

With this aim, a Nanoparticle Surface Area Monitor, TSI3550, was used for assessing exposure to nano particles produced and manipulated in laboratory and industrial facilities. This equipment indicates the human lung-deposited surface area of particles expressed as square micrometers per cubic centimeter of air ($\mu\text{m}^2/\text{cm}^3$), corresponding to tracheobronchial (TB) and alveolar (A) regions of the lung. Also, granulometry of particles was measured in the nano range using a Scanning Mobility Particle Size Spectrometer, TSI3034. Particles were sampled using a Nanometer Sampler Analyser, TSI3089 and observed further on using scanning electronic microscopy.

The obtained results clearly demonstrated the existence of airborne nanoparticles, as shown in figures 1 and 2, and also allowed the determination of lung-deposited surface area of nanoparticles, as well as the dose per unit lung mass and unit lung area, in the analyzed environments [1-4].

References

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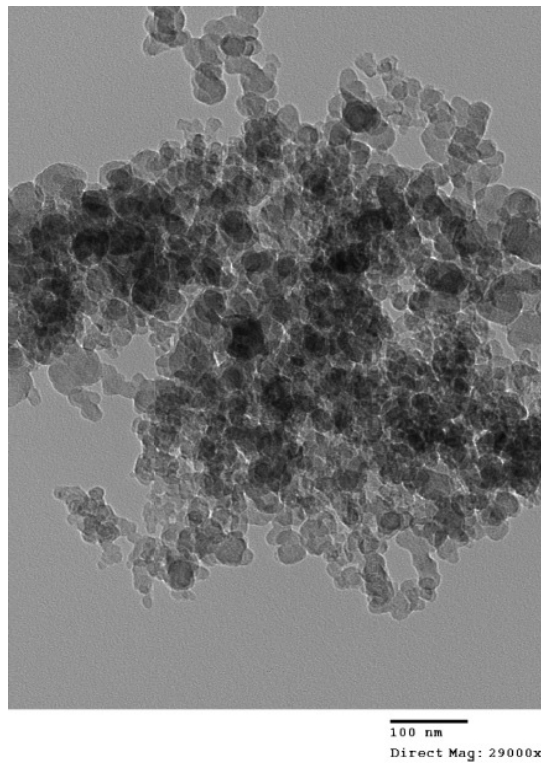


Figure 1 – TEM image of ultrafine particulates collected outdoor in Lisbon

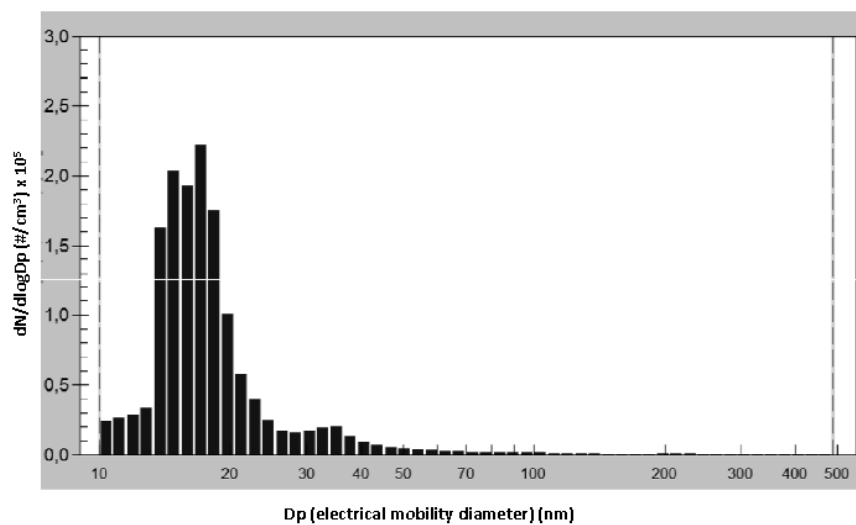


Figure 2 – Size distribution of ultrafine particles collected outdoor in Lisbon