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Societal Challenges of Nanotechnologies

13th LEIBNIZ CONFERENCE OF ADVANCED SCIENCE

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Lichtenwalde, 27. April 2012

Content

Social risks of nanotechnologies

- (Eco-)toxikological risks of nanomaterials
- Risk research and management of nanomaterials
- Ethical questions

Challenges for the economic implementation

- Imminent shortage of skilled labor
- Commercialization barriers

Public reception and social dialogue

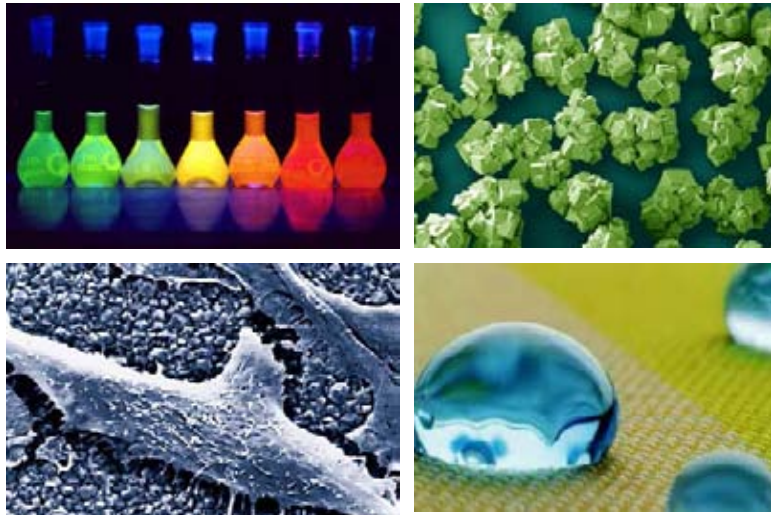
- People's knowledge and perception of the population
- Role of the media
- Information and dialogue with stakeholder and the public

Conclusion and need for action

(Eco-)toxicological Risks of Nanomaterials

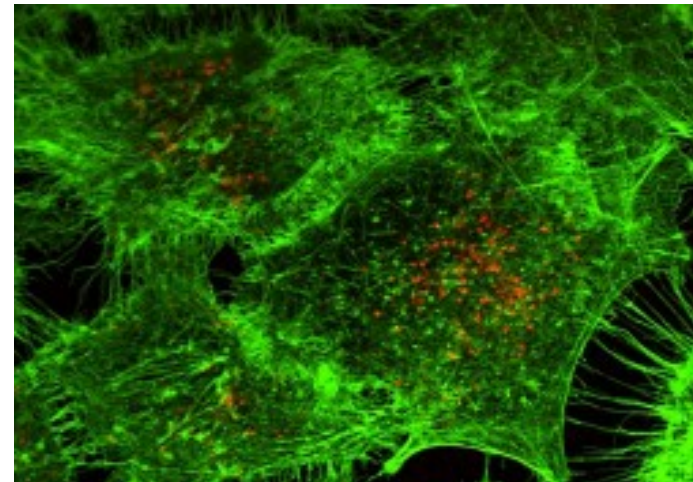
Desirable nano-effects for technical use

- Quantum effects for optoelectronics
- Enlarged surfaces for catalysis, separation etc.
- Biocompatibility, molecular recognition for drug targeting
- Selforganisation, multifunctional materials
- ...



Undesirable nano-effects for human/environment

- Uptake and distribution in the human body through enhanced barrier permeability (skin, cells, blood-brain etc.)
- Increased toxicity (e.g. by enlarged surfaces)
- Increased mobility and distribution in the environment
- Bioaccumulation
- ...



Nanoparticles in human lung tissue

Definition of Nanomaterials

ISO/TR 11360:2010: Nanotechnologies - Methodology for the classification and categorization of nanomaterials

Nanomaterials

Nanoobjects
(external dimension 1 -100 nm)

Nanostructured Materials
(internal structure/ surface structure 1 -100 nm)

Nanoparticle
(3d nano)

Nanotubes/
-fibers (2d nano)

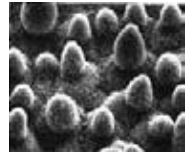
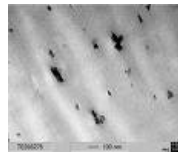
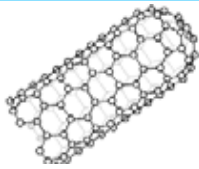
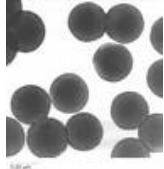
Nanoplatelets
(1d nano)

Nano-
composite

Composed
NM

Nanostruc-
tured surface

shell
structures



Distinction criteria for nanostructured materials

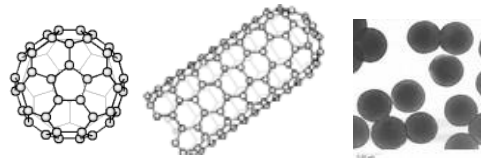
Proposal of the EU-Commission:
 Number size distribution: > 50 % Nano-objects
 Volume specific BET-surface > 60m²/cm³

Problem: At present no reliable and practicable measuring method for validation available

Exposition of people and the environment with nanoobjects

Most critical with regard to (eco-)toxikological risks are unbound nano-objects

Nano-objects



Potential emission of nano-objects within the value added chain/ along the life cycle



Generation



Processing

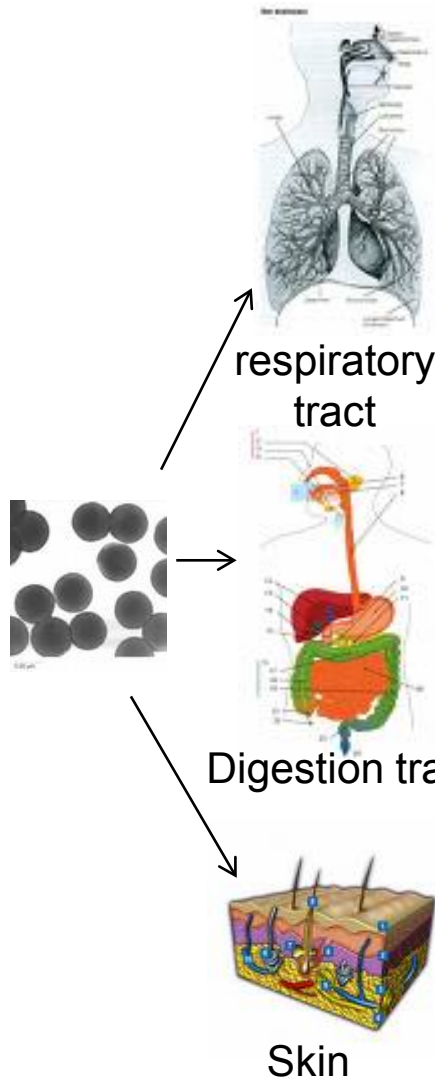


Product
usage



Recycling/
Disposal

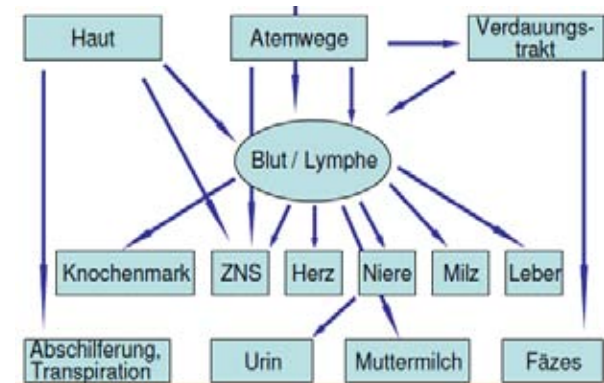
Exposition route into the human body



risk factor

- high In high concentrations inflammation reactions in the lung, carcinogenesis
- ? Little knowledge on uptake and effects, Food law requires authorization of nanomaterial usage
- low Intact skin is an effective barrier against nanoparticle penetration

Systematic effects?



modified from Oberdörster 2005

Risk Research on Nanomaterials

- International Level
OECD: Since 2006 „Working Party on Manufactured Nanomaterials“ (WPMN)
Aim: international harmonized methods and strategies for risk assessment,
Testing programme for 13 commercial relevant nanomaterials
(www.oecd.org/env/nanosafety)
- European Level
EU: > 50 current or finished projects of nanomaterial risk research in FP6 und
FP7; Financial volume ca. 140 Mio. Euro
(www.nanosafetycluster.eu)
- National Level
D: BMBF-Funding activities NanoCare and NanoNature, Investigation of
nanomaterial effects on humans and the environment, ca. 20 projects;
Financial volume ca. 40 Mio. Euro
(www.nanopartikel.info)

Risk Management

Regulation

- Chemical Legislation (EU: REACH, CLP)
- Product Legislation
 - Cosmetics (EU: Labelling as from 2013)
 - Food contact materials (EU: Labelling and registration)
- Worker protection (D: Gefahrstoffverordnung)

Self regulation of Industry

- Code of Conduct (Several corporations e.g. BASF)
- Guidelines for safe handling of nanomaterials (e.g. VCI, Paint industry)
- Transparent communication (e. g. citizen dialogues, quality labels)

Worker Protection Measures

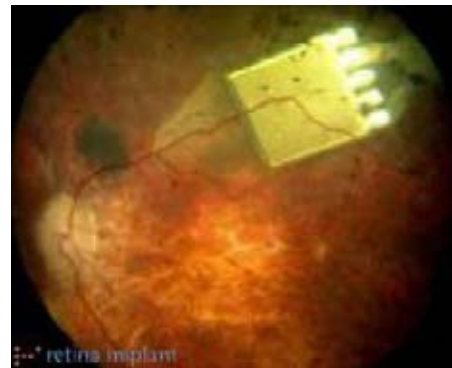
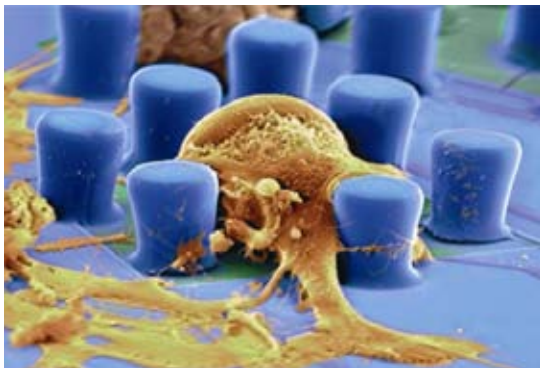
- Prevention of nanoparticle emissions (processing, closed vessels, exhaust ventilation)
- Personal protective measures (respiratory masks, protective gloves etc.)
- Communication of hazardous properties along the processing chain (Safety data sheets) ...

Measures for Consumers/Environment

- Labelling of nanoproducts (Cosmetics, food)
- Product databases (e. g. www.nanotechproject.org)
- Quality labels (e. g. textiles)
- LifeCycle-analysis (behaviour during usage, disposal/recycling)

Ethical Questions

- Boundaries between human/ machine are blurring (“Human Enhancement”)
- Potential misuse for criminal and terroristic purposes
- Potential for military applications
- Imperilment of informational self-determination through ubiquitous nanosensors (e.g. concerning diagnostics)
- Who benefits of nanotechnologies? Are developing countries excluded from the development of technologies (“NanoDivide”)



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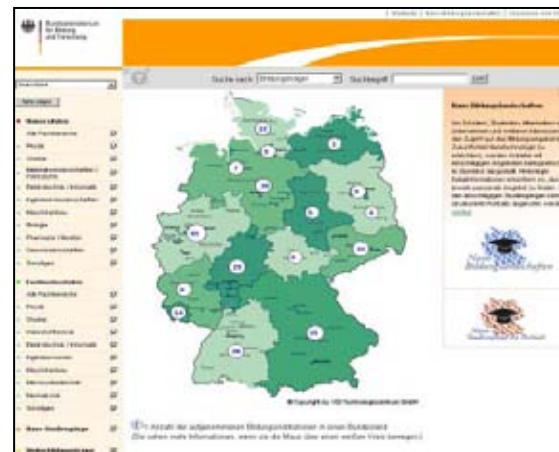
Innovation Barriers

Potential skill shortage

- Demographic Development (“Ageing Society”)
- Interest for MINT-Qualifications improvable
- Emigration of talented researchers (“Brain drain”)
- Adoption of education appropriate to qualification demands



BMBF- young researcher competition NanoFutur

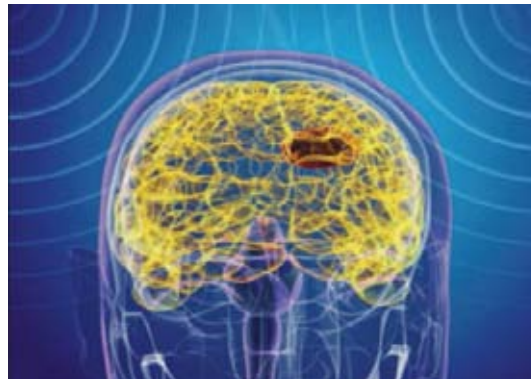


Overview on study and training courses on nanotechnology (www.nano-bildungslandschaften.de)

Entrepreneurial challenges

- Scale-up from lab to fab
- Time-to-Market often long (registration procedures, long term innovation cycles)
- Difficulties to integrate in existing production lines
- Financing Problems (access to venture capital, limited profit margins)
- Challenges with regard to standardisation, reproducibility, durability of nano-effects
- Hard Price-/Performance competition
- Liability risks of nanomaterials?
- Public acceptance
- Potential regulatory restrictions

Example: Nanoparticle based cancer therapy – ca. 20 years from basic research until medical devices approval



Source: Magforce Nanotechnologies

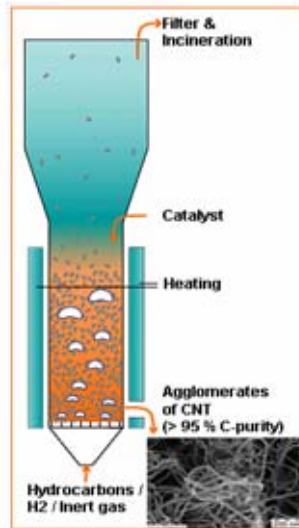
Example: Value added chain carbon nanotubes (CNT)

Research

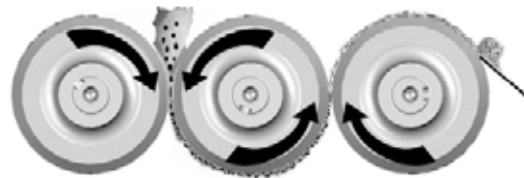


- Outstanding material properties
- strength
 - conductivity
 - ...

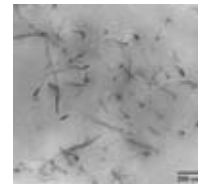
Industrial production



Processing



Dreiwälzwerk zur Compoundierung



CNT-Polymerkomposit

Components/Products



- 20 years after scientific discovery still few product applications
- Production capacities scaled up significantly (approx. 2.400 t), but relativ low utilization
- Innovation barriers: safety aspects (fiber morphology), processing difficulties, forward integration necessary, competing technologies (e.g. graphene)

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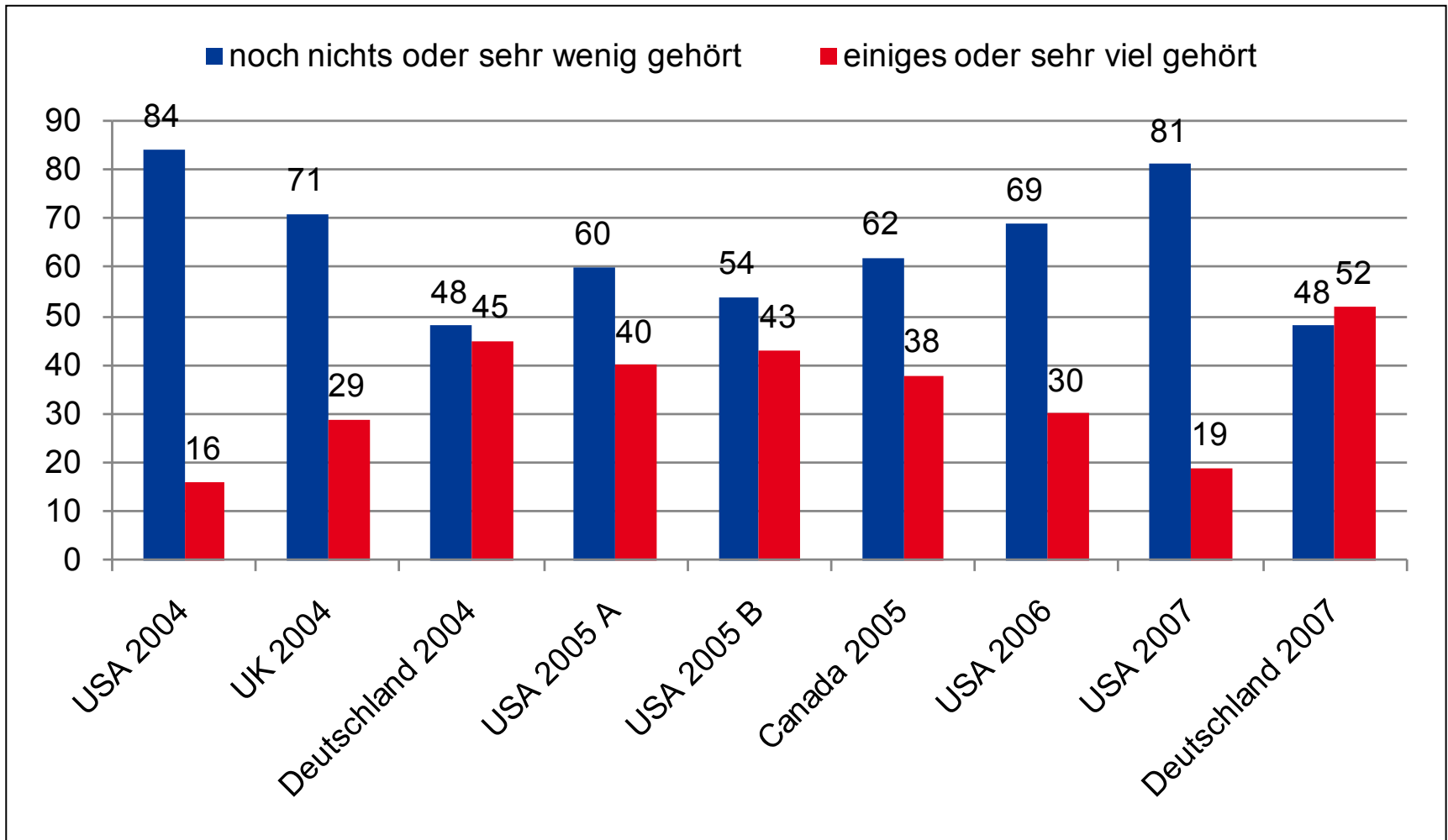
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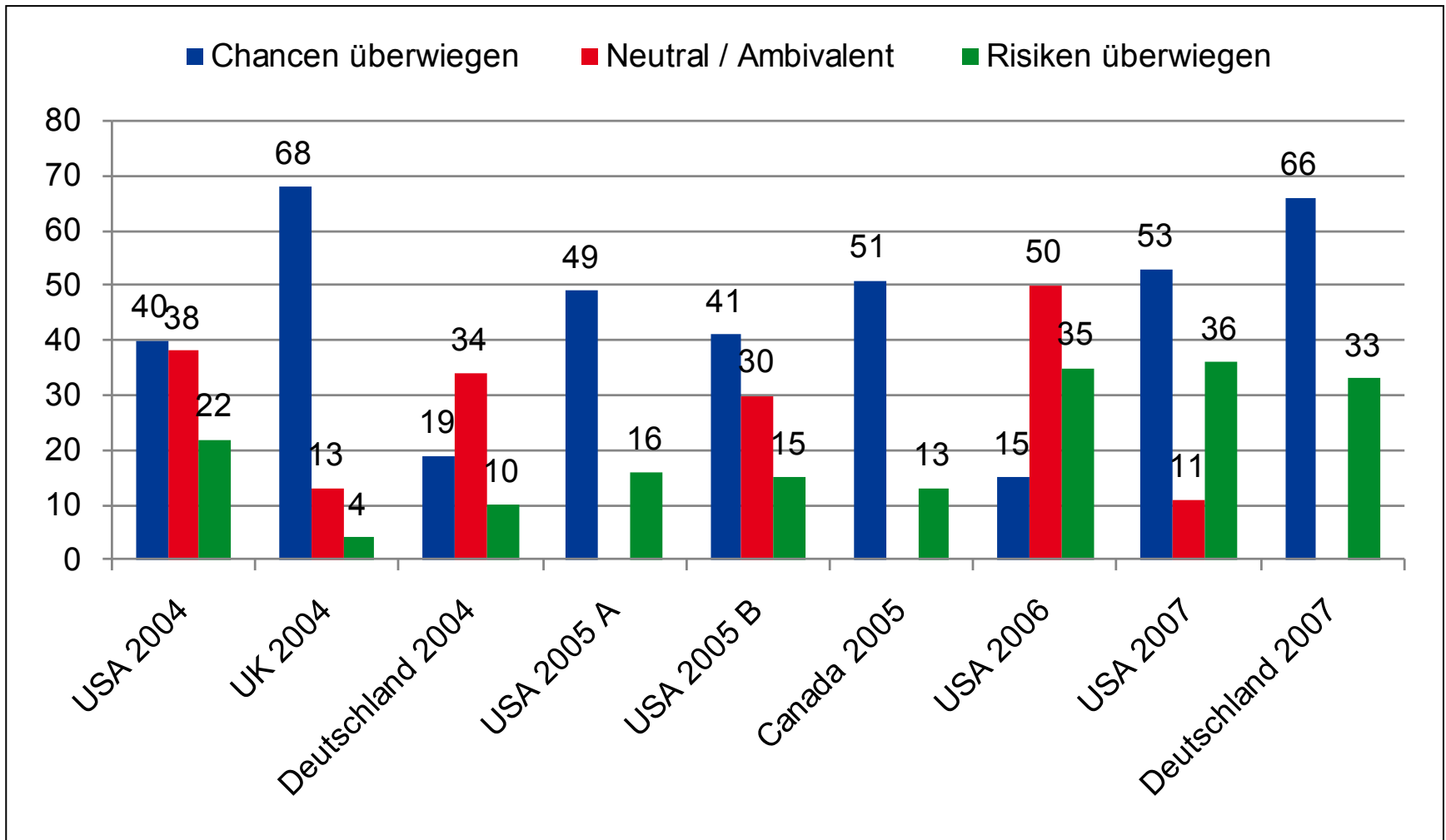
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Public knowledge and perception



Public knowledge and perception



Nanotechnology in the media : From hype



Rechnen mit dressierten Atomen

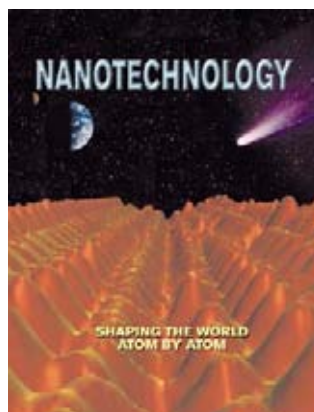
Dank Nanotechnologie ist Zahnreparatur aus der Tube möglich

In vielen Alltagsbereichen sollen diese Alleskönner unser Leben verändern / Keine „Exotendisziplin“ / BASF gut positioniert

Die kleine Technik-Revolution

Die Veränderung von Stoffen auf der Molekül-Ebene ermöglicht viele neue Anwendungen – Nanotechnik

2



- Quellen:
- 1 - Die Wunderwelt der winzigen Giganten: PM 10/2002
 - 2 - Die kleine Technik-Revolution: Rhein-Neckar-Zeitung, 30.10.2002
 - 3 - Rechnen mit dressierten Atomen: Welt am Sonntag, 11.11.2002
 - 4 - Dank Nanotechnologie ...: Badische Neueste Nachrichten, 3.11.2002
 - 5 - 'Nano-U-Boot': Der Spiegel 52/2001
 - 6 - Aufbruch in die Zwergenwelt: Der Spiegel 52/2001
 - 7 - Nanotechnology: Shaping The World Atom By Atom: National Science and Technology Council, September 1999
 - 8 - 'Verkabelter Kosmos': Der Spiegel 47/2002

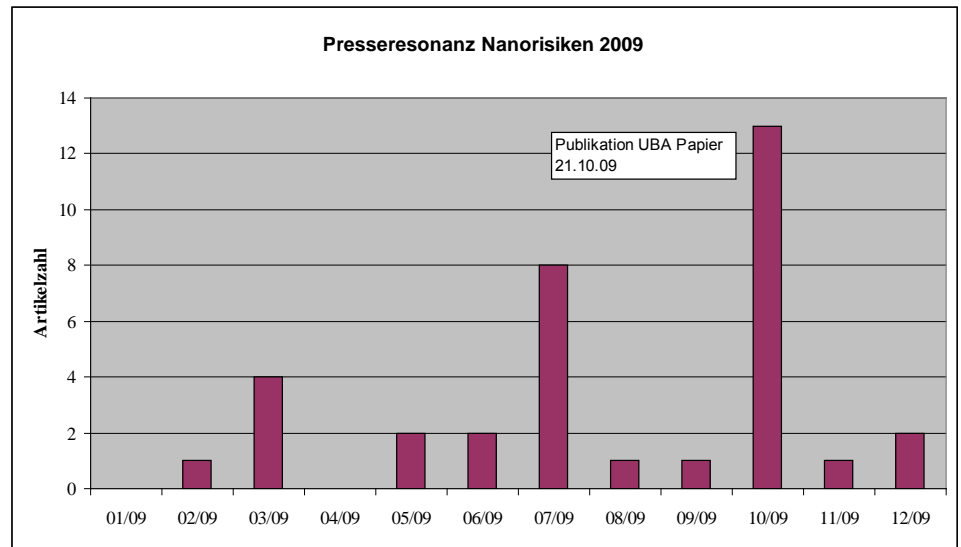
... to hysteria



UBA background paper 10/2009



Rheinische Post vom 22.10.2009



- Only 5-10 % of articles addressing risks of nanotechnologies (period of 2005 to 2010)
- but negative headlines get very high media resonance

Information and public dialogue

Providing objective and scientific based information

- Balanced information on chances and risks targeted on information needs
- Numerous initiatives on federal and state level (e.g. BMBF information campaign nanoTruck, BMBF website www.nanopartikel.info)
- Demand for public product register for more transparency (should be sector specific)

Dialogue with stakeholders

- Several initiatives on federal and state level as well as the chemical industry
- In Germany the dialogue has resulted in constructive discussions e.g. within the Nano-Dialog of the federal government (2006 bis 2012), in France activities have been boycotted by some stakeholders

Dialogue with citizens

- Variety of event formats to address specific information demands and to include open questions (e. g. consumer conferences, citizen dialogues etc.)

Summary – SWOT-Analysis for Germany

Strengths

- High engagement of industries
- Excellent and diversified research landscape
- Diversified research funding (Federal, State, EU level)
- Constructive dialogue on chances and risks

Weaknesses

- Commercialization too slow
- Venture capital investments improvable
- Founding mentality more distinct in other regions
- Scepticism of end-user branches against new nanotechnology solutions

Opportunities

- Establishment of new technology platforms and value chains
- Cross sectional efficiency gains and innovation impulses
- Contributions to resource saving technologies (green nano)

Threads

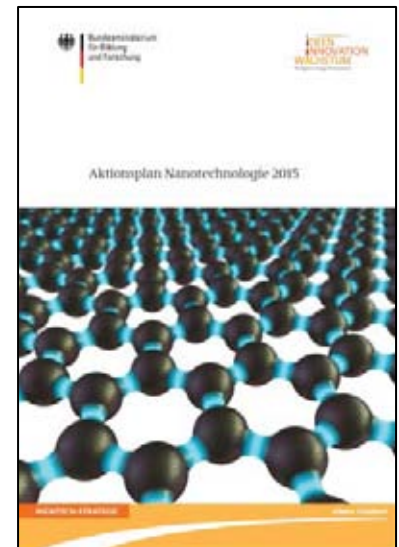
- Uncertainty with regard to regulatory constraints on EU level
- Lack of standards and distinct definitions
- Open safety questions
- Imminent skill shortage

Demand for Action: Policy Measures

► Actionplan Nanotechnology 2015 of the Federal Government

Objectives:

- Supporting Research – Intensifying Knowledge and Technology Transfer
- Securing Competitiveness
- Identifying Risks of Nanotechnology – for Safe and Responsible Handling
- Improving Framework Conditions
- Intensifying Communication – Conducting Dialogues
- Extending International Cooperation



EU Funding for Research and Innovation

Horizon 2020 (2014-2020, ca. 80 bn €) – Priorities:

- Excellent science
- Industrial leadership
- Societal challenges

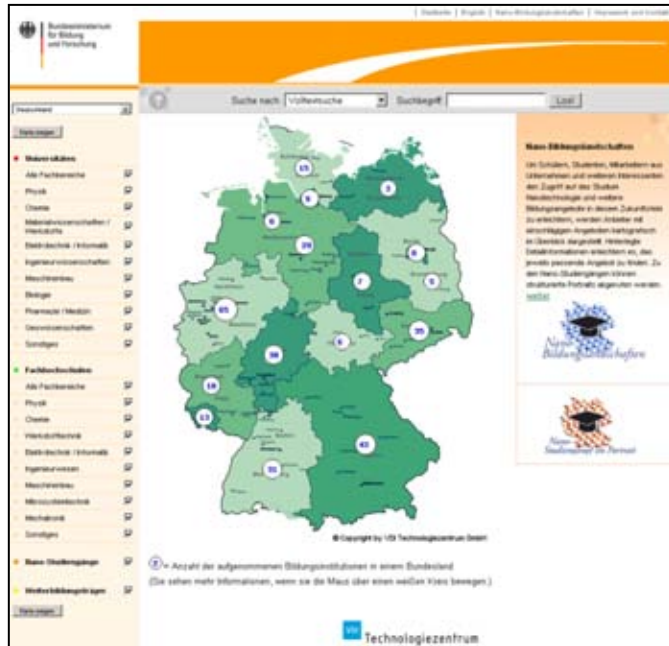


Industrial leadership

- Leadership in enabling and industrial technologies (*ICT, nanotechnologies, materials, biotechnology, manufacturing, space*)
- Access to risk finance (*Leveraging private finance and venture capital for research and innovation*)
- Innovation in SMEs (*Fostering all forms of innovation in all types of SMEs*)

Proposed Funding of the topic Nanotechnology/Advanced Materials/Manufacturing ca. 3,8 bn € (2014-2020)

Further Information



Aus- und Weiterbildung in der Nanotechnologie
www.nano-bildungslandschaften.de



Infokampagne nanoTruck
www.nanotruck.net



nano.DE-Report
www.bmbf.de/de/nanotechnologie.php



Sicherheit von Nanomaterialien
www.nanopartikel.info