

Overview of completed and ongoing activities in the field: Safety and Risks of Nanotechnology

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Introduction: Nano Safety and Risks

The implementation of nanotechnology poses **unknown risks** which are difficult to assess with respect to their impact on

- The environment
- Human health
- Ethical, legal and societal issues

Main source of unknowns:

Material properties **can** change on the **nano scale!**



Impact on the environment

- Nanomaterials are already released into the environment
- Because of their small dimensions nanomaterials can be largely distributed within the environment in water streams, soil and air
- Like other chemicals nanomaterials can accumulate in the environment, but their effects are still unknown
- The persistence or degradation of nanomaterials in the environment is still unclear and can have enormous impacts



Impact on human health

Nanomaterials can have a huge impact on human health:

- they can be absorbed in many ways by the human body (skin, lung, gastro-intestinal tract)
- They are distributed within the whole organism via blood and lymphatic systems
- They accumulate in organs (e.g. brain, kidney, liver)
- Because of their small size they can reach every place in the body



Ethical, legal and societal implications

- Public perception of nanotechnology is a crucial determinant for its successful establishment as a future driving force in the economies worldwide
- As nanomaterials have different properties compared to the bulk materials new legislation and regulation will be necessary on an international level
- Ideas like toxic particles that can go everywhere and self-replicating nanorobots can produce fear and uncertainty in the broad public and can lead to severe societal problems



Approach

1. The current State-of-the-Art about safety and risks of nanotechnology is assessed by
 - collecting key publications of both proponents and critics of nanotechnology
 - summarizing international programs and projects supporting research on nano risks
 - identifying key players in the field of risk assessment of nanotechnology are listed
 - Organizing events with key players and stakeholders



Approach

2. The need for actions is analysed and specified from the data obtained
3. Recommendations for immediate actions to be taken are elaborated



Some Key Players

- Borm, Paul J.A., The Netherlands
- Chen, H.H., Taiwan
- Colvin, Vicki, USA
- ETC Group, Canada
- Gehr, Peter, Switzerland
- Howard, Vyvyan, UK
- Oberdörster, Günther, USA
- Oberdörster, Eva, USA
- Welland, Marc, UK



Selected Key Publications

- ETC Group (Action Group on Erosion, Technology and Concentration):
Nano's Troubled Waters
April 2004, <http://www.etcgroup.org/search.asp?slice=recent>
- Günther Oberdörster:
Pulmonary effects of inhaled ultrafine particles
November 2000, Int. Arch. Occup. Environ. Health. 74(1): pp 1-8
- Mihail C. Roco:
Societal Implications of Nanoscience and Nanotechnology
March 2001, <http://www.nsf.gov/home/crssprgm/nano/nsfnnireports.htm>
- Vicki Colvin:
The potential environmental impact of engineered nanomaterials
October 2003, Nature Biotechnology, Volume 21, Number 10, pp1166-1170
- Vicki Colvin:
The Differential Cytotoxicity of Water-Soluble Fullerenes
November 2004, Nano Lett. (2004) 4 (10), 1881 - 1887



Selected EU Projects Supporting Research on Nano Risks

Projects:

- NANO-PATHOLOGY
- NANODERM
- NANOSAFE I+II
- NANOLOGUE
- NANODIALOGUE

CA, SSA:

- IMPART
- NANOTOX



Need for Actions

Conclusive data on the health and environmental effects of nanomaterials will be a key in building the public's trust for nanotechnology

- Gaps in the knowledge about health risks and environmental consequences of nanotechnology must be filled by high level research
- Ongoing and future research must be restructured to address safety issues of nanotechnology
- Research efforts must be coordinated
- Adequate research funding must be provided
- Dialogue with the public must be enhanced and moderated
- Risk assessment must be made according to the different fields of nanotechnology on programme as well as on project level



Different fields of nanotechnology and inherent risks

Materials / Powders	Nanobio / NanoMedicine	Devices	Instrumentation	Nanofactory / Replication
<ul style="list-style-type: none"> - Novel Materials - Nano Particles - Surfaces 	<ul style="list-style-type: none"> - Biomaterials - Life Sciences 	<ul style="list-style-type: none"> - Optical Devices - Light Sources - Sensors - Energy Storage - Photovoltaics 	<ul style="list-style-type: none"> - Tips and Probes - Data Storage 	<ul style="list-style-type: none"> - Machining - Self Assembly
<div style="background-color: #00A09A; color: white; padding: 5px;">Environmental Risks</div>	<div style="background-color: #ADD8E6; padding: 5px;">Environmental Risks</div>	<div style="background-color: #ADD8E6; padding: 5px;">Environmental Risks</div>	<div style="background-color: #ADD8E6; padding: 5px;">Environmental Risks</div>	<div style="background-color: #ADD8E6; padding: 5px;">Environmental Risks</div>
<div style="background-color: #00A09A; color: white; padding: 5px;">Toxicity</div>	<div style="background-color: #ADD8E6; padding: 5px;">Toxicity</div>	<div style="background-color: #ADD8E6; padding: 5px;">Toxicity</div>	<div style="background-color: #ADD8E6; padding: 5px;">Toxicity</div>	<div style="background-color: #ADD8E6; padding: 5px;">Toxicity</div>
<div style="background-color: #ADD8E6; padding: 5px;">Societal Impacts</div>	<div style="background-color: #ADD8E6; padding: 5px;">Societal Impacts</div>	<div style="background-color: #ADD8E6; padding: 5px;">Societal Impacts</div>	<div style="background-color: #ADD8E6; padding: 5px;">Societal Impacts</div>	<div style="background-color: #00A09A; color: white; padding: 5px;">Societal Impacts</div>
<div style="background-color: #ADD8E6; padding: 5px;">Economic uncertainty</div>	<div style="background-color: #ADD8E6; padding: 5px;">Economic uncertainty</div>	<div style="background-color: #ADD8E6; padding: 5px;">Economic uncertainty</div>	<div style="background-color: #ADD8E6; padding: 5px;">Economic uncertainty</div>	<div style="background-color: #ADD8E6; padding: 5px;">Economic uncertainty</div>
<div style="background-color: #ADD8E6; padding: 5px;">No or little risks</div>	<div style="background-color: #ADD8E6; padding: 5px;">Medium risks</div>	<div style="background-color: #00A09A; color: white; padding: 5px;">High risks</div>		

Source: TEMAS AG



Recommendations for Immediate Implementation

Evaluation and Recommendations, active Accompaniment and Coaching of Projects:

- Give the applicants clear advice to handle S&R issues
- Elaboration of solution plans for known and unexpected risks
- Research of latest and updated literature about nano risks
- Regular reviewing of obtained results about nano risks
- Aiding in the publication of the results



Example: Austrian Nano Initiative, Assessment of Safety and Risk issues at project level

Procedure:

a. Verification of

- Impact on the environment
- Impact on human health
- Ethical, legal and societal implications

b. Specific recommendations for actions to be taken



Evaluation Safety and Risks of Nanotechnologies

Cluster:
 Project No. Project Acronym

1. Risk field (Classification)

Example
of an S&R
evaluation
form

Materials / Powders	Nanobio / NanoMedicine	Devices	Instrumentation	Nanofactory / Replication
- Novel Materials - Nano Particles - Surfaces	- Biomaterials - Life Sciences	- Optical Devices - Light Sources - Sensors - Energy Storage - Photovoltaics	- Tips and Probes - Data Storage	- Machining - Self Assembly
Environmental Risks	Environmental Risks	Environmental Risks	Environmental Risks	Environmental Risks
Toxicity	Toxicity	Toxicity	Toxicity	Toxicity
Societal Impacts	Societal Impacts	Societal Impacts	Societal Impacts	Societal Impacts
Economic uncertainty	Economic uncertainty	Economic uncertainty	Economic uncertainty	Economic uncertainty
No or little risks	Medium risks	High risks		

Source: TEMAS AG

2. Recommendations

Before project start a statement should be given, in which the proposed ways to store and dispose materials containing metal nano clusters or metallic nanocrystals are described.

A review with experts 6 months after project start is recommended to discuss and evaluate the measures taken to address possible environmental hazards associated with the project.

In addition to these specific issues we recommend to take the general measures given in the document General_Recommendations.pdf, which are the same for all possible risk issues.

Dr. Jürgen Höck
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Date:
 Signature:



Thank you for your attention

More information about Nano S+R are available at
<http://www.temas.ch> / current topics



Recommendations of the example

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