Exposures in Chemical Nanotechnology

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INTRODUCTION

Exposures to ultrafine dust due to naturally emitted and incidentally generated nanoscale particles are already known. The exposure to specifically engineered nanomaterials is a topic of actual interest.
Keeping in mind the special and heterogeneous spectrum of exposure, exposed individuals underwent detailed examinations in our institute and at their workplace. We also analysed the chemical nanotechnology work sites.

METHODS

The measurement of number concentrations of ultrafine and nano particles during representative activities was carried out using the handheld condensation particle counter (CPC, TSI GmbH, Aachen, Germany). This model is capable to count single particles at concentrations as high as 10^5 pt/cm³, detecting particles in a size range between 10 and 1.000 nm.
Occupational activities included production, modification of surface and further processing of oxide nano particles with primary particle size of < 10 to 100 nm e.g. ZrO_2, SiO_2, Al_2O_3, CeO_2, $Ce_2(MoO_4)_3$ and TiO_2.
Simultaneously, dust particle samples of indoor air were collected, visualized and analysed by REM and EDX.

RESULTS

Measurement of number concentrations of ultrafine and engineered nano particles allowed the evaluation of maximum concentrations compared to background levels.
Background concentrations of 4.000 to 10.000 pt/cm³ did not change during filling of small amounts of nano particle powder *(figures 1 & 2).*
Filling of larger quantities resulted in short-term maxima of 15.700 pt/cm³ (within the fume-hood) versus 16.400 pt/cm³ (without deduction, *figures 3 & 4*).
While spray-painting a nano particle containing formulation maximum concentrations of up to 140.000 pt/cm³ have been documented - the user was wearing a protective mask. Measuring within this mask only maxima < 10 pt/cm³ were detected - even during spray-painting *(figures 5 - 7).*
More than 30 minutes after short-term maxima, background levels remained at concentrations of 30.000 pt/cm³ - indicating an inhalation exposure with potential hazards when the mask is removed early *(figure 8).*
Using REM and EDX nanoscaled particles of Zirconium were visualized and identified *(figures 9 & 10).*

CONCLUSION

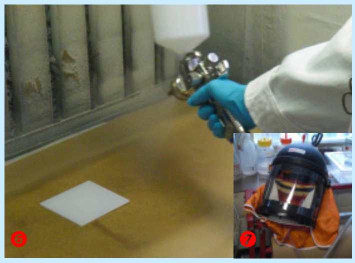
At present particle concentration levels at work sites during different uses of nano particles have shown no high peak concentrations. Spray-painting with nano particles is an exception – however the user is fully protected by wearing personal protective equipment.

Figures 1 & 2: Filling of nano particle containing powder.

Figures 3 & 4: Processing of larger quantities of nanomaterials – measurement of particles carried out using the CPC 3007.

Figures 5 & 6: Spray-painting using a nano particle containing formulation.

Figure 7: Protective respiratory mask.



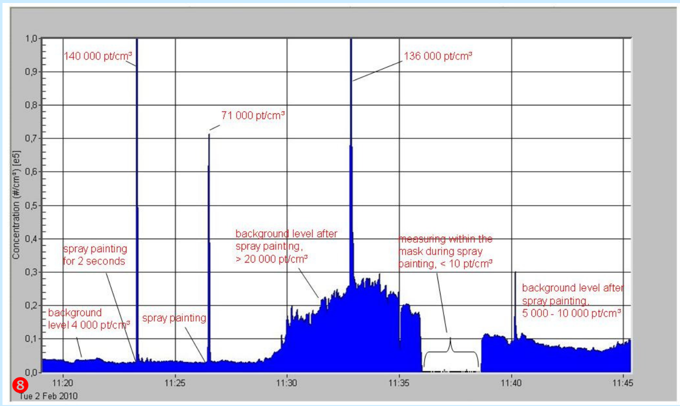


Figure 8: Measurement profile: Spray-painting.

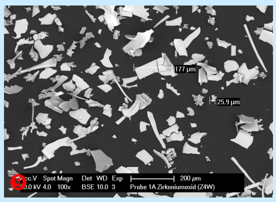


Figure 9: REM-analysis of yttrium stabilized ZrO_2.

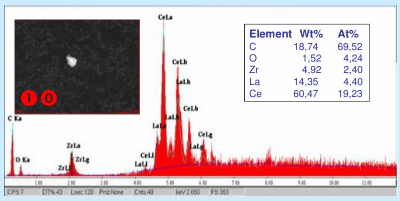


Figure 10: EDX-analysis: Presence of Zirconium.

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