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Implementation of sampling and characterization methods for nanoparticles

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Introduction

The use of nanoparticles (NP) and nanotechnology is growing and workers exposure assessment to nanomaterials poses new challenges to agencies involved in the field of health and safety at work. Little is known on the risk related to the workplace environment (Seipenbusch *et al*, 2008). Characterization of exposure is an important factor of toxicological studies. Electron microscopy (EM) is one of the main tools used to characterize NP (Jarausch & Leonard, 2008; Shin *et al*, 2009). The aim of this study was to develop an optimal characterization method through NP air sampling. This presentation describes the implementation of EM methods based on sampling by two impactors (an electrical low pressure impactor (ELPI) from Dekati Corp and a micro orifice uniform deposition impactor (MOUDI) from MSP Corp).

Methodology

TiO_2 NP of 5 nm were generated in an inhalation chamber at a concentration of 2 mg/m³. TiO_2 NP suspensions (2.5 and 5 g/L) prepared with deionized water were nebulized with a constant output atomizer (TSI model 3076) and a Collison nebulizers. The suspensions were sonicated and filtered to remove large aggregates. NP were collected by ELPI and MOUDI impactors. The ELPI has a lowest stage cut diameter of 7 nm and gives a direct reading allowing a comparison with electron microscopy data. MOUDI impactor has rotating plates allowing a better distribution of the particles. Copper grids were glued on substrates placed on impaction plates using templates created specifically for this purpose. Then the copper grids were analysed by EM.

Results

EM characterization of the initial bulk powder (figure 1a), as well as the TiO_2 suspensions (figure 1b), revealed that NP were agglomerated and had spherical and rod morphologies. The microscopic analysis showed that NP collected on grids were in agglomerated state. Furthermore, the size of the particles and agglomerates present in the aerosols were larger and sometimes beyond the nanometric range (1 – 100 nm).

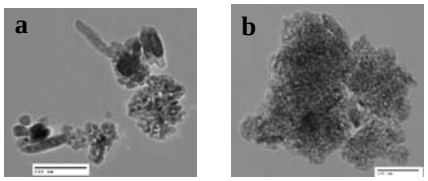

Figure 1 : a) bulk TiO_2; b) TiO_2 suspension

Discussion and conclusion

When analysing a grid from an impactor stage, a representative analysis of the population of the particles needs to be performed in order to get significative statistics and establish, for example, the median diameter. An image analysis software is a useful complementary tool for the characterization of particles. Many similarities can be drawn between the problematic posed by characterization of asbestos fibers and NP. Some of the counting rules for asbestos fibres by EM could be appropriate for the counting of NP. For example, the number of NP that needs to be counted to obtain representative data from the population of NP in the air.

In order to understand and to infer results evolving from nanotoxicological studies, a thorough characterization at each step of the experimentation is necessary. Since characterization of NP will get widely used, we should think about applying the expertise and the knowledge developed with other contaminants like asbestos and other mineralogical dust. There might be a need for harmonization between analytical methods.

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