

**Nanotechnology: Do traditional OSH concepts fit to innovative materials?**

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ICOH 2012, Cancun, FP61 Nanomaterials and occupational health, 22 March 2012

**Nanotechnology: a challenge for OSH**

**Nanomaterials: The surface makes the difference**

$< 100 \text{ nm} = 0,1 \mu\text{m} = 0.0001 \text{ mm}$

**We are bulk ...**

**We are nano...**

... with its specific physical and chemical properties

... with its modified physical and chemical properties

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**... and a nano doesn't love to walk alone !**

... in workplace air

... and in the lung !

$1 \mu\text{m}$

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**Nanotechnology: a challenge for OSH**

**risk management**

**risk assessment**

**risk characterization**

**exposure at the workplace**

**hazard adverse effects to human health**

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**Nanotechnology: a challenge for OSH**

**Starting points for "nanotoxicology"**

**hazard**

fine / ultrafine dust / alveolar dust

**dust**  
(granular, persistent)

**particle toxicology**

**fibrous dusts**  
(long, thin, biopersistent)

asbestos / man-made mineral fibers

**chemical toxicology**

**"nano"**

substance-related toxic effects  
(GHS criteria for classification)

anything else ?

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**Nanotechnology: a challenge for OSH**

**Fibrous dusts**

**exposure**

**hazard**

**single fibres**

**fibre bundles**

**disperse cluster**

**compact cluster**

**disperse matrix**

**compact matrix**

**fibre principle**

- fibrous (length/diameter  $> 3/1$ )
- thin (below **3 microns**)
- long (above **5 microns**)
- biopersistent

**adverse effects**

- inflammation (lung tissue)
- cancer (lung, mesothelioma, ...)

**applicable to**

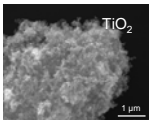
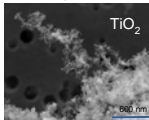
- asbestos (and other fibrous minerals)
- man-made mineral fibres (MMMF)
- fibrous nanomaterials


photographs: CNT (BAuA / nanolab)

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## Granular Biopersistent Particles

generated from a nanomaterial:  

sampled from workplace air: 

also sampled from workplace air:

photographs: BAuA / nanolab

**GBP principle**

- granular
- respirable (alveolar dust)
- biopersistent (no or low solubility)
- without known significant specific toxicity

**adverse effects**

- inflammation (lung tissue)
- lung cancer

**applicable to**

- alveolar dust from powders
- alveolar dust from processes
- alveolar dust from nanomaterials

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## Substance specific toxicity

New EU GHS Inventory of the European Chemicals Agency: <http://echa.europa.eu/web/guest/information-on-chemicals/classification-database>

Zinc oxide (bulk, powder)

- H 400 Very toxic to aquatic life
- H 410 Very toxic to aquatic life with long-lasting effects
- H 302 Harmful if swallowed
- H 332 Harmful if inhaled
- H 360 May damage fertility or the unborn child
- H 372 May cause damage to organs

Zinc oxide (nano)

- H 400 Very toxic to aquatic life
- H 410 Very toxic to aquatic life with long-lasting effects

... and "data lacking" really ?

**chemical hazards**

- acc. to classification (GHS)

**adverse effects**

- all impacts on human health

**applicable to**

- exposure to hazardous substances and mixtures
- exposure to emissions from processes
- exposure to nanomaterials

**but: no test - no classification**

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## BAuA research for safe use and design of nanomaterials

since 2010  
Impact of new technologies on safety and health at work:  
Nanomaterials

Contributions to chemical safety:  
Precautionary principles for nanomaterials

2005 – 2009  
nano particles, fine and ultrafine dusts at workplaces

2001 – 2004  
Carcinogenicity of biopersistent fibers und granular dusts  
Extrapolation of animal data to humans  
Traffic light model for acceptable and tolerable risks from carcinogens  
Dust related chronically diseases of the lung

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## What we've learned from research (I)

- analytical techniques for fine/ultrafine dust are applicable
- REM allows morphological characterization
- identifying background exposure is essential
- high dominance of agglomerates and aggregates
- no significant exposure levels at workplaces with adequate risk mitigation

no new effects observed directly related to "nano" properties

no relevant desagglomeration of inhaled NM in the lung

small differences in carcinogenic potency for GBP effects for "micro" and "nano" form (factor ~ 2 - 2.5)\*

\* Thomas Gebel, Arch. Toxicol., in print

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## What we've learned from research (II)

- limited relevance of *in-vitro* results for regulation
- need to apply precautionary principle for "data gaps" in classification
- "traditional" control strategies for dust are efficient for nanomaterials
- workplace measurements applicable, but complex and expensive
- the well known problems of SME to put OSH into practice ....

It's impossible to cover all nanomaterials with a common OSH strategy !

We face a lot of issues, but that also holds true for many other chemical substances and mixtures ....

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## Precautionary Principle: Where are we now?

risk level

uncertainty

2012 ?

scientific knowledge

nanomaterial I


nanomaterial II

nanomaterial III

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## Control Banding - a good choice



**new (nano)material**

- unknown hazards
- high dustiness

↓

**Control strategy (CS) / Control guidance series dep. on task-related quantity**


grams >>> engineering control (CS 2)  
kilograms >>> containment (CS 3)  
tons >>> containment (CS 3)

[www.baua.de/emkg](http://www.baua.de/emkg)

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## Use Control Guidance Sheets



[www.baua.de/emkg](http://www.baua.de/emkg)      [www.cosh-essentials.org.uk](http://www.cosh-essentials.org.uk)      [www.ilo.org/legacy/english/protection/safework/citri\\_banding/toolkit/icc/index.htm](http://www.ilo.org/legacy/english/protection/safework/citri_banding/toolkit/icc/index.htm)


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NanoValid

## OSH Guideline for safe handling of nanomaterials in labs and start-ups

- a BAuA contribution to the 7th EU framework program for research -



photograph: BAuA / Vox / Völkner

- started: November 2011
- contract period: 4 years
- basis: **overview on current OSH guidelines (OECD WPMN)\***
- field study for evaluation of efficacy
- manual / tool for training

\*[http://www.oecd.org/officialdocuments/displaydocument/?cote=en/jm/mono\(2010\)47&doclanguage=en](http://www.oecd.org/officialdocuments/displaydocument/?cote=en/jm/mono(2010)47&doclanguage=en)

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Research, Development, Policy, Transfer-to-practice

# baua:

The Federal Institute for Occupational Safety and Health (BAuA) as governmental research institution holds a key position in creating a safe and healthy work environment.



[www.baua.de](http://www.baua.de)

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