Nanoparticle release from nanostructured powders during low- and high-energetic dry dispersing processes

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Possible risk of substances to health, safety and environment depends on the coexistence of material toxicity and material exposure (NRC, 1983). The steadily increasing production, processing and use of nanomaterials necessitate thus an extended risk assessment taking into account the material's dispersing state. In this context, systematic dispersing studies on nanomaterials in laboratory can provide basic information about the ability and the quantity of nanoparticle release into the air (Kuhlbusch *et al.*, 2011).

Nanostructured powders (e.g. nano-pigments, powder flow agents) constitute the origin for the fabrication of many products and were thus the subject of several nanoparticle release studies (Kuhlbusch *et al.*, 2011). Performed laboratory investigations on nanostructured powders can roughly be classified according to the applied dispersing energy input into three treatment procedures: drop down procedures (e.g. Jensen *et al.*, 2009), fluidized bed methods (e.g. Maynard, 2002) and high energy dispersing (e.g. Stahlmecke *et al.*, 2009).

Up to now, no single method exists to characterize the particle release from nanostructured powders due to different treatment processes, i.e. every method simulates one typical handling procedure (e.g. refilling, emptying). Moreover, existing devices were mostly optimized for one kind of powder (e.g. fluidized bed methods for fibrous powders like carbon nanotubes). Current technical solutions have often the disadvantage of changing fundamental powder properties, like the mixing state or the bulk density. Improper combination with measurement instruments, as often observed in the literature, can lead to considerable artifacts in measured concentrations and particle size distributions.

To estimate the quantity range of (nano)-particle release into air from nanostructured powders (pigments, pyrogenic silica, titanium dioxide, zeolites) in accordance with ISO/TS 12025:2012, a low-energetic and a high-energetic dry dispersing procedure were used for aerosolization. The latter one based on the dispersing process within a rotating brush generator (Model RBG 1000, Palas GmbH, Germany) operated with dispersion cover A at a dispersing pressure of 3.5 bar (relative flow velocity of 100 $m \cdot s^{-1}$), a volumetric powder flow of 25.7 $mm^3 \cdot min^{-1}$ and a rotational steel brush frequency of 1210 min^{-1}. In the absence of suitable commercial aerosol generators that produce steady-state particle number concentrations and particle size distributions from various powders at weak dispersing energy input for SMPS-analyses, a dispersing device based on a linear-driven notch and a stainless steel capillary tube was developed (Göhler et al., 2010) and operated at volumetric powder flow rate of 30 $mm^3 \cdot min^{-1}$ and a relative flow velocity of 24.4 $m \cdot s^{-1}$.

For the purpose of cross-process comparability, the measured data were expressed as fractional numbers of released particles and related to the treated sample mass. Release data were determined not only for the nanoscale, but also for the submicrometre and micrometre size range, to characterize completely the simulated release scenarios. Results on the analyzed nanostructured powders showed, that the methodology is appropriate for (nano)-particle release analyses.

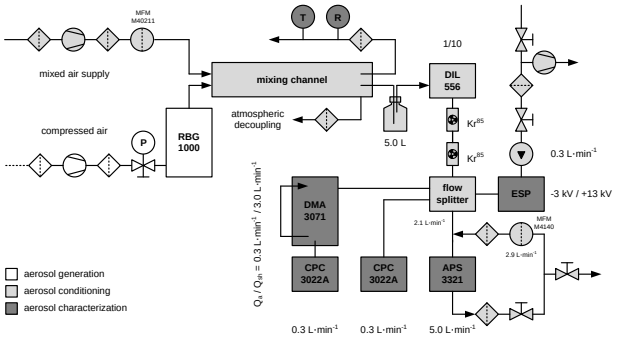

Figure 1: Schematic diagram of the operated experimental setup for high-energetic dry powder dispersion

The presentation will give detailed information on the experimental conditions, the performed evaluation of the measurement data and results of different nanostructured powders that were analyzed. Moreover, the presentation will discuss release data for further investigations on the (nano)-particle release into the air from powdered materials.

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