

Frequently asked questions on nanotechnology

FAQs, 15 November 2006

Nanotechnology is considered to be an important future technology. However its use is not new. It already arrived on the scene decades ago in varnishes and medicinal products even if it didn't go by this name. Nanotechnology is now used in a targeted manner in many areas of daily life like cosmetics, foods and consumer products without this being obvious to the consumer. There is no labelling obligation for nano products.

Industry, science and consumers believe that the use of nanomaterials will lead to improved product characteristics. This, however, raises the question whether new nano products may bring with them unknown risks for humans. In particular nanoparticles, which are present in unbound form, could lead to a specific health risk. BfR is involved in research into the risks of nanotechnology. In this context the Institute focuses on possible adverse reactions of nanoparticles in the human body.

Although nanomaterials are to be found in a growing number of products, more than half of all Germans scarcely know anything about this technology, its use or the potential risks. BfR has drawn up selected questions and answers on nanotechnology.

How small is a "nano"?

"Nanos" comes from the Greek and means dwarf. "Nano" is the term used for the billionth part of a metre (= 1 nanometre).

What do we mean by nanoparticles?

Nanoparticles are particles with a diameter of less than 100 nanometres (nm). Because of their small size nanoparticles have different physical properties to larger particles of the same substance. This makes them interesting for various applications. At the same time, however, the smallness of nanoparticles can lead to adverse reactions.

What do we mean by nanotechnology?

Nanotechnology is the generic term for a wide range of technologies which are used in various natural science disciplines like physics, chemistry, biology and medicine. It would in fact be more correct to talk about nanotechnologies. Nanotechnology involves research into, the processing and production of structures and materials with at least one dimension smaller than 100 nanometres (nm). Nanomaterials are "dot shaped" structures (nanoparticles, nanocapsules, clusters or molecules), "linear" structures (nanofibres, nanotubes, nanotrenches) and ultra-thin coatings. Inverse structures (pores) are also in this category.

With the help of nanotechnology it is possible to develop structures, techniques and systems with completely new properties and functions. Industry, medicine, science and consumers hope that this potential will lead to beneficial applications for instance in robotics, sensory technology, process engineering, biotechnology and medicine as well as for the further development of foods, consumer products and cosmetics.

In which products has nanotechnology already been used?

Already now consumers come into contact with products whose components have been produced with the help of nanotechnology, be they cosmetics, foods or textiles. The market for nano products is growing rapidly. It is the nano dimensions alone that make it possible to produce substances with completely new properties: car paint that is scratch resistant, a tie that is dirt repellent or sunscreens that offer better protection against UV light.

A database of nano products which are currently on the market can be accessed on <http://www.nanotechproject.org/44/consumer-nanotechnology>. The database "A Nanotechnology Consumer Products Inventory" is a project of the Woodrow Wilson International Centre for Scholars.

How can I tell whether a product contains nanomaterials?

Consumers cannot tell whether products contain nanomaterials or not. There is no labelling obligation for nano products. Consumers can only identify the use of nanomaterials when manufacturers promote their products by mentioning nanotechnology. But from advertising for a product alone it is not, however, possible to say whether the products actually contain nanoparticles or other nanomaterials.

Why are nanomaterials used in cosmetics?

Nanoparticles like titanium dioxide and zinc oxide are most widespread in UV filters in sunscreens. These nanoparticles have a high level of efficacy and protect the skin against UV rays. Nanotechnologically manufactured materials (so-called biocomposites) in toothpaste promote the natural tooth repair mechanism of saliva. In care products nanocapsules protect and transport active ingredients and enhance their effect. Fullerenes (football-shaped caged molecules made of carbon atoms) are being used in the first cosmetic products for this purpose. Research is underway on improving the physical properties (e.g. transparency) of finished cosmetic products through nanomaterials.

Are nanomaterials used in foods?

It is reported that nanomaterials are used as auxiliaries and additives in foods. For instance, silicic acid and other silicon-containing compounds are said to be used as thickening agents to prevent sodium chloride crystals and powder-form foods from sticking together and to make ketchup pour more easily. Silicic acid is also used as a flocculant in wine and fruit juice production. It is not yet clear whether nanoparticles are actually used and, if this is the case, whether free nanoparticles then occur in foods.

Nanomaterials are used in food supplements for specific purposes, too. There are reports of the use of silicon dioxide, colloidal silver, calcium and magnesium in nanoparticle form. It is not clear whether these materials are present in foods as nanoparticles or in aggregate form. The food industry is currently developing functional foods in which vitamins, omega 3 fatty acids, phytosterols and aromas are enclosed in nanocapsules and then released in the body.

Are nanomaterials also used in consumer products?

Nanomaterials are used in various ways in consumer products. For instance nanomaterials are used in food packaging, textiles, kitchen devices, varnishes and paints. Furthermore, they are used in products for surface sealing and cleaning as well as in polishing agents.

The packaging industry is interested in the application of nanoparticles which are bound as fillers in plastics and varnish layers or applied as coatings to polymer surfaces (films and containers). In food packaging nanoparticles prevent gas from penetrating the packaging or moisture from escaping. The use of nanoparticles could improve the mechanical and thermal properties of food packaging and protect food against UV light. In future, nanotechnology is to be used to develop packaging materials for foods which indicate whether the cooling chain has been interrupted or whether the sell-by date has been exceeded.

In the clothing sector special functional textiles are being developed, for instance protective insulating clothing or self-cleaning textile surfaces. By producing nanostructured polymer coatings on textile surfaces, textiles could in future acquire new properties and protect against UV rays or act as a water barrier. Antimicrobial silver nanoparticles are already used in socks, shoe insoles and a few clothing textiles.

Is there a specific health risk from nano products?

In order to estimate whether nano products constitute specific health risks it is important to know whether the nanomaterials used are bound in a matrix or are present in the product in unbound form. In particular free nanoparticles, nanotubes or nanofibres could lead to health risks through their small size, form, high mobility and higher reactivity.

Unbound nanoparticles could reach the human mechanism via three paths and develop a toxicological impact under certain circumstances: the respiratory tract, the skin and the gastrointestinal tract. Scientists believe that the greatest risks stem from the inhalation of nanoparticles. The latest scientific findings largely rule out the possibility of nanoparticles penetrating the human skin. We do not yet know whether there are any risks involved in the uptake of nanoparticles from the gastrointestinal tract.

Up to now most nano products consisted of nanoparticles that are enmeshed in a solid matrix or liquid suspension. Furthermore, nanoparticles tend to aggregate into larger unions which are generally larger than 100 nm. The toxic effects of nanoparticles linked to their small size and higher reactivity are then no longer relevant.

In principle, manufacturers are obliged to guarantee that their products are safe.

Has an assessment of the health risk of nanomaterials used in consumer products already been undertaken?

Studies have been conducted on some nanoparticles used in cosmetics. For instance there has been considerable research into the behaviour of nanoparticles made of titanium dioxide and zinc oxide on the skin. Several experiments confirmed that these nanoparticles do not penetrate the healthy skin cells of humans but remain on the skin surface. They do indeed reach deeper skin layers via the hair follicles (root sheaths) where they remain for some time but do not penetrate further. Hair growth then transports them back to the skin's surface.

However, at the present time some questions have still to be answered when it comes to assessing the health risk of nanoparticles. Very little is known about the possible specific toxic properties linked to nanoscalability. Very little data is available on human exposure to nanoparticles, too. Scientists are currently working on suitable test strategies to determine possible health risks in order to answer the open methodological questions.

Has there already been a product in which the nanomaterials caused damage to health?

So far BfR has not received any reports about cases in which health damage was shown to have been caused by nanoparticles or nanomaterials. The health disorders, in some cases severe, which occurred after the use of so-called nano sealing sprays were not due to nanoparticles according to the BfR findings. More than 110, in some instances, severe cases of health disorders had been reported to the poison control and treatment centres and BfR by the end of March 2006. Consumers had used the products Magic Nano Glass Sealer and Magic Nano Ceramic Sealer in spray doses with a propellant. Initially it was thought that nanoparticles were involved in the lung function disorders. According, however, to information from the manufacturers and tests by BfR, the products did not contain any nanosized particles. It is still not clear what caused the respiratory disorders.

What does the consumer know about nanotechnology?

Although new materials manufactured using nanotechnology are increasingly being used in consumer products, many people do not really know what this involves. According to a survey for instance 50% of Germans have no idea whatsoever what the abbreviation "nano" means. People who have already heard something about nanotechnology largely view the technology in a positive manner and point to its benefits. However, most consumers would like products manufactured using nanotechnology to be clearly labelled. (http://www.komm-passion.de/fileadmin/UL-AdvTec/Nanostudie_kurz.pdf)

In what way is BfR involved in research into the risks of nanotechnology?

BfR, together with the Federal Institute for Occupational Safety and Health and the Federal Environmental Agency, has developed a research strategy to identify the potential risks from nanotechnology. The objective of this research strategy is to structure the research area, to develop methods for measuring and characterising nanoparticles, to collect information on exposure and toxicological/ecotoxicological effects and to promote the development of a risk-driven test and assessment strategy.

In parallel to this, BfR will conduct a survey of experts in the field of nanotechnology in 2006. The goal is to identify nanomaterials which are being or could be used, to classify them according to concrete applications and to draw conclusions, from that information, about consumer exposure. Based on the available knowledge on exposure and hazard potential, BfR in co-operation with the interviewed experts will categorise the applications according to the degree of the probable risk and develop strategies for their minimisation.

BfR also examines how the subject nanotechnology is perceived by the public at large. A consumer conference identified the risks that consumers linked to the application of nanotechnology. The next step is to be a representative survey of the population and a media analysis.

What is the link between liposomes, micelles or vesicula and nanotechnology?

Organic compounds like liposomes, micelles or vesicles are used in foods to encapsulate other substances like vitamins or flavourings, to transport them around the body and release them in a targeted manner. As the size of these "transport containers" is frequently in the nanometre range, they are also called nanocapsules. However, in contrast to inorganic, insoluble nanoparticles, their nanoscalability does not lead to any new properties or, by exten-

sion, to any new biological effects. Hence, the use of nanoscale organic compounds is not classified as nanotechnology in the narrower sense by BfR. Organic substances like beta-cyclodextrin or polysorbates are frequently used for the capsule membrane. They are toxicologically tested and assessed, and are approved as food additives (E 459 and E 432 up to E 436).