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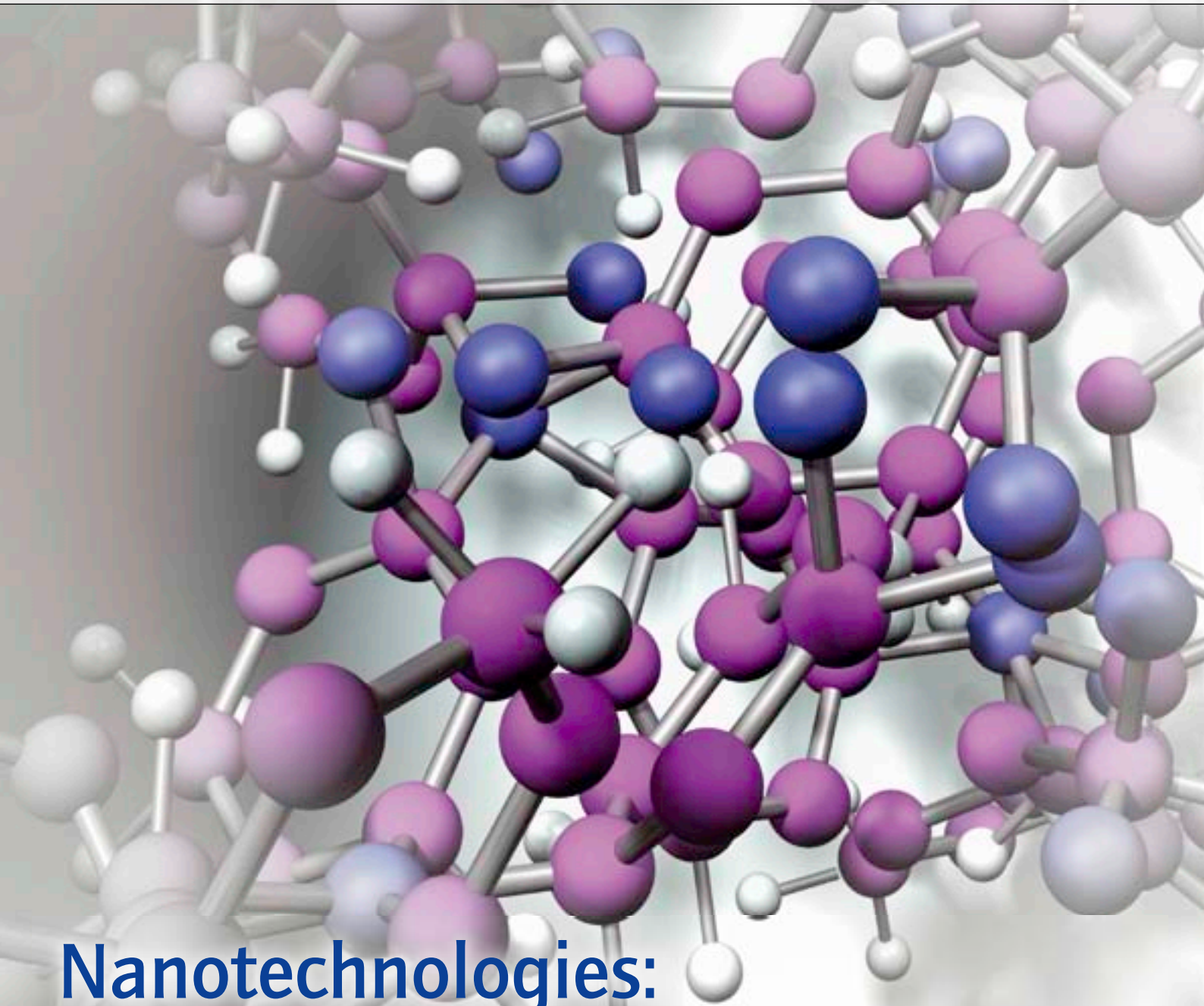
Sustainable reading from the Öko-Institut



Nanotechnologies: An opportunity for sustainability?

The prospects
An interview with Wolf-Michael Catenhusen of the German government's NanoKommission

Nanotechnology – where next?

There is currently a boom in nanotechnologies; Over 2,100 companies across 48 countries currently operate in the nanotechnology sector, and the number is rising. In 2009, Germany increased public spending on nanotechnology research to 441 million euros. Across the EU, around 3.5 billion euros will be spent between 2007 and 2013.

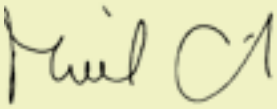
The nano debate is markedly optimistic: in addition to promising new markets and jobs, major advances in 'green nanotechnologies' hold great potential for sustainable development. Examples include saving resources through lightweight construction and optimised building materials, more efficient solar cells and batteries, improved drinking water filters and precisely targeted medicines.

However, some voices warn of potential dangers. The Federal Environment Agency (UBA) highlights 'serious gaps' in knowledge on nanomaterials. The key question, then, is just how serious these gaps are. The Federal Institute for Risk Assessment recently made headlines when it advised against nano-silver being used in products such as food, textiles and cosmetics, with which customers come into close contact. Another reason why some exercise caution is the fact that insurers often limit liability where nanotechnologies are concerned, because the extent of any damage cannot yet be ascertained.

So where next? On balance, do nanotechnologies really represent an opportunity for sustainability? How must we frame their future development if we are to properly identify and truly exploit their potential for sustainability? We will be asking these questions here in eco@work and at the Öko-Institut's Annual Conference 2010. Neither sweeping generalisations nor unchecked euphoria represents the best way forward. Progress depends on our grasping the opportunities nanotechnologies represent, as well as quickly identifying, and avoiding, the risks. This has long been the Institute's approach. Early on, we began following developments in this burgeoning future technology through various research projects. We have collaborated with clients like the German Federal Environment Ministry (BMU) and Federal Environment Agency (UBA), companies like Novartis, Ciba, BASF and Nanogate, the Swiss Centre for Technology Assessment (TA-SWISS) and the Hessen Agentur GmbH.

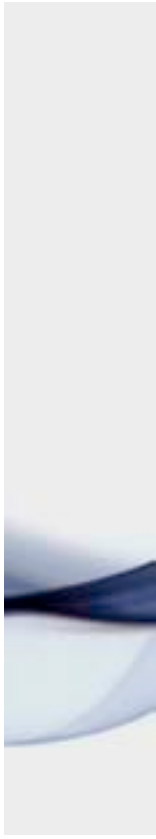
We believe in bringing representatives of government, business and society to the table for a discussion of the nanotechnologies that affect us all. And there is another reason why increased cooperation with business and civil society is needed: new nanoproducts come onto the market almost every day, yet research into risks has not yet caught up. The amount of publicly-funded supporting or precautionary research into nanotechnology is still way below the 10 to 15 per cent advocated by environmental and consumer protection associations. We hope this situation will soon change for the better.

Happy reading!



Michael Sailer
CEO,
Öko-Institut

m.sailer@oeko.de



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Phone: +49 (0) 761/452 95-0, Fax: +49 (0) 761/452 95-88,
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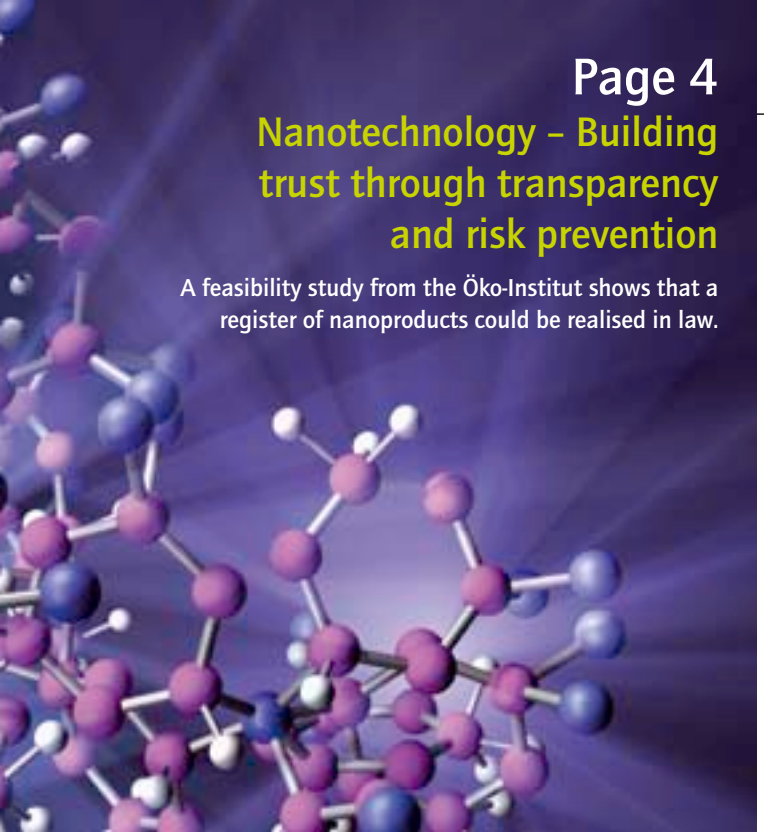
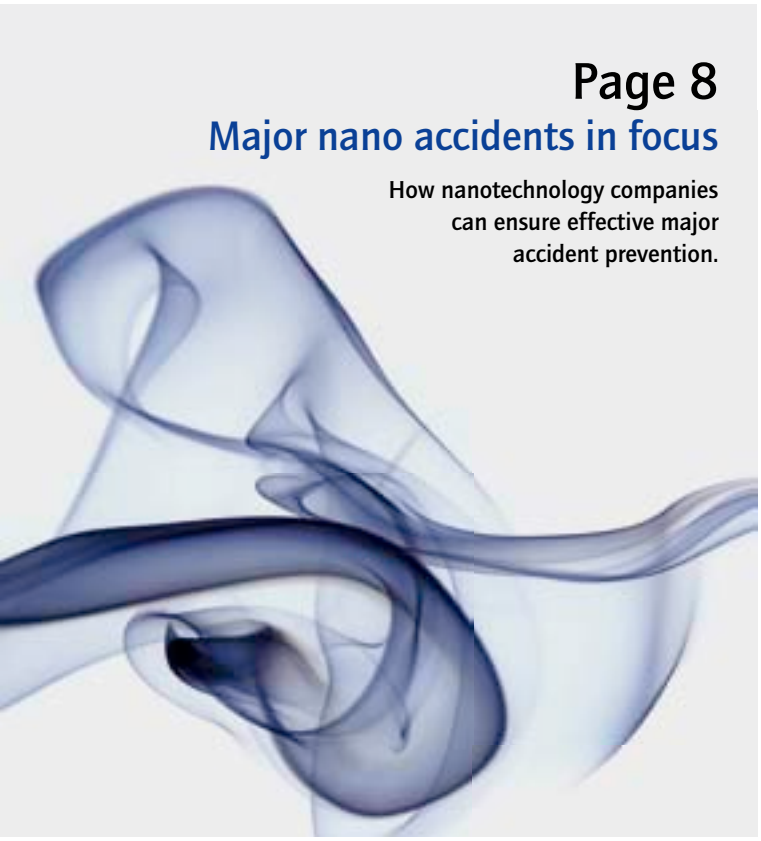


Page 4
Nanotechnology – Building trust through transparency and risk prevention

A feasibility study from the Öko-Institut shows that a register of nanoproducts could be realised in law.



Page 8
Major nano accidents in focus

How nanotechnology companies can ensure effective major accident prevention.

Page 11
What if ...

A vision for society as a whole is needed if nanotechnology is to be used sustainably, (a column).

Contents

Nanotechnology – Building trust through transparency and risk prevention

To date, precious little research has been conducted on the potential risks nanomaterials pose to people and the environment. Often, manufacturers and consumers are unaware whether intermediate or finished products contain nanomaterials. A register of nanoproducts could clarify these issues. A feasibility study from the Öko-Institut, with support from the Federal Environment Ministry (BMU), shows that a register of nanoproducts could be realised in law.

Nanomaterials have long been part of everyday life, be it as part of organic LEDs, unbreakable carbon nanotube fibres or new car body paints. These materials can also be found in products such as sports and work clothing, medicines, sun creams and cleaning products with which customers come into close contact. The online product database at the Woodrow Wilson Center records over 1,000 such consumer nanoproducts worldwide – and the numbers of nanoproducts going unreported may be much higher, since this list is based on information volunteered by manufacturers. A study by Friends of the Earth Germany warns that around 300 consumer products on the market worldwide, including cosmetics and sports clothing, employ nanosilver for its antibacterial properties. This despite indications that it can damage the environment, for example by building up bacterial resistance. Even in the sensitive sector for food contact products, Friends of the Earth Germany counted 93 products containing nanomaterials, mainly nanosilver or nanotitanium dioxide, for example in food additives and food packaging, or as coatings for cooking utensils and household appliances. Nanomaterials have also been found in fertilisers and agrochemicals.

"Consumers are increasingly coming into contact with nanoproducts. This is not without its difficulties, not least in the case of nanomaterials about which there is cause for concern. What is more, the effects of many nanomaterials on people and the environment have not, or not sufficiently, been researched – particularly in long term trials". This is how Andreas Hermann summarises the issue; he is an expert on environmental law and nanotechnology based at the Öko-Institut. The NanoKommission, an expert body set up by the German federal government, has also emphasised the sizeable gaps in our current knowledge of nanotechnology. Yet the question of how to prevent potential risks was not resolved in the commission's first report dated 2008.

On the one hand, industry representatives saw voluntary 'Recommendations for responsible use of nanotechnologies' as sufficient. On the other hand, environment and consumer associations asked that nanoproducts be subject to reporting and labelling requirements. Since then, the calls for stronger regulation have only grown louder. Proof of this can be found in a recent consultation conducted in the context of the EU's planned Strategic Nanotechnology Action Plan (SNAP). More than two thirds of respondents support the establishment of a nano-directory which would provide an overview of the use and safety aspects of nanomaterials.

The NanoKommission has discussed the introduction of a nanoproduct register as a potential regulatory instrument, and once again failed to reach a clear conclusion. In order to resolve such unanswered questions, the Institute produced a feasibility study into the establishment of such a register by the German authorities. The study was published in June and found, in the words of the Institute's Andreas Hermann, that: "From a legal viewpoint, a register of nanoproducts and accompanying notification requirement for nanoproducts manufactured or offered for sale in Germany would be both possible and achievable". A register would also make sense from a policy point of view: "It would ensure transparency and risk prevention and strengthen trust in nanotechnology."

A lack of regulation despite cause for concern.

"First we took an inventory", lawyer Hermann explains of the feasibility study. It became clear from this that there was a general lack of concrete regulation, at both national and EU levels. The EU's only reporting and labelling requirement for nanoparticles to date is in the new Regulation on cosmetic products. No decision has yet been reached as to whether nanoparticles will be permitted in food under the review of the Novel Foods Regulation. Even the EU's chemicals Regulation REACH is incomplete in this regard: "Nanomaterials may be covered in principle as source materials, but there is a lack of communication on their use in the onward production chain, right up to the end product stage", Hermann notes. "As a result, at present neither manufacturers, authorities nor consumers can be sure whether or not a product contains nanomaterials."

Preventing risks, permitting innovation.

In order to keep pace with the great diversity and ever-growing number of nanomaterials, the Institute's study proposes different levels of reporting obligation in the context of the nanoproduct register. "We must think this issue through from the very beginning, and the first step is to label any nanomaterials used as source and raw materials. Then we need to notify semi-finished products such as mixtures and modified nanomaterials, and finally end products too", Hermann explains. "This will ensure transparency about the use of nanomaterials throughout the production chain." If new scientific findings on potential dangers come to light, the production chain will then be able to react quickly. "This will enable us to truly prevent risks without intervening unduly to block innovations", summarises Hermann.

The Institute's feasibility study indicates that a national product register would comply with the EU's rules on the free movement of goods. However, Hermann believes there is a better solution: "If we are to truly minimise risks effectively and exclude possible competitive disadvantages, it makes sense to introduce an EU-wide register of nanoproducts".

"It is no longer acceptable for consumers to be unclear whether their textiles or food contain nanoparticles", states Hermann. "Now is the time for political decisionmakers to take action, especially at EU level. They must establish the necessary legal basis for the transparent and responsible handling of nanotechnology".

David Siebert

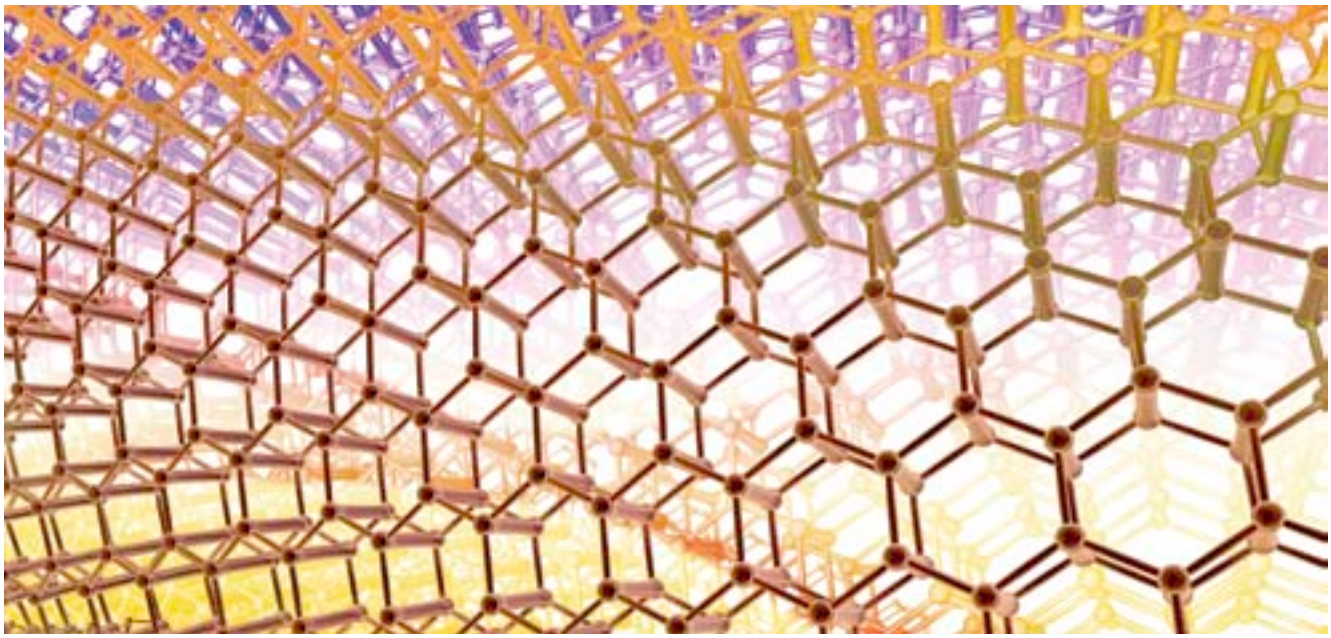
a.hermann@oeko.de
www.oeko.de/103/knowledge1

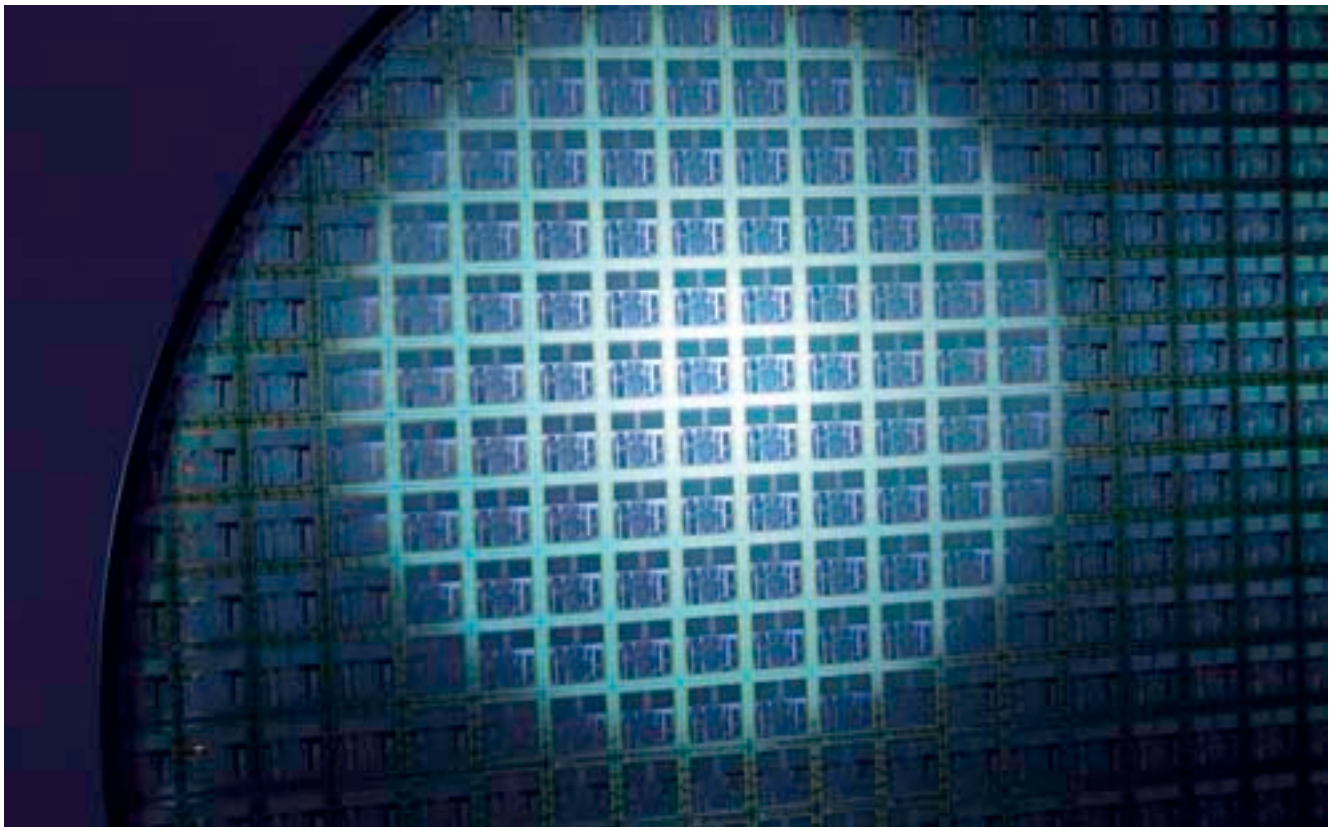
Is it all nano?

A dazzling proliferation of nanotechnology

Nanotechnology cuts across boundaries. Its applications range from medicine to food and food packaging to materials technology, the chemicals and automotive industries, mechanical engineering, electronics and information technology. The umbrella term 'nanotechnology' covers both the manufacture and the application of 'nanomaterials'. These include 'nano-objects' with one, two or three outer dimensions at the nanoscale (approximately 1-100nm), and 'nanostructured materials' with a nanoscale external or internal structure, for example compounds or mixtures containing nano-objects.

Nanomaterials have a larger surface area than the same materials in a larger form and may therefore exhibit different, often fundamentally new, properties such as greater chemical and physical reactivity and mobility. The Öko-Institut advocates a broader 'nano-definition', as even materials with dimensions of up to 200 nanometres can exhibit typical nano-properties.





Nanotechnology

A great opportunity

Nanotechnology is considered to hold the key to the 21st century. It is expected to bring innovation spanning several sectors and drive growth in the economy. A new study by US consultancy LUX predicts that the global market volume for products containing nanomaterials could rise from 147 billion dollars in 2007 to three trillion dollars in 2015.

In Germany, around 750 companies work on the development or marketing of nanoproducts, and in around half of these companies such products make up over 30 per cent of turnover. In 2007, nanoproducts were responsible for 33 billion euros in profit.

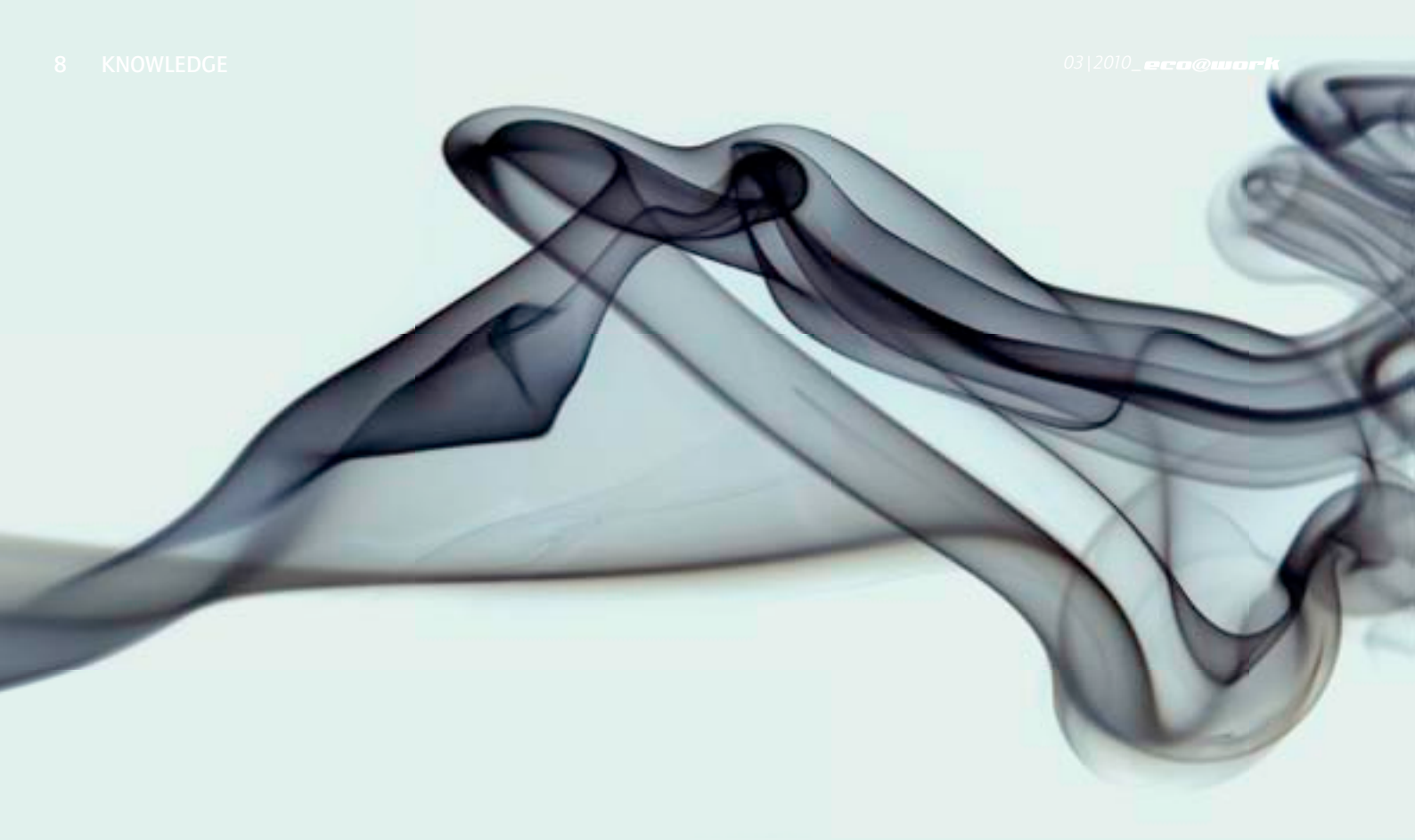
Nanotechnology holds great promise of progress in the fight against hunger, disease and climate change. Yet much of that progress is still a long way off. The question is, will those in need actually benefit from these innovative nano-applications? Nanotechnology currently has some rather unspectacular applications. Consider for example the dirt-resistant, disinfectant properties of some nanoparticles are employed in paints, varnishes and coating materials. Major growth is expected in the nano-electronics sector: soon miniscule nano processors, memory, sensors and displays will enter the market.

Furthermore, nanotechnologies could provide important impetus for environmental protection, for example because they enable materials to be used in a more resource-efficient, sustainable way. The term 'green nano' was coined to cover these possibilities. Examples include energy saving organic LEDS, more powerful batteries, new types of solar cell, lighter materials which help save energy, or filter systems to prepare water.

A great risk

Worldwide, new research results are constantly being published which indicate potential risks to people and the environment from individual nanomaterials. For example, carbon nanotubes can behave like asbestos and cause tumours in the lungs of rats. Research results on the effects of nanosilver and nano-titanium dioxide used in hydroponics also raise concerns. They cause an increase in mortality among water fleas. Nanosilver can breach the blood-brain barrier in some fish species, and cause deformities in fish embryos even at low concentrations.

As a general rule, the more freely the nanoparticle can circulate, the greater the potential risk. The risk is especially high where nanoparticles can be breathed in. In contrast, human skin provides relatively effective protection against nanoparticles. It is not clear what happens when nanoproducts – in the form of sun creams or cosmetics – are applied to damaged skin (such as areas of acne or sunburn). If the nanoparticles are integrated into a solid matrix, the potential risk is reasonably low. However, we must still consider the long-term behaviour of seemingly firmly-integrated nanoparticles. Studies have shown that titanium dioxide particles used for self-cleaning in outdoor paints can be washed off house walls by rain. Equally, silver nanoparticles used in sports clothing for their antibacterial properties can separate from the clothing in the wash and end up in the waste water. In the case of many nanoparticles, we do not know whether they degrade in soil or water over the long term. *ds*



Major nano accidents in focus

The risk of a 'nano-Bhopal' is generally deemed to be small. Yet to date no sound scientific risk analysis has been performed. The Öko-Institut's 'Sustainability assessment for nanoproducts' is a tool intended to help companies ensure better prevention of major industrial accidents.

What would happen if a major accident were to release nanomaterials? How great is the risk of this type of major accident involving nanomaterials? Although these materials are already used extensively in industrial production processes, no satisfactory answers have yet been supplied to these questions. To date, there has been little serious discussion on the possibility of such a major accident. Thus for example Switzerland's Precautionary Matrix for Synthetic Nanomaterials aims to assist companies in their assessment of the risks from such materials, but explicitly excludes major accidents from consideration. Equally, the EU's Seveso II Directive is not easy to apply to nanomaterials (Directive on the control of major-accident hazards involving dangerous substances, transposed into German law by the Störfallverordnung StöV, Ordinance on major accidents). Although the European Commission considers the Directive to be basically suitable for nanomaterials, it also notes that there is insufficient scientific basis for an assessment of the risks from nanomaterials.

Against this background, the Institute is developing a 'Sustainability check for nanoproducts' (see box) with which to assess the need for risk prevention with regard to major accidents in the production and processing of nanomaterials. The foundations for this check have now been laid.

New properties – new risk?

Nanomaterials may exhibit different properties than the same materials in a macro form; the nano form may be toxic or ecotoxic. The difference emerges because surface area increases with particle size, meaning that surface effects end up determining the properties of a material in a particular form. For this reason, volume-based thresholds for certain chemicals, above which problematic effects may occur, cannot be simply transferred from non-nano materials to their nano counterparts. Nanomaterials which have been identified as potentially dangerous should therefore be allocated their own thresholds under the Seveso II Directive.

Furthermore, new research indicates the need to investigate potential risks from nanomaterials for people and the environment.

Of course nanomaterials should not be classified as toxicologically suspect per se, yet there are indications that some individual nanomaterials may interact with biological systems (see also the box on page 11).

Thus some research into cell cultures demonstrates that silicon dioxide can damage neuronal cells. Experiments in hydroponics prove that silicon dioxide, titanium dioxide

and zinc oxide have antibacterial effects. Titanium dioxide also has ecotoxicological effects on algae and water fleas.

The risk of release: Decisions on a case-by-case basis.

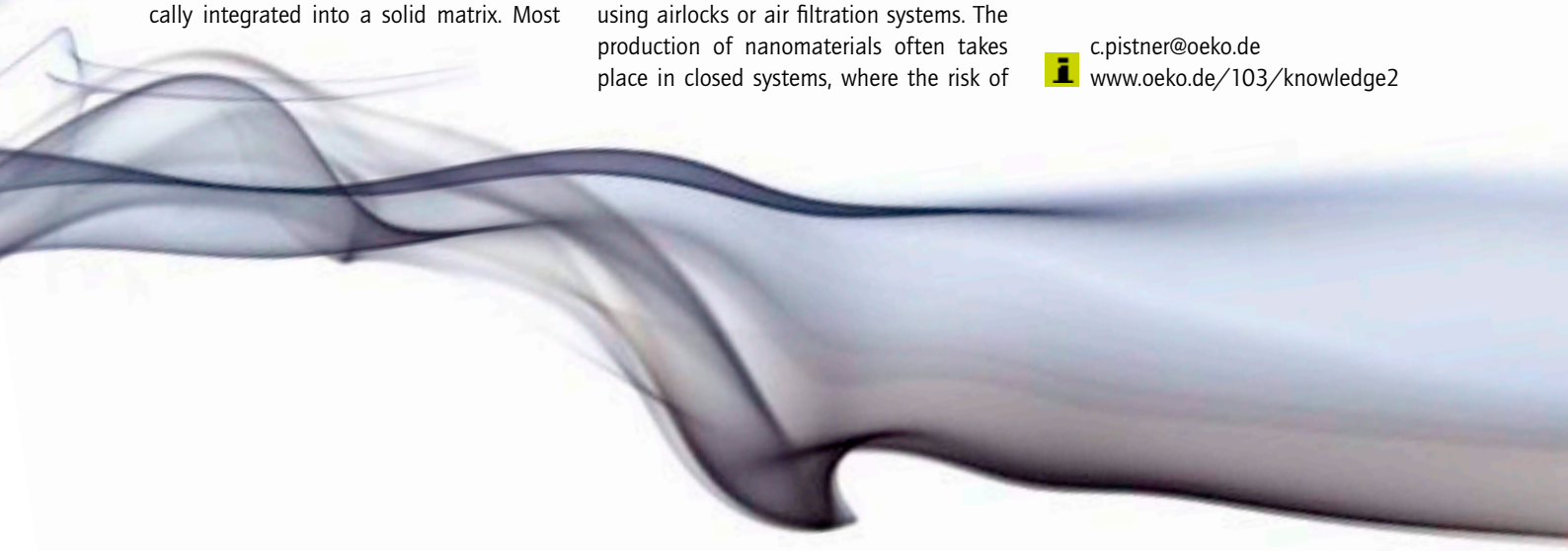
Just how likely is a major accident? Nano-conferences occasionally discuss key terms such as 'nano-Bhopal', but large accidents are not deemed probable. One reason given for this is that nanomaterials are typically integrated into a solid matrix. Most also change their aggregate state upon release into the air, with fine nano-dust for instance binding to larger particles which pose less of a threat. However, such arguments must be tested on a case-by-case basis: during production at least, nanomaterials are not normally integrated into a matrix. Furthermore, a major accident could involve mechanical forces, for example in a fire or explosion, which are greater than the forces binding the particles into the matrix. It would also be possible for the bonds holding nanoparticles to be loosened by rain, or immersion in water. So far only patchy information is available on the aggregation behaviour of nanomaterials under environmental conditions.

In order to assess the risk of a major accident, production facilities and processes must be investigated. The key factor is whether or not the facilities have special protection against release of nanomaterials into the environment, for example using airlocks or air filtration systems. The production of nanomaterials often takes place in closed systems, where the risk of release is lower. On the other hand, the risk of release can sometimes be greater during processing, as typical processes such as milling, decanting and mixing the relevant materials or binding them into a matrix – for example adding nanosilver to paints and varnishes – may take place in an open facility. The general production conditions must also be scrutinised. Factors which could trigger or worsen a major accident might include placing flammable or volatile materials in a particular environment or process where conditions such as high temperature or pressure prevail.

In future, an evaluation tool which builds on these key questions will make it possible to determine whether or not additional precautions are required. There may also be indications of which improvements, made when operating processes and plants, could reduce the risk of release during a major accident.

Dr. Christoph Pistner

c.pistner@oeko.de
www.oeko.de/103/knowledge2



Nanoproducts – a sustainability check

NanoKommission seeks companies to work with. The expert body set up by the German federal government is conducting, for the very first time, a standardised, methodical assessment of the opportunities and risks involved.

The debate within the NanoKommission and in the public arena is increasingly turning to how nanotechnologies can contribute to sustainable development. But just how 'green' are nano-applications in practice? The Öko-Institut is currently working with BASF and Nanogate on a nano-sustainability check to answer that very question. This check will enable companies to examine the concrete benefit nanoproducts bring for the environment, climate protection and society and to optimise the energy and resource efficiency of their nano-applications and access a true picture of any risks. The tool is currently being tested using two case studies; after this initial test phase, additional users will be welcome.

The sustainability check uses the SWOT analysis, borrowed from the business world, to give an overview which combines product-specific strengths and weaknesses with external opportunities and risks. The analysis of strengths and weaknesses involves checks on the characteristics and potential of nanoproducts and materials with regard to CO_2 emission reductions and energy efficiency; it also looks at their toxic effect and economic cost. External conditions are investigated in order to assess opportunities and risks. These conditions include recyclability, availability of raw materials, subsidies, impact on employment, society's values and legal aspects such as insurance. Following a check against key indicators, measures can be developed to maximise sustainability potential and minimise weaknesses and risks.

m.möller@oeko.de

'The question is not whether, but how, to regulate'

The German government has asked the NanoKommission to assess the opportunities and risks arising from nanotechnologies and to develop strategies for the responsible use of nanomaterials. The resulting stakeholder dialogue brings together representatives from worlds of policy, science and business with consumer and environmental organisations. The NanoKommission published its first report in 2008, after two years' work. We interview Wolf-Michael Catenhusen, Head of the German federal government's NanoKommission.

Mr Catenhusen, what do you like about working for the NanoKommission?

I am interested to see if we can learn from past mistakes. We can no longer afford catastrophes like the chemical industry accidents of the 1960s or the communications meltdown over genetic engineering. We should be able to avoid such problems with nanotechnology as long as we succeed in developing a new culture of innovation in terms of risk assessment and communication. There is a good chance we will succeed, since nanotechnology has been accompanied by research into risks and a dialogue with society right from the very early days.

Which issues is the NanoKommission addressing during the second phase of its work, between 2009 and 2011?

Firstly, we are discussing in more detail the possible outcome of a comprehensive benefit/risk assessment of nanomaterials and products. Secondly, we are specifying factors which will help determine the potential risk. And thirdly we are also discussing the current status of and prospects for the regulation of nanomaterials.

Will a voluntary commitment by the industry be enough to ensure the responsible handling of nanotechnologies?

All parties in the NanoKommission are now agreed on regulation: related activity is currently underway within the EU and OECD. The question is not whether to regulate, but how and where to do so. A variety of opinions on this will be supplied in our final report.

What concrete efforts are being made at the moment towards regulation?

The EU is seeking to regulate nanomaterials within the framework of the REACH Regulation. Nanoproducts will come under the Novel Foods, Cosmetics and Food Packaging Regulations. Germany must take a position on these issues within the Council of Ministers, and we are therefore seeking transparency about methodology, labelling and risk assessment.

What is your view on a general labelling obligation for all nanoproducts?

I am sceptical about this idea. Labelling computers which have nanoprocessors makes no sense to me. There is already an EU obligation to list nanoparticles on the label of cosmetics, and an obligation in the pipeline for foodstuffs. The latest question at EU level is about labels on food packaging. The German government abstained from the vote on the Cosmetics Regulation in Brussels.

Didn't the NanoKommission also discuss the introduction of a register of nanoproducts?

Yes, I think it would make sense. It is true that nanomaterials are already registered under REACH, but nanoproducts are not treated in the same way. Any register of nanoproducts should be Europe-wide because of the Single Market. However, it remains to be seen whether the register's primary aim will be to create transparency for consumers or to record risk prevention data for government bodies.

The Federal Institute for Risk Assessment (BfR) currently warns against the use of nanosilver in products with which customers come into close contact. What is your response?

We already have legislation on this issue for food and cosmetics, but not for textiles. The BfR's position raises the question of whether a lack of or incomplete knowledge about the potential damage done by nanoproducts could justify reversing the burden of proof, for instance by temporarily suspending their use or even banning them. The question is hotly debated within the NanoKommission. This is not the approach taken by chemicals policy. It often links precautionary measures to exceeding a threshold or to concrete proof of the scale of damage. We will make a statement on this in our final report.

You argue the case for a 'green nano' mission statement. Why is that?

The mission statement should mean that sustainability, low risk, resource efficiency and climate and environmental protection act as guiding principles for all research and development of nanomaterials and applications. If publicly funded research incorporated the 'green nano' mission statement into its funding requirements, it would provide a powerful incentive.

Thank you for taking the time to speak to us.

Interviewer: David Siebert

wo-catenhusen@t-online.de

www.bmu.de/nanokommission
www.oeko.de/103/values

Wolf-Michael Catenhusen, 65, has been Head of the German federal government's NanoKommission since 2006. Between 1980 and 2002 he was an SPD Member of the German Bundestag. Among other responsibilities, he chaired the Bundestag Study Commission on Opportunities and Risks of Genetic Engineering between 1984 and 1986. From 1998 to 2002 and 2003 to 2005, Mr Catenhusen was Parliamentary State Secretary to the Federal Minister of Education and Research.

What if ...

...'nano' really could save the planet?

Society needs a shared vision if nanotechnology is to be used sustainably

Nanotechnology is considered to hold the key to the 21st century. That's what the glossy brochures and promotional lectures say. Such talk gives people hope: of solving major problems, of medical progress, of saving resources and the environment or at least of conquering new markets.

Yet a quick look at the nanoproducts actually available on the market is enough to bring us back down to earth with a bump. One company in the States offers a nutritional supplement containing nanoscale gold, claiming that this 'wonder drug' promotes wellbeing and improves concentration and motor skills. In terms of nutritional physiology, humans certainly don't need such products; in terms of toxicology they are downright dubious. The benefit of other such nano-wonders is also questionable. What about the 'nano-polishes' for cars? Although they do not claim to increase 'automotive skills', perhaps the intention is to increase the owner's health and wellbeing by means of the regular Sunday car wash and polish?

Sure, 'Nano' sells. But are all the claims simply so much hype? The reality is more complicated. The umbrella term 'nano' covers many different processes, materials and applications. These include products advertised as 'green nanotechnology'. In fact, it is highly likely that nanomaterials could allow interesting innovations in applications such as energy saving, solar cell optimisation, energy-saving lightweight construction technology, energy storage or the preparation of drinking water.

But what lies behind the claims? What is the true scale of the environmental relief brought by nanotechnologies, and is it possible that this positive is outweighed by negatives at other stages of the nanoproduct life cycle? We welcome the move the federal government has made through the NanoKommission to discuss on a case-by-case basis the opportunities and risks brought by nanoproducts and materials, and to draw up appropriate instruments to quantify and evaluate them.

Yet if environmental and social benefit is to be derived from nanotechnologies we first need a shared vision of that benefit: what can nanotechnology applications contribute to the key challenges of the coming decades? They might help us move our energy supply away from carbon by switching to non-fossil fuels, help develop energy-efficient everyday products and help supply an ever-growing global population with clean drinking water. We need to know which product groups are a priority in our search for innovative solutions with which to achieve ambitious climate protection targets. Which parties need to work together to accelerate innovation?

We need developers and manufacturers of nanomaterials and products, but we also need every single member of society. Consumer behaviour in the industrialised world continues to consider the mega rather than the nano scale. This is shown particularly clearly in the automotive industry: do we need to own the latest, largest model; wouldn't car sharing or another mode of transport make for a better alternative? New consumer behaviour patterns and future technologies can both make a major contribution to sustainable development, but only if we are prepared to think differently and use solutions intelligently.

Martin Möller

m.möller@oeko.de
www.oeko.de/103/action

Martin Möller is a qualified engineer and has worked as a researcher at the Öko-Institut since 2002. He runs the 'Sustainability check for nanoproducts' project and is currently planning the Institute's Annual Conference on nanotechnologies.