Dustiness of nanomaterial powders: comparison between the small rotating drum and the vortex shaker methods

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The "dustiness" of nanomaterial powders has been tested using several different quantification methods that all involve the application of a given mechanical energy level to a particular amount of powder, whereby nano-objects and their agglomerates and aggregates (NOAA) are aerosolized and measured. Besides the different operation procedures (environmental conditions, measurement strategy, etc.), the manner in which the output data are analysed and reported is of importance and influence on the results. The absence of a harmonized approach concerning the measurement strategies and techniques, metrics and size ranges considered, as well as the procedures of data analysis and reporting severely limits the comparability of results stemming from these dustiness methods. This is a critical issue when such data are used for scaling or quantitative predicting (airborne) nanomaterial exposure.

In an aim to develop European standards, a research program (Dustinano) has been launched with the objective to develop a harmonized approach for testing dustiness of nanomaterial in powder form, taking into account four existing test systems used in Europe. Here we present the work performed for two of them, which are 1) the small rotating drum, SRD (Schneider and Jensen, 2008) and 2) the vortex shaker, VS (Witschger, 2011). Each system has been deployed in two institutes.

Ten powders produced on an industrial scale were chosen with the objective to study substances covering a wide range of parameters, such as their specific surface area, SSA (Figure 1).

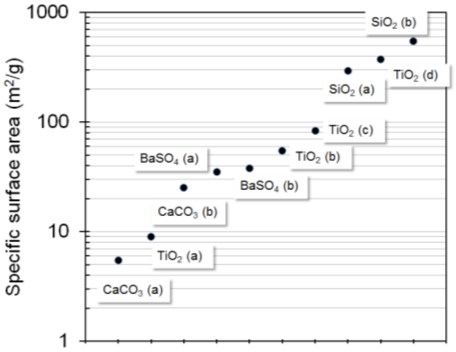

Figure 1. Specific surface areas obtained by N_2 adsorption (BET method) for the 10 tested powders.

A complete characterization of each powder was carried out, among which: powder particle size distribution by Laser Diffraction, SSA by N_2 adsorption, bulk density by He Pycnometry, water content by TGA, size, morphology and chemical analysis of the NOAA by analytical electron microscopy, crystal structure by powder X-ray diffraction.

The harmonized test procedure for intercomparison tests is based on the use of: 1) a respirable cyclone for gravimetric sampling, 2) a Condensation Particle Counter as reference instrument for number concentration measurement, 3) the MiniParticle Sampler (MPS, Ecomesure, France) for collection of particles for electron microscopy observations/analysis, 4) the Electrical Low-Pressure Impactor (normal or +, Dekati, Finland) for size-resolved aerosol measurement. Associated with this methodology, new standard parameters are proposed to qualify the dustiness of powders, including the number- and mass-based dustiness indices, airborne particle emission rate as well as particle size distribution of the emitted aerosol.

First results show good reproducibility and strong influence of the aerosolization method (Figure 2). The number-based and mass-based dustiness indices of the investigated powders present a large span over several orders of magnitude. The size distributions of the emitted aerosols cover the range from about 50 nm to about 10 µm in aerodynamic equivalent diameter.

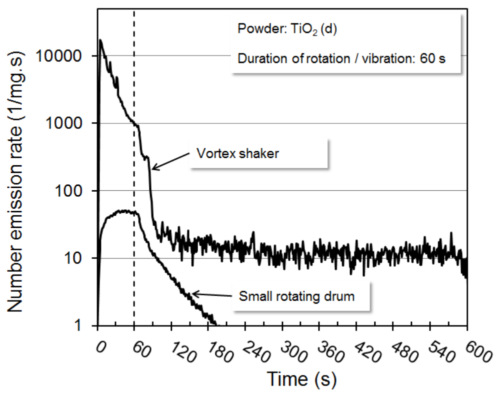

Figure 2. Comparison of number emission rates obtained in the SRD and VS for the SiO_2 (b).

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Schneider & Jensen (2008) Ann Occup Hyg, 52, 23
Witschger O. *Monitoring Nanoaerosols and Occupational Exposure*. Nanoethics and Nanotoxicology. Springer Berlin Heidelberg; 2011. p. 163-99.