

nanoRISK

OPTIMIZING THE BENEFITS OF NANOTECHNOLOGY
WHILE MINIMIZING AND CONTROLLING THE RISKS

Insider Report

NANORISKCAT - A CONCEPTUAL DECISION SUPPORT TOOL FOR NANOMATERIALS

In a project funded by the Danish Environmental Protection Agency (EPA), the Technical University of Denmark (DTU) and National Research Centre for the Working Environment have initiated the development of a screening tool called NanoRiskCat (NRC) for the evaluation of exposure and hazard of nanomaterials contained in products for professional and private use.

Authored by Steffen Foss Hansen and Anders Braun from DTU's [Department of Environmental Engineering](#) and Keld Alstrup-Jensen from the [National Research Centre for the Working Environment Environmental Project](#), the 268-page report on the NanoRiskCat screening tool [can be downloaded as a PDF file](#) from the Danish EPA's website.

The project's aim was to identify, categorize and rank the possible exposure and hazards associated with a nanomaterial in a product. NanoRiskCat is using a stepwise approach based on existing data on the conventional form of the chemical as well as the data that may exist on the nanoform. However, the tool still needs to be further validated and tested on a series of various nano products in order to adjust and optimize the concept and thereby to achieve a screening tool as informative and practical as possible.

It is the view of the Danish EPA that the traffic light ranking of the health effects may be further modified to obtain a better ranking in the various categories. Thus titanium dioxide in sunscreen is ranked as red due to lung effects of titanium dioxide, because the tool in its present form does not sufficiently take account of which type of health effects that are most relevant for the most relevant exposure route of the product. In this case the inhalational exposure of titanium dioxide from a sunscreen seems less relevant.

Executive Summary

Nanomaterials are being used in a rapidly increasing number of products available for industries and private consumers. The number of nanomaterials that can be manufactured using nanotechnologies is immense and the improved material properties enable use in multiple different products. During the last decade more and more evidence has emerged in the scientific literature suggesting that some nanomaterials may have hazardous properties.

With this background, the Danish Environmental Protection Agency has identified a need for developing a new concept that can provide support to companies and regulators in regard to assessing, ranking and communicating what they know about the risks of nanomaterials in specific product uses. In this case, risk should be defined as a combination of the likelihood of exposure and adverse effects, i.e. any chance of an adverse outcome to human health, the quality of life, or the quality of environment.

Through this project, DTU Environment and the National Research Centre for the Working Environment have initiated the development of a screening tool, NanoRiskCat (NRC), that is able to identify, categorize and rank exposures and effects of nanomaterials used in consumer products based on data available in the peer-reviewed scientific literature and other regulatory relevant sources of information and data. The primary focus was on nanomaterials relevant for professional end-users and consumers as, as well as nanomaterials released into the environment.

The wider goal of NanoRiskCat is to help manufacturers, down-stream endusers, regulators and other stakeholders to evaluate, rank and communicate the potential for exposure and effects through a tiered approach in which the specific applications of a given nanomaterial are evaluated.

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RESEARCH PROBES POTENTIAL LINK BETWEEN CANCER AND ZINC OXIDE NANOPARTICLES IN CONSUMER PRODUCTS

A study led by a group of Nanyang Technological University (NTU) researchers has found that a chemical commonly used in consumer products can potentially cause cancer.

The chemical, Zinc Oxide, is used to absorb harmful ultra violet light. But when it is turned into nanosized particles, they are able to enter human cells and may damage the cells' DNA. This in turn activates a protein called p53, whose duty is to prevent damaged cells from multiplying and becoming cancerous. However, cells that lack p53 or do not produce enough functional p53 may instead develop into cancerous cells when they come into contact with ZnO nanoparticles.

The study is led by Assistant Professor Joachim Loo, and Assistant Professor Ng Kee Woei, from NTU's School of Materials Science and Engineering. They worked with Assistant Professor David Leong, 38, from the Department of Chemical and Biomolecular Engineering, National University of Singapore, a joint senior author of this research paper.

The findings suggest that companies may need to re-assess the health impact of nanosized Zinc Oxide particles used in everyday products. More studies are also needed on the use and concentration levels of nanomaterials in consumer products, how often a consumer uses them and in what quantities.

"Currently there is a lack of information about the risks of the nanomaterials used in consumer products and what they can pose to the human body. This study points to the need for further research in this area and we hope to work with the relevant authorities on this," said Asst Prof Loo. The groundbreaking research findings were published in this month's edition of *Biomaterials* ("[The role of the tumor suppressor p53 pathway in the cellular DNA damage response to zinc oxide nanoparticles](#)"), one of the world's top journals in the field of biomaterials research. The breakthrough also validated efforts by Asst Prof Loo and Asst Prof Ng to pioneer a research group in the emerging field of nanotoxicology, which is still very much in its infancy throughout the world.

Nanotoxicology studies materials to see if they are toxic or harmful when they are turned into nano-sized particles. This is because nanomaterials usually have very different properties when compared to when the materials are of a larger size.

Asst Prof Ng said the team will carry out further research as the DNA damage brought about by nano-sized Zinc Oxide particles is currently a result of an unknown mechanism. But what is clear is that besides causing DNA damage, nanoparticles can also cause other harmful effects when used in high doses.

"From our studies, we found that nanoparticles can also increase stress levels in cells, cause inflammation or simply kill cells," said Asst Prof Ng who added that apart from finding out the cellular mechanism, more focused research is also expected to ascertain the physiological effects and damage that nano-sized Zinc Oxide particles can cause.

Asst Prof Loo pointed out that besides enhancing the understanding of the potential risks of using nanomaterials,

advancements in nanotoxicology research will also help scientists put nanomaterials to good use in biomedical applications.

For example, although killing cells in our bodies is typically undesirable, this becomes a positive outcome if it can be effectively directed towards cancer cells in the body. At the same time, the team is also studying how nanomaterials can be "re-designed" to pose a lesser risk to humans, yet still possess the desired beneficial properties.

This research discovery is one of the latest in a series of biomedical breakthroughs by NTU in healthcare. Future healthcare is one of NTU's Five Peaks of Excellence with which the university aims to make its mark globally under the NTU 2015 five-year strategic plan. The other four peaks are sustainable earth, new media, the best of the East and West, and innovation.

Moving forward, the team hopes to work with existing and new collaborative partners, within and outside of Singapore, to orchestrate a more concerted effort towards the advancement of the fledgling field of nanotoxicology here, with the aim of helping regulatory bodies in Singapore formulate guidelines to protect consumer interests.

The research team would also like to work with the European Union to uncover the risks involving nanomaterials and how these materials should be regulated before they are made commercially available. Asst Prof Joachim Loo, who received his Bachelor and Doctorate degrees from NTU, was the only Singaporean representative in a recent nanotechnology workshop held in Europe. At the workshop, it was agreed that research collaborations in nanotoxicology between EU and South-east Asia should be increased.

LIFE CYCLE OF INORGANIC NANOPARTICLES IN BIOLOGICAL FLUIDS

New research results that will lead to improved understandings of the impact of nanomaterials on human health and more effective strategies for detoxification of nanoparticles have recently been published in the journal *Small* ("[Hardening of the Nanoparticle-Protein Corona in Metal \(Au, Ag\) and Oxide \(Fe₃O₄, CoO, and CeO₂\) Nanoparticles](#)").

The researchers studied the surface modifications of metal (Au, Ag) and metal oxide (Fe₃O₄, CeO₂ and CoO) nanoparticles with sizes ranging from 7 to 20 nm dispersed in commonly used cell culture medium supplemented with serum. All tested nanoparticles absorb proteins onto their surface, thereby forming a protein corona through a dynamic process evolving towards an irreversible coating (hard protein corona).

Despite the fact that the studied nanomaterials have similar characteristics of hydrophobicity and surface charge, different temporal patterns of the protein corona formation were observed that can be considered a fingerprint for nanoparticle identification. Moreover, the researchers found that the protein corona formation on CoO nanoparticles reduces their adverse effects on cellular oxidative stress.

This is done by providing detailed guidance on mapping and reporting of the:

- 1.Exposure potential for professional end-users
- 2.Exposure potential for consumers
- 3.Exposure potential for the environment
- 4.A preliminary hazard evaluation for humans
- 5.A preliminary hazard evaluation for the environment

A generic template for mapping and reporting these five aspects for a specific application of a given nanomaterial has been developed and can be found in Appendix 1 of the report.

In its simplest form, the final outcome of using NanoRiskCat for a nanomaterial in a given application will be communicated in the form of a short title describing the use of the nanomaterial (e.g. MeO in ship paint) and a five-color coded dots, where the first three dots always refer to potential exposure of professional end-users, consumers and the environment in that sequence and the last two colors always refer to the hazard potential for humans and the environment. The colors signify whether the indications of exposures or effects separately are high (red), medium (yellow), low (green), or unknown (grey).

Color Coding

The color-coding of the dots representing the exposure potential (dot numbers one to three) is based on the generic use descriptor system established by the European Chemicals Agency (ECHA) in the current REACH Guidance on information requirements and chemical safety assessment Appendix R.124. For each use category, a color code has been assigned based on 1) the location of the nanomaterial (bulk, on the surface, liquid or airborne) and 2) a judgment of the potential for nanomaterial exposure based on the description and explanation of each process, product category, technical function, article and environmental release category provided in the REACH Guidance.

When assigning a color to the dot representing potential human health hazards (dot number four) related to the specific application of a given nanomaterial the following indicators/qualifiers should be considered:

1. Does the nanomaterial fulfil the HARN paradigm?
2. Is the bulk form of the nanomaterial known to cause or may cause serious damaging effects, i.e. is the bulk form classified according to the CLP with regard to one or more serious health hazards such as germ cell mutagenicity, carcinogenicity or reproductive toxicity in category 1A, 1B or 2?
3. Is the bulk form of the nanomaterial classified for other less severe adverse effects according to the CLP such as skin corrosion/irritation category 2 and specific target organ toxicity-single exposure category 3?
4. Is the specific nanomaterial known to be acute toxic?
5. Are there indications that the nanomaterial causes genotoxic, mutagenic, carcinogenic, respiratory, cardiovascular, neurotoxic or reproductive effects in humans and/or laboratory animals or has organ-specific accumulation been documented?

The human hazards information on the bulk form of the material may be used as a starting point in order to describe a possible minimum level of concern in regard to the toxicological profile for the nanomaterial. A guiding principle is that information about the bulk form of the material can be used under the assumption that any toxicological and ecotoxicological effects of the nanomaterial are equal to or larger than those reported on for the bulk material. Thus hazard data on the bulk material forms the basis of the lowest level of concern with regard to the nanomaterial.

In NRC, indications of the level of environmental effects (dot number five) should include considerations of whether the nanomaterial in question is reported to be:

- 1.Hazardous to environmental species?
- 2.Persistent?
- 3.Bioaccumulative?
- 4.Leading to potentially irreversible harm to the environment (e.g. ecosystem effects)?
- 5.Readily dispersed?
- 6.Novel?

It is important to note that NanoRiskCat is a stepwise and tiered approach in the sense that once a color code has

Exposure			Effects	
Prof	Consum	Environ	Human	Environ
•	•	•	•	•
			7b ^{a)}	2 ^{b)}

Red, yellow and green indicate high, medium and low indication of exposure/effect level whereas grey indicates too limited data to assess exposure/effect; a) "based on in vivo evidence of a combination of hazards from testing of the nanomaterial" (see Appendix 2, Table A2.1); b) "based on LC₅₀ or EC₅₀ < 10 mg/l for the testing of the nanomaterial" (see Appendix 2, Table A2.2)

Example of the evaluation of environmental hazard of C₆₀ in C₆₀ LubExtreme according to NanoRiskCat

NANORISKCAT...

been triggered this finalizes the screening process.

To help communicate the scientific reasoning behind the human health and environmental hazard categorization and the assigned color code, a number of standard sentences have been included in the framework. These sentences are primarily meant to reflect whether the categorization has been reached based on *in vivo* or *in vitro* studies and in regard to which effect or endpoint. Depending to the final categorization in regard to human health and environment, the user of NRC has to select one or more of those sentences that best reflect the scientific basis for assigning the color code.

Examples

In order to illustrate the feasibility of NanoRiskCat two nanomaterials (titanium dioxide and C₆₀) were used as training sets in two different applications i.e. C₆₀ used in a lubricant and TiO₂ used in sunscreen. These examples were chosen order to be used in the development of the concept but they are also included in the current report in order to illustrate the applicability of NanoRiskCat. Example of the evaluation of environmental hazard of C₆₀ in C₆₀ LubExtreme according to NanoRiskCat. It is important to underline that NanoRiskCat is not a product label and NanoRiskCat is only to be used for evaluating the nanomaterial as an ingredient under the physical conditions it occurs in the product. NanoRiskCat does not evaluate exposure and effects from the other constituents and impurities in the product nor does it take into account the specific content of nanomaterial in the product. Thus, NanoRiskCat is directed towards the generic use descriptors and scenarios, which for instance are apparent in the product categories used in REACH. Although NanoRiskCat is generic in nature and can be used on all kinds of nanomaterials and applications, the NanoRiskCat color code itself is application-specific. Thus, a NanoRiskCat color code does not in itself allow for an overall evaluation of risks associated with a given nanomaterial.

A significant strength of NanoRiskCat is that it can be used even in cases where lack of data is prominent and hampers the completion of traditional risk assessment procedures. Another is that the results of NanoRiskCat can be easily communicated to interested parties. A significant weakness of NanoRiskCat is that many of the cut-off values used primarily in the environmental hazard evaluation is based on dose-by-mass which we know is probably not valid for all nanomaterials as it is an ongoing discussion on which dose-metrics will be the best to use in nano-ecotoxicology. Furthermore, the process by which the color code is assigned to human hazards associated with the nanoform of a given material is based primarily on scientific expert judgement and a holistic assessment of the evidence of mutagenicity, carcinogenicity, respiratory toxicity, etc. As expert interpretation of scientific literature vary, so can the conclusion reached and the human hazard color code assigned to nanomaterial. It is not possible to provide clear-cut

guidance and rules at this point in time for how to complete holistic evaluation of the human and environmental hazards associated with the nanoform of a given material. *It is crucial in this context that the users of the NRC explain what literature they have identified as relevant and explain how they interpret the reported results and assign the various color codes in the NRC template provided in Appendix 1.*

The result of NRC does not lead directly to an decision in contrast to other decision-making tools available for nanomaterials, but NRC does provide a informed and structured foundation for decision-making by including a number of indicators that define whether exposure and effects are likely (or unlikely) to occur and whether the nanomaterial may have harmful properties of concern.

Decisions Are Stakeholder-Dependent

Decisions that could come out of using NanoRiskCat are stakeholder-dependent. Regulators could use NRC as a screening tool to identify possible uses where risk management measures may be further examined e.g. to develop guidance on controlled uses, or to evaluate whether specific restrictions would be required or to identify data needs. Companies can use NanoRisk- Cat to communicate what they know about the exposures and effects of the nanomaterial they use, assess the need to develop guidance for safe uses that e.g. limit exposures by changing the product formulation or the use of the nanoproduct or work systematically with designing safer nanomaterials. Likewise, the company could develop guidelines for professional end-users and consumers about the safe uses of their nanomaterials and products. Down-stream users (e.g. consumers) can use NanoRiskCat to make a preliminary assessment of a range of nanomaterials as a mean to select the seemingly safest material.

Finally, independent parties such as academics and nongovernmental organizations can use the tools to learn more about what companies know about exposures and effects of their nanomaterials and they can use NanoRiskCat to do their own independent evaluation and subsequently engage in an informed dialogue about nanorisks with companies and regulators. It is finally important to stress that the color coding obtained in NanoRiskCat should not be seen as an absolute categorization. It rather serves as a step in an iterative process in which stakeholders in risk-related issues can reach a common – and guided - understanding of the level of potential exposures and effects of nanomaterials in specific products.

As decisions that could come out of using NanoRiskCat are stakeholderdependent, it is important to emphasize that it has not been possible within the framework of this project to validate the NRC concept further. To promote a wider use of the tool it is considered necessary to perform additional case studies and if relevant adjust the processes and decision criteria in order to obtain a screening tool as informative and practical as possible.

CONSUMER SAFETY GROUPS FILE FIRST LAWSUIT ON RISKS OF NANOTECHNOLOGY

Concerned by the growing body of scientific reports cautioning against the unregulated use of nanotechnology in consumer products, a coalition of nonprofit consumer safety and environmental groups sued the Food and Drug Administration (FDA). The case is the first lawsuit over the health and environmental risks of nanotechnology and nanomaterials.

The lawsuit demands FDA respond to a petition the public interest organizations filed with the agency in 2006, nearly six years ago. The coalition is led by the International Center for Technology Assessment (CTA), on behalf of fellow plaintiffs Friends of the Earth, Food and Water Watch, the Center for Environmental Health, the ETC Group, and the Institute for Agricultural and Trade Policy.

"Nano means more than tiny; it means materials that have the capacity to be fundamentally different. Yet more and more novel nanomaterials are being sold infused into new consumer products every day, while FDA sits idly by," said George Kimbrell, ICTA Attorney. "The agency's unlawful delay unnecessarily places consumers and the environment at risk." The eighty-page petition documents the scientific evidence of nanomaterial risks stemming from their unpredictable toxicity and seemingly unlimited mobility. The [2006 petition](#) (pdf) requested FDA take several regulatory actions, including requiring nano-specific product labeling and health and safety testing, and undertaking an analysis of the environmental and health impacts of nanomaterials in products approved by the agency.

Nanomaterials in sunscreens, one of the largest sectors of the nano-consumer product market, were also a focus of the action. The petitioners called on the agency to regulate nano-sunscreens to account for their novel ingredients rather than assume their safety, and to pull such sunscreens from the market until and unless the agency approves them as new drug products.

"Year after year goes by but we have yet to see the FDA do the bare minimum and require nanosunscreens to be labeled as such. This is a basic consumer right," said Ian Illuminato of Friends of the Earth. "We're well past the 1800s -- nobody likes or should be forced to use mystery chemicals anymore."

"It is unacceptable that the FDA continues to allow unregulated and unlabeled nanomaterials to be used in products consumers use every day," said Wenonah Hauter, executive director of Food & Water Watch. "It is past time for this agency to live up to its mission and protect public health by assessing the health and environmental risks of nanomaterials, and to require labeling so that consumers know where these new materials are being used."

"The scientific consensus is that nanomaterials require specific testing to account for their novel capacities and potential risks. The FDA must do such testing as part of a pre-market safety assessment in a broader regulatory initiative to protect public health," said Steve Suppan of the Institute for Agriculture and Trade Policy.

EPA WATCHDOG SAYS THE AGENCY NEEDS TO MANAGE NANOMATERIAL RISKS MORE EFFECTIVELY

In a new report ("[EPA Needs to Manage Nanomaterial Risks More Effectively](#)"), the U.S. Environmental Protection Agency Office of Inspector General (OIG) finds that EPA does not currently have sufficient information or processes to effectively manage the human health and environmental risks of nanomaterials.

EPA has the statutory authority to regulate nanomaterials but currently lacks the environmental and human health exposure and toxicological data to do so effectively. The Agency proposed a policy under the Federal Insecticide, Fungicide, and Rodenticide Act to identify new pesticides being registered with nanoscale materials. After minimal industry participation in a voluntary data collection program, the Agency has proposed mandatory reporting rules for nanomaterials under the Federal Insecticide, Fungicide, and Rodenticide Act, and is also developing proposed rules under the Toxic Substances Control Act.

However, even if mandatory reporting rules are approved, the effectiveness of EPA's management of nanomaterials remains in question for a number of reasons:

- Program offices do not have a formal process to coordinate the dissemination and utilization of the potentially mandated information.

- EPA is not communicating an overall message to external stakeholders regarding policy changes and the risks of nanomaterials.
- EPA proposes to regulate nanomaterials as chemicals and its success in managing nanomaterials will be linked to the existing limitations of those applicable statutes.
- EPA's management of nanomaterials is limited by lack of risk information and reliance on industry-submitted data.

These issues present significant barriers to effective nanomaterial management when combined with existing resource challenges. If EPA does not improve its internal processes and develop a clear and consistent stakeholder communication process, the Agency will not be able to assure that it is effectively managing nanomaterial risks.

The OIG recommends that the Assistant Administrator for Chemical Safety and Pollution Prevention develop a process to assure effective dissemination and coordination of nanomaterial information across relevant program offices. The Agency agreed with this recommendation and provided a corrective action plan with milestone dates. This recommendation is open with agreed-to actions pending.

NATIONAL RESEARCH COUNCIL ISSUES NEW NANO RISK REPORT

Despite extensive investment in nanotechnology and increasing commercialization over the last decade, insufficient understanding remains about the environmental, health, and safety aspects of nanomaterials. Without a coordinated research plan to help guide efforts to manage and avoid potential risks, the future of safe and sustainable nanotechnology is uncertain, says a new report ("[A Research Strategy for Environmental, Health, and Safety Aspects of Engineered Nanomaterials](#)") from the National Research Council. The report presents a strategic approach for developing research and a scientific infrastructure needed to address potential health and environmental risks of nanomaterials. Its effective implementation would require sufficient management and budgetary authority to direct research across federal agencies.

The committee that wrote the report found that over the last seven years there has been considerable effort internationally to identify research needs for the development and safe use of nanotechnology, including those of the National Nanotechnology Initiative (NNI). However, there has not been sufficient linkage between research and research findings and the creation of strategies to prevent and manage any risks. For instance, little progress has been made on the effects of ingested nanomaterials on human health and other potential health and environmental effects of complex nanomaterials that are expected to enter the market over the next decade. Therefore, there is the need for a research strategy that is independent of any one stakeholder group, has human and environmental health as its primary focus, builds on past efforts, and is flexible in anticipating and adjusting to emerging challenges, the committee said.

Because the number of products containing nanoscale materials is expected to explode, and future exposure scenarios may not resemble those of today, selecting target materials to study on the basis of existing market size -- as is the practice now -- is problematic. To help guide research, the committee noted the following four research categories, which should be addressed within five years:

- identify and quantify the nanomaterials being released and the populations and environments being exposed;
- understand processes that affect both potential hazards and exposure;
- examine nanomaterial interactions in complex systems ranging from subcellular to ecosystems; and
- support an adaptive research and knowledge infrastructure for accelerating progress and providing rapid feedback to advance research.

While surveying the existing resources for research, the committee acknowledged a gap between funding and the level of activity required to support the committee's strategy. The committee concluded that any reduction in the current funding level of approximately \$120 million per year over the next five years for health and environmental risk research by federal agencies would be a setback to nanomaterials risk research. Moreover, additional modest resources from public, private, and international initiatives are needed in critical areas.

UPCOMING EVENTS LOOKING AT THE RISKY SIDE OF NANO

[Exposure to nanoparticles in human populations: Immune system biomarkers in vitro and in vivo](#)

February 26 - February 29, 2012, St. Christoph (Austria)

[NanoImpactNet-QNano conference: "From theory to practice - development, training and enabling nanosafety and health research](#)

February 27 - March 2, 2012, Dublin (Ireland)

The event consists of a three-day Integrating conference (including a special stakeholder session) and two one-day Training schools.

[Managing Nano Risk - Implementation of a management system for a safe use and application of nanomaterials](#)

March 23, 2012, webinar

The webinar provides a short overview over the present risk profile of nanotechnology and synthetic nanomaterials. An enterprise-wide risk management system approach is presented.

[Nanomedicine: Visions, risks, potential](#)

April 19-20, 2012, Berlin (Germany)

This conference aims at discussing recent trends in the development of nanotechnological methods in medical applications with experts from different involved fields of research from an interdisciplinary perspective. There will be sessions on scientific and technical aspects of nanomedicine, on risk and other ethical issues as well as on the social impact of nanomedicine in the context of science, industry and the public.

[7th International Conference on the Science of Exposure Assessment \(X2012\)](#)

July 2-5, 2012, Edinburgh (UK)

X2012 will bring together the leading international experts and provide a platform for the exchange of knowledge and expertise in exposure assessment sciences. X2012 will contribute to the developments in state-of-the-art methodologies and practices in this field, and thereby improve our knowledge base to effectively control exposure to hazardous agents in the work environment, at home and elsewhere in the general environment.

[SENN2012 - International Congress on Safety of Engineered Nanoparticles and Nanotechnologies](#)

October 28-31, 2012, Helsinki (Finland)

The goal is to summarize and share the latest knowledge on the safety of engineered nanomaterials and nano-related technologies. The emphasis is on producing solutions to the safety challenges related to engineered nanomaterials and nanotechnologies. Another aim is to enable commercial opportunities for the safe use of these materials and technologies.

IN SHORT – PAPERS, INITIATIVES & UPDATES

PAPER: Role of TiO₂ nanoparticles in the elevated uptake and retention of cadmium and zinc in *Daphne magna*

This study has demonstrated the enhanced uptake and retention of Cd and Zn in *D. magna* when the metals are bound to nano-TiO₂. The increased bioavailability may also explain the results of a previous study which found that nano-TiO₂ enhanced the toxicity of copper to *Daphnia magna*. doi: [10.1021/es202110d](https://doi.org/10.1021/es202110d)

PAPER: Graphene-based nanoplatelets: A new risk to the respiratory system

The graphene-based nanoplatelets used in this study are commercially available and consist of several sheets of graphene (few-layer graphene). The researchers first derived the respirability of graphene nanoplatelets from the basic principles of the aerodynamic behavior of plate-shaped particles which allowed us to calculate their aerodynamic diameter. This showed that the nanoplatelets, which were up to 25 µm in diameter, were respirable and so would deposit beyond the ciliated airways following inhalation. The data presented in this study data suggest that nanoplatelets pose a novel nanohazard and structure-toxicity relationship in nanoparticle toxicology. doi: [10.1021/nn204229f](https://doi.org/10.1021/nn204229f)

STUDY: Dispersion and retention of dusts consisting of nanoparticles in lungs

This project ([Dispersion and retention of dusts consisting of ultrafine primary particles in lungs](#); pdf) funded by the German Federal Institute for Occupational Safety and Health aimed at studying the dispersion and retention behavior of dusts consisting of nanoscaled primary particles. Toxicological studies have demonstrated that the effects observed for nanoscaled particles are better correlated to the particle surface or particle number than to the administered mass doses. The toxicokinetic fate of nanoscaled particles and the potential effects induced after deposition in lungs are predominantly determined by the agglomeration status. Systemic particle effects, i.e. effects on the remote organs, in addition to those on the target organ respiratory tract are conceivable only for particles with a nanoscaled aspect.

STUDY: Genotoxic mode of action of fine and ultrafine dusts in lungs

Another project ([Genotoxic mode of action of fine and ultrafine dusts in lungs](#); pdf) funded by the German Federal Institute for Occupational Safety and Health aimed at studying local genotoxicity of fine and ultrafine particles in lung epithelial cells by evaluating the current literature and by using an immunohistochemical approach on existing lung tissue samples from (nano)particle-exposed animals. Local genotoxicity was assessed by applying immunohistochemical detection and subsequent quantification of different markers for DNA damage in lung tissue samples from a previous study. In conclusion, this study demonstrated that using immunohistochemical detection and quantification of different genotoxicity markers in lung tissue samples could be a promising approach for testing local genotoxicity and the genotoxic modes of action of particles in the lung.

REPORT: Elusive ultrafine indoor air contaminants yield to analysis

Researchers at the National Institute of Standards and Technology (NIST) spent 75 days on the job carrying out some very important homework—measurements in a "typical dwelling" of the release, distribution and fate of particles almost as tiny as the diameter of a single DNA molecule. Particles ranging in size from 100 nanometers down to 2.5 nanometers that were emitted by gas and electric stoves, hair dryers, power tools and candles were tracked and analyzed ("[Evolution of Ultrafine Particle Size Distributions Following Indoor Episodic Releases: Relative Importance of Coagulation, Deposition and Ventilation](#)"). Tests also revealed that for many indoor sources, such as stovetop cooking with gas, more than 90 percent of the particles emitted were smaller than 10 nanometers. In turn, emissions of smaller particles result in higher airborne concentrations that dissipate primarily through coagulation.

PAPER: New insights into nanoparticles and dividing cells

What happens when living cells take up nanoparticles, those tiny entities that could offer new ways of delivering drugs into the body? A new study has tracked the progress of nanoparticles as cells divide, and their findings will help us better understand how different tissues in the body process a dose of nanoparticles. doi: [10.1038/nnano.2011.191](https://doi.org/10.1038/nnano.2011.191)

SURVEY: Information gathering on nanomaterials: Lessons learned and reported information

[This document](#) (pdf) presents lessons learned from information gathering surveys carried out by OECD countries and summarises non-confidential business information and statistics on nanomaterials. It includes useful information on how to design/implement information gathering surveys and the most commonly used nanomaterials along with use patterns and volumes used among OECD countries.

PAPER: Nano form of titanium dioxide can be toxic to marine organisms

Researchers have observed toxicity to marine organisms resulting from exposure to a nanoparticle that had not previously been shown to be toxic under similar conditions. Until now, they say, no research has demonstrated that photoactivity causes environmental toxicity of TiO₂ under natural levels of UV radiation. The authors suggest, therefore, that UV exposure should be considered when conducting experiments to determine the ecotoxicity of nanomaterials having photoactive potential.

doi: [10.1371/journal.pone.0030321](https://doi.org/10.1371/journal.pone.0030321)

SURVEY: National activities on life cycle assessment of nanomaterials

[This document](#) (pdf) provides a snapshot of information on national activities on the life cycle assessment of nanotechnologies provided by OECD countries. As a "living document", it is expected to be updated as new information becomes available.

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**OPTIMIZING THE
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RISKS**

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